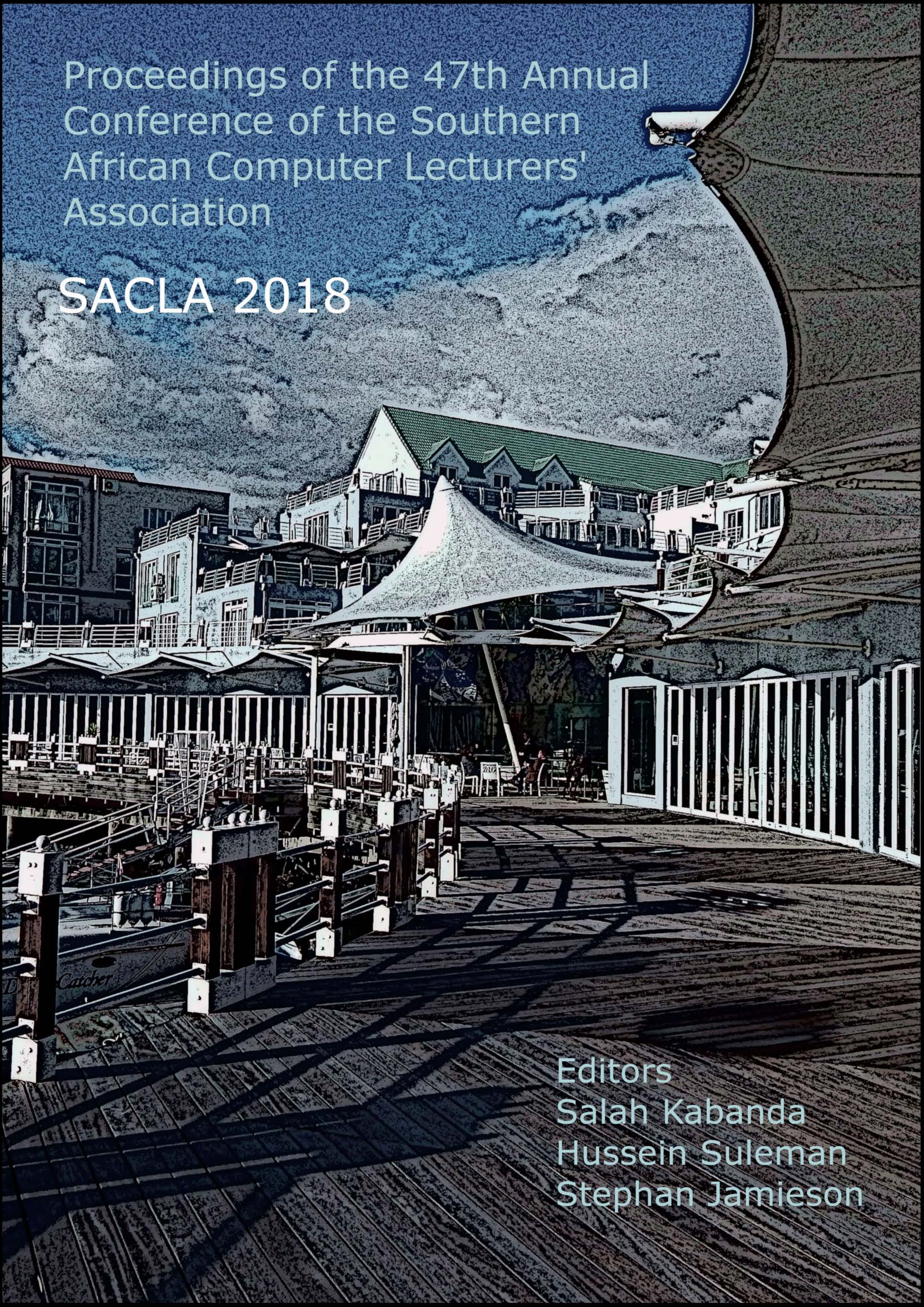
# Proceedings of the 47th Annual Conference of the Southern African Computer Lecturers' Association

## SACLA 2018




Editors
Salah Kabanda
Hussein Suleman
Stephan Jamieson

# Proceedings of the 47th Annual Conference of the Southern African Computer Lecturers' Association (SACLA 2018)

June 18-20, 2018, Krystal Beach Hotel,
Harbour Island, Gordon's Bay, South Africa

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# Preface

This volume of SACLA Proceedings contains selected papers of SACLA`2018, the 47th Annual Conference of the Southern African Computing Lecturers' Association, held in Gordon's Bay (South Africa), on 18-20 June 2018.[1] It supplements the papers published in a CCIS volume.

SACLA 2018 provided a forum for the discussion of original research and practical experiences in teaching and learning of Information Systems, Computer Science, Information Technology and related disciplines, as well as the use of software tools in support of education more broadly.

The programme for SACLA 2018 had a mixture of keynote addresses, papers, panel sessions, and workshops, to meet the needs of a diverse range of attendees from across many different facets of computing education.

The keynote speakers were: Richard Baskerville, Professor of Information Systems at Georgia State University and Professor in the School of Information Systems at Curtin University, Perth, Australia, who spoke about cybersecurity in a digital world; and Mark Horner, CEO of Siyavula, who spoke about adaptive and individualized learning.

Papers were selected through a rigorous double-blind peer-review process, with an international programme committee of reviewers. Every paper was peer-reviewed by at least 3 members of the programme committee. 77 papers were submitted. 23 papers (30%) were accepted for publication in this volume. A further 24 papers (31%) were accepted for presentation at the conference. All papers in this volume have been finalised after incorporating feedback from both reviewers and discussions at the conference.

The Best Paper Award was presented to Douglas Parry and Daniel Le Roux for their paper titled Off-task Media Use in Lectures: Towards a Theory of Determinants.

The programme included a panel on the dividing line between schools and universities in the teaching of IT. There were 2 workshops: one on accreditation of IT diploma programmes; and another to assist authors to prepare publications for Springer CCIS.

We wish to thank all members of the Programme Committee and additional re-viewers for diligently reviewing papers, as well as helping to solicit submissions and publicise the conference in general. There were 42 members on the Programme Committee. Approximately half were from outside South Africa, and 15 were from outside Southern Africa, the region of focus for the conference.

We also thank conference session chairs, presenters of papers, invited speakers and staff who assisted with producing a high quality programme.

July 2018
Salah Kabanda
Hussein Suleman
SACLA 2018 Programme Co-Chairs

[1] https://sacla.uct.ac.za/

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# Keynote Abstracts

# Cyber Security: Going Digital

Richard L. Baskerville

Georgia State University, USA

**Abstract.** There are two main forms of information security reasoning: exposure control reasoning and ethical control reasoning. Emphasis on each of these form of reasoning can cycle continuously without some form of damping. Based on a study of a US Health Information Exchange, we will explore how "going digital" can change the goal of cybersecurity. By converging the goals of the system and its security, we can dampen the continuous swings in security reasoning.

## Biography

Richard L. Baskerville is Regents' Professor and Board of Advisors Professor of Information Systems at Georgia State University and Professor in the School of Information Systems at Curtin University, Perth, Australia. His research regards security of information systems, methods of information systems design and development, and the interaction of information systems and organizations. Baskerville is editor emeritus of the European Journal of Information Systems. He is a Chartered Engineer, and holds a BS summa cum laude University of Maryland, MSc and PhD London School of Economics, PhD (hc) University of Pretoria, and DSc (hc) Roskilde University.



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# Offering High Quality Individualised Learning Using Adaptive Intelligence

Mark Horner

Siyavula Education, Cape Town, South Africa

**Abstract.** Siyavula Education is an education technology company focused on creating adaptive learning experiences. Siyavula has authored a catalogue of free and open textbook titles for Grade 4 - 12 Mathematics, Physics and Chemistry, of which more than 10 million copies have been printed by the Department of Basic Education and distributed to 25 000 schools across South Africa. While access to textbooks is absolutely necessary, alone they do not optimally support learning. Our current focus is Siyavula Practice, a low-cost adaptive learning tool tailored specifically for high school Maths, Physics and Chemistry. Siyavula Practice is a learning platform that enables optimised, adaptive practice for mastery based on cognitive and learning science research. This approach allows it to complement any teaching or tutoring strategy, be it project-based, lectures or home schooling. Siyavula Practice is well positioned to serve learners in African contexts because of the ease of accurate alignment with the local curriculum; compatibility with old and new mobile phones as well as PC browsers; and in South Africa is zero-rated access over the Vodacom and MTN mobile data networks. I will present the design of Practice and specifically decisions that enable use in a developing context as well as results from our first impact analyses.

## Biography

Dr Mark Horner is the CEO of Siyavula Education, a social enterprise focused on building rich, integrated learning experiences for maths and science using science and technology.

Mark has been working in the education sector since 2002 with openness, technology and community as his main tools. He was the Shuttleworth Foundation Fellow for Open and Collaborative resources as well as the co-founder of the Free High School Science Texts project. Mark has a PhD in physics from the University of Cape Town and conducted his research at Lawrence Berkeley National Laboratory in California on the results from the STAR experiment at Brookhaven National Laboratory in New York.



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# Academia and Careers

# Is the Research-Teaching Nexus Connecting with Young Researchers?

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**Abstract.** Transitioning from being a learner of computer science and information systems subject material, and implementer of learned technical concepts such as programming in a simulated real-world environment – to becoming a researcher who needs to plan my own research project, make sense of the accompanying literature, gather data, analyze results, and write up the research in academic language, is challenging.

In an endeavor to make sense of this challenging process, this paper focuses on the improvements planned for the facilitation of the honors research project subject offering. The initial approach is discussed, as well as the changes planned. The six dimensions forming research-teaching nexus were used to guide the study. Participants were involved in supplying feedback on the planned guidance, through the completion of a questionnaire. Open-ended questions supplied enhanced insight into how the participants perceive the offering. Lastly, the researcher reflected on dimensions that may pose challenges to students and researchers and how these challenges may be addressed.

**Keywords:** Research-teaching nexus, Young researchers, Honors research project.

## 1 Introduction

In the context of the North-West University (NWU), with more than 35,000 students across three campuses, as well as more than 35,000 students enrolled for online courses, the Vaal Campus (VC), with slightly more than 7,000 students, is the smallest campus. Being situated in the Vaal Triangle, an industrial hub, and included in Gauteng, the giant economic hub of South Africa, there is much potential for growth. Being a small campus, with limited resources, only a small selection of courses are offered. Information Technology (IT) is the most prominent in the Faculty of Natural and Agricultural Sciences. With an intake of 240 students across two related courses, namely that of IT and the Extended IT, graduate numbers have grown to such an extent that the intake of students in the honors course in Computer Science and Information Technology with Computer and Information Systems (CS&IT-C&IS) was subjected to a set of


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criteria – compared to previous intakes where all students who completed the IT degree could continue with the subsequent honors qualification.

Four subjects, each made up of two semester modules, are offered in the honors course. In addition, a year-long compulsory subject, that of a research project completes the requirements of five subjects in this 128 credit course. For the purpose of nurturing further studies and research, the compulsory research project is deemed important. Unfortunately, IT students, with their technical background, find the research project challenging. They are familiar with IT projects involving information systems development, but the research component is new to them. Writing, grammar, sentence construction, and the research process are obstacles. For this reason, over the past five years much support has been made available to students doing the research project. The focus of this paper is on teaching support to enable growth of research among young IT graduates, and specifically how this support evolved at the VC of the NWU. The identification of potential future developments in this support is enlisted.

In subsequent sections of this paper, the following topics are addressed; namely the historical context of research support to honors students at NWU-VC (§2), the current context of research support to honors students (§3), related work (§4), the potential of connecting research and teaching in the context of teaching research concepts to honors students (§5), the research design of this study (§6), the findings of the research (§7), and finally concluding the paper and identifying possible future developments in the research support of honors students in CS&IT-C&IS (§8).

## 2 Historical Context

Making the transition from being a learner of subject material, and implementer of learned concepts – in a simulated real-world environment – to becoming a researcher who needs to plan a research project, make sense of extant research, gather data, analyze results, and write up the research in academic language, is challenging. In support of this ambitious endeavor, a series of lectures by staff members involved in post-graduate supervision are offered to guide students on topics related to research. Over the five years this support has been provided, the following program evolved:

1. **Introductory session**; academics available to supervise honors projects are introduced to students – with the focus being on making students aware of each staff member’s research focus.
2. **Academic writing**; addressing the mind-mapping of a topic, how to structure academic writing, how to paraphrase, in-text referencing and the compilation of a reference list.
3. **Research paradigms**; introducing the four research paradigms prevalent to the field of Information Systems, namely positivism, interpretivism, critical, and design science research.
4. **Action research (AR) vs design science research (DSR)**; explaining a methodology with one accompanying process used in critical social theory and the same in design science research, supports the notion of mixed methods.

5. **The research proposal**; introduction of the NWU research proposal template to students, and the discussion of the sections to be included, depending on the applicable research paradigm.
6. **Positivistic research**; scrutinizing a methodology and one accompanying process used in positivism – the focus here is on how to collect and analyze quantitative data.
7. **Interpretive research**; studying a methodology and one accompanying process used in interpretivism – concentrating on the collection and analysis of qualitative data.
8. **Ethics in research**; the importance of ethics in research is the focus of this session, in addition students are introduced to the ethics application process and guided to complete an application based on their research project.

Classes were offered over the most part of the first semester in sessions of one hour each, once every alternate week. An attempt was made to make the sessions as practical as possible – with reference to research projects from previous years to make the explanations come to life. Assignments followed some classes, namely academic writing, research paradigms, AR vs DSR, positivism, and interpretivism. With the assignments, the broadening of student knowledge to extend beyond the application of their own research project is one aim, while the other is to guide them to understand the nature and application of their particular project. With the remaining topics students apply their newly acquired knowledge by producing outputs; these include a research proposal for their project, and an ethics application to obtain ethical clearance for their research project.

During the first semester – in parallel with the lecture series, individual students, as well as pairs of students were encouraged to approach academic staff with the intention to find an academic to guide them in the completion of their research project. This is in accordance with the findings of Calitz et al. [3] concerning post-graduate alumni with regard to the value of supportive academic staff in the success of post-graduate studies.

As soon as a student or pair of students and a guiding academic is matched, the process of research is ready to start. Each student-supervisor group will set the ground rules regarding how the work is to be done. For the purpose of this introduction-to-research project, a simplified five-chapter breakdown is supplied to all students:

1. **The research proposal as introductory chapter**; addresses key concepts, introducing the research methodology identified as relevant to the study, motivating the study, stating objectives, highlighting ethical issues, and a chapter breakdown.
2. **Literature review**; to address the key concepts to the study.
3. **Research design**; a literature review of the chosen research methodology – in the context of the accompanying research paradigm, method to be used in the research, the data collection and analysis, as applied to the study.
4. **Findings**; a description of the research conducted, with its accompanying findings.
5. **Conclusion**; a summary of the research project linked with the objectives set at the start of the project, concluding remarks pertaining to the findings, possible future research, and reflection on the process.

For the research project students, each chapter has a set due date, with the assumption that chapters may be scrutinized, and feedback supplied by the supervising academic(s) beforehand. After each due date a pre-determined marking scheme is used to allocate marks to the chapter. Each supervising academic(s) is (are) responsible for the marking of his or her (their) student(s). After the completion of chapter 3, all students and supervising academics were invited to a colloquium where groups of students present their partly completed research to groups of academics. This intervention occurred in the middle of each year, typically June–July. Valuable feedback is supplied by the supervising academic(s), as well as colleagues not involved with a particular student, or pair of students. Following this intervention, students may improve the marks obtained for the first three chapters by making amendments according to the feedback supplied. A combination of the assignment and chapter marks make up a participation mark (PM). Earning a PM in excess of 40% affords a student the continuation of the research project.

For the last two chapters, student-supervisor groups follow the set pattern. At the end of the academic year, after the completion of chapter 5, students present their completed research projects at a research project day. The project day occurs towards the end of the academic year, typically October–November. The format is similar to that of the colloquium. With this presentation, an opportunity is allowed for the improvement of the mark of each of the last two chapters. A final mark is compiled for the research project, after which a moderation process is undertaken. A final mark of 50% affords a student a pass.

As is often the case when a group of people needs to coordinate their efforts to accomplish a goal – in the event of an unstructured subject such as the research project – problems arise that need to be addressed. Problems experienced with the research project centered on the assessment of chapters, the progression of the lecture series in relation to the progress of the actual research, and the fact that huge research problems are identified at the colloquium – a late stage in the progression of the research project.

With the start of the 2018 academic year, a decision was made to address the issues experienced with the research project. A workshop held at the start of 2018, involving academics making a contribution, invited a wide range of inputs. The newly planned program is described in the next section – the current context.

## 3 Current Context

The 2018 signified the implementation of a number of changes at NWU – on different levels. On a corporate level, the NWU embarked on a restructuring process that was started towards the end of 2015 and finalized at the start of 2018. This resulted in a unitary university with its focus diverted from three campuses, each focusing on their self-determined activities – to the alignment of all academic offerings across campuses. In effect, academics offering the same subject modules on all three, or even just two campuses, need to decide on their combined strategy. The eventual outcome of this approach is to have one study guide guiding all campus offerings, allowing students to move from one campus to the other and affording the same high standard of an offering.

With the unitary NWU in mind, one study guide has been compiled and the changes suggested in the workshop held at the start of 2018, have been incorporated. Four larger changes were considered important:

1. The **lecture series** should be started earlier in the year – to be completed before students need to finalize their research proposals. The order of presentations should be adjusted to align with actions to be performed by students. In some instances, more time should be made available for more in-depth offerings.
2. Students can only **do research projects as individuals**. This change allows each student to only rely on him- or herself in following the process, and internalizing a complex undertaking.
3. The **process of producing a mini-dissertation** in the research project subject, should be **aligned with what is followed for masters and doctoral studies**. This implies that the colloquium that was held after the completion of chapter 3, should now be conducted after the completion of the research proposal (chapter 1). The intention is that this will also be the point where a decision will be made regarding the progression of each student. Completion of assignments, attendance of the lecture series, and the quality of the research proposal are all aspects to be taken into consideration.
4. Assessment schemes were scrutinized and amended to ensure the integration of guidance of each chapter with the fair allocation of marks. Currently no allowance is made for the improvement of allocated marks to chapters. This places the onus of producing a well-developed chapter with the support of the supervisor, on the student – before the final set due date.

As was mentioned in the introduction, a stricter approach to the acceptance of 2018 honors applicants were followed. This resulted in a smaller group of students, sending a message to graduate students planning to do an honors qualification in future, that good results in the IT course is a pre-requisite for enrolling for the honors degree. It is also hoped that the stricter selection will ensue improved research project quality.

Regarding the simplified five-chapter breakdown that was discussed in Section 2, no amendments were implemented. In future it is envisaged that a set of templates should be compiled, each one guiding research done in a particular paradigm.

With the above-mentioned changes in mind, the improved lecture series program:

1. A two-hour introductory session.
2. Research focus areas – each including a group of academics available to supervise honors projects are introduced to students – with the focus being on making students aware of areas of research available to them, and
3. Research paradigms – introducing the four research paradigms prevalent to the field of Information Systems (positivism, interpretivism, critical, and design science research).
4. A day-long workshop, including the topics of;
   - postivisim,
   - interpretivism,
   - critical research, and

   - design science research.

   The intention is to allow time for students to practically implement quantitative and qualitative methods, and then reminisce on it with their peers and the workshop facilitators – before doing assignments on the mentioned topics.
5. A two-hour session on academic writing and how to write a proposal – two weeks before the research proposal due date.
6. A day-long colloquium where students present their research proposals in the focus area of their choice – with the purpose to get inputs from supervisor-academics with knowledge of the particular research focus area, allowing refinement of each student's project. Strictly this intervention is not part of the lecture series, but it amends the purposes of the lecture series.
7. A two-hour session on the ethical procedures at the NWU – in time for applying for ethical clearance for students' research projects.

Allowance is made for lecture sessions to be scheduled beyond this point (end of April each year), should the need arise. Set due dates are in place to ensure the completion of the subsequent four chapters. The final research project day is now planned for September each year. The intention is that should an opportunity arise to use a project in research outputs – the last quarter of the academic year is available to produce such an output.

An important implementation that was purposefully made, was to include lecturing staff still inexperienced in research in this research project subject. Five staff members were invited to attend the lecture series and they are invited as co-supervisors with the intention to learn about the process. It is hoped that this group will expand their knowledge and confidence in research to facilitate their personal research progress as well as their contribution to the honors project endeavor.

The changes listed in this section may likely result in improved outcomes with regard to the pass rate for the research project as subject, the number of enrollments on masters and eventually doctoral levels, as well as the possibility of improved research outputs of academic staff. Such improvements would be an excellent outcome to the proposed and planned changes.

In the mind of the author greater possibilities may be investigated. The fact that this research project lies at the intersection of teaching and research where research on research paradigms, methodologies and techniques are taught, along with the African dispensation centering on developing young researchers – in most cases from previously disadvantaged groups – open up opportunities to improve this intervention even more. The next section looks into six research-teaching categories suggested by Weller [17], that may be utilized to improve both the teaching and research in the research project and beyond.

## 4 Related Work

In an effort to place this study in context of the broader community of preparing students for further research, other approaches to teaching honors students are enquired. As theoretical underpinning of this study, the research-teaching nexus is investigated.

### 4.1 Approaches to Teaching Honors Students

When scrutinizing studies conducted in computing regarding preparing honors students to become researchers, the time intensity of such preparation is highlighted by an international study performed by Holz et al. [7], as well as a South African study performed by Galpin et al. [5]. The latter authors also make mention of the necessity of involving multiple academics to support the academic(s) offering the material – as is the case at NWU, and the fact that much responsibility for the success of the research project lies with the student. This is in accordance with the NWU strategy to simulate research studies beyond an honors. In accordance with the experience at NWU, the research project is indicated as the most valuable of the honors course [5]. Importantly, Holz et al. [7] found that "*active research across the computing curriculum helps students link computing theory to computing practice*". This is significant, since the practical nature of computing and such focus may divert the focus from active research during the graduate years. Therefore, it may be helpful to make computing staff aware of this notion. A more recent international study in the engineering discipline done by Khoukhi [9], places much emphasis on the value of assessment rubrics. This is in accordance with the experience of staff involved in the study reported on in this paper.

### 4.2 Connecting Teaching with Research

In a quest to prepare students to become life-long learners to be able to learn new skills in a world that changes constantly, the integration of teaching with research became more and more important. Work on the research-teaching nexus determines whether there is a link between quality research and good teaching, as well as how research-teaching links may be manifested in practice.

The approach to a curriculum may be considered regarding six dimensions of research-teaching links [6,8,16], these dimensions are also shown in Table 1.

1. teaching may be research-led: the outcomes of research informs the curriculum and a student's understanding is developed based on current findings regarding *content*;
2. teaching may be research-oriented: students learn through the *process* of research followed in a discipline;
3. teaching may be research-tutored: students would discuss current findings regarding *content*, as well as practices;
4. teaching may be research-based: students need to perform research activities;
5. teaching may be research-informed: teachers, possibly in collaboration with students, enquire into their teaching;
6. research may be influenced by teaching: the involvement of students in a lengthy research project may inform a study. This may occur with the involvement of postgraduate students [11], but also with under-graduate students [15].

The first four dimensions, as described above, was mapped by Jenkins, Healey [8]. According to them, the first two dimensions, research-led and research-oriented teaching place "students as an audience for disciplinary research", while research-tutored and research-based teaching (dimension 3 and 4) situate "students as participants in research". Unfortunately, their mapping neglects the last two dimensions.

**Table 1.** Connecting research and teaching in practice, six dimensions adopted from Weller [17].

| Research-teaching nexus | Aims | Teacher role | Typical learning activities |
|---|---|---|---|
| Teaching is research-led | To teach current research, including the research of researcher-teachers | Researcher-teacher as expert | Listen to lectures and read texts that present the outcomes from current research |
| Teaching is research-oriented | To teach what it means to carry out research in the discipline | Researcher-teacher as role model | Engage in tasks that develop understanding and application of research methodologies, skills and techniques |
| Teaching is research-tutored | To share and discuss disciplinary research practices and outcomes | Researcher-teacher as mentor | Write, peer review and discuss essays or papers on research topics and processes |
| Teaching is research-based | To provide authentic research and enquiry experiences | Researcher-teacher as partner | Complete small-scale independent research assignments, collaborate with researchers as research assistants or participate in research placements |
| Teaching is research-informed | To employ systematic enquiry into learning and teaching to design, carry out and evaluate teaching | Teacher-researcher as developer | Undertake small-scale (collaborative) enquiry into specific learning and teaching activities |
| Research is teaching-influenced | To develop and enhance research processes and outcomes on the basis of engagement in teaching | Teacher-researcher as learner | Engage students in data collection, analyzing raw data or peer reviewing conference papers or draft journal articles that are emerging out of ongoing or recently completed research |

## 5 Research design

Triangulation, where quantitative, as well as qualitative methods are incorporated to collect data to inform the research [12], are used in this case study [4,10]. Seaman [13] claims that when comparing quantitative and qualitative data, the latter is richer than the former since qualitative data contain more information. Although this claim is true, some valuable insights may be obtained by using both types of data through a combination of techniques.

The focus is on the six dimensions of the research-teaching nexus and how it may guide the offering of an honors research project. A questionnaire – with open-ended questions included – are used to collect the data. A case study relies on the context of a current and authentic instance such as a subject offering [18]. Although Yin [19] utilizes case studies only in the positivist paradigm, Myers [10] claims that case studies may be conducted in any of the paradigms of positivism, interpretivism and critical research. The overall purpose of a study guides the selection of the case study design; the purpose may be to describe, explore, or compare cases to one another [19]. In the case of this study, only one case is studied. This case is described and explored, and multiple explicit outcomes are anticipated [1].

The research question: "*May the lens of the research-teaching nexus be of value towards honors students' learning needs regarding research, when evaluating the contribution of current teaching approaches?*", is investigated.

With the purpose to get feedback from students with regards to how they prefer to learn about the research-process, as well as how to do research, a questionnaire was compiled. In an effort to determine how comfortable students feel with the intended implementations of the research-teaching connection mappings during the formal offering and guidance of the research project, questions were formulated and linked to in-context examples (see Table 2). A Likert-scale was utilized, covering: Strongly agree (1), Agree (2), Disagree (3), and Strongly disagree (4) – to match student opinions to statements. The question is listed below:

> *Indicate your agreement with regard to the statements reflecting learning about and conducting research that is listed below. Your preferences with regard to how the research project (ITRI 671) is, or should be facilitated. In a general sense these statements may be seen as reflecting how you would prefer to learn about research and the research process.*

**Table 2.** The six dimensions connecting research and teaching in practice that was adopted from Weller [17] are related to interventions in the research project with corresponding statements formulated to use in the questionnaire.

| **Research-teaching nexus** | **Aims** | **Content vs Process** | **In context example** | **Statements** |
|---|---|---|---|---|
| Teaching is research-led | To teach current research, including the research of researcher-teachers | Focused on content to learn about research | Lecture series; introduction to research paradigms, positivism, interpretivism, critical research, and design science research | Listen to lectures and read texts that present the outcomes from current research |
| Teaching is research-oriented | To teach what it means to carry out research in the discipline | Involvement in the basic processes; qualitative and quantitative techniques | Lecture series workshop on; positivism, interpretivism, critical research, and design science research | Engage in tasks that develop understanding through the application of research methodologies, skills and techniques |
| Teaching | To share and | Study content, focused | Supervisor-student relationship, | Write, peer review and discuss essays or |

| Research-teaching nexus | Aims | Content vs Process | In context example | Statements |
|---|---|---|---|---|
| is research-tutored | discuss disciplinary research practices and outcomes | on own research | colloquium intervention, research focus groups | papers on research topics and processes |
| Teaching is research-based | To provide authentic research and enquiry experiences | Doing own research as a process | Supervisor(s) guiding student, student conducting own research | Complete small-scale independent research assignments, collaborate with researchers as research assistants or participate in research placements |
| Teaching is research-informed | To employ systematic enquiry into learning and teaching to design, carry out and evaluate teaching | Disseminating content regarding aspects of the research with the purpose of taking a student by the hand | Development of material intended to guide students – with the involvement of students (example Botes, Smit [2]) | Undertake small-scale (collaborative) enquiry into specific learning and teaching activities |
| Research is teaching-influenced | To develop and enhance research processes and outcomes on the basis of engagement in teaching | An extension of the research project – where the process research process is followed beyond the project into the academic community. | Involving honors research project students in conference participation (example Thomas et al. [14]) | Engage students in data collection, analyzing raw data or peer reviewing conference papers or draft journal articles that are emerging out of ongoing or recently completed research |

An open-ended question was then included to obtain input from students with regard to any suggestion they may have with regards to the improvement of the offering:

> *State suggestions concerning the ideas you have with regard to the facilitation of learning about research and its processes – for the purpose of ensuring successful honors research projects, as well as your progression from being a student of research to a researcher. How do you prefer to learn about research, as well as how to conduct research? Elaborate on your ideas to facilitate understanding and ensure possible implementation.*

## 6 Discussion of findings

A group of 22 students are enrolled for the honors research project. In addition, five academic staff members who are still inexperienced in research, have been invited to participate. Of the extended group, 16 questionnaires were completed, 13 students and three academics staff members.

For the purpose of the discussion, the six dimensions have been grouped in pairs where the first two dimensions are grouped (teaching is research-led and teaching is research-oriented) as the first content-process pair. This pair is perceived to be on the starting point of teaching the young researchers about research. In Fig. 1, the darker grey represents "teaching is research-led" and the lighter grey "teaching is research-oriented". It seems that most students are in agreement that this way of facilitation is according to their preferences. Respectively, only two and three participants indicated that they disagree with the statements. Nobody indicated strong disagreement.

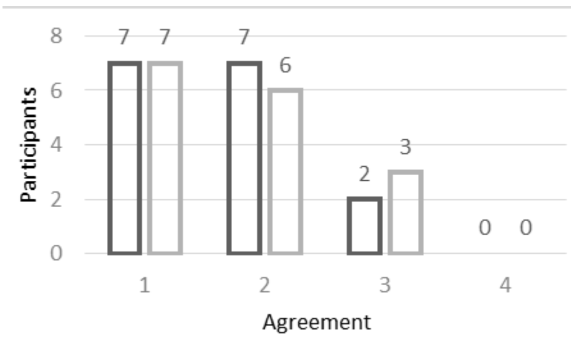


**Fig. 1.** Responses: Dimension 1 and 2.

Subsequently the next two dimensions are grouped (teaching is research-tutored and teaching is research-based) as the second content-process pair. This pair is perceived to be building on the first two dimensions by using the acquired knowledge as scaffolding structures to build more in-depth content-and-process paired concepts regarding teaching the young researchers about research. In this layer, more participation is expected from students. In Fig. 2, the darker grey represents "teaching is research-tutored" and the lighter grey "teaching is research-based". It is noted a slight shift is presented when comparing Fig. 2 to Fig. 1; a smaller number of participants are strongly in agreement, while the participants in agreement are still high. Also, some participants strongly disagree with these statements, while this was not the case with the first dimensional pair. In comparison, participants still are mostly in agreement that this way of facilitation is according to their preferences, but respectively five and four participants indicate their discomfort.

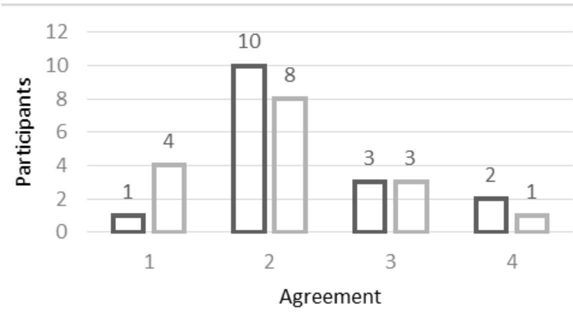


**Fig. 2.** Responses: Dimension 3 and 4.

The last two dimensions are grouped (teaching is research-informed and research is teaching-influenced) as the third and last content-process pair. This pair is perceived to form the apex of teaching, where facilitation of the content-becomes-process research implementation comes together in the minds of the young researchers. In this ultimate layer, students are expected to conduct research in a bounded context. In Fig. 3, the darker grey represents "teaching is research-informed" and the lighter grey "research is teaching-influenced". It is noted the slight shift presented in comparing Fig. 2 to Fig. 1, is maintained when comparing Fig. 3 to Fig. 1. In addition, Fig. 2 is very similar to Fig. 3, with a slight slant towards agreement. Again, some participants strongly disagree with these statements. Participants still are mostly in agreement that this way of facilitation is according to their preferences, but respectively three and five participants indicate their discomfort.

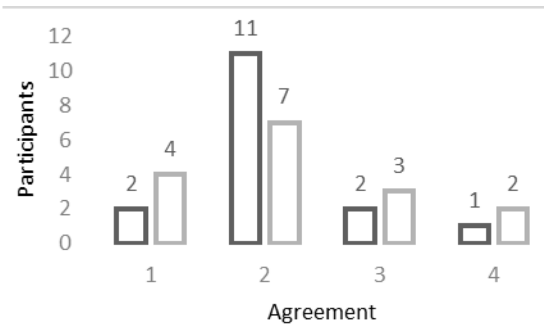


**Fig. 3.** Responses: Dimension 5 and 6.

Analyzing the open-ended responses, resulted in the identification of five codes, with the individual foci on the workshop during which the questionnaire was completed <WRK-S>, the allocation of supervisors and the course of facilitation <SUP-V>, two scenarios included as examples in the first part of the questionnaire were corroborated by the two suggestions <R-ART> and <P-DSC>, and a summary of the intended course of facilitation in the research project offering <SUMM>. The responses of the participants is listed in Table 3. Although no new suggestions were made in the open responses, concurrence with the current planned approach is encouraging.

**Table 3.** Code table with responses.

| **Code** | **Description** | **Responses** |
|---|---|---|
| WRK-S | Since the questionnaire was completed during the paradigm full-day workshop, participants tended to spend much attention on its value. | The workshop idea was very informative and made me much more comfortable when it came to the paradigms compared to the first evening class. |
| | | Learn about the different ways on how to go about doing the research then take the first step and so on. |
| | | This workshop must be continual as it was very informative. |
| | | Practice makes perfect. Trying out practical examples helps. |
| | | Workshops. |
| | | Been given small examples and then replicate similar cases. |
| | | Analyzing examples, and creating activities on a smaller scale to further learn about the style required. |
| | | I am happy with how the learning sessions and activities were carried out. |
| SUP-V | Participants reflecting on the allocation of supervisors, and how the future process may be conducted. | Have an interactive practical writing session(s) in groups with a Lecturer/Supervisor present to assist and facilitate these sessions. |
| | | Sessions with supervisors on progress and how to improve the project or how to get further research. |
| | | I think that students may need help choosing a study. |
| R-ART | The suggestion of reading articles is in agreement with an option mentioned as a possibility. | Reading articles. |
| P-DSC | The suggestion of having peer review discussions is in agreement with an option mentioned as a possibility. | Peer review discussions. |
| SUMM | This participant response summarizes the intended approach to be followed exceptionally well. | I prefer to learn about research in a pragmatic, practical way. The more I can be a part of and included in the research process, the better. I would expect to be involved in undertaking smaller, bite-sized studies to be exposed to a wider assortment of research designs and methods. These small-scale practicals should be constantly and consistently monitored and moderated, as novice researchers often overcompensate to try deal with their lack of knowledge and broader context. |

When reflecting on the proposed offering, two dimensions pose concerns, namely *teaching is research-tutored,* where the formation of research focus groups may assist students to obtain deep knowledge of the paradigm, methodologies and techniques their project rely on, and *research is teaching-influenced*, where student participation in conferences are not common. In the former case, the available weekly time allocated may be scheduled involving students and supervisors to read an article on a selected research topic to be discussed and placed in context of the research. With regards to the latter case, an in-house conference may be arranged with the accompanying ‘publication’ of the papers prepared.

## 7 Conclusion

In this paper an attempt was made to use the research-teaching nexus, adopted from Weller [17], in the practice of preparing honors students to make the transition from being a learner of subject material, and implementer of learned concepts, to becoming a researcher who needs to plan a research project, make sense of current literature, gather data, analyze results, and write up the research in academic language.

The research question: “*May the lens of the research-teaching nexus be of value towards honors students’ learning needs regarding research, when evaluating the contribution of current teaching approaches?*”, was addressed. From literature it is clear that the research-teaching nexus is useful in more areas than only teaching under-graduate students. Here it was also found to be useful in guiding and evaluating the offering of the honors research project subject as was discussed here, although it may be argued that dimensions were adapted to suit the context of post-graduate teaching, as well as the topic of the discipline of research.

From the research conducted, participants indicated that the offering is according to their preferences. It is noted that some participants show some discomfort with the latter four dimensions. This discomfort may be addressed by supervisors taking extra care in guiding students through the process of internalizing concepts, as well as in conducting the research. Although no new suggestions for enhancement were made by participant, this may be an indication that the offering is in accordance with expectations. Reflection on the part of the researcher, who forms part of the group of supervisors, indicates that some of the dimension implementations may be difficult for students (and supervisors) to achieve. Additional effort should be made to accommodate students in studying articles, for example. Although participation in conferences based on the project research has occurred in the past, this is not a successful endeavor and in many cases the students are not interested to participate themselves. Organizing a student conference – with the compilation of the accompanying proceedings may address this challenge.

Regarding the chapter breakdown that was discussed in Section 2 and mentioned in Section 3; although no amendments were implemented in 2018, it is envisaged that a set of templates should be compiled for future use, each one guiding research from a particular paradigm. Such a template may be utilized as a learning instrument, where the differences in methodology, terminology and sources associated by each paradigm may be addressed by a corresponding template.

Future research will focus on the improvement of this offering, by holistically scrutinizing the offering, improving instruments, and compiling material that may guide these students.

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# Overcoming the Corporate University and its Effect on Computing Education

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**Abstract.** In this reflective paper, the corporatisation of the university was examined, presenting a literature review of the issues involved, supplemented by personal experience. The concept of a university – and of scholarship – was explored, and changes that led to the all-administrative McUniversity were highlighted. The consequences of the resulting managerialism in terms of time pressures, productivity measurement, and the instrumentalisation of academics and students were explored in the various dimensions of scholarly work – tuition, research, and other required tasks – as well as its effect on colleagues. The guilt and shame that ensued were noted. Recognising that this trend was unlikely to be reversed, the authors proposed slow scholarship as a way in which academics could respond: ways of changing thinking about ourselves, our colleagues, and our approaches to tuition and research. The importance of balance was also considered. The paper concluded by emphasising the need to find autonomy and to focus on critical thinking.

**Keywords:** Corporate university, Instrumentalisation, Managerialism, Slow scholarship.

## 1 Introduction

In this reflective paper we consider our experience of the corporatisation of higher education and its effect on scholarship in computing education. Much has been written on the effects of corporatisation in universities in other parts of the world (the UK, US, and Canada, for example), and many examples have been provided to illustrate the deleterious effect this has on academic staff, research, and teaching. These effects are due to the time crunch placed on academic staff, the loss of autonomy, and pervasive performance management and measurement.

To ensure that the quality of computing education does not suffer as a result of the new managerialism foisted on academic staff, we explore the effect on computing education in the broad areas of research and tuition, recognising that these are achieved together with colleagues. Understanding the consequences of corporatisation on computing education means that we are in a better position, as academics, to recognise the effects of the expanding managerialism and instrumentalisation in the current corporate university and can, thus, respond in thoughtful ways.



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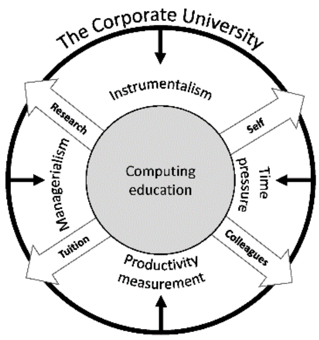


**Fig. 1.** A response to the corporatization of the university.

Fig. 1 summarises the argument presented here. The corporate university may constrain the scholarship of computing education though instrumentalism, managerialism, increasing time pressures, and productivity management. In responding to this, academic staff can take several steps to begin moving out of this constricting environment through how scholarship is practised: in how we define ourselves and our colleagues, and how research, and tuition are accomplished.

After reflecting on what a university is, and the corporatisation that has taken place, we move on to considering its effect on the exercise of computing education in the main areas of an academic's work. Suggestions on how to counter these effects are then presented, and we conclude by highlighting the two main ideas that summarise our suggested response.

## 2 The Corporatisation of the University

The corporatisation of the university, which has taken place over the last five decades, has led to a shift away from academic autonomy and shared governance, leaving a university governance model with little resemblance to that which earlier academics would recognise. It is important to understand this shift, as well as its impact on the self-identity of academics, students, and those in administrative positions. We consider what the ideal of a university was before examining where we are now. In avoiding nostalgia, we take a hard look at the types of changes that have taken place, and through a literature survey combined with personal experience, we detail the impact that the changes have had on scholarship.

We show that the corporatisation of the university has led to the exclusive and irresponsible use of quantification in order to "manage" the university. Much of what is thus discussed around measurement and data is the result of corporatisation.

### 2.1 The university then and now

Although universities, and the ideal behind a *universitas magistrorum et scholarium*[1], have existed for centuries, the foundation for the modern university is accepted as that envisioned by Willhelm von Humboldt [16,31]. In this view, the concept of *Bildung* was enshrined – a unity of teaching and research, in which there was freedom of the sciences and autonomy, where the teacher was a mentor for the student, who was not simply learning, but preparing to undertake his or her own research. Ultimately, the model provided for more than just vocational training, seeking to allow each human being to reach personal maturity.

Today, however, universities are largely seen as businesses that have profit margins, provide services to customers, and have people who produce a product to be sold to the customers. In this sense, the university is known as a McKinsey-type entity – a corporate entity that is managed in the same way as a business.

How did we get from the concept of a university as a place removed from outside influence, focused solely on teaching and enquiry, to an international corporation competing for market share, with customers and a chief executive officer (CEO)? This corporatisation can best be explained as the result of neoliberalist economic policies [46,52]. In the US, and elsewhere, such policies led to a reduction in government funding for universities [29], which led to universities having to seek funding elsewhere [29], prompting partnerships with the private sector – a form of privatisation. However, to be fair, the shift followed a policy change from governments rather than a conscious one by universities. This privatisation led to the adoption of business management attitudes, resulting in managerialism and an overbearing administration. The natural consequence of managerialism is a never-ending drive to improve *efficiency* and *productivity*, and establish *accountability* [29] (as opposed to the trust-based systems of the collegially governed higher education institute).

## 3 The Effect of Scholarship in Computing Education

Scholarship is not defined by the university. It is an identity that is defined and agreed on by those who are scholars themselves, remembering that it is possible to pursue scholarship at any institute that is willing to support enquiry. Scholarship, then, is a self-understood identity, defined by discovery, integration, application, and teaching [3]. Discovery relates to basic research, dealing with underlying theories and principles, conducted without any consideration for its practical application [7], and typically results in pure knowledge and understanding. Although Bush [7] refers to this as *scientific capital* – a fund from which one can draw for future practical applications – we prefer the term *foundational knowledge*, avoiding the trap of likening research to capitalist ideals. The scholarship of integration, uses this knowledge, along with other basic research, in a broader context – understanding where knowledge fits in. The scholarship of application applies this knowledge to specific real-world problems, and although it

[1] The term *university* is derived from this Latin phrase, meaning ‘community of masters and scholars’.

may spawn new fields of enquiry, it tries to solve problems by applying existing knowledge. Finally, the scholarship of teaching relates to engaging with students, creating future scholars, and contributing to *Bildung* – creating a well-rounded individual capable of functioning as a responsible member of society.

Although the intent behind the McKinsey-type university is the survival of the institute, it has had adverse effects on scholarship as discussed below. The current climate, characterised by managerialism, has become known as the *all-administrative university* [12]. Even though there have been extensive reports on this bureaucratisation of universities and its negative effects, it appears that the expansion of the all-administrative university is not nearing an end, evidenced by the number of papers being written (the reference list being a small sample).

We view the effect of the corporate university in the following broad categories: its effect in general, on teaching, on research, the creation of additional workload, the view of colleagues, and the ensuing guilt and shame. The focus is on our experience, supported by literature where similar experiences are reported elsewhere. It is not implied as a generalisation which applies to all academics all the time.

### 3.1 On Scholarship in General

Managerialism, essentially, has a narrow application and is ill-suited to university governance [47] – as a simple example, consider that managerialism requires the justification of an activity through its profitability; which degree programmes would survive if subjected to such myopic scrutiny[2]? Furthermore, fairly antiquated managerial ideas have been applied in universities [34]: mission and vision statements dating from the 1980s, for example [47]. These dated ideas also seem to be at the core of professionalisation of managerialism[3] at the expense of academic roles in the university [34], seen in the first part of the title of Ginsberg's book: *The fall of the faculty* [12]. To support this managerialism, bureaucracy is expanded [34], and quality is not something that is critically examined by those performing the task (in this case, the faculty), but is externally bestowed by a centralised body [34]: the "quality police" [10,n.p.]. The university, thus, becomes an externally guided entity [29].

Additionally, managerialism leads to requirements for higher productivity, reaffirming the view that they were inefficient to begin with [34]. The result is quantified control, where a single economic criterion is of greatest importance: the quantification of higher education [25]. Academics are quantified as a feature vector of metrics – a point located in an n-dimensional space and little more. This quantification is built on rationalisation: the consideration that only measurement and data are important [19], leading

[2] There are more examples, and the rest of the paper does provide some; however, thorough treatment is not possible because of limited space.

[3] Turning the task of running a university over to people who consider themselves professional managers – where loyalty is to managerialism rather than the ideals of the educational institute.

to the McDonaldisation [38] of society and, ultimately, the creation of the McUniversity [34] and the rationalisation of scholarship. *Bildung*, and the development of the whole person, recedes into the background.

In the McUniversity, quality and scholarship are measured, whereas it should be judged [1], and is little more than a form of surveillance [1,12,34]. By definition, a measure requires uniformity or homogeneity. The unit of measurement must be standardised, and the measured attributes must be homogeneous. Focusing on uniformity and centralisation in scholarship leaves little room for renewal, to the students' detriment [3]. Standardisation may eventually lead to a lack of distinction between different domains of enquiry, as they themselves become standardised [34].

Measurement of productivity attempts to make employees more efficient by producing more goods faster, with a focus on quantity rather than quality. The resultant time pressures may lead to the "dulling [of] academics' intellectual energies" [47, p.82]. Such time compression produces severe stress in most academics [29], eroding the sense of self and of others. This is because the McUniversity does not allow for time-consuming (or time-wasting) activities related to intellectual reflection on, engagement with, or debate about, ideas [14]. Time is further compressed and extended, with increasing demands to perform in wider spheres of required competence: teaching, research, administrative academic citizenship, and community engagement [20]. Also, time spent on various tasks is tracked and measured [6]; annually we report on the proportion of time spent on various tasks as percentages (but not the actual hours spent).

This form of hyper-supervisory control [6,25] means increasing surveillance on activities of academics and students. The consistent monitoring results in Foucault's panopticon [34], where the academic knows the right responses to gain reward – it no longer being peer recognition or community with students and colleagues, but cold, rationalised career progression (or simply survival). The culture of measurement [45] also can lead to an instrumentalisation where success is reduced to meeting required metrics and tasks may be seen as a means to an end [1,36].

Although academics may have more flexibility in organising time, exactly because of compressed time and wider engagement spheres as discussed above, the perception is increasingly "You can work any 20 hours of the day you want" [51, p.503]. This culture of working long hours[4] is often interpreted as commitment to the university, which, when seen by line managers, may give one a competitive edge [55]. Yet time is often fragmented and multitasked [29,55], leading to the loss of being sufficiently present in time, focused and mindful, to do the thinking and reflection required to generate new and worthwhile thoughts [14,29].

In the McUniversity, all goods are reduced to "private, economic goods", and humans are transformed "into objects for market-based investment" [52, p.94]. The result is the creation of the exchange-value problem: the quantification of education and scholarship relies on metrics as proxies to determine quality and does not recognise the human effort behind the activities. Academics, therefore, may have to fend for themselves [13], which erodes the community of scholars and students. Instead of collegial

[4] At a faculty meeting, a senior university manager at the authors' institute held his own long hours up as an example to follow.

discussion on workload, we now have negotiations [6]; instead of the free discussion of ideas, we have the development of patentable results; and instead of masters guiding scholars pursuing knowledge, the syllabus becomes a contract [38], where students pay for a degree and discussions are recorded for fear of the customer lodging a service delivery complaint.

### 3.2 On Tuition

The above pressures affect tuition in several ways. Firstly, the corporatisation of teaching, and the subsequent application of managerialism to this, result in the academically rooted language of 'students', 'courses' and academic hierarchical structures such as 'dean' and 'vice-chancellor' being replaced by management-speak: 'customers', 'products', 'CEO', and so on [25,34]. The contractual syllabus between customer and service provider [38] allows no expansion, deviation, or renewal from the initial thoughts around the work to be explored [38]. This rigidity is an anti-pattern as far as transferring critical thinking to students is concerned; it teaches that once a path has been chosen, deviation cannot be tolerated – certainly an extremely anti-science mode of thinking. In South Africa, the Form 3 or Module Form, for example, serves as an exact map of what a course must cover, and is submitted to the Council for Higher Education after registration and accreditation of a degree programme. Modifications are tolerated within a range; should the form be too different from that on file, an administrative process ensues, requiring the involvement of nearly all staff in the university[5].

Along with the time pressures, it becomes very easy to instrumentalise students in a simple service relationship where they may become irritations, appropriating time from other (more important) tasks such as research [9,45] and other required, measured activities. Related to this is the expectation to respond to queries from a student customer within 48 hours [40]; thus, responses may be rushed and not given the necessary thought.

Secondly, while recognising that there is a need to provide a skilled workforce for a developing country, the McUniversity may become focused on skills-based training [47], and academics are pressured to prepare students for a job [43]. Particularly in computer programming, there are calls to teach C# or Java instead of the current programming framework being used, because these languages are perceived as the ones required in job advertisements. The computing disciplines are particularly prone to this approach to learning, as they are linked directly to job opportunities rather than a general, liberal arts education [51]. Ritzer [38] warns of universities producing byte-sized McNuggets: easily digestible bits of information and ideas that managers think will sell and that satisfy, instead of challenge, the student customer [34]. Higher education should not be about pleasing customers [34] or providing a way to fill a market niche, simply continuing to feed the corporate machine, but preparing students to challenge the status quo [12]. Related to this is insufficient time to always fully consider, plan, and reflect on module content or keep current in a discipline; so decisions regarding

[5] The forms are routinely written very broadly to ensure that this is not a problem, however, our experience lately is that this practice is frowned upon.

content may be hastily made based on routine cognition [14,24]. Furthermore, course offerings are decided based on economic concerns. Such streamlining of curricula is the result of programme viability analyses based partly on student numbers for particular courses and their direct employability. Courses not seen as useful ("boutique" courses [8, p.7] without market-bearing value) are trivialised as not directly job related, and are scrapped [18,34,53]. Ultimately, pedagogical practices are re-oriented towards the preferences, tastes, and mores of an increasingly consumerist student audience and corporate advisory boards [6].

In the third place, teaching may become rushed, leading to poorer performance by stressed academics, with a direct impact on student learning. Research has shown that students rate the quality of instruction by academics showing higher levels of job satisfaction and lower levels of emotional exhaustion more highly, although student achievement was unaffected [21]. This points to a paradox in delivering promised quality university education, while the focus on efficiency and revenue streams undermines this [27,32]. The demand for increased quality often simply translates into a demand for improved pass rates, reducing quality to a simple metric rather than personal maturity. This measurement may result in rushed, ever-increasing attempts to improve quality by performing ever-more demanding improvement exercises, none of which is interested in the community of students and academics, but rather focuses obtusely on the numbers as a proxy for quality – a narrow focus on output without considering the student [3] and a source of demoralisation for many scholars [34].

Lastly, time pressures mean that there is less time to reflect on the meaning of teaching and learning [8]. The effects are seen at curriculum/tuition meetings, where the focus is on rubber-stamping curriculum changes without dealing with loss of academic control over maintaining curriculum quality and integrity. This absence of critical engagement with the curriculum and teaching is also seen in improvement plans to be drawn up when a course pass rate is below a set minimum and plans that must be presented for improving the pass rate, without any thought regarding the lack of student achievement in the first place.

### 3.3 On Research

In research, performativity measurement and metrics are most prominent, and Excel spreadsheets are used to determine an academic's research score based on the type and number of research outputs and grants held. Ultimately, academic staff attempt to collapse complex academic and scholarly activity into a flat set of metrics [6], which have little to do with what academics actually concretely do, but are nonetheless used, leading to the rethinking of the self-identity of academics. Such metrics determine what is important, with incentives possibly guiding behaviour and setting new norms.

Research output is seen as having financial value to the university, turning intellectual activity into a sellable commodity [4,32] via state subsidies for research published in approved journals and at approved conferences, although there is little measure of the standing of either. Notably, there is a push for patentable research [53], and an innovation and technology transfer department has been set up, which regularly holds workshops on intellectual property rights. Output is further increased through writing retreats, although it is made clear that the academic will have to report on progress towards producing a deliverable to justify money spent on retreat attendance [4]. It may be argued that an academics only worth is his or her ability to bring in funding via publications, grants, and patents [40].

Although it is not stated policy, the method used for calculating research output points encourages individualism [53], and discourages collaboration, as the units allocated to each output are divided among the authors. For meeting output targets, required to meet performance expectations, academics are encouraged to work independently rather than share the available points.

Corporatisation may also led to a focus not just on the number of outputs, but to the publication of high-impact research. Academic output may be ranked based on Hirsch's notorious h-index[6] [6], as well as the use of journal impact factors [2], the validity of both being heavily debated [23].

The push for outputs raises questions regarding the quality of outputs when quantity and speed are emphasised, with content being unimportant [4,14,15,41]. While there may be greater productivity, there may be less creativity [29,55]. The narrow focus on numbers turns research into academic 'tin-pan alleys' with the creation of popular research satisfying the ever-increasing demand for speedy knowledge production. The measurement of research output and the lack of time to explore new research areas mean that academics may be less willing to take the risks involved in critical engagement or express (unpopular) views possibly leading to output rejection thus skewing research by pursuing only safe topics [4,28,29,43]. Also, the lack of time to give deep reading the required focus and commitment results in academics simply mining for specific information [29].

An effect on postgraduate research supervision is also evident, as students may be taken on for the reward resulting from a completed study and probable outputs, as well as maintaining the required postgraduate student numbers. Here, the topic may not matter; just because it can be studied, it does not mean that it should [48]. Academics may even take on students only tangentially linked to their own areas of expertise, if at all, to make up quotas or to exploit them for their metrics value (points and publications). There have been questions about the focus on producing a graduate who can carry out a required research methodology and report on it (a research technician) – rather than one who will struggle with the more critical and philosophical issues – producing PhDs (Doctors of Philosophy) without any apparent philosophy [48].

Thus, academics may become entrepreneurs who 'sell' themselves to their university, prospective students, and grant funders, while competing against each other [43,45], sometimes putting research above other tasks, such as tuition [1].

[6] We could provide a reference to Hirsch's paper 'An Index to Quantify an Individual's Scientific Research Output' here. However, as we disagree with its usefulness, citing it would only increase its h-index, proving our point: the h-index does not provide information about the sentiment regarding a paper.

### 3.4 On Additional Tasks

Research and tuition arguably form the centre of an academic's work life; but tasks take up time, too. In terms of measurement, as an academic should dedicate a percentage of time to community engagement, this task has been converted into hours to be completed; along with research, this is measured using an Excel spreadsheet. Exactly what counts as community engagement for a computer-literate academic keeps changing. In the past, it would have included using computer skills to benefit and teach communities around the university; it is now increasingly part of tuition, and academics are rewarded for adding community engagement tasks to formative assignments. Publishing research done in such community engagement activities is doubly rewarded – as extra points on the community engagement spreadsheet on top of the usual research output points.

Overarching the activities undertaken by academics are the associated administrative tasks; yet there is a contradiction in calls for efficiency, while swamping academics with administration [15]. As more and more is expected of academics, the administrative load around reporting increases, often with competing expectations, shorter time frames, and inadequate support and infrastructure [13,29,54]. Then, when administrative systems fail or do not perform as expected, the academics who deal directly with students must do more with less and find creative ways (without time for thought) of working around the failure. This is particularly true of supposedly technologically astute computing academics who should be able to find a quick technological solution to the problem.

### 3.5 On Colleagues

The corporate university engenders an instrumentalist view of academic colleagues where relationships may become a mining for resources [29]. Networking can be an opportunity to get something useful out of colleagues to promote one's own career without offering anything in return in what is becoming increasingly superficial communication [29,37].

The measurement of production leads directly to competition with colleagues [15]. Together with the way research outputs are calculated, academics may become loners without collegial relationships [1,29]. It has been argued that instrumentalisation makes it easier being non-present, quickly approving meeting decisions and moving on without debates about the merits of choices made, and not asking deeper questions and challenging one another [29]. The concept of collegial decision-making has conceivably been abandoned due to the non-participative, managerialist paradigm in the wider university where decisions are made for academics without their input [20].

The corporatisation of the university could lead to academics feeling that management sees them as resource generators and no longer cares [40]. At a faculty meeting in our institution, a senior manager stated that academics were not forced to work at the institution and could leave when they pleased; although not stated explicitly, this implied that academics were replaceable [5]. The only solace that computing academics have is the skills shortage in the discipline, although this does not seem to make much difference to how they are managed.

### 3.6 Guilt and Shame

Time pressures and productivity management can generate feelings of guilt and shame [1,33,40,45,55] – guilt at how little is being achieved and shame at inadequacy. The corporate university counts on the commitment of academics towards their work and its intellectually satisfying nature [20], using guilt as motivator to get staff to continually self-sacrifice and self-discipline [13,51]. There is also a sense that the managerialist approach, which sees change as a sign of dynamism, seeks to keep an unbalanced and uncertain environment by changing performance measurement categories, leading to uncertainty among academics about future expectations [45,54].

An institutional survey at the authors' university rated staff stress levels and, on completion, indicated how one should go about dealing with the stress. There was no indication that the survey was interested in the institutional cause of the stress (the *why*), but simply *how* each individual must deal with it. This leads to the perception that the staff member is at fault, increasing the academic's guilt and shame at their time management that needs remedying [9,14].

## 4 What Can Be Done

Our accusations against the McUniversity have focused on measurement and rationalising of the individual. What then should we do? We take our cue from Berg and Sieber's Manifesto [1], and agree that the complex activity of scholarship cannot be reduced to a set of metrics; doing so denies the essence of scholarship, which requires mental and physical space, freedom to think through and pursue areas that may not appear "commercially viable", and support to transfer these attitudes and principles to students – its ancient Greek root means "one who lives at ease".

A return to the traditional university of a few decades ago is unlikely; the university will not cease to exist, and the time-pressured and productivity-measuring university is probably here to stay [39,44,45]. Academics can protest and resist the changes where possible (some say they should [34,42,47]), but whether they have the courage or time for this has been questioned [28,39,43]. Two further options must be avoided: feeling that nothing can be done and accepting that university workers are like any others in a capitalist economy, or considering this a crisis and giving in to panic, thus exacerbating the stress [1].

A slow scholarship, along the lines of the slow movement, has been proposed, where academics "live in the present in a meaningful, sustainable, thoughtful and *pleasurable* way" [1, p.11, quoting Parkins and Craig, italics in original]. Slowness is neither nostalgia nor a silver bullet to solve all the university's problems, and it does not equal idleness [44] or the go-slow typical of some industrial action. Rather, in resisting speed and poor quality, it focuses on autonomously controlling the quality of the present, and acknowledging the disruptions in everyday life, yet taking pleasure in hesitative, deliberate, rational, and emotional reflection and dialogue [1,4,9,27,44]. The approaches suggested below attempt to instil these ideas in academic practice, thus partially overcoming the constricting corporatisation of the university.

### 4.1 Rethinking the Self

The starting point may be to acknowledge that some may be struggling, which is not necessarily an easy admission in an intellectually individualistic culture [1]. What is needed is a slower, mindful, deliberate academic identity rather than a slower way of doing academic work [49]. Linked to this is the call, as part of an ethical imperative, to be kind to ourselves [1], and to recognise our success in spite of the constrictions of the current university.

Academics can consciously slow down, on the basis that working less at times can mean working more efficiently and productively (what the corporate university wants in the first place) [1,17]. It has, thus, been suggested that time out, an hour a day, be taken off to work on a project requiring thought rather than action to allow for the possibly required creative daydreaming and apparent inactivity [1,17,51]. Time and space are needed to cultivate good ideas and higher-order thinking through reading, writing, discussing, and even arguing [14,36]. Such timeless time is characterised by an internally motivated use of time based on autonomy and freedom [27,50,55]. Lewis [22] provides an excellent analogy: such open time is required much like the open square in the four-by-four puzzle that allows other pieces to be moved into the required positions.

While recognising that ICTs can have a positive role to play [9], they can add to the information overflow that academics must handle [41]; although email helps us work together, it does not get the work done [29] – hence the call to disconnect from the "nonstop orgy of connectedness that can sometimes drown out ... meaning" [41, n.p.] and get offline [1,17]. This would be particularly true of time set aside for thought, as while the brain can toggle between tasks, it cannot do two things simultaneously [41].

### 4.2 Rethinking Collegial Relationships

The best way to reconfigure our relationships with colleagues is to be present – taking time for others by going offline and actively engaging with those with whom we share in discussions, meetings, seminars, and informal spaces [1,4,15,44]. We support our colleagues when we give them, and their writing, the attention and deliberation they deserve, as well as being open to giving and receiving feedback, recognising that we can give the issue under discussion the power to matter and the colleagues in the exchange the power to change us [4,9,44]. It has been suggested that thoughtful dialogue around agenda items be undertaken before meetings to reduce the likelihood of meetings turning into the rushed rubber-stamping of decisions [44]. Although ICTs do provide for very efficient means of instrumental communication, there is little opportunity for real dialogue [29], so they are probably not the best way to build the collegial relationships envisaged here.

In the process, we develop an alternative ethics and politics of time, moving the focus from the end product to a collegial process [1] while simultaneously de-instrumentalising our colleagues. We acknowledge that academic work can be emotional (despite the corporate university trying to turn academics into "cognitive stick figures whose behavior is unaffected by emotions or interactions" [30, p.197]) and that we may even disagree strongly [1]. It has been argued that our well-being is a collective process, not a possession, and that both negativity and positivity are contagious [26].

### 4.3 Rethinking Tuition

The corporatisation of tuition has “taken the fun out of teaching” [13, p.1098, quoting Bowen and Schuster]. Berg and Seeber [1] believe that the way to take back tuition via a slow scholarship approach is to take pleasure in it. This pleasure is not, however, self-indulgent; nor is it, as Aristotle noted, a state, but an activity [26]. In advocating for a “pedagogy of pleasure” [1, p.35], we should recognise students’ humanity, giving them the attention and reflection required to build their intellectual capacity, while finding positive meaning and enjoyment in interactions with students [1,9].

Tuition is much more than just technique; it is based on the academic’s integrity and self-identity [1]. Thus, it is important that the student’s body not just be seen as providing life support for the brain [1] and that the pleasure in tuition be taken beyond pure cognitive dimensions. In many ways, academics’ interactions with students should be similar to those among themselves, which may be why it has been suggested that academics keep their office doors open [29] so that they remain open to interactions with colleagues and students and do not isolate themselves behind closed doors.

### 4.4 Rethinking Research

The focus in rethinking the approach to research is possibly to concentrate on judging rather than measuring [1], taking the position of evaluating PhDs on the acceptability of the quality rather than giving a mark. Shifting the focus to judging the value and relevance of research requires a similar shift in aspiring for quality rather than simply quantity [1,44]. Instead of focusing on the low-hanging fruit, it may be necessary to start probing some of the more “messy” [44, p.10] questions, which are unlikely to have neat, quickly produced answers and may even lead to inconvenient results, and accept the responsibility to raise and test more controversial views [36,44]. In an editorial questioning whether academics are producing doctors of philosophy without any philosophy, Thorne [48] asks whether the era of theory has passed and calls for a stronger focus on the more philosophical questions of why research is being undertaken rather than just how it will be accomplished. Similar approaches could be taken to supervision practices in postgraduate research.

### 4.5 Finding Balance

The slow scholarship approach be attempted with balance in mind: timeless time and scheduled work time should not be allowed to take over personal time, especially when pleasure has been sought and found, and individual options must be found to lead a temporally balanced life [41,55]. Furlong [11] reminds us that it is not about balancing work and life as though they were two sides of a coin, but that life is the coin, and work is only one side of it.

To attempt any change, it is necessary first to believe that we have the agency and responsibility to make changes, realising that many of the behaviours that appear to treat colleagues, students, research, and other areas of academic life instrumentally involve time pressures and imposed productivity management systems. Primarily, academics must speak to one another about what is happening to vent their possible collective anxiety about feelings of helplessness before they start whining about it [1] and share attempted alternative approaches.

It should also be noted that there can be speed balance: sometimes there is good in fast (such as being up to date in a current debate) [17,27], and sometimes more thought must be employed. The focus is on taking back the power and feeling that decisions are autonomous rather than forced [27].

## 5 Conclusion

Over the last few decades, the corporate university, as an idea factory, has seen a shift of focus towards the factory dimension to the detriment of ideas [5] and, through instrumentalisation, has seen time and people as tools in generating an academic product for use as a resource in a capitalist economy.

Risking candour (as Berg and Seeber [1] call for), it must be noted that although the issues raised in this paper have been discussed by the authors (and with colleagues) for over a year, there has never been the time to write them down. When the authors were on research leave simultaneously, time was found to present the ideas in a paper. However, bowing to the requirements of our corporate institution, even though this conference seemed the obvious place to present these ideas, we had to ensure that it was one approved by our institution, so that we could claim points for it towards our performance management scores. We worked on it collaboratively, realising that we would be diluting the points we would be able to claim towards our performance metric, and did so consciously.

The two main ideas that can be highlighted in response to the corporatisation of the university, and taking back our power and autonomy, relate to (i) finding a form of slow scholarship that works, and (ii) learning/teaching/practising critical thinking. Firstly, in a world characterised by speed, where it is about the survival of the fastest, Honoré [17] calls for finding our inner tortoise. There is a need for individuals to find what patterns of slowing down to think work for them and to find ways of fitting these into the various dimensions of academic scholarship. Secondly, we must encourage, teach, and engage in critical thinking in all facets of our work – what was called "experts at 'crap detecting'" [35, p.3] in the book *Teaching as a Subversive Activity*. This thinking must be applied to our own work, and to our interactions with colleagues and students, as part of the exercise of being more present in time.

A path must be found that still complies with the requirements of the corporate environment of the current university, while finding ways of acting outside its restrictions [44], realising that this paper emphasises the individual rather than addressing structures. However, will a change in an academic's approach to his or her work make any difference when promotion criteria remain focused on measuring production, or does an appeal for such an approach do little more than deflect the inevitable [9]? Is such a hope utopian [14]? Only time will tell.

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# South African Secondary School Pupil's ICT Career Inclinations

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**Abstract.** Secondary school scholars are generally not familiar with careers in the Information and Communications Technology (ICT) field and are not aware of the course contents of Computer Science or Information Systems degree programmes. In this paper the authors have expanded on previous research conducted in the Western Cape and Eastern Cape provinces of South Africa. Previous research focused on scholar career inclinations to study Computer Science (CS) or Information Systems (IS) at Higher Education Institutions (HEIs) in South Africa. Information Technology (IT) and Computer Applications and Technology (CAT) are subjects offered at numerous secondary schools in South Africa and the assumption made in this study is that secondary school scholars are more familiar with the terminology and course contents of these subjects (IT and CAT). In this study, the concept of IT offered by HEIs in diploma or degree programmes was added to the survey used in the previous two studies. The results indicate that Grade 9 and Grade 11/12 secondary school scholars were not familiar with the CS/IS/IT fields of study and that they were more familiar with the concept of IT and showed a small inclination to study CS/IS/IT.

**Keywords:** Scholar career intentions, Information Technology.

## 1 Introduction

The Information and Communications Technology (ICT) skills shortage is of national and international concern. Presently CareerJunction [10] are advertising more than 5000 IT positions and specifically have 2068 Software Developer positions available. Modern business practices require the implementation of new technologies supported by a workforce with current and diversified ICT skill-sets. Acquiring suitable ICT skills has become a difficult task and employers are seeing government intervention at all levels.

The school system in South Africa is under increased pressure and is faced with low matriculation pass rates, specifically in subjects such as science and mathematics. A number of schools are experiencing a decline in the number of secondary school pupils


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(learners or scholars) enrolling for the Information Technology (IT) school curriculum. The IT curriculum at school level is being criticised and under-prepared teachers are blamed, including the lack of suitable IT facilities. Two surveys conducted in South Africa amongst grade 9 and grade 12 secondary school pupils in the Western Cape and Eastern Cape have shown that secondary school pupils are not considering careers in Computer Science (CS) and Information Systems (IS) [30,19]. Teachers, career/guidance counsellors and parents contribute to secondary school pupils' career decisions and are not encouraging secondary school pupils to pursue careers in ICT.

Secondary school pupils with an aptitude for ICT are reluctant to pursue CS, IS and Information Technology (IT) degree programmes at universities. The image of computing held by the general public, teachers and career advisors is deteriorating even though teenagers use social networking sites daily and computing has become part of every secondary school pupil's life [27]. Secondary school pupils generally have misperceptions of what ICT professionals do and secondary school pupils' disinterest can be attributed to a lack of familiarity with the subject [11].

In a study in the U.S.A., involving more than 800 high school students, more than 80% indicated that they had "no idea" what computer scientists actually do [27]. Carter [11] reported similar findings in that "an alarming number of students (80%) had no idea what CS majors learned". The annual survey from the Higher Education Research Institute at the University of California (HERI/UCLA) indicated a continual decline in ICT programme registration since 2000 and highlighted the negative impression of computer science as a profession amongst high school children [23].

In South Africa, limited research has been conducted specifically relating to secondary school pupils' knowledge of ICT careers and career choices specifically relating to ICT. The reasons why secondary school pupils did not choose to study CS and IS degree programmes and what their general perceptions of the ICT industry were, have been investigated by Jacobs and Sewry [19] and Seymour, et al. [30].

The research question addressed in this paper is: *What are secondary school pupils' ICT career inclinations and perceptions of the ICT industry?*

This paper provides additional and valuable supporting evidence regarding secondary school pupils' knowledge and career intentions specifically relating to CS, IS and IT qualifications. In this paper, the research problem and research objective are discussed in Section 2. Literature on secondary school pupils' career intentions and previous research studies are discussed in Section 3. The research methodology is discussed in Section 4 and the survey results are presented in Section 5. The paper is concluded and proposals and future work is presented in Section 6.

## 2 Research Problem

In the studies conducted by Seymour, et al. [30], and Jacobs and Sewry [19] the career intentions of secondary school pupils to study Computer Science (CS) or Information Systems (IS) in the Western Cape and Eastern Cape of South Africa were investigated. In both studies the term Information Technology (IT) was used to include both CS and IS knowledge areas.

The ACM and IEEE have identified five disciplines resulting in computing-oriented degrees. The five main academic disciplines recognised by the accreditation bodies internationally in computing and the latest recommended curricula guidelines are:

- Computer Science (CS2013) [3];
- Information Systems (IS2010) [1];
- Information Technology (IT2008) [5];
- Computer Engineering (CE2016) [4]; and
- Software Engineering (GSwE2009) [6].

Computer Science is the only discipline with nearly 40% of the core courses in the category of Software. Information Systems is the only discipline with more than 50% of the courses in the category of Business. Information Technology is the strongest in the Net, Web and database categories, including software. Presently the IT2008 curriculum is being re-evaluated and the IT2017 will soon be made available for comment.

Nationally, universities and comprehensive universities are offering CS, IS and IT degree programmes based on the CS2013, IS2010 and IT2008 curriculums. The authors were aware of the possible confusion and misperceptions secondary school pupils may have of IT and that they would not know of the IT discipline or degree programmes at university level. The School of ICT at NMU for example offers IT diplomas and BIT qualifications based on IT2008 curriculum guidelines and the authors therefore decided to repeat a sub-section in the questionnaire, which only referred to CS and IS (Figure 1) and refer specifically to the IT knowledge area.

The research problem investigated in this study is based on the realisation that secondary school pupils may be more familiar with the two Grade 10–12 National Senior Certificate subjects, namely Information Technology (IT) and Computer Applications Technology (CAT). It is therefore assumed that secondary school pupils are more familiar with the term Information Technology (IT) and that that a separate ACM/IEEE discipline and curriculum exists for IT [5]. In the questionnaire used in this study, the questions relating to the knowledge areas of CS and IS were repeated for IT (Figure 1). The research objective of this study was to determine secondary school pupils' career intentions regarding a career choice in CS/IS/IT.

## 3 Secondary School Pupils' Career Intentions

### 3.1 Secondary School Pupils' Perceptions of ICT

Research has indicated that secondary school pupils choosing a career and specifically ICT careers are influenced by parents, teachers, career counsellors and role models [7]. However, Govender and Khumalo [21] found that a small number of IS first year students were inspired by family or friends when deciding about whether to take IS as a major or not. The ICT skills shortage worldwide has sparked renewed interest in research into what influences secondary school pupils' career choices. Various authors and panels have cited the need to attract more high school secondary school pupils to enroll in CS/IS/IT tertiary degree programs. Research currently is focusing on how and why secondary school pupils make decisions to pursue ICT careers and studies [7,9,21].

The Running on Empty ACM report [28] indicated that approximately two-thirds of the states in the U.S.A. have limited computer science education standards for secondary schools and that most high schools include Computer Science as an elective and not as part of the core education. Roman [26] indicates that "much has been written over the last decade about the abysmal state of the education arms race in the U.S.A.". The downward spiral of computer science is continuing and very little is done to redirect the trend [26].

The Conference Board of Canada [12] conducted an extensive study on secondary school secondary school pupils' views about ICT and why a limited number chose careers in ICT. Researchers interviewed 1, 034 grade 9 and 10 secondary school pupils, 60 parents and 54 guidance/career counsellors. The results indicated that 36% of the secondary school pupils considered ICT career opportunities and their decisions were only marginally influenced by job availability and job security. Secondary school pupils (37%) found ICT jobs to be creative and 77% indicated that they believe ICT jobs provide better salaries.

The concerns secondary school pupils identified were that ICT jobs were difficult and complex (34%), the jobs were "not fun" (31%) and "not cool" (25%). The study found that girls' enthusiasm for ICT was lower than boys'. The majority (83%) of secondary school pupils reported that they consult with their parents/guardians for education and career advice. The study found that parents/guardians found ICT less appealing than secondary school pupils. Career/guidance counsellors (75%) viewed ICT careers in a positive light.

Secondary school pupils may develop a negative attitude towards computing as a result of pre-university education [2]. In South Africa, research indicates that the high school subject IT, has a negative impact on future career choices by secondary school pupils and has direct impact on the number of ICT professionals entering and graduating from Higher Education Institutions (HEIs) [20,16].

Research conducted by Babin, et al. [7], Biggers, et al. [9] and Govender and Khumalo [21] has focused on identifying reasons for the lack of interest by secondary school pupils and specifically females in choosing computing as a career choice at tertiary level. The results indicate that secondary school pupils are uninformed or misinformed about ICT career opportunities and job availability. The secondary school pupils' perceptions are that a career in computing is asocial, only focusing on programming and having limited connection to the outside world [9].

*Shadow IT* an intervention in New Zealand, allowed girls to observe a day in the life of a woman working in IT. The girls who participated had a more positive attitude towards IT and the intervention influenced their subject choices and career choices [18]. Interest in IT has been found to have a significant positive impact on the selection of a CS/IS/IT major subject at university [22].

### 3.2 Previous Research Studies

Researchers have developed [21,9,11] and applied various existing instruments and surveys [19,30] to measure secondary school pupils' attitudes, beliefs and perceptions in both CS and IS. Heersink and Moskal [17] developed and validated two assessment instruments measuring attitudes and beliefs about CS and IT. The instruments measured the constructs of: confidence, interest, gender, usefulness and profession. Factor analysis indicated that students could distinguish between the constructs for CS but not for IT.

Research conducted on the reasons why secondary school pupils are not choosing ICT careers in South Africa, are based on two main studies in the Western Cape by Seymour, et al. [30] and by Jacobs and Sewry [19] in Grahamstown (Eastern Cape) respectively. The studies were conducted to determine Grade 12 secondary school pupils' inclinations to study Computer Science or Information Systems at tertiary level in South Africa.

Seymour et al. [30] conducted a study amongst secondary school pupils in the Western Cape, South Africa investigating secondary school pupil's inclinations to major in Information Systems or Computer Science. The study found that secondary school pupils from previously "disadvantaged" schools, schools with limited or no computer infrastructure and offering no computing related subjects (IT or CAT), indicated that they were more inclined to study Information Systems or Computer Science.

The Grahamstown, Eastern Cape study [19] indicated that secondary school pupils attending previously disadvantaged schools were more inclined to study CS. Female and white secondary school pupils were less inclined to consider studying CS or IS. The results further indicated that secondary school pupils who have negative perceptions of ICT salaries and the job market were less inclined to study CS or IS.

Jacobs and Sewry [19] conclude that educational institutions need to promote accurate representations of IT-related subjects and career fields to secondary school pupils. Their research results further indicate that, of the secondary school pupils who take IT as a school subject, very few continue with IT courses at tertiary level. Thus, after being exposed to the IT curriculum at school, secondary school pupils then decide not to continue with a career in computing.

In these studies, it was found that secondary school pupils' previous experience with computers affected their attitudes toward any future use. Both studies found that secondary school pupils with no access to computers at school were more inclined to study Computer Science than those with access to computers. The studies also found that secondary school pupils who have negative perceptions of IT jobs available are less inclined to study Information Systems or Computer Science. Both studies found that secondary school pupils do not know what the Information Systems as a field of study is about although the perceptions of Computer Science were slightly more accurate.

### 3.3 IT and CAT School Subjects – 2017 Matriculation Results

In 2017, 629,155 full-time and 173,276 part-time secondary school pupils wrote the National Senior Certificate examination in South Africa. A pass-rate of 75.1% was announced by the Department of Basic Education [24]. The provinces in South Africa with the highest pass-rates were Free State (86.1%), Gauteng (85.1%) and the Western Cape (82.8%). In the Eastern Cape achieved the lowest pass-rate of 65.0% (n=43,981). The number of secondary school pupils who passed with a "Bachelor Pass" was 28.7% (n=153,610). The Mathematics subject pass rate for 2017 was 51.9% (n=127,197). The Eastern Cape Province Mathematics pass rate of 40% and above for 2017 was 26.5% (n=9541). The minimum pass-rate for Grade 12 subjects and for Mathematics is 30% and above [25].

Computer Studies (CS) started as an official subject in the Western Cape in 1979 and the two subjects Information Technology (IT) and Computer Applications Technology (CAT) has its roots in CS [13]. Grade 9 secondary school pupils in South Africa need to choose seven subjects in order to obtain the National Senior Certificate in Grade 12. Four compulsory subjects (2 official languages, Mathematics or Mathematical Literacy and Life Orientation) and choose three optional subjects from a list of 25 approved subjects. IT and CAT are included in the list of 25 approved subjects.

IT at school includes topics such as solution/application development (algorithms and problem solving), communication technologies (Networks and e-communication), system technologies (hardware and software) data and information management (databases) and social implications (legal, ethics, social, etc.). The majority of the time in this curriculum (± 60%) is spent on programming i.e. solution/application development (algorithms and problem solving). CAT covers topics such as word processing, spreadsheets, databases, HTML, information management, Internet technologies and social implications.

A limited number of schools offer IT as a subject in South Africa as it requires teachers with the required skills set and extensive computer facilities. The IT pass-rate for 2017 was 87.8% (n=3596) and for CAT 92.7% (n=33,810). The pass-rate for IT was 92.6% (n=4464) in 2014, 93.1% (n=4028) in 2015 and 90.3% (n=3926) in 2016. An annual decline over a 4-year period in the number of secondary school pupils passing the IT subject.

## 4 Research Methodology

Research has indicated that secondary school pupils' interests and career choice, including ICT careers, are influenced by parents, teachers, career counsellors and role models [7]. The ICT skills shortage worldwide has sparked renewed interest in research into what influences secondary school pupils' career choices.

Researchers have developed and used various existing instruments and surveys to measure secondary school pupils' attitudes, beliefs, interests and perceptions in both CS, IS and IT [21,19,9,11,30]. Research currently focuses on secondary school pupil's career interests, career awareness and career knowledge [7,9].

The research conducted on the reasons why secondary school pupils are not choosing ICT careers in South Africa, is based on two main studies by Seymour, et al. [30] in the Western Cape and by Jacobs and Sewry [19] in Grahamstown (Eastern Cape) respectively. The questionnaire used was initially developed by Seymour, et al. [30] at the University of the Western Cape and adapted by the Dept. of IS at Rhodes University [19].

The Scholar Career Interest Questionnaire was obtained from the Department of IS at Rhodes University, South Africa. The study conducted by Jacobs and Sewry [19] catered for secondary school pupils to indicate their knowledge of the Computer Science and Information Systems. The questionnaire was adapted by the authors to include IT as a knowledge area as secondary school pupils/learners were familiar with this field of study at school level (Figure 1). Nationally, universities are offering IT degree programmes based on the ACM/IEEE IT2008 curriculum. The authors were aware of the possible confusion and misperceptions secondary school pupils may have of the IT and that they would not know of the IT discipline at university level.

Permission to conduct the research was first requested from the Department of Education in the Eastern Cape. A list of schools, including schools that offer IT and CAT were obtained from the Department of Education. A number of schools was selected and the principals were approached to request participation in the study.

Initially, 24 research hypotheses were compiled to be tested in the research study based on previous research conducted by Seymour, et al. [30] and Jacobs and Sewry [19]. Table 1 indicates the final research hypotheses applicable to the CS/IS/IT Interest Questionnaire selected.

A combination of descriptive statistics and inferential statistics were used to analyse the quantitative data from the seven surveys. The statistical analyses included the Cohen's d practical significance test, paired difference test (t test) and the chi$^2$ test with Cramer's *V* test for practical significance. *Cohen's d* practical significance test measures the practical significance for inferential tests based on sample means [29]. The threshold values used for the Cohen d test are Small: $0.20 < |d| < 0.50$, Moderate: $0.50 < |d| < 0.80$ and Large: $|d| > 0.80$. The Cramer's *V* test is included when using a Chi$^2$ test measuring the association between two variables within a table. The value of Cramer's *V* is an indication of the practical significance of the association between the two variables within a table. The practical significance interpretation intervals used in the statistical analysis is shown in Table 2.

**Please indicate to the best of your knowledge how strongly you agree or disagree with the following statements on a scale of 1 to 5 where:**

*1 – Strongly Disagree*
*2 – Disagree*
*3 – Neutral*
*4 – Agree*
*5 – Strongly Agree*
**(Please circle your option)**

| | Strongly Disagree | | | | Strongly Agree |
|---|---|---|---|---|---|
| The typical student doing **Information Systems**: | | | | | |
| 11. Spends most of his/her time writing computer programs. | | | | | |
| 12. Spends most of his/her time interacting with other people. | | | | | |
| 13. Spends most of his/her time working alone. | | | | | |
| 14. Designs new computer hardware. | | | | | |
| 15. Is a whiz at mathematics. | | | | | |
| 16. Started the degree with a strong prior background in computers. | | | | | |
| | | | | | |
| The typical student doing **Computer Science**: | | | | | |
| 17. Spends most of his/her time writing computer programs. | | | | | |
| 18. Spends most of his/her time interacting with other people. | | | | | |
| 19. Spends most of his/her time working alone. | | | | | |
| 20. Designs new computer hardware. | | | | | |
| 21. Is a whiz at mathematics. | | | | | |
| 22. Started the degree with a strong prior background in computers. | | | | | |
| The typical student doing **Information Technology**: | | | | | |
| 23. Spends most of his/her time writing computer programs. | | | | | |
| 24. Spends most of his/her time interacting with other people. | | | | | |
| 25. Spends most of his/her time working alone. | | | | | |
| 26. Designs new computer hardware. | | | | | |
| 27. Is a whiz at mathematics. | | | | | |
| 28. Started the degree with a strong prior background in computers. | | | | | |
| | | | | | |
| 29. People completing a degree in Information Systems / Computer Science / IT have a starting salary above the average. | | | | | |
| 30. There is currently a high chance of finding a job with an Information Systems / Computer Science / IT degree. | | | | | |
| 31. There will always be a high chance of finding a job with an Information Systems / Computer Science / IT degree. | | | | | |

**Fig. 1.** The three knowledge areas for CS, IS, and IT.

**Table 1.** List of hypothesis for career interest questionnaire.

| **Hypotheses relating to the School Interest Questionnaire.** | |
|---|---|
| **$H_1$** | Scholars attending previously disadvantaged schools are less inclined to study CS/IS/IT than scholars attending previously advantaged schools. |
| **$H_2$** | Scholars with no access to computers at school are less inclined to study CS/IS/IT than Scholars with access to computers at school. |
| **$H_3$** | Scholars with no access to the Internet are less inclined to study CS/IS/IT than Scholars with access. |
| **$H_{4A}$** | Black scholars are less inclined to study CS/IS/IT than white scholars. |
| **$H_{4B}$** | Coloured scholars are less inclined to study CS/IS/IT than white scholars. |
| **$H_{5A}$** | Female scholars at grade 9 level have a less inclination to study CS/IS/IT than male scholars. |
| **$H_{5B}$** | |

| | |
|---|---|
| | Female Scholars at grade 11/12 level have a less inclination to study CS/IS/IT than male scholars. |
| **$H_6$** | Grade 9 scholars have less inclination to study CS/IS/IT than Grade 11/12 scholars. |
| **$H_{7A}$**<br><br>**$H_{7B}$** | Grade 9 scholars at a female only school have a less inclination to study CS/IS/IT than Scholars at a male only school.<br>Grade 11/12 scholars at a female only school have a less inclination to study CS/IS/IT than scholars at a male only school. |
| **$H_{8A}$**<br>**$H_{8B}$**<br>**$H_{8C}$** | Grade 9 scholars do know what CS as a field of study entails.<br>Grade 9 scholars do know what IS as a field of study entails.<br>Grade 9 scholars do know what IT as a field of study entails. |
| **$H_{9A}$**<br>**$H_{9B}$**<br>**$H9_C$** | Grade 11/12 scholars do know what CS as a field of study entails.<br>Grade 11/12 scholars do know what IS as a field of study entails.<br>Grade 11/12 scholars do know what IT as a field of study entails. |
| **$H_{10A}$**<br><br>**$H_{10B}$** | Grade 9 Scholars from advantaged schools are less inclined to study CS/IS/IT careers than Grade 11/12 Scholars.<br>Grade 11/12 Scholars from advantaged schools are more inclined to study CS/IS/IT careers than Grade 11/12 Scholars from disadvantaged schools. |
| **$H_{11A}$**<br><br>**$H_{11B}$**<br><br><br>**$H_{11C}$** | Scholars who have negative perceptions about an IT starting salary are less inclined to study CS/IS/IT than Scholars who have positive perceptions.<br>Scholars who have negative perceptions about the number of IT jobs available are less inclined to study CS/IS/IT than Scholars who have positive perceptions.<br>Scholars who have negative perceptions about the IT job market always having jobs available are less inclined to study CS/IS/IT than Scholars who have positive perceptions. |
| **$H_{12}$** | Scholars who have taken IT as a subject are more inclined to study CS/IS/IT than Scholars who have not taken IT as a subject. |

**Table 2.** Practical Significance Interpretation Intervals [15].

| **Practical Significance Interpretation Intervals** | | | |
|---|---|---|---|
| **Inferential Test: Statistic** | **Small** | **Moderate** | **Large** |
| t-Test: Cohen's d | $0.2 < d < 0.5$ | $0.5 < d < 0.8$ | $d > 0.8$ |
| Chi² Test: Cramer's V | | | |
| df* = 1 | $.10 < V < .30$ | $.30 < V < .50$ | $V > .50$ |
| df* = 2 | $.07 < V < .21$ | $.21 < V < .35$ | $V > .35$ |
| df* ≥ 3 | $.06 < V < .17$ | $.17 < V < .29$ | $V > .29$ |
| * df = minimum (Rows – 1, Columns – 1) | | | |

### 4.1 Main Study

Eleven schools finally participated in the study, five schools classified as being "advantaged" and 6 classified as "disadvantaged". Four "advantaged" schools offered IT and CAT, the remainder of the "advantaged" schools offered CAT and one "disadvantaged" school offered CAT. The high schools offering IT and CAT as a matriculation subject in Grade 10-12 are Alexander Road, Framesby, Grey and Victoria Park. Collegiate and Cowan only offer CAT and provide computer laboratory facilities for scholars. All schools were co-ed (boys and girls) schools, except Grey, which is a boys-only school and Collegiate a girls-only school.

A total number of 2820 questionnaires were distributed to 11 schools and a total of 1536 fully completed questionnaires were finally used in this study, a 54% response rate. The disadvantaged schools received 580 questionnaires and 107 questionnaires were finally used in the study, an 18% response rate. A total of 739 questionnaires were completed by Grade 9's, 455 by Grade 11's and 335 by Grade 12 secondary school pupils. The number of fully completed questionnaires completed by Grade 9 and/or Grade 11/12 secondary school pupils from the 11 schools were: Alexander Road (n=172), Framesby (n=390), Grey (n=321), Victoria Park (n=292), Collegiate (n=274), Cowan (n=60), Siwali S.S.S. (n=7), MPeko S.S.S. (n=2), Kwanobuhle (n=3), Holomisa (n=2) and Cingani (n=33).

The questionnaires were hand-delivered to each school in the Port Elizabeth area and NMU students who lived in the Eastern Cape region assisted with the administration in the region. The possibility of including schools, specifically Black schools not teaching IT, in order to do a comparative analysis was considered and included in the survey. A questionnaire was completed by ICT secondary school pupils/learners in the Eastern Cape, mainly from the Port Elizabeth metropolitan area. The questionnaires consist of closed questions presented using a 5-point Likert scale (1=Strongly disagree to 5=Strongly agree) and a limited number of open-ended questions. The results of the questionnaires will be analysed to quantitatively measure the intended outcomes.

## 5 Secondary School Pupils' Intentions to Study CS/IS/IT

A total of 719 (49%) males and 784 (51%) females participated in the study and 1035 (67%) of the secondary school pupils were White and 501 (33%) Black, Coloured or Indian. The career choices of all secondary school pupils (Grade 9, 11 and 12) who participated in the study indicate that secondary school pupils' first career choice is Medicine (17%), "Other" (13%), Arts and Engineering (10%), Computer Science (3%), Information Systems (1%) and Information Technology (4%).

The Grade 9 secondary school pupils' first career choice is Medicine (18%), Accounting (12%), Arts (12%), Other (11%), Engineering (10%), Computer Science (3%), Information Systems (0%, n=1) and Information Technology (4%). Combining the first, second and third career choices for each specific field of study, the field of study chosen either as first or second or third choice are Other (14%), Accounting (10%), Medicine (9%), Arts/Engineering/Law/Science (8%), Computer Science 3%, Information Systems (0%, n=1) and Information Technology (4%).

The Grade 11/12 secondary school pupils' first career choice is Medicine (16%), Other (15%), Engineering (11%), Accounting (10%), Computer Science (4%), Information Systems (1%) and Information Technology (4%). Combining the first, second and third career choices for each specific field of study, the field of study chosen either as first or second or third choice are Other (19%), Law (9%), Medicine (8%), Arts/Education/Accounting/Engineering (7%), Computer Science (5%), Information Systems (1%) and Information Technology (5%).

The results indicate that Grade 11/12 secondary school pupils are more career focused. Law and Education have become more prominent fields of study and Computer Science and Information Technology were considered as second and third career options. The Grade 9 secondary school pupils indicated if they had to choose between CS, IS and IT, 37% indicated Computer Science, 12% Information Systems and 46% Information Technology. The Grade 11/12 secondary school pupils indicated if they had to choose between CS, IS and IT, 40% indicated Computer Science, 18% Information Systems and 36% Information Technology.

In Grade 9, 13% used a computer daily compared to 44% in Grade 11/12. The alarming statistic is that 18% in Grade 9 and 32% in Grade 11/12 indicated that they never use a computer. The Grade 11/12 data included the data obtained at schools in rural areas (Transkei). The results further indicate that 93% of the Grade 9 and 82% of the Grade 11/12 secondary school pupils indicated that they had Internet access, however only 49% of the Grade 9's and 45% of the Grade 11/12's indicated that they used the Internet to read about careers in CS/IS/IT. The majority (78%) indicated they were aware of information about CS/IS/IT on the web.

Secondary school pupils answering the six questions relating to the statement "The typical student doing" IS or CS or IT indicated that the Grade 9 and Grade 11/12 secondary school pupils' views of the three fields of study are very "similar". The majority of secondary school pupils indicated that for the three fields of study you had to be "a whiz in mathematics" and have a "strong prior background in computers". Interestingly, the Grade 11/12 secondary school pupils indicated that Information Technology students spend more time writing computer programmes than Computer Science students. An explanation of this finding could be that Grade 11/12 secondary school pupils associate the IT degree program offered at university with the programming oriented IT school subject.

Grade 9 and Grade 11/12 secondary school pupils indicated that IS/CS/IT graduates have an above average starting salary. Both groups further indicated that there is a "high chance of finding a job" and "there will always be a high chance of finding a job" with an IS/CS/IT qualification. The results of the hypothesis testing are presented in Table 3.

**Table 3.** Results of hypothesis testing.

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|---|
| **$H_1$: Scholars attending previously disadvantaged schools are less inclined to study CS/IS/IT than scholars attending previously advantaged schools.** |
| **Conclusion:** Inclination to study CS/IS/IT is related to type of school (Chi²(d.f. = 1, n = 1536) = 123.47; p < .0005; V = 0.28 Small). However, H1 cannot be accepted based on the descriptive statistics; scholars attending previously disadvantaged schools are more inclined to study CS/IS/IT than scholars attending previously advantaged schools. |
| **$H_2$: Scholars with no access to computers at school are less inclined to study CS/IS/IT than scholars with access to computers at school.** |
| **Conclusion:** Although a larger proportion of the sampled scholars with access to computers at school are inclined to study CS/IS/IT than their peers without such access (24% compared to 19%), the difference is not significant (Chi²(d.f. = 1, n = 1493) = 2.72; p = .099) and thus $H_2$ cannot be accepted. |
| **$H_3$: Scholars with no access to the Internet are less inclined to study CS/IS/IT than scholars with access.** |
| **Conclusion:** Inclination to study CS/IS/IT is related to Internet access (Chi² (d.f. = 1, n = 1525) = 23.97; p < .0005; V = 0.13 Small). However $H_3$ cannot be accepted based on the descriptive statistics; scholars with no access to Internet are less inclined to study CS/IS/IT than scholars with access. |
| **$H_{4A}$: Black scholars are less inclined to study CS/IS/IT than white scholars.** |
| **Conclusion:** $H_{4A}$ cannot be accepted; Black scholars are significantly more inclined to study CS/IS/IT than White scholars (Chi² (d.f. = 1, n = 1318) = 31.87; p < .0005; V = 0.16 Small). |
| **$H_{4B}$: Coloured scholars are less inclined to study CS/IS/IT than white scholars.** |
| **Conclusion:** $H_{4B}$ cannot be accepted; the difference between Coloured and White scholars' inclination to study is not significant (Chi² (d.f. = 1, n = 1171) = 0.06; p = .809). |
| **$H_{5A}$: Female scholars at grade 9 level are less inclined to study CS/IS/IT than their male peers.** |
| **Conclusion:** $H_{5A}$ is accepted; female scholars at grade 9 level are less inclined to study CS/IS/IT than their male peers (Chi² (d.f. = 1, n = 731) = 42.48; p < .0005; V = 0.24 Small). |
| **$H_{5B}$: Female scholars at grade 11/12 level are less inclined to study CS/IS/IT than their male peers.** |
| **Conclusion:** Although a smaller proportion of the sampled female scholars are inclined to study CS/IS/IT than their male peers. The difference is not practically significant (Chi² (d.f. = 1, n = 772) = 3.91; p = .048; V = 0.07 Not Sig.) and thus $H_{5B}$ cannot be accepted. |
| **$H_6$: Grade 9 scholars have less inclination to study CS/IS/IT than Grade 11/12 scholars.** |
| **Conclusion:** Although the sampled Grade 9 scholars are less inclined to study CS/IS/IT than those in Grade 11/12, the difference is not practically significant (Chi²(d.f. = 1, n = 1536) = 10.68; p = .001; V = 0.08 Not Sig.) and thus $H_6$ cannot be accepted. |

| |
|---|
| **$H_{7A}$: Grade 9 scholars at a female only school are less inclined to study CS/IS/IT than scholars at a male only school.** |
| **Conclusion:** Although a smaller proportion of the sampled Grade 9 scholars are at a female only school, they are not less inclined to study CS/IS/IT than their peers at a male only school. The difference is not significant (Chi² (d.f. = 1, n = 319) = 1.23; p = .268) and thus $H_{7A}$ cannot be accepted. |
| **$H_{7B}$: Grade 11/12 scholars at a female only school are less inclined to study CS/IS/IT than scholars at a male only school.** |
| **Conclusion:** Although a smaller proportion of the sampled Grade 11/12 scholars at a female only school are inclined to study CS/IS/IT than their peers at a male only school. The difference is not significant (Chi² (d.f. = 1, n = 276) = 0.01; p = .935) and thus $H_{7B}$ cannot be accepted. |
| **$H_{8A}$: Grade 9 scholars do know what CS as a field of study entails.**<br>**$H_{8B}$: Grade 9 scholars do know what IS as a field of study entails.**<br>**$H_{8c}$: Grade 9 scholars do know what IT as a field of study entails.** |

One-sample t-test (n = 739; d.f. = 738; $H_A$: $\mu < 50$)

| Variable | Mean | S.D. | t | p | d |
|---|---|---|---|---|---|
| IS Knowledge | 22.48 | 24.39 | -30.67 | <.0005 | 1.13 |
| CS Knowledge | 32.22 | 19.58 | -24.69 | <.0005 | 0.91 |
| IT Knowledge | 20.51 | 23.28 | -34.43 | <.0005 | 1.27 |

| |
|---|
| **Conclusion:** Hypotheses $H_{8A}$, $H_{8B}$ and $H_{8C}$ are rejected; Grade 9 scholars do not know what CS, IS and IT as fields of study entails ($\mu < 50$). |
| **$H9_A$: Grade 11/12 scholars do know what CS as a field of study entails.**<br>**$H9_B$: Grade 11/12 scholars do know what IS as a field of study entails.**<br>**$H9_C$: Grade 11/12 scholars do know what IT as a field of study entails.** |

One-sample t-test (n = 797; d.f. = 796; $H_A$: $\mu < 50$)

| Variable | Mean | S.D. | t | p | d |
|---|---|---|---|---|---|
| IS_Knowledge | 24.50 | 24.25 | -29.68 | <.0005 | 1.05 |
| CS_Knowledge | 30.49 | 20.81 | -26.47 | <.0005 | 0.94 |
| IT_Knowledge | 19.86 | 22.97 | -37.04 | <.0005 | 1.31 |

| |
|---|
| **Conclusion:** Hypotheses $H_{9A}$, $H_{9B}$ and $H_{9C}$ are rejected; Grade 11/12 scholars do not know what CS, IS and IT as fields of study entails ($\mu < 50$). |
| **$H_{10A}$: Grade 9 scholars from advantaged schools are less inclined to study CS/IS/IT careers than Grade 11/12 scholars from advantaged schools.** |
| **Conclusion:** Difference between Grade 9 and Grade11/12 scholars not significant (Chi²(d.f. = 1, n = 1429) = 0.14; p = .709), thus $H_{10A}$ cannot be accepted. |
| **$H_{10B}$: Grade 11/12 scholars from advantaged schools are more inclined to study CS/IS/IT careers than Grade 11/12 scholars from disadvantaged schools.** |
| **Conclusion:** Grade 11/12 scholars from advantaged schools are less inclined to study CS/IS/IT careers than Grade 11/12 scholars from disadvantaged school (Chi²(d.f. = 1, n = 797) = 102.89; p < .0005; V = 0.36 Medium). This is the opposite of what is stated in $H_{10B}$. |

| |
|---|
| **$H_{11A}$: Scholars who have negative perceptions about an IT starting salary are less inclined to study CS/IS/IT than scholars who have positive perceptions.** |
| **Conclusion:** Scholars who have negative perceptions about an IT starting salary are less inclined to study CS/IS/IT than scholars who have positive perceptions ($Chi^2(d.f. = 2, n = 1470) = 28.61$; $p < .0005$; $V = 0.14$ Small); thus $H_{11A}$ is accepted. |
| **$H_{11B}$: Scholars who have negative perceptions about the number of IT jobs available are less inclined to study CS/IS/IT than scholars who have positive perceptions.** |
| **Conclusion:** Scholars who have negative perceptions about the number of IT jobs available are less inclined to study CS/IS/IT than scholars who have positive perceptions ($Chi^2(d.f. = 2, n = 1464) = 33.77$; $p < .0005$; $V = 0.15$ Small); thus $H_{11B}$ is accepted. |
| **$H_{11C}$: Scholars who have negative perceptions about the IT job market always having jobs available are less inclined to study CS/IS/IT than scholars who have positive perceptions.** |
| **Conclusion:** Scholars who have negative perceptions about the IT job market always having jobs available are less inclined to study CS/IS/IT than scholars who have positive perceptions ($Chi^2(d.f. = 2, n = 1463) = 21.97$; $p < .0005$; $V = 0.12$ Small); thus $H_{11C}$ is accepted. |
| **$H_{12}$: Scholars who have taken IT as a subject are more inclined to study CS/IS/IT than scholars who have not taken IT as a subject.** |
| **Conclusion:** Although a larger proportion of the sampled scholars who have taken IT as a subject are inclined to study CS/IS/IT than scholars who have not taken IT as a subject, the difference is not significant ($Chi^2(d.f. = 1, n = 1516) = 3.21$; $p = .073$), and thus $H_{12}$ cannot be accepted. |

## 6 Conclusions

Secondary school pupils in South Africa are generally unaware of careers in ICT. The problems are further exacerbated in that parents, teachers and specifically guidance teachers do not encourage high school scholars to take IT as a matriculation subject and do not encourage secondary school pupils to pursue ICT careers [7]. The problems experienced within the high school system (under-qualified teachers, lack of IT teachers, teachers and career counsellors not promoting ICT careers and secondary school pupils' general lack of knowledge regarding ICT careers) are all contributing factors to the declining CS/IS/IT enrolment figures at HEIs. There are further major problems with the IT curriculum at school level, a shortage of qualified IT teachers and an inadequate ICT infrastructure at the majority of schools. The factors all contribute to the fact that secondary school pupils lack the interest to pursue ICT careers in South Africa.

The study by Jacobs and Sewry [19] indicated that in the Grahamstown area of the Eastern Cape, secondary school pupils' previous experience with computers affected their attitudes toward any future involvement. The study also found that secondary school pupils who have negative perceptions of IT jobs available are less inclined to study CS or IS.

The overall results indicate that secondary school pupils are not interested in CS/IS/IT careers and have a very limited knowledge of the fields of study. Students of previously disadvantaged backgrounds were more inclined to indicate that they were interested in ICT careers and female secondary school pupils were less inclined to pursue careers in ICT. All secondary school pupils had inadequate knowledge of CS, IS and IT and knew slightly more about CS than about IS and IT.

Grade 11/12 secondary school pupils preferred other fields of study not listed in the survey. Grade 11/12 secondary school pupils are more career focused and have chosen fields of study including Law, Medicine, Arts, Education, Accounting and Engineering. A small number of secondary school pupils were interested in Computer Science (5%, n=33), Information Systems (1%, n=8) and Information Technology (5%, n=31) as a first career choice.

The results of this study confirm the findings by Jacobs and Sewry [19] who indicated that secondary school pupils of colour and secondary school pupils with no access to computers are more inclined to pursue ICT careers. The study also found that secondary school pupils that have negative perceptions of IT jobs are less inclined to study CS and IS. The study further concluded that secondary school pupils lack the interest to pursue ICT careers.

The results of this study indicate the urgent need for interventions and emphasise the important fact that secondary school pupils do not pursue CS, IS and IT degree programs due to limited knowledge of the fields of study. The majority of comments provided by secondary school pupils indicated that they require and desire more information about the ICT career prospects and study directions. Future research should investigate redesigning the questionnaire with more current and appropriate statements relating to the CS/IS/IT study fields.

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# Teaching Programming

# A blend of Jigsaw and peer-to-peer approach to teaching programming in a systems development course

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**Abstract.** In this paper, jigsaw and peer-to-peer learning approaches are applied to teaching programming in a systems development course. The course's main objective is to develop a front end web based information system. However, students first develop their programming abilities before they embark on a key milestone of the course, which is the major project. Therefore, the first part of the course entails teaching programming. The effectiveness of the hybrid method in stimulating learning interest, increasing knowledge retention and assimilation, and improving performance is practically assessed in the context of teaching programming in a systems development course. Nowadays, there is a shift from teacher-centered learning to student-centered learning, hence new approaches are needed to foster stronger cooperation, collaboration and fruitful academic interactions among students from the undergraduate level. After teaching programming using the combined learning approach as a method of instruction, a survey was conducted among students to determine its effectiveness using various indices of quality. Not only does it yield interesting insights but it also demonstrates the impact and effects generated by adopting the hybrid learning method in teaching programming. The majority of the students were positive about the learning approach as reported in the results.

**Keywords:** Jigsaw, Peer-to-peer, Teaching and learning, Computer programming, System development.

## 1 Introduction

Programming has always been a difficult subject for novice learners. Robins et al. [31] observed that learning programming requires a lot of practice, collaboration and problem solving skills. Moreover, learning programming is not just grasping the syntax and semantics of the language, but it involves learning to construct mechanisms, decompose tasks, adapt patterns, and represent programming knowledge, which constitute a steep learning curve for novice learners [12]. In order to alleviate the learning challenges of novice programmers, several strategies have been suggested to improve programming pedagogy including collaborative learning, which was also suggested by Sentence and Csizmadia [34]. This approach minimises the problem of individuals failing, which may result in learners giving up learning as failure erodes the confidence to learn programming within a systems development course. Therefore, collaborative learning in



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programming, as explained by Hayashi et al. [14] shifts the burden of complexity from an individual to the team. Although numerous collaborative learning techniques are presented in the literature, Bati et al. [3] stress that most of the techniques focus on the process, while little or no emphasis is placed on the environment and academic milieu that dovetails with the peculiarities of learning programing.

Traditionally, the common method of teaching has always been based on lecturer-to-student instruction where a lecturer instructs students, who then respond by taking copious notes or posing questions to the lecturer. In this learning paradigm, students are the recipients of knowledge and lecturers assume the role of initiating and dispensing knowledge. However, there has been a significant shift from the passive means of instruction to active and interactive methods of instruction with a view to increase active participation and engagement of learners, as presented by Michel et al. [24], Hackathorn et al. [13], Barraket [2], and Jadallah [18]. However, teaching programming intrinsically requires practical cooperation under the framework of collaborative learning. This entails pair programming which creates positive peer pressures among students for learning programming.

Given the current wave of interest for modern forms of instruction, mobile technology has increasingly become a crucial tool for learning, as explained by Montrieux et al. [25], and educators continue to harness its great potential in teaching difficult subjects, such as programming. A study by North and Ophoff [27] about South African university students' usage of mobile technology found that more than 90% of the students have access to mobile devices and use them in their academic activities, as also echoed by Kreutzer [19]. However, these tools have not been fully integrated into the learning process especially in teaching programming. As expressed by Sung et al. [35], learning programming cannot be limited to the classroom only. It requires outdoor learning and experience, hence the integration of mobile technology enhances collaboration and facilitates learning outside the classroom. Collaborative learning is essential for learning programming, since the course requires problem solving and critical thinking skills. This implies that programming is both problem-based and practical oriented. Moreover, there is a diverse range of student abilities including weak and bright students. Hence, for a relatively difficult and practical course such as programming, an efficient learning approach is required to ensure easy sharing of knowledge not only to increase interest, and retention in the course, but also to improve performance and deepen practical knowledge.

In this study, two methodologies are hybridized and applied to teaching programming in a systems development course with a view to improve student experiential learning. These methods are: jigsaw and peer-to-peer. They are explained in-depth by Tewksbury [38] and Goldschmid and Goldschmid [11]. The methodologies are amalgamated in a way that harnesses their individual qualities in the context of teaching programming. Moreover, this approach is also handy in cases where there are large student numbers, which often times poses challenges, such as alienation, lack of efficient participation and less academic engagement. This innovative approach was therefore applied to improve participation of students, increase experiential learning of programming and improve performance. The study is based on the survey that was conducted on third year students in the programming and system development course guided by the following questions:

1. What was the impact of the hybrid approach on students' interest in learning programming?

2. Was there a demonstrable practical understanding of programming and increased knowledge of its application as a result of using the combined learning approach?

3. To what extent did the hybrid approach influence the performance of students?

# 2 Related Literature

## 2.1 Jigsaw learning approach

The jigsaw learning strategy was created by Aronson and Patnoe [1] to facilitate student participation and foster the learner-centered approach. Students under this approach are split into small groups which are heterogeneously structured and each member of the group becomes an expert on a specific aspect of the subject in hand. Each member then engages in a series of discussions with others in order to share knowledge and learn from each other.

Students break out in small groups and the course material is also broken into parts to be shared among groups. Each group takes its part of the "puzzle", as explained by Persky and Pollack [28]. Students interact with each other in different groups especially groups that have similar parts of the "puzzle". The expert group collects all the necessary information to be topic experts and ensure that everyone in the group has the correct information about the topic. Finally, students revert to their jigsaw group to share their knowledge with other fellow members. Moreover, access to other pieces of the puzzle is strategically made known through other group members to ensure efficient participation and cooperation between students.

Escudero et al. [10] presented the impact of the jigsaw learning method on students' performance. The study reveals significant interest by students in using the jigsaw method due to its cooperative nature. Students who have additional learning needs are able to obtain support easily due to the engaging and cooperative nature of the jigsaw learning environment. This is in contrast to the individual method that accents the abilities of the bright students without regard for struggling students [10]. The jigsaw learning approach is inherently structured and collaborative in nature. Sahin [32] assessed the efficacy of the jigsaw II method in improving students' performance. Results indicate a positive uptake and improved student performance. This is similar to the work presented by Huang et al. [17] which used a social tool as a learning platform for students to collaborate and discussion of the materials uploaded on the social platform. Results show that both bright and struggling students prefer the jigsaw learning approach. However, the very bright students prefer the individual method. The problem is that the low-achieving students do not effectively benefit from the jigsaw when it is applied independently of peer-to-peer learning method.

A study by Huang et al. [17] was conducted on the application of the jigsaw method to mobile learning where students assisted each other through some experts that presented their discussions online to enable access to all students including failing students in order to benefit from the discussions. The effect of the jigsaw method reduced the failure rate among students and subsequently increased the teachers' affinity towards using this method. In a very recent study of students' knowledge retention in Vietnamese higher education, Dat [8] found that students retained 99 percent of the content six weeks after it was taught using the jigsaw approach. This finding was affirmed by Bhandari et al.'s [4] study in which the jigsaw approach was used in a physio class.

Voyles et al. [41] show that the jigsaw method improves the key aspects of effective learning which include communication, collaboration, listening and knowledge sharing. However, the peer-to-peer component is not strong enough to facilitate individual to individual partnership that facilitates a transfer knowledge from one person to the other. As a result, the gap between high and low performing students keep expanding.

Rachmah [29] applied the jigsaw learning approach to the psychology class at the University of Lambung. The study focused on the impact towards students' self efficacy to learn by the jigsaw learning method. After experimenting with the t-test, results show increased student motivation to learn and improved self-efficacy. However, other studies, such as one done by Sengul and Katranci [33] show different results when the jigsaw learning method is singly applied. However, student accountability to each other improved as demonstrated by Persky and Pollack [28] due to the obligation and responsibility that comes from the positive competition and the need for each member to complete their task so as to obtain the collective score as a group.

The jigsaw strategy has been applied extensively in teaching various subjects, such as chemistry and others. The feedback from numerous studies including Maden [21], Mengduo and Xiaoling [22], indicate that the jigsaw learning framework is creating a positive impact to learning difficult courses. However, students that have communication impairments or other communication challenges find it hard to participate under the learning approach. This is also true for students that fear group interactions but would be comfortable with peer-to-peer engagements.

Although student achievement is enhanced as a result of high motivation and keenness due to students' active participation, vanWyk [40] observes that the teacher still acts as an expert in this paradigm. All the individual groups benchmark their work against the teacher's expert knowledge on the subject which makes the teacher central to the learning process.

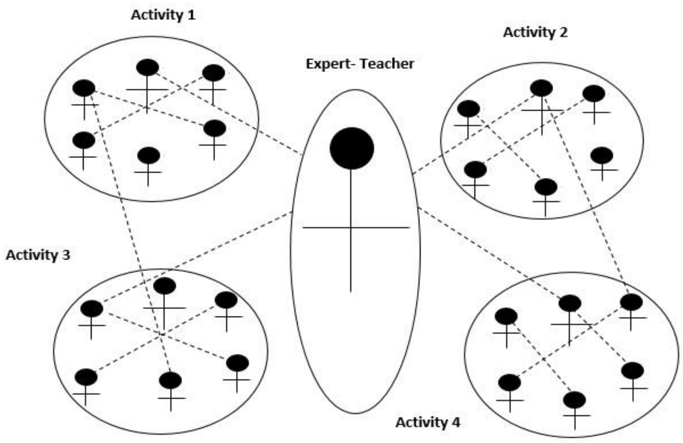


**Fig. 1.** Jigsaw expert structure that demonstrates how the academic content being studied can be divided into different tasks and assigned to each different group.

Each task is further decomposed into sub tasks for each member in the group. This is to ensure full participation of every learner in the circle. However, the complexity of the task at hand affects the students' motivation, for example, bright students would enjoy cooperative learning if the task is challenging and difficult [17]. Although more gifted and talented learners mingle with the less talented ones to share knowledge and offset their individual weaknesses, Shachar and Fischer [36] express concerns that the dominance of an individual student in the group is prevalent especially if there has not been a rigorous peer-to-peer structure underpinned by a common set of standards and expectations.

## 2.2 Peer-to-Peer Structure

The peer-to-peer learning structure is about acquiring knowledge and skills through equals or people with equal status as expressed by Topping [39]. Peer-to-peer is another form of cooperative studying and collaborative learning whereby there is no expert or teacher who is of a different status, individuals work on tasks independently but learn from each other through peer-to-peer interaction. Learning is facilitated by easy sharing of information and knowledge between peers.

Dehghani et al. [9] evaluated the efficacy of the peer learning method at Shiraz University. The class of 35 students was divided into groups of two or three students each. The teacher guided the knowledge sharing between students, the results indicated an increase in stimulated learning and improved anxiety coping. Similar effects are echoed by Raymond et al. [30], but added that peer learning reduces the isolation felt by online students. However, 29 percent of students disliked the method on the basis that if the student does not have good communication and interaction skills, the student benefits less from the peer-to-peer learning process [30].

Wessel [42] presented different types of peer learning techniques, such as peer tutoring, peer online learning and feedback. With these techniques subsumed in the peer-to-peer structure, students' social abilities are improved which in turn enhances better communication to create better academic performance which is also experienced by Mengping [22]. Students are less likely to feel intimidated when interacting with their peers than when interacting with teachers. In this approach, teachers let students drive the learning process to create an environment of student active engagement.

Boud et al. [6] observed that the peer-to-peer structure instils the value of responsibility since anyone can contribute or share ideas. Power within the network of learners is distributed and not concentrated in one individual as an expert. One of the benefits of the structure, as demonstrated by Henning et al. [15] is improving the performance for weak and less-achieving learners. However, the diversity component is limited because students could pair homogeneously. This means that the peers are of the same nature which hampers effective learning and decrease performance. Moreover, another inherent challenge is peer exploitation especially where you have a gifted and hard-working peer who is always willing to do all the tasks without giving an opportunity for the other peers to partake in the discussion and learn.

Stone et al. [37] observed the importance of an expert/teacher in the peer-to-peer learning framework. Peers pass information to each other without critical assessment hence requiring the teacher to control the learning process. However, when it comes to new ideas and complex concepts, Stone et al. [37] demonstrate that new learners feel at ease to learn from their fellow peers thus reducing anxiety and low self-esteem thereby increasing academic performance.

Learners in the peer-to-peer framework follow a reciprocal model where each peer, P can either be at the sending or receiving end of the learning process as demonstrated in Figure 2. The framework contributes to rigorous learning since peers benefit from a wide array of knowledge gained from different peers through collaboration. However, concerns of apprehension by the learners in the peer-to-peer structure are discussed in the literature [16,20].

Coorey [7] presented the strategies for design education and active learning. In a dynamic learning environment, the active learning strategy that was specifically proposed was peer learning to augment any other technology that is available for teaching and learning. Results indicate high student comprehension rates. Mustafa [26] investigated peer learning as an academic culture among graduate students in education. Despite peer learning's academic benefits, challenges still exist, such as lack of infrastructure and technologies that support peer learning.

Bjork et al. [5] assessed the perception of students on adoption of peer learning method in the clinical learning environment beyond the traditional hospital setting. Students that used the peer learning method registered higher scores compared to students that used the individual method. In a similar vein, students at Bushehr University of medical sciences were surveyed in regard to their experiences about peer learning, as shown by Mengping [23]. The majority of them expressed satisfaction with the peer learning method and highlighted in-depth learning and little stress as some of its demonstrable benefits. However, there are concerns around over dependency on peers given that weak students can depend more on the high achieving students. The question of adequate competence necessary for peers to drive the learning process is also a concern presented by students and educators.

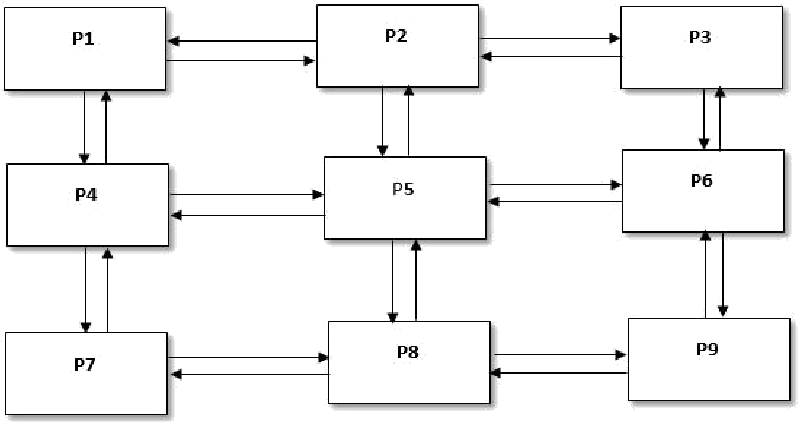


**Fig. 2.** Peer-to-Peer Learning Matrix Structure demonstrating the communication process between peers in a peer-to-peer academic setting.

## 3 Methodology

### 3.1 Context

A systems development course is offered as a two semester course in the third year of the Bachelor of Commerce programme majoring in Information Systems and Technology. The major part of this course is taught sequentially by two instructors. The project management section of the course consists of three weeks of teaching, while the remainder of the course focused on programming and development of the front end and back end of a system.

### 3.2 Population

In a class of 137 students, the jigsaw approach was applied by dividing students into groups of 10 students each. In addition, the group members were allocated numbers based on their academic abilities. The highest scores were 85%, 82% and 80%. These students formed group A while the lowest achieving students whose scores were 35%, 42% and 44% formed group B. Group C consisted of students whose scores were 72%, 75% and 78%. The next lowest achieving group's scores were 33%, 40% and 41%. These students formed group D. The same criteria was used to form other groups. Students' abilities are extrapolated from their assessment marks from the previous year by examining their academic records to determine the progressive academic strengths and weaknesses of each student

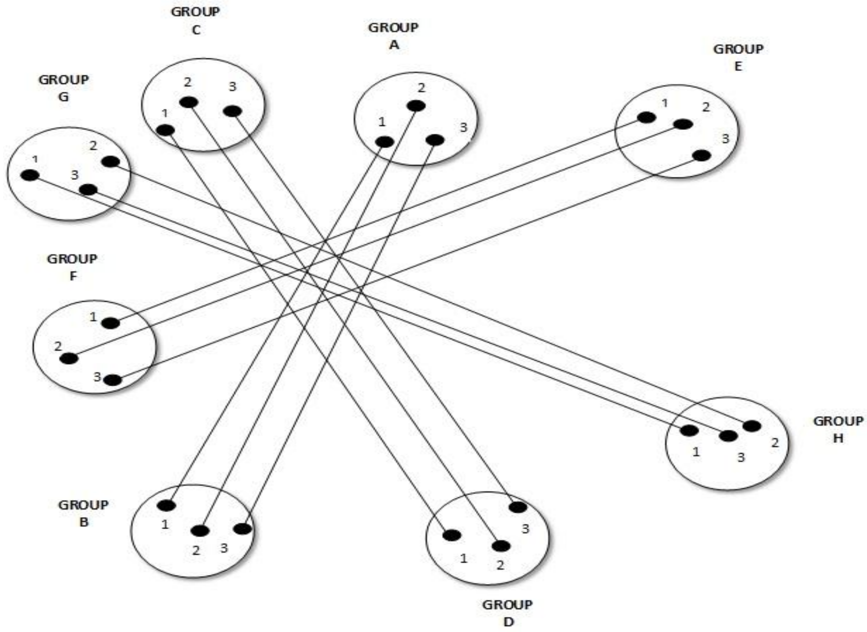


**Fig. 3.** Students break out into groups and are allocated numbers based on their academic abilities. The combined approach is implemented in a systems development course.

For example, since the highest mark in a class of 137 students was 85%, 1 was assigned to the student who got 85%. The second best student scored 82% marks and was assigned 2. The third best student scored 80% marks and was assigned 3. As shown in Figure 3, in group A, high-performing students are allocated numbers first in the sequence of 1, 2, 3, etc. in their performance order. In group B, low-performing students are allocated numbers first in the same sequence of 1, 2, 3, etc. based on their academic records for example a student who scored 35% marks was assigned 1, a student who scored 42% marks was assigned 2 and a student with 44% marks was assigned 3 in a different group. Similar criteria was used for other groups. Any labels can be assigned to students for identification and easy pairing.

As shown in figure 4, the peer-to-peer and jigsaw group meetings are integrated in the same learning process for effective learning of programming. This learning structure brings together high and low-performing students to interact and share knowledge. This is particularly important in the programming course where students were required to develop a software product that would be used to facilitate business oriented processing and business decision making. The role of the teacher is to implement the structures presented in Figures 3 and 4.

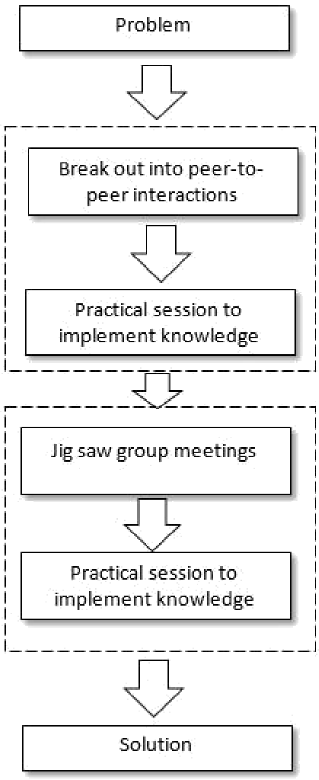


**Fig. 4.** A hybrid learning model showing the key components of the proposed approach.

The major project component of the course fit well in the combined learning structure because the major project was based on a hybrid model consisting of analysis, design and implementation. It had different aspects that made sharing and collaboration easy between peers within the groups. Students were tasked to create a front-end system for the major project and a website that makes use of the server-side programming. The milestones were broken down into small manageable tasks and allocated to different groups. Further to peer-to-peer collaborations which subsumes pair programming in different groups, discussions also took place across groups as the peer-to-peer component is emphasized by awarding marks for all peer-to-peer contributions in all the groups. Programming was a key component of the system development course.

### 3.3 Survey

Most of the information regarding peer-to-peer and jigsaw learning methods in the academic settings have been discussed extensively in literature although scantily applied to the context of the South African academic environment. In this paper, the efficiency and utility of combining jigsaw and peer-to-peer learning methods are investigated.

Both techniques are combined into one learning methodology for programming. A survey was conducted on 137 students from different streams and data was collected using questionnaires.

### 3.4 Survey instrument structure

The survey is structured in four sections. The first section deals with the impact of the learning approach towards interest and motivation for programming. Students are asked to determine if the combined approach increases their interest in learning programming which in turn affects their ability to learn and to achieve the course learning outcomes. The second section focuses on knowledge maximization. Students are asked whether the learning approach helps students to attain required practical skills and knowledge in programming. The learning flexibility under this method gives students the confidence to communicate and exchange knowledge between each other in order to be more adept at programming. The third section deals with the broad impact of the learning method. Students give their take on whether the approach improves their course performance. This is important because it assesses the overall impact of the learning method on the systems development course. The fourth and final section surveys the perceptions of both weak and high-achieving students about the learning approach. Students are asked whether the applied learning model alleviated their fears especially those associated with the difficulty of learning programming. Given the general perceptions on the programming course, this study aimed to assess how the new learning approach impacted, if at all the process of learning to program.

### 3.5 Data Analysis

The analysis of data starts with an overview of the sample population which covers 137 students between the ages of 21 and 28 years. 75% of students fall between 21 and 25 and the rest fall between 26 and 28. Students that did not disclose their age are 10%. Among the respondents, 55% are female and 45% are male. The surveyed students are registered in different courses including, Computer Science (71 respondents), Commerce (55 respondents) and Business Science (11 respondents). Respondent information is summarized in Table 1.

**Table 1.** A summary of the respondents.

| Degree program | Respondents # | Percentage % |
|---|---|---|
| Bachelor of Computer Science | 71 | 51.8 |
| Bachelor of Commerce | 55 | 40.1 |
| Bachelor of Business Science | 11 | 8 |

Questionnaires were used to collect data in the survey. It took a single period, 60 minutes to collect data from each lecture class. However, students were told that they could use a double session to complete the questionnaires at their own pace. There were no distinct observed behaviours occasioned by the age demographics in usage of the hybrid learning structure.

**Table 2.** Survey Questions.

| Questions | Respondents | Strongly Agree | Agree | Strongly Disagree | Disagree | Not Sure |
|---|---|---|---|---|---|---|
| Did the hybrid approach increase your interest in learning programming? | 137 | 94 | 35 | 0 | 2 | 6 |
| Was there a demonstrable practical understanding of programming and increased knowledge of its application as a result of using the combined learning approach? | 137 | 75 | 45 | 0 | 7 | 10 |
| Did your course performance improve as a result of using the combined learning approach? | 137 | 49 | 40 | 0 | 26 | 22 |
| Did the approach alleviate the fears you had due to difficulties associated with learning programming? | 137 | 52 | 57 | 3 | 10 | 15 |

From Figure 5, it can be seen that 94 respondents strongly agreed that a hybrid of jigsaw and peer-to-peer learning approach enhances the interest in learning to program. This comes to 69% of the 137 students that were sampled. 35 students (26%) agreed, 2 students (1%) disagreed and 6 students (4%) were not sure. Students were able to give feedback after the lecture that was conducted using the combined learning method.

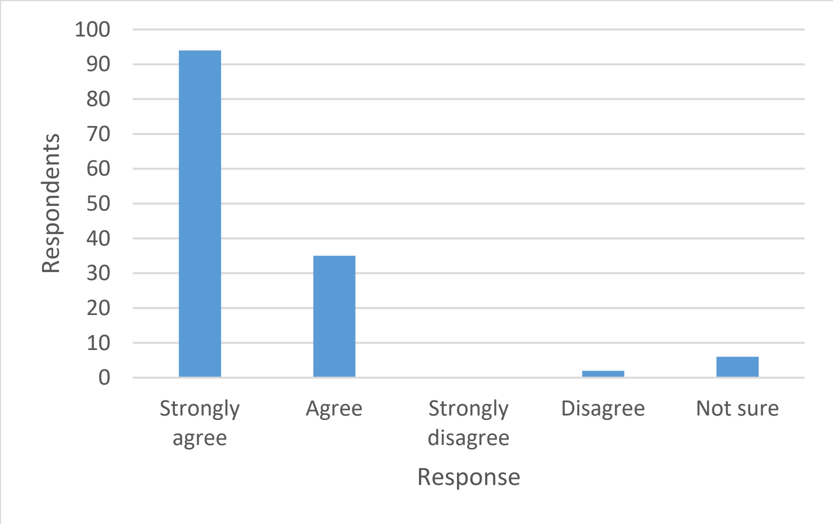


**Fig. 5.** Effect of the combined learning approach on students' interest and motivation towards programming.

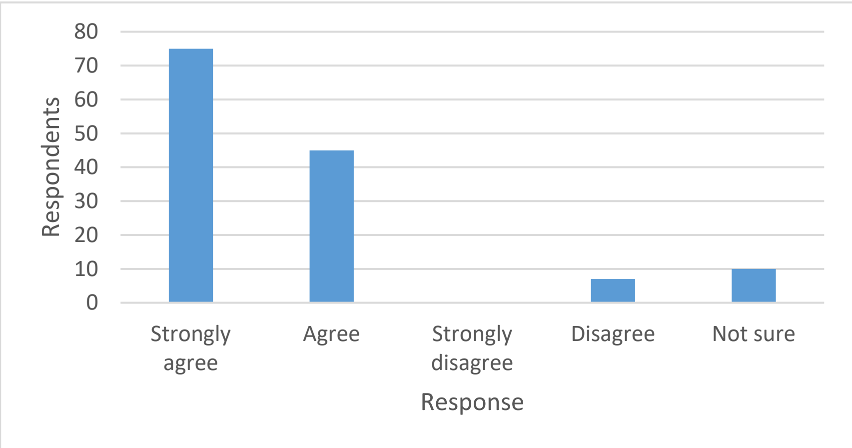


**Fig. 6.** The impact of the combined learning approach on increasing students' practical understanding and knowledge of programming.

In Figure 6, 75 students expressed strong agreement to the influence of programming on increasingly attaining the practical programming knowledge. This comes to 55% of the population sample. 45 students (33%) agreed, 7 students (5%) disagreed and 10 students (7%) were not sure.

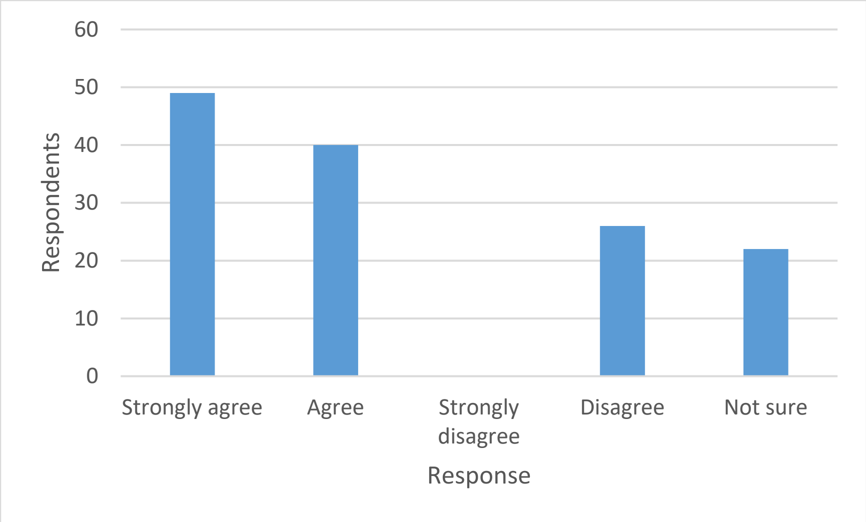


**Fig. 7.** The impact of the combined learning approach on increasing students' practical understanding and knowledge of programming.

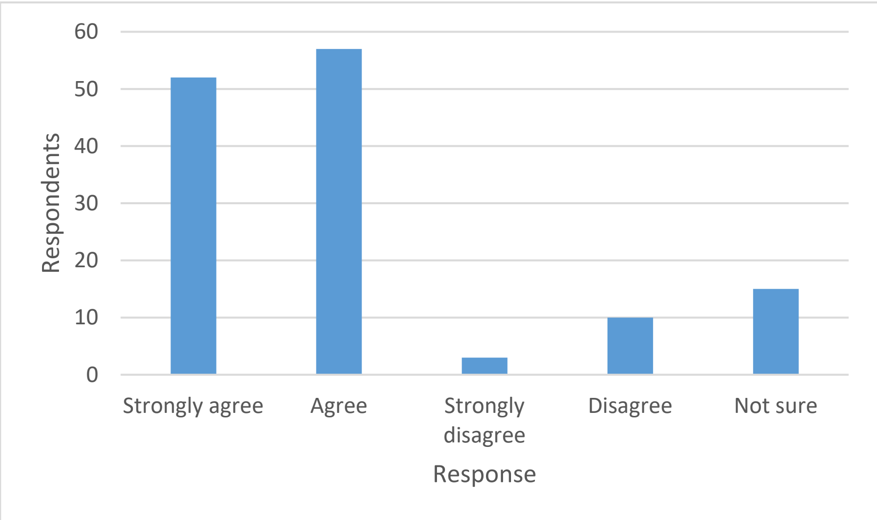


**Fig. 8.** The impact of the combined learning approach on increasing students' practical understanding and knowledge of programming.

In figure 7, 49 students (36%) strongly agreed to the direct influence of the combined learning on the performance. This implies that respondents attributed their performance in the course to the combined learning method. 40 students (29%) agreed, 26 students disagreed (19%) and 22 students (16%) were not sure.

In Figure 8, 52 students (38%) strongly agreed that the combined learning approach alleviated their pre-conceived notions and fears associated with learning programming. The approach made learning programming easier. 57 students (42%) agreed, 3 students (2%) strongly disagreed, 10 students (7%) disagreed and 15 students (11%) were not sure.

**Table 3.** T-test sample statistics

| | t | df | Sig. (2-tailed) | Mean Difference | 95% Confidence Interval of the Difference | |
|---|---|---|---|---|---|---|
| | | | | | Lower | Upper |
| NotSure | 2.496 | 136 | .014 | .0438 | .009 | .078 |
| StronglyAgree | 17.845 | 136 | .000 | .7007 | .623 | .778 |
| Agree | 6.831 | 136 | .000 | .2555 | .182 | .329 |

In Table 3, the two tailed p-value is statistically significant as it is less than 0.05, hence rejecting the null hypothesis. The population sample for all participants was 137 students. The difference between means is calculated and the different relative to the variation in the data are shown in the figure.

As a result of the high achieving students having to work harder in groups hence making more contributions in the groups and transferring knowledge to the weaker students, 35% of the respondents registered disagreement in the survey. However, the majority of the correspondents affirmed that the combined learning approach is an effective mechanism for learning programming. Respondents were able to understand programming better and apply it easily when the learning method was used as a method of instruction.

## 4 Conclusion and future work

The jigsaw and peer-to-peer learning methods have been extensively applied independently of each other in improving learning in institutions. However, the current learning environment has drastically changed due to among other things diversity and increasing competition. According to Bati et al. [3] programming is still perceived as a difficult subject by many learners despite several postulated mechanisms aimed to alleviate the challenges of learning programming. The strands of collaborative learning, such as pair programming and peer–to-peer have been recognized as dependable ways of learning programming. In this paper, a hybrid approach that integrates jigsaw and peer-to-peer learning models was postulated to address the difficulties associated with learning programming, by harnessing the benefits of both methods. This approach was applied in teaching programming in the systems development course of 137 students. Subsequently, a survey was conducted and the majority of students indicated that the approach improved their learning and alleviated their fears for programming. The approach also provides an impetus and an enabling environment for academically weak students to improve their performance, as they share knowledge with high-performing students. Students felt more confident and in control of the learning process under this approach which increased their problem solving skills and programming practice. The potential future directions for this research include creating an intelligent algorithm for distributing students into specific groups according to their performances. The future work will make further comparisons between the hybrid method and each individual method.

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# The Nature of Pre-Service Teachers' Experiences while Transitioning from Visual to Procedural Programming

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**Abstract.** Pre-service teacher's experiences were investigated while transitioning from visual (Scratch) to procedural (QBASIC) programming in a Nigerian College of Education. Using a hermeneutic phenomenological method of inquiry, data was collected through interviews, observation and student reflective journals. A total of twenty-four students enrolled in 2015/2016 and thirty-four students enrolled in 2016/2017 academic sessions were purposively sampled out of the population. We found that using Scratch as a foundation for the learning of QBASIC programming supported the learning of programming concepts, and motivated students to learn QBASIC programming. Although pre-service teachers experienced frustration regarding the Scratch environment and the learning of control structures and repetitions, they attributed their knowledge in QBASIC programming to the impact felt in Scratch. It was therefore proposed that Scratch programming be introduced as a semester course during the pre-service teachers' first year at the College of Education.

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# Communities

# An Investigation of the Benefits of a Learning Community in a B.Tech Information Technology Qualification

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**Abstract.** The Information Technology (IT) industry is one of the fastest evolving industries world-wide. The creation of a learning environment for IT students where they are exposed to the latest technology and developments in industry poses a huge challenge to IT departments in higher education institutions. Students should not only be taught programming techniques that will provide them with skills that will enhance their employability, but they must also be taught project management skills that will enable them to plan, schedule and manage the progress of IT projects which will improve their marketability. Currently Advanced Development Software IV (OPG41AB) and Information and Technology Management IV (ITM41AB) are two compulsory modules that run concurrently in the B.Tech. IT program during the first semester at the Central University of Technology Free State (CUT). Due to the very short time span of both these modules a decision was taken to investigate a linked course model for the teaching these two modules. The study was a quasi-experimental field study, which collected quantitative and qualitative data with a survey. Time management skills, team work, leadership skills, communication skills, and problem solving skills were determined to be the most important benefits students gained. The results of this study could be used in the implementation of a linked course teaching approach that could provide an enhanced teaching and learning environment for students.

**Keywords:** Collaborative learning, Linked courses, Graduate attributes, Learning communities.

## 1 Introduction

Students in higher education institutions today live in one of the most information rich societies that ever existed. They are bombarded daily with a never-ending flood of information from various sources. It is crucial for students to develop an ability to make sense of this sea of information to be successful in tertiary education and in life. This ability will to a large extent depend on how well they will be able to connect and integrate contrasting theories, facts and contexts in order to understand their multifaceted world [21].



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Educators from all over the world have realised that the tertiary experience of students have become too fragmented to prepare them for the intricacies of today's world [6]. According to [12] a shift from the traditional Instruction Paradigm to the Learning Paradigm played a central role in the implementation of collaborative learning opportunities by tertiary institutions.

A huge challenge in the IT Department at CUT currently is the extreme time-pressure on the B.Tech. students. Students are expected to complete 10 subjects for their B.Tech. qualification, and most students are registering for 5 subjects during the first semester and 5 subjects during the second semester. It is extremely challenging to provide students with projects of a big enough scale to practically apply the knowledge and skills that they are being taught. Due to the extreme time-pressure the development of graduate attributes are often not incorporated into assignments and activities. The creation of a learning community where the two compulsory modules of the B.Tech qualification are linked, could alleviate this time-pressure while at the same time providing students with the opportunity to actively participate in the learning process by taking ownership of the development of their own uniquely designed computer applications.

Little research on linked courses in the African continent is currently available, and this paper will aim to fill this gap providing results of research that was conducted at a South African Higher Education Institution. Previous research also focused to a large extent on linked courses for students in their first and second year of study, while this research examines post graduate linked courses.

The objective of this study was to determine which benefits students obtained from the linking of OPG41AB and ITM41AB, and to provide recommendations on how linked course teaching can be used to provide an enhanced teaching and learning environment for students.

This paper is structured to first provide a background on learning communities. It is followed by the methods, results, discussions and conclusions of the paper.

## 2 Learning Communities and Linked Courses

Collaborative learning can be described as a collection of educational methodologies that involve the combined intellectual effort of students or of students and teachers. Students are usually working in groups of two or more in the search of mutual understanding and meaning, or in creating solutions or products [8]. Collaborative learning activities encourage students to explore their course material to form connections between their newly acquired and existing skills, knowledge, and experiences, allowing them to actively respond to the ever-changing needs of society. Tertiary institutions have a major role to play in the development of integrative skills that are necessary for students to meet the challenges they are facing [4].

One way to approach collaborative learning is the creation of learning communities. Learning communities can be defined as a group of individuals who collaboratively engage in a learning effort toward a mutual goal during a typical time period of one semester in academic settings [13]. The interdisciplinary learning environments that are created by learning communities help students to be active participants in the learning process by fostering an environment where creative thinking, open communication and negotiation is encouraged, resulting in mutual respect for each member in the community [4].

Various approaches are employed to establish student learning communities. The linked course model is a popular approach for the creation of learning communities and is offered in many higher education institutions [12]. According to [11] linked courses is one group of students enrolling for two different courses. The lecturers of each course structure the assignments and syllabi of the courses in such a manner that they complement each other.

A large variety of academic disciplines have been linked using the linked course model over the past two decades. For example, Art and English, English and Computer and Web Skills, American History and Multimedia [1], English and Biology [11], Psychology and Writing [2], Theology and Sociology [5], Music and Art and Design [7], and Online Educational Materials and Distance Education [12].

The benefits of collaborative learning and linked courses reported in literature is summarised in Table 1. As can be seen from the summary in Table 1, collaborative learning and linked courses have the potential to enhance student learning in various ways as well as improve critical graduate attributes like collaboration, teamwork, communication and leadership skills.

**Table 1.** Benefits of collaborative learning and linked courses.

**Benefits of collaborative learning**

| **Theme** | **Reference** |
|---|---|
| Help participant students learn more effectively | [9][19] |
| Respect for opinion of other group members | [9] |
| Build skills that help participants to resolve differences in group | [9] |
| Cultivation of teamwork, cooperation and leadership skills | [9] |
| Participants become more actively involved in classroom learning | [14] |
| Enriched understanding and knowledge of participants | [19] |

**Benefits of linked courses**

| **Theme** | **Author** |
|---|---|
| Participants are more interested and enthusiastic about learning | [11] |
| A greater sense of community among the participants | [10][21] |
| Additional contact between participants and instructor outside of class | [16][21] |
| Improvement in grades and overall performance | [2][18][20] |
| Integration of knowledge of different disciplines | [12][7] |
| Enhanced intellectual development, and motivation of participants | [12][21] |

## 3 Research Design and Methodology

A quasi-experimental field study was used in this study in which the experimental group consisted of 39 students that were simultaneously enrolled in OPG41AB and ITM41AB in the IT Department of CUT. The comparison group consisted of 17 students enrolled in ITM41AB but not in OPG41AB. The two subjects were taught by two different lecturers. The study made use of a non-probability sampling strategy. The non-probability sampling method that was used in this study is judgmental sampling. When using a judgmental sampling method, the researcher chooses the subjects who will take part in the research based on specific criteria [15]. All 39 students that were enrolled for both subjects were included in the sample of this study. OPG41AB and ITM41AB are two compulsory courses that run concurrently in the B.Tech. IT program during the first semester at CUT. Due to the very short time span of both these modules a decision was taken to investigate linked course teaching of these two modules. The subject, OPG41AB, focuses on providing students with game programming skills, whereas ITM41AB focuses on the project management activities that are needed to manage a successful information technology project. The two courses were linked via a project in which students had to create a mobile financial literacy educational game. Students were required to work in groups of not more than 4 students per group and the 39 students were divided into 15 groups. Figure 1 portrays the linkage of the two subjects.

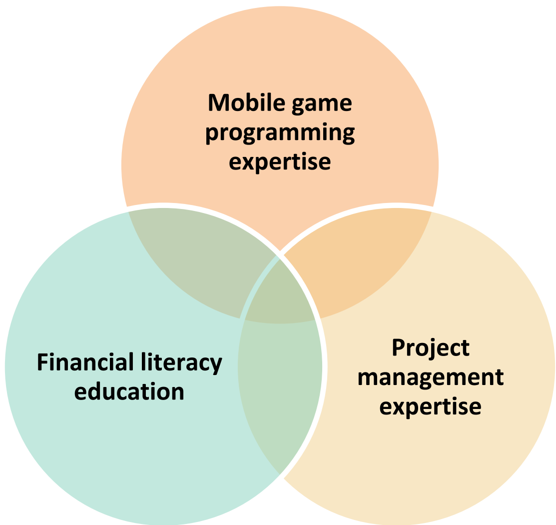


**Fig. 1.** Linkage of OPG41AB and ITM41AB.

In order to successfully complete the project, the students had to combine mobile programming expertise, gained from OPG41AB, with project management skills, acquired in ITM41AB. In OPG41AB the project contributed towards the course mark of the subject as the major assignment and in ITM41AB, which is a continuous evaluation subject, the project constituted 60% of the overall subject mark.

Due to time restrictions placed on OPG41AB by its examination-based evaluation model and the iterative nature of game development, the lecturer opted to use Software Prototyping as a Software Development Model for the project's Software Development Lifecycle (SDLC). The specific Software Prototyping applied was Rapid/Throwaway Prototyping that was linked to the project management component (ITM41AB) via the following phases/goals:

- Vision and Scope: A description of the financial literacy game idea and game mechanics.
- Horizontal Prototype: A paper prototype/storyboard.
- Vertical Prototype(s): Individual implementations of game subsystems and mechanics.
- Pre-Alpha: Unpolished, partially completed version of the financial literacy game used as an internal milestone for project management.
- Alpha: Unpolished completed version of the financial literacy game.
- Alpha Evaluation: Critical reviews by peers to identify: positive characteristics, negative characteristics and defects of the financial literacy game.
- Beta/Release: Polished, completed version of the financial literacy game.

This approach allowed students to receive quick feedback on the requirements and refine the game mechanics early in the development. Specifically, the Alpha Evaluation allowed learners to identify and correct missing and confusing functionality which could then be corrected before the Beta/Release version of the financial literacy game was submitted for formal evaluation. The project was assessed individually in each subject. In OPG41AB the assessment of the project mainly focused on the correct application of programming principles, and the functionality of the game. In ITM41AB the assessment of the project comprised the following: planning document, weekly progress reports, user manual, technical manual, individual critical reflection, application of gaming principles, game design and creativity, financial literacy training content of the game, project management rating of peers, and peer assessment.

This study gathered both quantitative and qualitative data through a survey. The survey included fixed response questions using a 7-point Lickert scale as well as open ended questions. The Lickert scale is valuable for measuring the direction of attitudes, as well as measuring the force of the attitudes [15]. The researchers used a 7-point Lickert scale as a larger scale allows more data to be gathered in terms of the strength of the attitude held [15]. The open ended questions were used to provide more depth to the quantitative findings of the Lickert scale. The quantitative data was entered and analysed with Excel and content analysis were used to analyse the qualitative comments of students. The research question that was investigated in this study was: What are the benefits for graduate students involved in linked course training in IT at CUT?

## 4 Results and Discussions

Of the 39 students that were included in the sample population for this study, 38 completed the survey. Table 2 contains a summary of the fixed response questions of the survey. As mentioned before, a 7-point Lickert scale was used to determine the strength of the attitudes that students had towards various aspects of the project with (1) Strongly Disagree, (2) Disagree, (3) Slightly Disagree, (4) Neutral, (5) Slightly Agree, (6) Agree, and (7) Strongly Agree. The various items in the survey are ranked in Table 2 according to the strength of the attitude that the students had toward the specific item.

**Table 2.** Students evaluations of the linkage of OPG41AB and ITM41AB (n=38).

| Item | (1) | (2) | (3) | (4) | (5) | (6) | (7) | M | Rank |
|---|---|---|---|---|---|---|---|---|---|
| The collaboration between OPG41 and ITM41 saved me time. | | | | 3% | 3% | 24% | 71% | 6.63 | 1 |
| The collaboration between OPG41 and ITM41 was very beneficial to me. | | | | 5% | 5% | 21% | 68% | 6.53 | 2 |
| The experience I gained while doing this project helped to prepare me for industry. | | | | | 21% | 26% | 53% | 6.32 | 3 |
| The collaboration between OPG41 and ITM41 helped me to grasp the concepts of both subjects better. | | | | | 18% | 34% | 47% | 6.29 | 4 |
| The collaboration between OPG31 and ITM41 better prepared me for industry. | | | | 5% | 18% | 24% | 53% | 6.24 | 6 |
| I was able to generate a creative and fun idea for my mobile educational game. | | | | 5% | 18% | 26% | 50% | 6.21 | 7 |
| The project manager ratings that were conducted by my group members were helpful to me. | | 3% | 3% | 5% | 8% | 34% | 47% | 6.11 | 8 |
| Peer ratings motivated me to work harder. | | | 5% | 11% | 5% | 32% | 47% | 6.05 | 9 |

Students had the most positive attitude in terms of the time saving aspect of the collaboration (mean=6.63) with 71% of the students strongly agreeing, 27% agreeing and 3% slightly agreeing that that the collaboration between OPG41 and ITM41 saved them time. Students had the second most positive attitude concerning the benefits that the collaboration provided (mean=6.53) with 68% of the students strongly agreeing, 21% agreeing and 5% slightly agreeing that that the collaboration between OPG41 and ITM41 was very beneficial to them. The third most positive attitude was regarding the experience that students gained that helped them prepare for industry (mean=6.32) with 53% of the students strongly agreeing, 26% agreeing and 21% slightly agreeing the experience they gained while doing this project helped to prepare them for industry. The fourth most positive attitude was in relation to the help that the collaboration provided to grasp the concepts of both subjects better (mean = 6.29) with 47% of the students strongly agreeing, 34% agreeing and 18% slightly agreeing the collaboration between OPG41 and ITM41 helped them in this regard. As can be seen from Table 2, the feedback that was provided from students in terms of the collaboration between the two courses was overwhelmingly positive.

Open ended questions were used to get deeper insight into the quantitative findings of the fixed response questions. Content analysis was used in order to identify recurrent themes in the qualitative data and the percentage of the students that mentioned a particular theme was calculated. The results of the first open ended question of the survey are summarised in Table 3.

**Table 3.** Students' evaluations regarding the most important lessons that they have learnt.

| What are the five most important lessons that you have learnt by doing this project? | | |
|---|---|---|
| **Theme** | **%** | **Rank** |
| Time management skills | 76 | 1 |
| Teamwork | 63 | 2 |
| Communication skills | 42 | 3 |
| Leadership/Project management skills | 37 | 4 |
| Implementing project management techniques, including WBS, scheduling, and budgeting | 24 | 5 |
| Conflict management | 21 | 6 |
| To be sensitive to and to handle diversity within teams | 21 | 6 |
| Respect/value other people's opinions and ideas | 16 | 7 |
| MS project skills | 13 | 8 |
| Working under pressure | 13 | 8 |
| Eclipse/Android/4GL programming skills | 13 | 8 |
| Creating a financial literacy mobile game | 11 | 9 |
| Problem solving/Critical thinking | 11 | 9 |
| Plan before you begin | 11 | 9 |
| Tracking/monitoring progress | 8 | 10 |

As indicated by Table 3, time management skills (76%), teamwork (63%), communication skills (45%), leadership / project management skills (37%), project management techniques (24%), conflict management (21%), handling team diversity (16%) and respecting others opinions (16%) were listed as the most important lessons students learned from the collaboration project. It is important to note that 6 of these 8 items were social skills that students obtained.

The ability to work as a member of a team that was listed by 63% of the students as an ability that they gained by participating in this project is in line with the graduate attributes recommended by the South African Qualifications Authority [17] which state that graduates need to be able to work effectively with others as a member of a team or group.

The development of communication skills listed by 42% of the students, as well as the ability to handle diversity (listed by 21% of the students) and the respect for other people's opinions and ideas (listed by 16% of the students) also align with the competencies listed by the Department of Education [3] that states that higher education's role is to produce graduates with communication skills, as well as the ability to deal with change and diversity, in particular, the tolerance of different views and ideas.

The skills obtained by students with the linking of OPG41AB and ITM41AB as listed in Table 3 also correlate with the benefits that were observed in prior research (as summarised in Table 1).

In the second open ended question students were asked to explain the benefits that the code they were writing for the ITM41AB project was the same code that they had to write for their OPG41 assignment. A total of 74% of the students mentioned that the greatest benefit was the time saved by writing the same code for both the subjects. In addition to time saving the following advantages were mentioned by students:

- "It was an absolute benefit and definitely not a disadvantage, because not only was it only one project/game to work on instead of two, but the project management helped a lot with the planning of how we spent our time and it helped us to stay on schedule and to stay on track. We worked on the game every week. Usually we would leave assignments until the last minute, but it helped to break up the work load over a number of weeks (8) to have enough time to finish."
- "We had to submit OPG41 code before the submission of ITM assignment, when the results came back we knew on which places to alter because we saw what needed to be upgraded and where we went wrong and we managed to fix those things and submit the upgraded assignment for ITM, and it also saved us time."
- "We've learned how to combine the knowledge of the two subjects on one project as we will in the workplace."
- "Apply the principles of project management and integrate it with android game programming."
- "You get to see the principles of Project Management in practice."
- "Practical experience of managing your own program."
- "Gives good perspective."

In the third open ended question, students were asked to what extent the project prepared them for work in industry and which skills that they gained doing this project will be most beneficial to them in industry. The results of this question are summarised in Table 4.

**Table 4.** Industry related skills.

| To what extent has this subject prepared you for work in industry, and which skills that you gained doing this project will be most beneficial to you in industry? | | |
|---|---|---|
| **Theme** | **%** | **Rank** |
| Leadership skills | 44 | 1 |
| Being able to work with different people/Teamwork | 31 | 2 |
| Communication skills | 31 | 2 |
| Time management skills | 19 | 3 |
| Solving problems | 14 | 4 |
| Stress management | 11 | 5 |
| Listening | 8 | 6 |
| Respect/Empathy | 6 | 7 |
| Setting of Schedules | 6 | 7 |
| Project management techniques. | 6 | 7 |

As indicated by from Table 4, leadership skills (44%), team work (31%), communication skills (31%), time management skills (19%) and problem solving skills (14%) were among the top 5 skills that were listed by students as the skills gained that will be most beneficial to them in industry. The listed skills in Table 4 correlate with the most important lessons learnt from doing this project, as listed in Table 3, providing evidence that students were consistent in providing their responses.

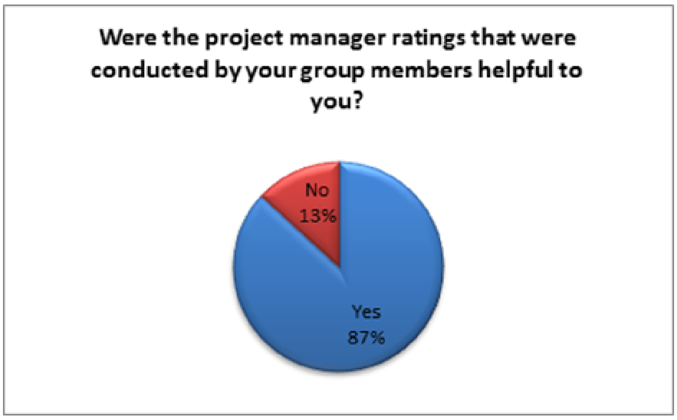


**Fig. 2.** Project manager ratings.

Due to the fact that students were working in groups on this collaborative project, peer evaluations were conducted. Students rated each other in terms of their overall performance on the project. Each student in the group also had the opportunity to serve as the project manager for a specified duration of time during the course of the project. Students were also required to rate the project manager on a weekly basis. In the survey students were expected to reflect on the effectiveness of both project manager evaluations (Figure 2) and peer evaluations (Figure 3).

As can be seen from Figure 2, 87% of students responded that the project manager ratings conducted by their group members were helpful. Students were asked to explain why these ratings were helpful and approximately 71% of the students commented that it helped them to identify their strengths and weaknesses as project managers and enabled them to improve their performance in this regard. Some comments made by students are listed below:

- “I saw what I lacked as a project manager and communicated with my project team asking them what I could do to improve my skills”.
- “They gave a critical reflection on what I was doing good and also revealed to me the sections that needed immediate improvement from me like my interpersonal skills”.
- “Helped each one of us to see their mistakes where one lacks a certain quality of a good leader so that that quality can be improved after seeing the problem.”
- “They were helpful as sometimes it does not feel right to tell someone about their weaknesses face to face.”

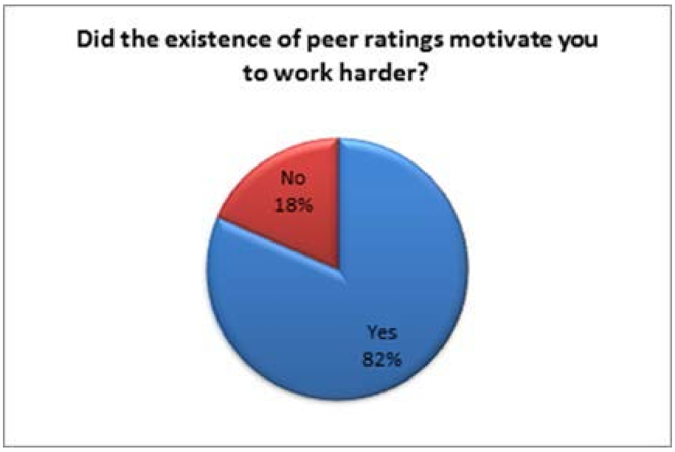


**Fig. 3.** Peer ratings.

Figure 3 indicates that 82% of students felt that peer ratings motivated them to work harder. Some of the comments made by students are:

- “It really motivated me to work harder because I wanted to show my group members that I am a hard worker.”
- “Nothing motivates me like getting positive response from someone I am working with.”
- “It felt good to hear positive things about myself and to see that my team members appreciates the work I do.”

- "It motivated me to do better and maintain a high standard throughout the duration of the project."
- "The ratings were a true reflection of how much I was contributing to the project and how helpful I was in obtaining the project objective."

## 5 Performance of Students

The performance of the 39 students that were enrolled for both ITM41AB and OPG41AB was compared against the control group of 17 students that enrolled for ITM41AB exclusively. The 92% pass rate for the project (60% of the overall mark for ITM41AB), of the linked group, was 10% higher than the 82% pass rate of the control group. The overall pass rate for the entire ITM41AB subject of the linked group (92%) was 16% higher than the pass rate of the control group (76%).

When the pass rate for the OPG41AB assignment of (96%) was compared against the pass rate of the assignment the year prior to the experiment (35%), there was an increase of 61% from the previous year when linking was not implemented. From the preceding discussion it can be seen that the linking of ITM41AB and OPG41AB shows a positive trend in terms of the performance of students.

## 6 Conclusion

The research question investigated in this study was: What are the benefits for graduate students involved in linked course training in IT at CUT?

From the results it is evident that the linking of ITM41AB and OPG41AB was very beneficial to students. There was a significant improvement in the pass rate of both subjects. The linking of the subjects helped students to grasp the concepts of both subjects better and students are better prepared for industry due to the fact that they could apply the knowledge of two subjects to create one end product.

Time management skills, team work, leadership skills, communication skills, time management skills and problem solving skills were determined to be the most important benefits students gained from the linking of the two courses. Students were also motivated to work harder by their peers and gained a great deal of insight into their own strengths and weakness from the peer evaluations that were conducted.

Currently there is a lack of published South African research on linked courses and the findings of this study are unique since it sheds light on the benefits of linked courses in a South African context. The largest majority of research, on linked courses, was done on the linking of first or second year courses and this study have highlighted the benefits of linked courses for graduate students.

It is recommended that for future research on linked courses instructors should ensure that courses with an examination-based evaluation model are not linked to a continuous evaluated course. The dates on which marks for examination-based courses and continuous evaluation courses must be submitted differs dramatically from each other and will hinder the effective collaboration of the two courses.

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# Computer Lecturers' Community Engagement: Inspired towards Science, Engineering and Technology

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**Abstract.** The aim of this study was exploring computer lecturers' community engagement. The paper introduces the Inspired towards Science, Engineering and Technology (I-SET) project, before a literature review on how computer lecturers use emerging technologies in community engagement. The paper shows their teaching practices and curricula, and students' experiences and assessment. The study is located within a theoretical framing clarifying issues around community engagement. An explanation of the methodology attends to the importance of interpretation for qualitative parts of the research design and considers issues of reliability and validity for quantitative designs. Quantitative and qualitative findings are discussed, providing respondents' demographics and qualitative responses — these are, in a number of instances, connected back to literature. The authors suggest how the implications of findings could be useful and applicable for other universities. Conclusions are drawn, providing guidance to researchers and practitioners, and the authors reflect on how findings make a contribution.

**Keywords:** Community engagement, Computer lecturers, LEGO.

## 1 Introduction

Inspired towards Science, Engineering and Technology (I-SET) is a community engagement flagship project of the College of Science, Engineering and Technology (CSET) at the University of South Africa (UNISA), aimed at inspiring young people and their communities' interest in Science, Engineering and Technology through fun activities involving robotics. These activities are mainly centred on children, with the age group being considered usually between 9 and 16, who build robots from LEGO blocks and program them to achieve certain objectives.

One of the attendees of the presentation of this paper at the 47th annual conference of the Southern African Computer Lectures' Association (SACLA 2018) asked which programming language was being used. In response, the authors would like to explain that the current version of LEGO Mindstorms EV3 corresponds to this being the third EVolution, which is icon-based. These kits have command box programming, rather than code programming. Older LEGO-supplied languages included Robot Command eXplorer (RCX) code, as well as ROBOLAB. According to Assaf [2, p.29], the LEGO


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Mindstorms “kit is shipped with a proprietary, visual programming language (NXT-G, EV3).” Shin, Siegwart and Magnenat [29, p.1] introduced and demonstrated a Visual Programming Language (VPL), which provided “children with a gentle introduction to programming” with LEGO Mindstorms EV3. Additionally, it can be programmed using LabVIEW (a visual data-flow language), “as well as classic textual languages such as Java and C/C++” [2, p.29]. As an example, Perez, Gold-Veerkamp, Abke and Borgeest [26] looked at a new didactic method for programming in C for freshmen students using LEGO Mindstorms EV3. ev3dev, which is a Linux operating system from Debian for EV3, also allows for programming using many other languages, including Python, with additional libraries.

As computer lecturers, we “are involved in Information and Communication Technology (ICT) education in the cyber world” [17, p.99]. Goosen and van der Merwe [19, p.116] indicated that Higher Education Institutions (HEIs) were being “encouraged to improve educator training as well as their participation in other education events concerning education pedagogy for application in various educational contexts.” Vorster and Goosen [33, p.119] also expressed “the need for closer cooperation between HEIs and the school system in developing the skills required by teachers and learners”. The objectives of the I-SET project reported on in this article therefore included:

- In terms of Community Engagement, computer lecturers aim to participate in and host events that will inspire young peoples’ interest and participation in science, engineering and technology. They are therefore presenting face-to-face training for coaches and teams, hosting and participating in the First Lego League (FLL) North Gauteng Championship, and participating in the First Lego League National Championship, as well as the World Robotics Olympiad (WRO).
- Regarding Community Development, the project aims to use Web 2.0 technologies to create and deliver open educational resources for use by the communities involved.
- With regard to Research, plans are in place to identify pertinent community engagement research questions in the project.

The I-SET project objectives stated show that the rationale of the paper is thus well-grounded in the community engagement environment, and also support the idea that knowledge about community engagement can be obtained through technology, while, at the same time, inspiring students’ and their communities’ interest in Science, Engineering and Technology in Southern Africa. The topic is therefore novel, relevant, timely and should be of interest to various stakeholders at this SACLA 2018 conference.

In light of the I-SET objectives detailed above, the aim of the study reported on in this paper thus was to explore, against the background of the I-SET project as a community engagement activity, research questions on how computer lecturers can use LEGO to:

1. excite and **motivate** their computer students through creative activities [8]?
2. increase their students’ perception of the **usefulness** of programming activities?

and/or help their students to:

3. see the **relevance** of programming activities to their daily lives?
4. experience pleasure/**fun** from participating in these activities?

In the next section of this paper, a review will draw on the latest literature on topics related to how computer lecturers can use LEGO for renewing their teaching practices and curricula, as well as renewing their students' experience and even assessment, by building on the past in terms of the latest and most relevant references with regard to related work. As similarly indicated in Goosen and Gouws [16], this paper will be "concluded by presenting a summary of results obtained and the paper as a whole, reflecting on how these results make an original contribution towards scholarly debate in the field".

## 2 Literature Review

In line with the community engagement project as described in this paper, Qidwai [27], in his paper, shared his experiences with a programme with the aim to improve the educational levels and standard of education in particular communities where students are not being encouraged to take up careers in the fields of Science, Engineering and Technology. This was due to these students either lacking financial resources or focus and motivation, which, in turn, was owing to various social problems related to a vicious circle of poverty and crime. Computer lecturers, together with senior and graduate students from an elite higher education institution, had served in this and similar programs to involve students from minority groups and inspire these students to become of the same calibre. In that study, the use of the LEGO® Mindstorms™ Robotic Invention System (RIS)™ showed a large increase in students' motivation and focus towards especially engineering education.

According to Patterson-McNeill and Binkerd [25], the RIS represents a programmable toy that can be used educationally. The latter authors described the fundamental characteristics of the RIS and supplied the reader with Universal Resource Locators (URLs) as these relate to the community of LEGO users. Additionally, their paper supplied readers with a list of products that are available for free or commercially, for programming the RIS. Similar to aspects of their paper, one of the aims of the current paper could also be to act as a resource for computer lecturers, who might be considering using the RIS in their classrooms. Thus, their paper included a section on how computer lecturers were at that stage using such robots in their classes.

On their poster, Wiesner and Brinda [34] expressed the opinion that most students' belief that being able to cope with tasks associated with robots may be the result of earlier playful experiences involving Lego bricks. Speaking to most of the research questions set for the current study, the latter authors pointed out that using educational robots such as, for example, the Mindstorms robotic system have been demonstrated as highly motivating media, resulting in changes in students' attitudes in computer courses, from primary school right through up to higher education institution level. For successful learning, a significant factor is keeping students' motivation at a constantly high level. The use of robots can enhance students' **motivation**, because they attract their attention, generate curiosity, and even seem to have an action provoking character. To handle the real robots could establish an awareness of personal **relevance**, emphasizing motivation.

The Lego Robotics kits has evolved through three versions (generations) – the RCX kit and then the NXT kit, with the latest being the EV3 kit, which was only launched in August 2013. Some of the following literature presented specifically refers to the earlier two of these generations.

While Hamada and Sato [20] explained a novel method for using LEGO Mindstorm NXT robots as a learning technology in automata theory, Bradley, de la Puente and Zamorano [3] described a set of tools for fully developing real-time applications under Linux using the LEGO® Mindstorms® NXT robotics kit as target. These technologies can provide real-time and embedded systems lecturers with alternatives to conventional software models aimed at learning. A paper by Agarwal, Harrington and Gusman [1] illustrated an application that had been developed to demonstrate how it was possible to exploit the built-in features of technology into robotics programming by manipulating LEGO Mindstorm NXT robots. Using these applications, it was shown that this was a moveable, moderately-priced and functional development in robotics programming.

Similar to the motivational aspects mentioned in the first research question, as well as the first paragraph of this literature section, the purpose of a research study described in the paper by McWhorter and O'Connor [24, p.438] was investigating the efficacy of utilising LEGO Mindstorms robotic activities for influencing students' motivation in an introductory higher education institution computer programming course. Different aspects in this regard were assessed using the 'Motivated Strategies for Learning' questionnaire. Their experiment detected "a statistically significant difference between groups", relating to extrinsic goal orientation. A LEGO group showed a larger reduction in extrinsic goal orientation levels – this suggested that they were motivated less to learn material for incentives such as marks, as opposed to possibly being more motivated to learn by internal motivators. Students responding to follow-up questions implied that a number of them enjoyed such LEGO Mindstorms activities.

Finally, a discussion of the issue of teaching with robots could benefit from including the views of e.g. Slangen, van Keulen and Gravemeijer [30], who considered the pedagogical aspects related to what students can learn from working with robotic direct manipulation environments, explicitly.

## 3 Theoretical Framing

Kroeze and Pretorius [22] pointed out that it seems to be assumed that all computer lecturers at higher education institutions should be teaching, conducting research and become involved in community engagement. More recently illustrating this, an article by De Beer [7] reflected on the involvement of HEIs with community engagement in South Africa. Also in 2011, Sung, Hepworth and Ragsdell [31] showed that although this is so, particularly for the South African context, inspiring students towards science, engineering and technology is a global vision — these authors take this issue to a worldwide platform by referring to an increasing awareness over the past decade at a number of HEIs, where the significance of effectively engaging with their local communities in terms of the services they deliver have been acknowledged.

With aspect similarities to the chapter by Goosen [15], this section of the paper will highlight how practitioners could e.g. use trans-disciplinary approaches to conduct research in the context of community engagement. It further explores applicable conceptual issues against the background of the question ‘What is a community?’ and will explain what community engagement is, in order to develop an understanding of the concept, specifically as it pertains to HEIs and/or computer lecturers [7]. Ironically in terms of the LEGO theme in this paper, the latter author used concepts related to building blocks for defining community in ways, which makes it possible to manage and operationalise a safer environment for learning.

A community can be described in terms of having geographical boundaries and people who share certain common interests with structures that promote interdependence [7]. In the context of sustainable and inclusive quality education through research informed practice on Information and Communication Technologies (ICTs) in education, Goosen [14, p.218] indicated that “HEIs are increasingly engaging more actively with” their communities for facilitating e-education, and empowering and benefiting these communities — this makes sense in light of De Beer [7, p.19], quoting Hall, stating that the term community “can, and does, mean anything from a” higher education institution’s “own staff and students and a community of practice to civic organisations, schools, townships, citizens at large and ‘the people’ in general.” Goosen [11] pointed to the fact that one of the characteristics of e-schools is that there is also engagement with their communities. Goosen and van der Merwe [18] agreed that e-schools should be working in partnership with the wider community to ensure shared knowledge about e-learning. Illustrating e.g. aspects related to the latter, in her inaugural lecture, Goosen [12] described feedback from 43 respondents from a school district in the Gauteng province in South Africa, regarding their e-schools’ connections to their communities.

In the context of community engagement projects such as the one discussed in this paper, De Beer [7] is of the opinion that HEIs form part of their societies, have the necessary resources, and as centres of expert knowledge for higher education and excellence, have the responsibility of participating and ploughing back into their communities. This same author [7, p.27] therefore called upon HEIs to demonstrate their social responsibility by committing to the common good to make available their expertise and infrastructure through community engagement projects. The seminar, where the data reported on in [10] had been collected, represents one such an opportunity.

Goosen [9] expressed the opinion that the enabling and supportive roles required of HEIs in development have the implication of creating a learning context in which communities and HEIs are willing to learn from one another and are able to exchange ideas and share suggestions with the aim of providing communities at grass root level with a network for mobilising local resources for achieving the goals they have set and “with the information they need to make their decisions meaningful” [7, p.23]. The findings of a study reported on by Rambe and Bere [28]], on a strategy for leveraging student participation by using WhatsApp mobile messaging, suggested that participation in such learning communities heightened and fostered creating and exchanging knowledge. De Beer [7], however, also warned that involvement in projects does not equal participation. Involvement merely means that people are allowed to participate in particular activities in prescribed ways.

In line with what was suggested by Havenga and Mentz [21], the authors conclude that participation by more students from all communities is needed in computer fields, as opposed to only a few gifted (pale male) students from select privileged communities.

As an illustration of addressing such a situation, Dahlberg, Barnes, Buch and Rorrer [6, p.1] reported on a community engagement project with a mission to find viable strategies for broadening and promoting the empowerment and capability of communities, including, for example, "women, under-represented minorities and persons with disabilities" to participate in Computer Science.

## 4 Design and Methodology

The following section will explain the execution of the research methodology and design, including expounding in terms of details on how the data was obtained.

As part of the I-SET initiative, a training event was organised on campus, with the purpose of introducing potential and existing coaches, mentors and leaders of LEGO robotics and/or First Lego League (FLL) teams to the range of issues that are important to the coaching or mentoring of a robotics and/or FLL team, including:

1. Where does LEGO Robotics fit into education?
2. The issues and reality related to what a team is, setting up and possible team building initiatives, as well as marketing and promoting their teams, and finding sponsorship options
3. What is needed to teach in terms of building and programming of the robots
4. The equipment requirements around the LEGO To Go Box: What's in it and where do they get it?
5. Teaching students about the importance and focus of research, teaching students how to do research and how to get students to do research
6. Competition opportunities with regard to the FLL and the World Robotics Olympics in South Africa, and the FLL Competition registration and website.

Any parents, computer lecturers or persons who had a particular involvement in the FLL and/or were interested in starting or continuing robotics training for a LEGO robotics team in a specific school or community were invited to attend the event.

Because Goosen [13] pointed out why ethical data management and research integrity is important, especially in the context of community engagement, in terms of ethical concerns, the contact details of the project leader for this research study were provided to all potential respondents, in case they had any queries regarding the research. Potential respondents were informed as to what they would be expected to do, what information would be required and how long their participation would take — their participation did not require more than 20 minutes of their time.

By signing the letter of consent, they understood that their participation in this research was voluntary, their responses would be treated in a confidential manner and their privacy with regard to anonymity as a human respondent would be ensured, where appropriate (e.g. by using coded names of respondents and/or their institutions). As research respondents, they were free to withdraw from the research at any time without any negative or undesirable consequences to themselves and they would at all times be fully informed about the research process. They were offered no significant incentives to be respondents in this study. They would not be placed at risk or harmed in any way, e.g. no responses would be used to assess them, their students/child(ern) and/or their schools/institutions.

Respondents were assured that research information would be used only for the aims of this enquiry. Their trust would not be betrayed in the research process or its published outcomes, and they would not be deceived in any way. They could either give their informed consent to participate in this research or, in line with the principle of voluntary participation, choose not to take part.

Everyone, who attended the event as described in this section, were invited to participate in this research project. In addition, as advised by McGill [23], notice of the survey was given to everyone who attended. Disappointingly, only a relatively small number of responses were obtained; thus, the conclusions that are drawn based on these responses can not necessarily be viewed with statistical confidence.

Similar to that of Buisman and van Eekelen [5], this article reports on a case study, as an instance of a meeting used for data collection.

Please note that apart from the open spaces prepared after each question in the questionnaire for respondents' answers, right at the end of the questionnaire, additional space was further made available, so that respondents could provide their own unprompted thoughts.

## 5 Discussion of Findings

The overwhelming majority of the twelve respondents (10; 83%) were female.

**Table 1.** Respondents' ages.

| 18 – 24 years | 25 - 34 years | 35 – 44 years | 45 – 54 years | Older than 55 years |
|---|---|---|---|---|
| 0 (0%) | 2 (17%) | 3 (25%) | 4 (33%) | 3 (25%) |

Table 1 shows that although the respondents' ages were spread fairly evenly across the options provided, they leaned towards older persons, with no-one below the age of 25. The reader should note that no students (below the age of 25) were represented in the sample of respondents – the adult respondents reported how they guided their students as the latter worked with robots.

**Table 2.** I am involved as a…

| Parent | Teacher | Coach | Mentor | Supporter | Community/sponsor representative |
|---|---|---|---|---|---|
| 1 (8%) | 5 (42%) | 3 (25%) | 0 (0%) | 3 (25%) | 0 (0%) |

Table 2 shows that almost half of the respondents were involved as teachers, with equal numbers of coaches and supporters, and only a small number of parents.

**Table 3.** Respondents' educational qualifications.

| None | HED | FDE | BEd | BEd (Honours) | MEd | PhD | Other |
|---|---|---|---|---|---|---|---|
| 5 (42%) | 4 (33%) | 0 (0%) | 0 (0%) | 1 (8%) | 0 (0%) | 0 (0%) | 2 (17%) |

As specified in Table 3, almost half of respondents had no educational qualifications. In terms of those who indicated that they did have such qualifications, however, more than a third of respondents completed a Higher Education Diploma (HED). No one indicated having e.g. a Further Diploma in Education (FDE).

**Table 4.** Respondents' academic qualifications.

| None | B degree | Honours degree | M degree | PhD | Other |
|---|---|---|---|---|---|
| 4 (33%) | 5 (42%) | 2 (17%) | 1 (8%) | 0 (0%) | 0 (0%) |

Although a third of respondents had no academic qualifications, as specified in Table 4, almost half of them completed some form of Bachelor's degree. A quarter of respondents had post-graduate level academic qualifications. Please note that information in Tables 3 and 4 are not exclusionary — some-one who had a BEd degree would be classified as being part of the 'Other' section for Table 3, as well as under the B degree for Table 4. Although there might be some overlap, the five (42%) respondents who indicated no educational qualifications in Table 3 was not exactly the same group who indicated having a B degree in Table 4.

**Table 5.** Number of years' experience with First LEGO League.

| Novice | 1 year | 2 years | 3 years | 4 years | More than 4 years |
|---|---|---|---|---|---|
| 2 (17%) | 3 (25%) | 3 (25%) | 1 (8%) | 0 (0%) | 3 (25%) |

Table 5 displays that the number of years' experience that respondents had of being involved with First LEGO League were spread fairly evenly over the options provided: a quarter of each had one, two or more than four years' of experience, while less than 10% had three years' experience. Less than 20% of respondents were novices.

We will next present detail from the qualitative part of the questionnaire used. Note that the headings presented reflect the questions that were asked.

**Why are you involved in First Lego League?** Almost half of respondents indicated that they were involved in First Lego League in order to educate the "wonderful" students, to teach them core values and extend their potential. One respondent simply loved Lego, others found it to be "fun and educational" and "an interesting and challenging league", while another had an "interest in robots and electronics". One parent had a "school kid". Last, but not the least, one respondent indicated that she worked for the College Deanery Marketing Team, and thus got involved "automatically".

**What do you like about First Lego League?** One respondent liked the creativity associated with FLL, while another liked the competitions best. Although students were provided with opportunities to learn about robotics in an interactive way through playing, they built their skills related to problem solving and the programming of robots, with no spoon-feeding involved. Two of the respondents liked the way in which FLL contributed to the total broad development of students. One of the respondents indicated that she liked the programming best — even though she was struggling at that stage, she was confident that she would 'get it'. A further two of the respondents had not had their own teams yet, but indicated that when they have a team, they thought that they would like to support students in order to see their patterns being turned into real three-dimensional (3D) models.

**What do you do to get to know the students in your First Lego League team better?** At least two of the respondents indicated that the students in their FLL teams were in the 'regular' school classes that they teach. Three more respondents specified that they used "ice-breaking sessions" and/or team building exercises. While one respondent spoke to the students to get to know them better, another allowed the students to play and then observed them. Yet another respondent used to help students individually with the way the game was played.

**What do you do to motivate the students in your First Lego League team?** One of the respondents indicated that this should not be a problem, while another believed in self-motivation for these students. Two more respondents referred to fun items being used and having students relate to young, fun (male) coaches. Yet another brought something new to every meeting — even if it was just sharing the manual information. Finally, one respondent made use of club tournaments, while another relied on students researching together and sharing their hardships.

**What do you do to encourage the students in your First Lego League team?** It was a pity to hear from one of the respondents that the school that students in her team came from did not do much to encourage them. Other contributors indicated that they chose to be present as much as possible, and used a club format or credit system for positive reinforcement.

**…especially students with high anxiety levels?** At least four of the respondents alluded to using fun, making it fun and showing students "the fun in the activities", while another referred to using laughter and jokes. Students were also reminded that it was “not only about winning toys” and of the Lego team work values. One respondent allocated some of these students with a so-called “nurturing buddy”.

**…especially students with low confidence?** According to Breedt and Pieterse [4, p.17], confidence is an influential factor for students’ engagement in Computer Science education. A “lack of confidence is prominent as a barrier to education and attempts to address it have not all been very successful.” Therefore, with regard to what respondents did to encourage especially students in their First Lego League teams with low confidence, two of the solutions offered in the study reported on in this paper referred to giving such students responsibilities / “important roles” in the team “like playing team leader”, time keeper or refreshments manager for e.g. two weeks. The notions of getting “a nurturing buddy”, fun and the Lego teamwork values were again mentioned in this context. Finally, discussions were also sometimes used, as well as incorporating such students with (more) confident teammates.

**What do you do to help students in your First Lego League team develop positive attitudes?** One of the concepts mentioned most often in response to this question related to the respondents having “a positive attitude” themselves and being positive when speaking to students, especially while encouraging and praising older students to do better if they failed the first time. Again, fun, group discussions and simply choosing to be there for students were mentioned. Sometimes one of the respondents would “invite someone they don’t know to **motivate** them for 10 minutes”.

**How do you help students in your First Lego League team to set achievable aims and goals?** At least one respondent encouraged students to set high goals. Four more of the respondents revealed that they encouraged and helped students to break their main exercises down into smaller tasks and steps, set parameters and added challenges in a step-by-step fashion. Others made use of teaching building exercises, posters and/or examples from expert programmers.

**Please describe one of the ways in which you increase your students’ perception of the usefulness of First Lego League.** Some of the respondents chose to talk or give presentations about the usefulness of the tasks, while others introduced students to people with jobs in programming, so that the students could see the connections. While one respondent achieved this by teaching globally, another pointed to the development of higher and 3D level thinking. Finally, one of the respondents indicated that she was known for being professional, and some students therefore paid attention to anything she did.

**Please describe one of the things that you do in your team that helps students to see the relevance of their First Lego League activities to their daily lives.** Although one respondent was not able to answer this question, as she did not have a team yet, others again mentioned giving presentations themselves, or inviting speakers, such as an engineer, to speak to students on different topics relevant to their everyday lives, problem solving and/or how related activities could become their jobs.

**Please describe one of the things that you do in your First Lego League team that helps students to experience pleasure from participating in these activities.** Students were reminded that these were toys and it could be so much fun! They were given compliments and exposed to sharing behaviour. Students also took turns in leading the teams, so that they all felt responsible. Respondents let students take part in knock-out robot games and again mentioned informing students about robots, electronics and related careers.

**Please describe one of the things that you do in your First Lego League team to instil a spirit of curiosity in your students.** Some of the respondents allowed students to solve problems, to build in their free time and/or provided them with additional access to the computer centre, so that they could conduct research on their own team discussions. Respondents also used displays for their students to explore or emphasised the importance of listening to what students wanted. Finally, some respondents introduced students to topics of interest that they had not heard about, or used a reward system.

## 6 Discussion and Conclusions

This paper started by introducing the I-SET project and associated objectives. Similar to that of Wiesner and Brinda [34], the objectives of this project, specifically in terms of community engagement, were aimed at coming to conclusions regarding inspiring students' and their communities' interest and participation in science, engineering and technology, when these students use educational robots. These objectives justify importance and relevance for inspiring students' and their communities' interest in Science, Engineering and Technology in Southern Africa. The aim of this study therefore was exploring, against the background of the First Lego League as a community engagement activity, research questions on how computer lecturers can use LEGO to:

1. **motivate** their students?
2. increase their students' perception of the **usefulness** of programming activities?

and/or help their students to:

3. see the **relevance** of programming activities to their daily lives?
4. experience pleasure/**fun** from participating in these activities?

### 6.1 Motivating Students

In relation to especially the <u>first research question</u> around **motivating** students, like Dahlberg, et al. [6], the authors of this paper have come to the conclusion, based on the findings presented here, that the students in this study enjoyed these kinds of exercises and were engaged in debating the effectiveness of the solutions they had arrived at. For these students, their engagement with the Lego activities and taking part in these competitions were both motivational and educational.

### 6.2 Increasing Students' Perception of the Usefulness of Programming

The literature review drew on topics related to how computer lecturers can use LEGO for renewing their ICT teaching practices, curricula and community engagement, as well as their students' experience and even assessment, by building on the past, in terms of the latest and most relevant references to related work. In an example of such pedagogical research that specifically speaks to the second research question set for this study, Uludag, Karakus and Turner [32, p.186] came to the conclusion, based on years of presenting similar courses, that the type of computer courses described in this paper should "be taught in terms of practical domains" and/or contexts that increase their students' perception of the **usefulness** of programming activities – this was also in line with what respondents indicated, thus confirming literature perspectives from the insights gained from the qualitative results obtained in this study.

### 6.3 Seeing the Relevance of Programming Activities to Students' Daily Lives

Also relating to the first research question, as well as the third one on **relevance**, like the study reported on by McGill [23], this paper also looked at influences on students' **motivation** of learning to program with robots. Overall, the findings, which can be concluded from of the study reported on in this paper, related to respondents indicating that they helped their "students to see the **relevance** of their First Lego League activities to their daily lives". Uludag, et al. [32] pointed out that this could be due to students' familiarity and comfort in understanding and using Information and Communication Technologies for teaching and learning.

### 6.4 Experience Pleasure/Fun from Participating in These Activities

Concerning both the first and last research questions that had been set for this study, as indicated by Wiesner and Brinda [34], **fun** was mentioned as a satisfying factor for students by many of the respondents, and played an essential role in keeping students' **motivation** alive. The conclusion that can be drawn from respondents' anecdotal responses was that there also is a growing need to integrate the kind of activities fostered by these tools with the broader and more general capabilities of computer lecturers.

The study was also located within a relevant theoretical and conceptual framing, which clarified issues around community engagement in the context of renewing ICT teaching and learning for development. As was described in that section of this paper, the community engagement activities as outlined were also in line with what was described by Goosen [9], in that these provided a structure through which computer lecturers, students and their communities could collaborate to help each other and contribute knowledge and skills to their mutual benefit. This also enabled them to bounce ideas off each other in attempts aimed at presenting material to students in an interesting fashion. An original contribution to the area of research is further made when such discussions could possibly lead to sharing views, and an increased sense of responsibility being shared.

With regard to issues relating to the execution of the research methodology and design, along with McGill [23], the authors concluded that adapting a survey to the applicable research environment was important for ensuring usable findings. Findings obtained in this study were similar to those found in studies by McWhorter and O'Connor [24], with especially the qualitative data indicating that respondents felt that robots made a novel contribution towards inspiring students' and their communities' motivation by sparking their interest in Science, Engineering and Technology in Southern Africa.

In terms of suggestions about how the possible **implications** of these findings could be useful and applicable for other institutions, Goosen [9] pointed out the importance of supplying communities at grass root level with a network to exchange ideas and share suggestions for improved implementation, where small discussion groups engage with the implications of e.g. renewing their curricula for computer lecturers' professional teaching practice.

This same author [9], however, finally also warned that if computer lecturers did not receive release time for participating in community engagement and associated activities, such as those described in this paper, they would have to accomplish all this added work in their own time, and this could make them feel like they do not have sufficient time. It is therefore **recommended** that authorities carefully consider the interpretation of findings as presented in this paper, in order to not only allow, but, instead, actively support, computer lecturers' participation in First LEGO League and similarly related community engagement activities, for inspiring and sustaining students' and their communities' interest in Science, Engineering and Technology.

## 7 Contact Details

As several of the attendees of the presentation of this paper at the SACLA 2018 conference asked how they could obtain more information about this project and/or contact the project, the following contact details are provided:

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- You can 'Like' I-SET on https://www.facebook.com/pg/isetlego
- and/or follow the project on Twitter: http://twitter.com/isetlego
- You could also have a look at project activities on YouTube: http://www.youtube.com/isetcommunity.
- SlideShare: http://www.slideshare.net/I-SET

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# Redesigning of an Open Online Community of Practice for sharing Course Information for Educators

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**Abstract.** While there are various tools available for Open Online Community of Practice (OOCoP) to use for information sharing and knowledge creation, the features may not be user friendly and as such affect the acceptance of the tool by the users. Such was the experience of the Computer Studies teachers in Namibia with Google Groups. By employing a participatory design with the Computer Studies teachers, the limitations of the Google Groups were identified and user requirements to customize a Learning Management System (LMS) were gathered through focus group interviews and questionnaires. This resulted in the customized tool to support OOCoP, NamSchoolTalk. NamSchoolTalk was evaluated using the Extended Unified Theory of Acceptance and Use of Technology (UTAUT) model to explain user intentions to use the customised tool and subsequent usage behavior. While the findings showed that NamSchoolTalk could improve collaboration, enhance the learning process and active participation of an OOCoP of Computer Studies teachers, further study is needed to determine the effectiveness of NamSchoolTalk for the information sharing and professional development of teachers in other subject areas and varying levels of computer literacy.

**Keywords:** Open online community of practice, Collaborative learning, Interface redesign.

## 1 Introduction

Global organisations such as Global e-Schools and Communities Initiative (GeSCI) and the United Nations Educational, Scientific and Cultural Organisation (UNESCO) have stepped in to facilitate initiatives related to the integration of Information and Communications Technology (ICT) in teacher education in Namibia [6]. These initiatives have helped support existing Communities of Practice (CoP), multi-stakeholder partnerships, capacity building of policy-makers and the development of international standards on ICT competencies for teachers [6,16]. This so far has been vital in facilitating information sharing for the Namibian teaching community as it attempts to develop teachers' professional practice. Information exchange and knowledge creation are key


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aspects of any thriving CoP [14,25]. However, in Namibia there are poor communication channels amongst the Computer Studies teachers due to the sparse distribution of these educators. Though workshops have been facilitated in the past to try and enhance information sharing among Computer Studies teachers, it is not a practical solution due to the time, place and cost constraints it places on all involved. To facilitate easier information sharing and regular communication, the Computer Studies teachers in Namibia used Google Groups as an OOCoP tool. This tool was used to facilitate information sharing and professional development. However, due to the complicated user interface, it was not used as much to support the professional development of the teachers.

In order to support the Computer Studies teachers' need for a user-friendly tool that would be readily accepted and used, this paper focused on addressing the research question: How can the current OOCoP platform used by Computer Studies educators in Namibia be evaluated and redesigned for information sharing? To answer the research question, the existing OOCoP tool used by the Computer Studies teachers in Namibia had to be evaluated and redesigned.

## 2 Context and Background of Study

In most African countries like Namibia, Computer Studies and ICT curricula are considered as the major vehicles for more advanced technical literacy skills at high school level [6,10][17, p.30]. The Namibian initiatives are influenced by the Vision 2030. Vision 2030 is a national objective towards improving the quality of life for citizens to the level of developed nations by 2030 [18]. As a result, the current state of affairs for the Computer Studies teachers effectively blurs Vision 2030 for the nation in its attempt to groom ICT ready citizens. The National Institute for Educational Development (NIED), a branch of the Ministry of Education of Namibia (MoE) is responsible for curriculum development and ensuring smooth nationwide information sharing amongst teachers [4,22]. As the nation ratchets towards Vision 2030, a development plan for Namibia, Computer Studies and ICT have received top priority to groom ICT ready citizens. This prioritization mainly targets the knowledge dissipaters, the subject teachers. In order to support the professional development of the Computer Studies teachers, a Community of Practice (CoP) was formed. A CoP can be described as a group of individuals of a common interest, who develop and participate in relationships where information exchange and knowledge creation are key [14,24]. Furthermore, CoPs are also viewed as communities that develop, share and refine a specific practice [2,7]. Thus CoPs are pivotal in the sharing of tacit knowledge by teaching practitioners in Namibia as portrayed by the Computer Studies teachers.

Although CoPs have been accepted and incorporated in many organisations in literature, some researchers argue otherwise particularly for school setups. A meticulous approach is crucial for one to commit towards the adoption and use of an OOCoP for Computer Studies teaching practitioners in Namibia. OOCoP refers to the state when knowledge sharing in CoPs no longer takes place exclusively within the boundaries of the organisations. Through OOCoP, such "open" setups tend to widen the horizons of social interactions, thereby enabling the sharing of tacit knowledge on a cross-organisational level. Additionally, in an OOCoP members can join irrespective of their qualification(s) or personal profile. Such OOCoPs can be classified as Open or Public [23]. The OCoP for Computer Studies teachers in Namibia therefore falls under this category. Having an OOCoP allows the Computer Studies teachers to tap into and benefit from expertise outside of the school setup and thereby enhance the quality of Computer Education in Namibia.

ICT infrastructure and the members formulate the foundation of an OOCoP environment. The ICT infrastructure defines the enabling environment for the OOCoP members to use and adopt the developed social networking platform. For positive usage behaviour to be induced and natured, the accessibility, availability and performance of the ICT infrastructure needs to be carefully considered [3]. Furthermore, careful and well-protracted use of technological tools that allows users to become content-generators is obviously of paramount importance for OOCoPs. Thus, an OOCoP should ideally be a place for the development of a shared repertoire which will eventually play a key role in the provision of knowledge for future practice [12].

The Google Group used by the Computer Studies OOCoP lacked proper archiving facilities, which makes it difficult for members, particularly new members to access past discussions. It also lacked an improved social fabric to encourage the participation of members as members' view learning as a social event [15,8]. The success of OOCoP also depends on continuous technology training and support for the members [21]. Google groups in addition does not allow participants to learn any new skills as it has limited features.

The limitations of the Google Group features to fully support the information sharing and knowledge creation needs of the Namibian Computer Studies teachers OOCoP-prompted the need to evaluate and re-design an appropriate platform for them.

## 3 Methodological Approach

This study valued the perceptions of the Namibian Computer Studies teachers in their OOCoP environment therefore the research was more inclined towards an interpretative paradigm.

In order to examine factors that affected the adoption of an OOCoP tool, a microscopic investigation of a real-life scenario was necessary. Since a functional OOCoP is already in place, the case study approach was used as the main research methodology, where the case was the OOCoP for Computer Studies teaching practitioners in Namibia. The OOCoP comprised of more than 20 Computer Studies teachers and up to 5 other ICT practitioners. Furthermore, a case study approach was suitable as it enabled the study of a phenomenon in its real context, especially that the boundaries between phenomenon and context are not clear [2].

A participatory design was used in gathering user requirements and aiding with customising the platform to better suit their needs and preferences. The participatory design helped the OOCoP members to have a more pronounced say in the customisation of a new OOCoP tool, which is NamSchoolTalk.

Within the case study, multiple methods were employed to strengthen the findings. This approach called triangulation allowed the same issue to be studied from various perspectives that complement and verify each other [11]. Due to the sparse distribution of the OOCoP members, focus group interviews were strategically scheduled thereby allowing for qualitative data to be collected from the targeted OOCoP members. Due to time constraints, only two focus group interviews were conducted during the study. Participants' suggestions were considered and used to refine the proposed tool before making the tool available to the entire OOCoP members. To capture the views and experiences of the redesigned prototype from all the OOCoP members, online surveys were used.

Computer Studies Curriculum Panel members meet more often than the ordinary OOCoP, yet they are a subset of the OOCoP. The Curriculum Panel is made up of the most experienced and most competent subject teachers together with other subject experts who may not be necessarily teaching the subject. In this study, the experts were subject administrators from NIED, a lecturer at the Namibia University of Science and Technology (NUST) and a former Senior Educational officer for Computer Studies. It also involved the chief marker and other markers of Computer Studies at various levels of national assessment such as Junior Secondary Certificate (JSC), Namibia Senior Secondary Certificate Ordinary (NSSCO) and Namibia Senior Secondary Certificate Higher (NSSCH). For this reason, it was convenient to set up a focus group interview during two of their meeting sessions.

Primary research was conducted by in-depth, semi-structured, open-ended focus group interviews with a stratified sample of 6 members as the survey respondents to explore the uses they are making of the OOCoP, their experiences and their perceptions of barriers and drivers to adoption. The members included 3 Computer Studies teachers (comprising of the Chief marker for NSSCH and NSSCO together with a marker for JSC) and 3 educational practitioners from various educational spheres of NIED and NUST. These 3 educational practitioners were selected into the Curriculum Panel, as they are highly participative in the current OOCoP, the Google Group. These 6 members form the core of the experts of the OOCoP. This approach was chosen as the setup depicts a complex social world from a participant's perspective [26].

Online survey questionnaires were developed and completed by members of the OOCoP (the users of the OOCoP platform) with the aim of identifying the challenges involved in sharing information with regards to existing ICT infrastructure on the new tool, to identify the factors that can influence the adoption of an open online community of practice and sustain its use. In this study, participants comprised of individuals who visited the NamSchoolTalk portal in chosen 30-day duration. A survey pop-up showed on the website and it requested for their participation. The current OOCoP is made up of only 25 active members, these all participated in the completion of the online questionnaire.

# 4 Findings

The findings of this study focus on answering how the OOCoP platform used by Computer Studies educators in Namibia can be evaluated and redesigned for information sharing and will be discussed under the challenges of the existing OOCoP tool, user requirements of the redesigned OOCoP tool, and the evaluation results of the redesigned OOCoP.

## 4.1 Challenges of the Existing OOCoP Tool

The focus group interviews revealed the following challenges the Computer Studies teachers faced when using Google Group for information sharing:

1. Group members who access Google Group using their cell phone found it difficult to follow a discussion, as the content was not mobile friendly.
2. Discussions are not stored or archived in a structured repository such as a database. This makes it difficult to search for old discussions as they appear as threads of emails.
3. If a new member joins, they will not be able to view old discussions and they end up posting discussions that have already been discussed by old members.

## 4.2 User Requirements for the Redesigned OOCoP Tool

The OOCoP through focus group interviews identified the features that they felt the redesigned OOCoP would need to have to facilitate information sharing:

1. Availability of an archiving tool for discussions.
2. Easily accessible repository to allow for the uploading and downloading of resources such as documents, audio or video files to support information sharing among members.
3. Ability to perform live chats so that members can perform discussions at real time, thereby enhancing communication channels.
4. Ability to continue with open threads for discussion forums similar to the ones provided by the Google Group.
5. Ability to easily login to access the OOCoP to avoid distractions from other issues as it is in the email box under the Google Group.
6. Need for Wikis so that collaborative work can be promoted for the OOCoP members.
7. Need for notifications for various activities such as starting a discussion, responses to the discussion, uploading of materials etc.
8. User friendly interface that allows members to easily use the platform with minimal training.
9. Availability for a calendar management option.
10. Provision for online news and announcements features.
11. Cost of use.

12. Level of user-friendliness.
13. Ease and timeframe for customization.
14. Ease of maintenance once implemented and adopted.
15. Educational focus.

The above-mentioned user requirements informed the evaluation and final selection of a tool that supported the information sharing needs of the Computer Studies teachers OOCoP as shown in table 1.

**Table 1.** Evaluation of features of the different social networking tools considered in this study.

| | Coursera | Edmodo | Google Groups | NEO LMS | Black-board |
|---|---|---|---|---|---|
| Analytics | √ | √ | | √ | √ |
| Apps | | √ | | √ | √ |
| Assignment Submission | √ | √ | | √ | √ |
| Discussion Fo-rums | √ | √ | √ | √ | √ |
| Easy to use file upload / download capacity | √ | | | √ | |
| Grading | √ | √ | | √ | √ |
| Instant messag-ing | | √ | | √ | |
| Online calendar | | √ | | √ | |
| Online news / announcements | | √ | | √ | √ |
| Online quiz | √ | √ | | √ | √ |
| Threading of messages | √ | √ | √ | √ | √ |
| Wikis | | √ | | √ | |
| Widgets that al-low connection to social media | | √ | | √ | √ |

Based on the evaluation results, NEO LMS was chosen as the preferred tool that met all the user requirements and can be customized at no additional cost for the Computer Studies OOCoP members. The customized NEO LMS was named NamSchoolTalk by the Computer Studies OOCoP members.

Some of the main features of NAMSchoolTalk are shown below:

**Groups available.** The Computer Studies Group is made up of all the members of the OOCoP. Curriculum Panel Group is a subset of the Computer Studies Group. Curriculum Panel members take part in updating and developing new curricula for the Computer Studies subject.

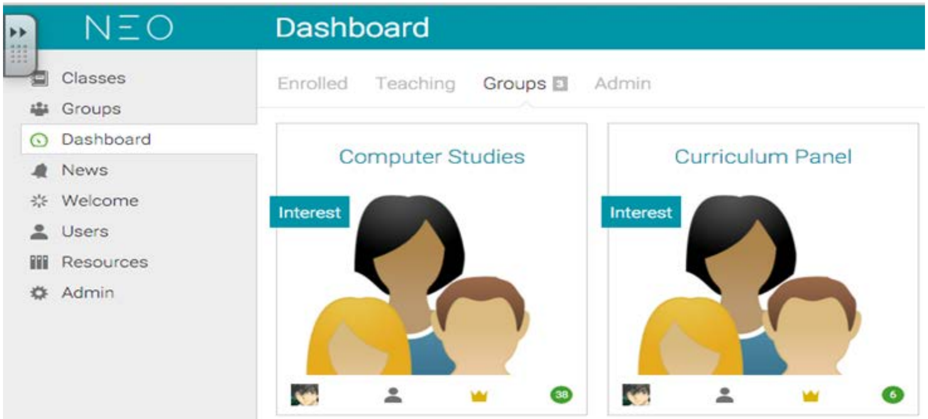


**Fig. 1.** Groups available on NamSchoolTalk.

**Levels available.** Computer Studies is divided into Junior Secondary Certificate (JSC), Namibia Senior Secondary Certificate Ordinary (NSSCO) and Namibia Senior Secondary Certificate Higher (NSSCH). Teachers choose which group they want to participate in. There is an extra level for Advanced Photography, which caters for the teachers who want to develop their photography skills. This extra level is not part of the curriculum.

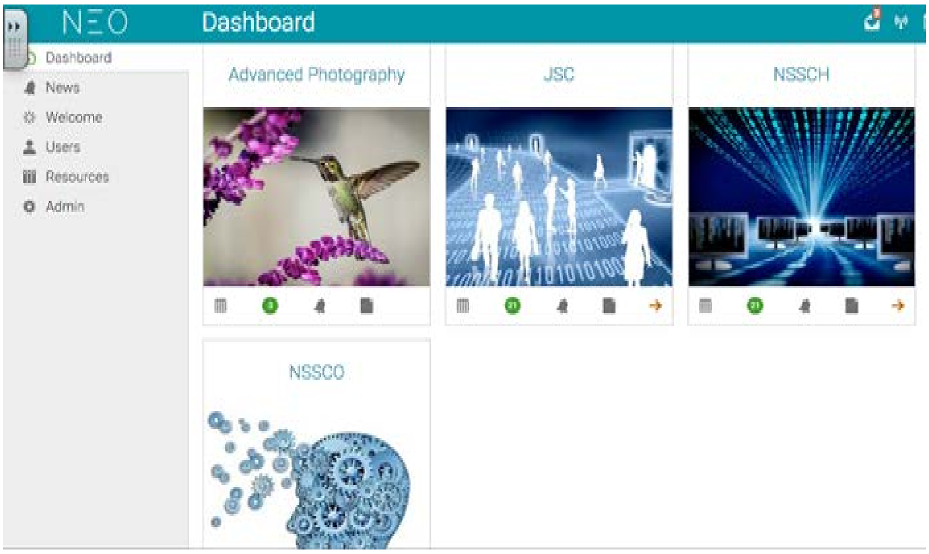


**Fig. 2.** Levels available on NamSchoolTalk.

**Chat rooms.** Members can also create chat rooms and discuss any issues at hand freely at real time. In the illustration above members were discussing the National Examinations for 2015 academic year.

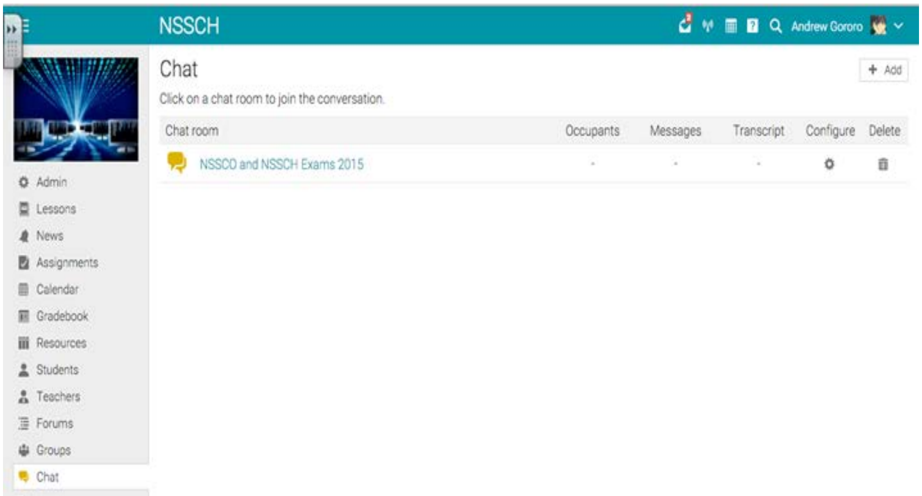


**Fig. 3.** Chat rooms on NamSchoolTalk.

**Resources.** Members can upload or download subject material such as notes, video clips or other files (of various formats like pdf, doc, xls etc.) and share with other members.

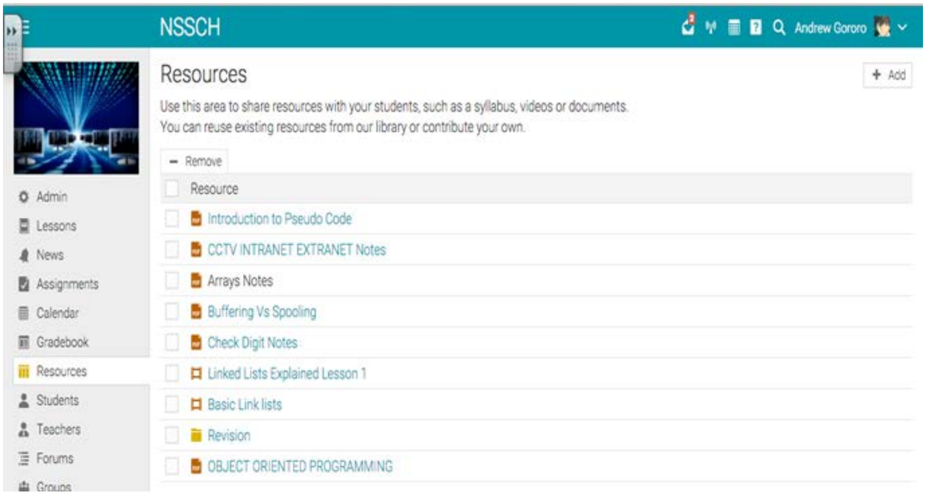


**Fig. 4.** Resources available on NamSchoolTalk.

### 4.3 Evaluation Results of the Redesigned OOCoP Tool, NamSchoolTalk

Upon completion of the customisation of NmSchoolTalk, the Computer Studies OOCoP members were asked to use the tool and share their findings through an online survey. The findings of the evaluation are based on 90-day voluntary use and discussed using the Extended Unified Theory of Acceptance and Use of Technology (UTAUT) model to explain user intentions to use the customised tool and subsequent usage behaviour. In UTAUT, the three constructs, performance expectancy, effort expectancy and social influence are theorised to influence behavioural intention to use a technology. On the other hand, behavioural intention and facilitating conditions determine technology use [1]. In addition to the four constructs, the suitability of the tool for professional development and to support the openness and trust principles of an OOCoP are also discussed.

**Performance Expectance of the Respondents.** Performance expectancy refers to the extent to which a user or potential users believe the system will help him or her realize the benefits in job performance [5,13]. Performance expectancy strongly influences behavioural intention. A research on adoption of social networking technologies in Ghana universities also supports this notion [3]. Behavioural Intention on the other hand is the readiness to use the new system [13]. It was crucial to solicit the users' opinions on performance expectancy in order to understand its influence on the behavioural intentions of Namibian Computer Studies teachers towards the potential adoption of NamSchoolTalk. The findings show that sharing of resources was the feature that the respondents found most useful. Posting a discussion was the next useful feature. The next feature the respondents found useful was accessing resources. Searching for information was found to be the least useful feature for the respondents. The respondents indicated the need for the search feature to have additional functionalities such as linking to the World Wide Web and/or a particular search engine. The other feature of NamSchoolTalk that respondents mentioned which made them use the system was the archive feature. The user friendliness of NamSchoolTalk was also an aspect, which appealed to the respondents to use the system.

> "*The appearance and ease of navigation is beyond my expectations. This can be shown by how I can perform various tasks like a pro even though started using the platform recently and without any arranged training. I feel this platform has the potential to become popular favourite for many teachers if it is given a little bit of time.*" R4

One respondent requested for SMS notifications on activities taking place on NamSchoolTalk. Although the search tool still requires further development, the findings show that most of the Computer Teaching practitioners are ready to use the various features provided by NamSchoolTalk.

**Effort Expectancy.** Effort expectance refers to the perceived ease of use of the system [13,19]. It influences behavioural intention, particularly when users are experiencing the system for the first time [19]. Computer Studies teaching practitioners in Namibia expressed their perceptions on effort expectancy for various features of NamSchoolTalk. The findings show that the majority of respondents found accessing resources, sharing resources and posting a discussion being the easiest tasks to perform. Starting a discussion was considered the next easiest. Using the search tool had the least number of respondents requiring minimum effort as compared to other tasks carried out in the research. Instead most respondents in the research rated this task as needing moderate effort and with one respondent noting that maximum effort is needed. The user friendly and intuitive design attributed to the ease of navigation and therefore providing an easy to use platform for most teachers.

> *"The platform is user friendly and it is easy to navigate through. With the little time that I have used the platform, I managed to enjoy using the features with little effort."* R8

Additionally, the ICT background of most of the teachers helped in easing the learning process on using NamSchoolTalk. To summarize, the findings show that the Computer Studies teaching practitioners found using all the features of NamSchoolTalk easy with the exception of the search tool, which a minority found to be a bit difficult.

**Social Influence.** Social influence refers to the extent to which an individual senses that the important peers believe that he or she should use the new system [9]. In other words, an individual's behaviour is influenced by the way in which they are viewed by others if they decide to use new technology [19]. Social influence therefore implicitly or explicitly influences behavioural intention. Positive social influence seems to positively influence adoption although other factors such as age, gender and facilitating conditions still play an important role. The role played by a member's social influence should not be overlooked as it can thrust the potential member towards or against adopting and using the system. Most respondents were positively influenced towards using NamSchoolTalk mostly by learners, friends and colleagues as evidenced by the following comment:

> *"Colleagues are very positive about the platform. They also influenced me and other new members to join in or come on board."* R9

One of the respondents could not comment on the impact of social influence on the use of NamSchoolTalk due to being the only Computer Studies teacher in that region with full internet access in the school. The respondent's comments seem to show that NamSchoolTalk does not alleviate the professional isolation that some teachers feel as evidenced by the following comment:

> *"Since NamSchoolTalk is still a new platform, I haven't heard much about it from my surroundings. The other problem is that we are the only school offering ICT and with full Internet access in this region, so it will be very difficult to get the opinion of other teachers around here."* R2

**Facilitating conditions.** Facilitating conditions refer to the extent to which an individual believes that organisational and technical infrastructure support their use of technology [9]. Adoption of the new system will be directly affected by the facilitating conditions as they attract or repel users' access and use of the system.

Most respondents indicated that they have all the right conditions such as ICT literacy skills and the ICT infrastructure that they need to use NamSchoolTalk. The encouraging conditions identified by the respondents are ICT proficiency, teaching experience and availability of a computer with Internet access. Some respondents also identified the unavailability of adequate time to work on NamSchoolTalk and lack of financial incentives as setbacks as they try to adopt and use NamSchoolTalk. The majority of the teachers responded that they have the right facilities to enhance their adoption of NamSchoolTalk. Their ICT proficiency background and reliable internet connectivity were the main attributes for their comfort. However, in few instances, the scarcity of time to work on the platform and lack of financial incentives were also identified as drawbacks. This could shrink member participation, thereby negatively the affecting adoption and use of NamSchoolTalk.

**Professional Development.** Furthermore, respondents were asked to rate the usefulness of the features of NamSchoolTalk based on their professional development needs. The findings show that all respondents find NamSchoolTalk to be highly useful for professional devel-opment because of various reasons. Some respondents appreciated the role of NamSchoolTalk for professional development due to enhanced collaboration opportunities:

> *"I feel the platform extremely helps me to become a better teacher as I can ask colleagues pertaining subject or topical based doubts. We can share experiences, approaches and even material / resources. I can only get better as a teacher as I would never this much help and collaboration if I was to either visit my colleagues or call them. There is much convenience through this platform."* R8

Other respondents appreciated the enhanced resource sharing opportunities offered by NamSchoolTalk towards positive professional development. Two respondents attributed the intuitive design of NamSchoolTalk platform and considerate members as a contributory factor that edified opportunities for professional development. Another respondent however showed a need for acknowledgement from either the school or MoE for members to take NamSchoolTalk more seriously.

**Level of trust and openness.** The trust commitment theory purports that for one to actively participate in an online community, one needs to trust in the online community and its members. Trust is crucial in ensuring participation [20]. Consequently, increased levels of trust coupled with openness point towards high chances of adoption and use of an OOCoP platform. The findings show that most respondents are extremely comfortable sharing any subject related information with colleagues and they also totally trust the subject related information that they acquire through this platform. The findings also reflect that some of the respondents still need to verify the information acquired, as they do not possess extreme levels of trust when using this platform.

The findings show that most respondents are more comfortable when sharing subject related information as compared to trusting the information they acquire through NamSchoolTalk due to various reasons. Participation tends to be skewed towards accessing posted resources than commenting on posted material due to the low levels of openness by most members. Most members therefore could likely favour to visit the platform mainly to upload or download resources rather than share comments on their experiences.

## 5 Recommendation for further study

Based on the findings of this study, the following recommendations for further study are made:

- The long-term adoption and implementation of NamSchoolTalk could not be established due to the time constraints of this study. It is recommended that a follow-up on this group be done at a later stage to see how effectively NamSchoolTalk has been adopted and used. NamSchoolTalk would need to be utilised by all the teachers in order for Namibia to fully realise the potential of this tool.
- While the calendar and announcements features in NamSchoolTalk were not used in this study, their potential for information sharing and allowing members to keep track of events by sending and receiving reminders and sharing of news would be worthwhile to explore.
- The social networking aspects of NamSchoolTalk such as blogs and wikis need to be explored in order for the users to benefit fully from the tool.
- The search tool would be need to be re-designed to make it more user friendly and access the Web from within the platform.
- The impact of NamSchoolTalk on the professional development and information sharing activities of other subject areas needs to be explored.
- The impact of low computer literacy on the use of this tool was not assessed due to the fact that the Computer Studies teachers possess high levels of computer literacy. In addition, the long term impact of low computer literacy on adoption and use could not be established due to time factors. These are critical areas for further research.

## 6 Conclusion

Information sharing among Computer Studies teachers is vital in facilitating professional practices in Namibia. It is also key in eliminating professional isolation which is a serious threat to subject development and growth. NamSchoolTalk, an OOCoP tool identified and customised in this research, provided important features that teachers found extremely useful and easy to use for information sharing and professional development. Features such as archiving facilities and various collaboration facilities like online chats and messaging enabled the sharing of unique experiences and subject resources for the teachers in various ways.

The full potential of NamSchoolTalk can only be achieved if this tool is used by all the teachers in the country. While this study is based on the Namibian context, there is a possibility for the suitability of this platform to be used by other institutions to support the professional development activities of CoPs. The application could be modified and be considered for the Computer Science and Information Systems lecturers in South Africa.

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# Teamwork

# Cultural Diversity and the Performance of Student Software Engineering Teams

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**Abstract.** We investigate the impact of cultural diversity on short-lived student teams who develop software in an educational setting. The aim is to determine whether there is a correlation between the cultural diversity of software development teams and the success of these teams. Cultural diversity is measured in terms of the variety of languages spoken by the team members and their ethnic differences. The team's success is measured in terms of the quality of the software project they produce as well as the extent of the collaboration in the team while working on the project. The purpose of the study is to gain insight into how cultural diversity affects the success of the teams. We conclude that the cultural diversity of teams has no observable effect on the success or failure of short-lived student teams in a software development project.

## 1 Introduction

Software projects often fail. Gupta et al. [11] state that between 50% and 80% of information systems projects fail. This high failure rate of software projects has led to intensive research on mitigating the failure of software projects [17]. It is commonly believed that team members' competence in "hard skills" plays an important role in project success, but a recent study of workplace success (surprisingly from a company most identified with science, technology and engineering – google) contradicts this conventional wisdom [29]. This is, however, not groundbreaking. For many years one of the reasons for failure which is often cited is human factors [17,22]. A project may fail as a consequence of the team's failure to collaborate [28].

When constructing and managing software development teams from culturally diverse backgrounds, it is important to guide the members to understand and appreciate cultural differences in order to avoid any misunderstanding arising from these differences [13,14].

The current literature is dominated by studies conducted in other countries [15,19,32]. There is little research reported on cultural differences in software engineering in Africa. The aim of the present study is to attempt to address this shortcoming.

Cultural diversity is prominent South Africa. Terms such as racism and xenophobia are often heard on the local news and used in conversation. A deeper understanding is needed of the role of cultural diversity in the workplace to provide a sound scientific foundation for project management in this environment.



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We believe that cultural diversity can positively contribute to the quality of work done by teams and might also lead to better team cohesion in spite of the logical arguments that language barriers are likely to cause communication problems and that differences in beliefs and morals may lead to diminished trust. The current research investigates these claims.

We conducted research specific to student teams performing software engineering tasks in tertiary education in a South African context. We envisioned that if we would identify trends in the relations between cultural diversity measures and the performance of our teams, that the findings may be applicable to student teams doing tasks not necessarily related to software engineering.

## 2 Literature Survey

### 2.1 Defining Culture and Diversity

Culture can be defined as a certain mental programming [7,14] that is learned by every individual since childhood [6,14] from the social environments [14,31] into which the child was born. This mental programming can be conceived as the symbols [14,31], the basis of each individual's values [6,8,9,14,27] and the norms [31,27] that guide the way that individuals behave [31,27,8] and think [27,7,8,14]. Hofstede et al. [14] state that even though culture is perceived by the public by means of actions, rituals and symbols, the significance of these are known only by the individuals who share the same cultural history.

Many researchers have studied how diversity in software development groups influences the effectiveness and eventual success of a project. Some reports highlight the positive aspects of such team compositions while others mention disadvantages to composing culturally diverse software development teams. Section 2.2 discusses some advantages of composing teams with a culturally diverse background and Section 2.3 points out some disadvantages of doing so.

### 2.2 Advantages of Cultural Diversity

It has been reported that teams that are culturally diverse more likely to be effective and successful in creative tasks [8,12,10]. The different views [31] of the individual team members in culturally diverse teams may encourage better reasoning and decision making about the software tasks [12,31,8], enhance the members' innovative skills [8,3] and promote learning [31,10]. Extensive cultural differences in software teams are also helpful for examining more options for system design options because individuals have different priorities [16].

### 2.3 Disadvantages of cultural diversity

Differences among individuals' beliefs, values, attitudes, and perceptions may inadvertently cause conflict [18,10,22]. Conflict in culturally heterogeneous teams can be difficult to manage, since each individual may have different priorities [16], views of relevance [31] and interpretations of requirements [6]. Furthermore, language barriers may inhibit satisfactory communication among team members [17,18]. Poor communication in teams leads in turn to diminished trust [10] which hinders individual performance and overall team effectiveness.

## 3 Problem Statement

### 3.1 Problem

Students enrolling for a Computer Science degree at the University of Pretoria are culturally diverse. They have different backgrounds, beliefs and morals. We are interested to know to what extent cultural diversity effects the performance of teams in our setting.

### 3.2 Objectives

It may be difficult to attain clarity about the problem stated in Section 3.1. Culture is in itself a complicated topic, and when combining it with the complexity of defining whether or not software development teams are successful, the resulting problem is wicked [4,5]. For this reason, this research defines cultural diversity only in terms of two aspects as described in Section 5.4. We also limit the study to determine the effect of cultural diversity on only two aspects of team success. The study is thus limited to only the following objectives in terms of our definition of cultural diversity:

- To assess whether culturally diverse software development teams produce better work than culturally homogeneous teams.
- To assess whether culturally diverse software development teams produce better work than culturally homogeneous teams.

This research observes these aspects only in short-lived teams who participated in a series of micro projects discussed in Section 4.

## 4 Setting

The software engineering capstone module is compulsory for the Computer Science degree offered at the Department of Computer Science at the University of Pretoria. During the first eight to ten weeks of the module, students are required to complete a series of four micro projects in different teams. New teams are assigned for each micro project. The different micro projects build on each other to constitute the design, implementation and testing of a single, fairly large, software product comparable to a real-world software product. The micro projects are, however, small and well-defined teaching assignments [23]. The students are expected to learn how to the use technologies and tools needed in software development and project management and at the same time to develop the soft skills needed to implement large systems of this kind [20,21].

# 5 Method

## 5.1 Data Collection

Data was gathered in the period 2011–2016. It included information about a total of 434 students who were assigned to a total of 246 differently composed teams.

The following information was obtained from student records maintained by the university's registration office:

- The ethnicity of each individual.
- The home language of each individual.
- The individual's marks for passed modules.

Scores were calculated regarding the ability of the students and their participation in their teams.

An ability score for each individual is calculated based on his/her performance in the prerequisite modules for the capstone module. This measure is used based on positive correlations between compliance with admission requirements for a module or programme and success which have been established through empiric research [25,26].

The participation of students in their teams were obtained by analysing the responses to the peer reviews after each micro project. We used the levels defined by Pieterse et al. [24] shown in Table 3. The students were expected to complete a peer review after finishing each of their micro-projects. In each review they were asked to reflect on how they perceived themselves and how their peers perceived them. The questions that the students had to answer guided them to reflect on their own contributions and also on the contributions of the other members. These questions were the same as those used by Pieterse et al [23]. The same questions were asked in all peer assessments. The participatory level of each of the students in the team was determined through the analysis of the answers students provided in these peer reviews for each micro-project team.

In a given year, each student in the class was assigned to a different team for each of four micro projects. This gave us 246 differently composed teams that we could study. For each of the teams the following information was compiled:

- A mark to evaluate the quality and correctness of the artefact that the team produced. This mark was assigned by the teaching staff.
- A team ability score based on the ability score of each individual.
- A team cohesion score based on the participatory ratings of the individuals in the team.

## 5.2 Data Processing

The anonymous student data for the individuals in each team was grouped to form a data set for each team. Typically, a student's data would be duplicated in the different data sets for all the teams in which he/she participated.

The data about each individual in each team was used to determine measures to describe the team in which the individual participated. Teams were excluded in cases where we did not have enough information about the individuals in these teams, or where we did not have access to the marks that had been assigned to the team's deliverables.

### 5.3 Participants

Table 1 summarises the attributes of the students who were observed.

**Table 1.** Profile of individuals

| | |
|---|---|
| Number of males | 345 |
| Number of females | 81 |
| Total number of individuals | 426 |
| Number of languages | 17 |
| Number of ethnic groups | 4 |

Figure 1 shows the number of individuals included in this research by gender and ethnic group and Figure 2 shows the number of individuals included in this research by first language. Those counted as "Afr/Eng" stated that they were equally fluent in Afrikaans and in English. Nguni includes IsiNdebele, IsiXhosa, IsiZulu and SiSwati. Sotho includes Sepedi, Sesotho and Setswana. Those counted as "Other" are international students whose first language is French, German, Polish, Portuguese, Russian, etc. Apart from being fluent in their first language, all the students should be fluent in English.

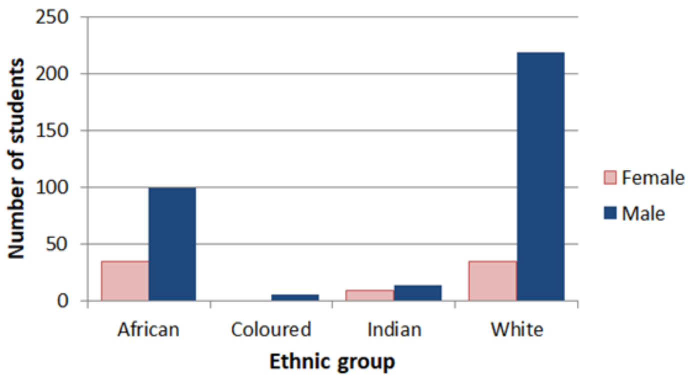


**Fig. 1.** Ethnicity and gender (n=426).

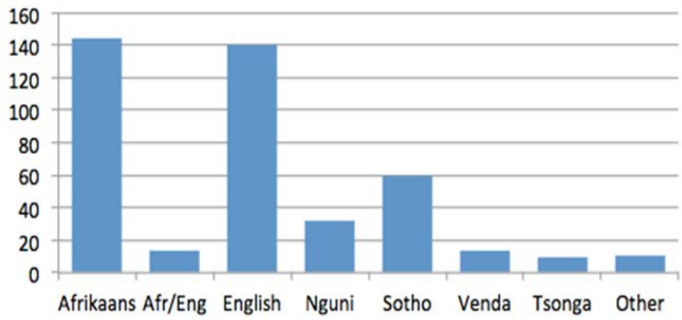


**Fig. 2.** Languages (n=426).

**Quantifying Cultural Diversity**

Diversity is defined as any difference (age, race, culture, etc.) that distinguishes individuals from one another [17,27]. This research considered only the national cultural diversity within a software development team. All other diversifying factors were ignored.

The diversity of a team is calculated by means of the following team member attributes:

- Team's ethnic composition
- Team's language composition

**Ethnic Diversity.** The ethnic diversity score of a team is expressed in terms of the ratio of the team members who belong ethnic groups other than in the largest ethnic group in the team. For example, if a team consists of 2 White, 0 Coloured, 1 Indian and 4 African members, the ratios for the four ethnic groups are 2/7, 0/7, 1/7 and 4/7. The ethnic diversity score for this team excludes the ratio for the majority group (the Africans). It is therefore 3/7 = 42.85%. The ethnic diversity distribution within teams as shown in Figure 3 indicates that the majority of teams in our investigation had low ethnic diversity scores.

**Language Diversity.** The language diversity score was calculated by counting the distinct languages spoken as first language by the members in a certain team, dividing this value by the number of individual members in the same team, and then multiplied by 100 to get a percentage score. Figure 4 illustrates that the distribution of languages in the various teams is fairly balanced.

The ethnic diversity score as well as the language diversity score are each used to investigate if there is any correlation between the diversity of the software team members and the success of a project.

Table 2 shows the descriptive statistics of the data about the diversity in the teams observed in the research.

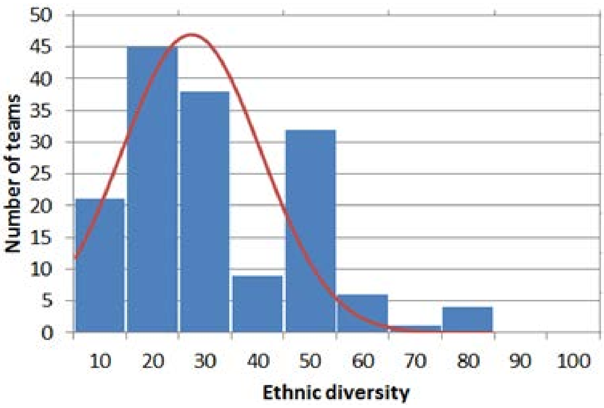


**Fig. 3.** Distribution of ethnic diversity scores.

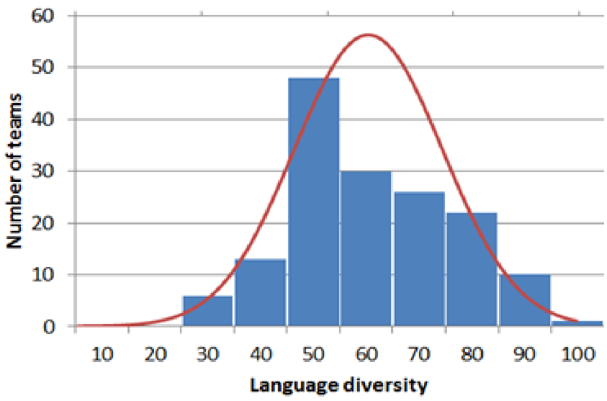


**Fig. 4.** Distribution of Language Diversity Scores.

**Table 2.** Descriptive statistics of team diversity data.

| | |
|---|---|
| Number of distinctive teams | 156 |
| Average number of individuals in a team | 7 |
| Ethnic diversity score – mean | 27.48% |
| Ethnic diversity score – standard deviation | 16.57 |
| Language diversity score – mean | 57.59% |
| Language diversity score – standard deviation | 14.73 |

## 5.4 Quantifying Project Success

Baccarini [2] defines project success in terms of two separate components, namely project management success and project product success. Management success includes successful team accomplishments regarding collaboration, cost and time [1] whereas product success focuses on the functionality and quality of end product [30].

In this research, success is defined only in terms of a measurement of team cohesion and a single measurement of the scope, functionality and quality of the product. Other criteria for project success, such as cost and time to market, were not considered. The success was calculated by means of the following attributes described in more detail in the remainder of this section:

- Normalised work quality
- Team cohesion

**Work Quality.** The work quality of each micro project team was measured in terms of the marks allocated during the summative assessment of the team deliverables. The lecturing staff evaluated the deliverables of each team. The marks awarded to each team were used as a measure of the quality and correctness of the artefact produced by the team.

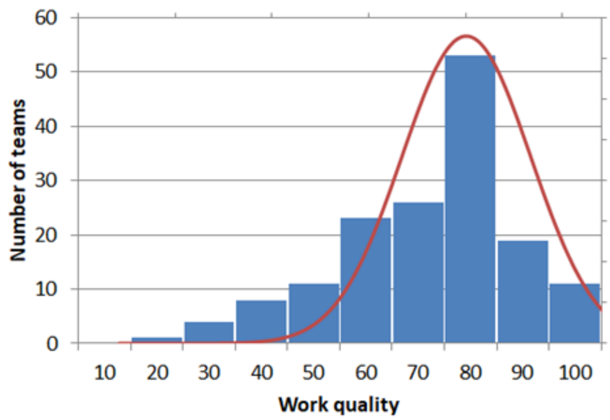


**Fig. 5.** Distribution of work quality scores

A team ability score is calculated for each team. This score quantifies the competence of the team, based on the average of a measure of the ability scores of the members in the team discussed in Section 5.1. The normalised work quality was calculated by applying standard statistical score normalisation to normalise the marks for the deliverable according to the team's ability score.

The distribution of the normalised work quality, shown in Figure 5, indicates that quality of the artefacts produced by the students was according to expectation.

**Team Cohesion.** We deemed team cohesion to be important for successful software development. For this reason, we derived a metric to quantify team cohesion in terms of a team's a participation success score to represent the software project-management aspect of project success in our context.

We determined a score to represent team cohesion, based on the participation level of each student in each team, which was established as described in Section 5.1. We attributed scores to each of the participatory levels shown in Table 3. These scores were selected on the basis of a theoretically preferential team composition of (teams that work well together).

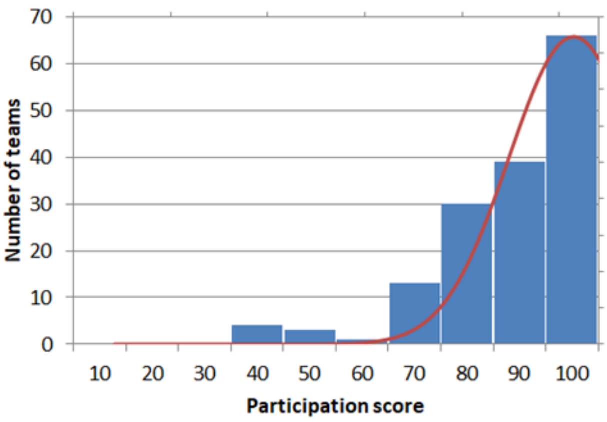


**Fig. 6.** Distribution of team cohesion scores.

**Table 3.** Description and scores for participation.

| Level | Description | Score |
|---|---|---|
| Insightful Shaper | A successful leader who manages to motivate and allow the other team members to participate. | 3 |
| Compliant Worker | A member who is relatively unquestioning and likely to accept the decisions of others without consideration, yet usually does what is expected of him or her. | 3 |
| Diligent Isolate | A member who willingly increases his/her effort when working in a team, not only to complete his/her own tasks exceptionally well but also to redo or improve the work of other members. | 2 |
| Social Loafer | A member whose contribution is perceived to be inferior to that of others in the team. | 1 |

A score was given to each individual in each team, based on the participation level scores. The scores of each individual in the team were added together and divided by the maximum score that the team could possibly achieve (i.e. 3 × number of members in the team). As shown in Figure 6, the team in general had very high team cohesion.

**Table 4.** Descriptive statistics of project success data.

| | |
|---|---|
| Number of distinctive teams | 156 |
| Average number of individuals in a team | 7 |
| Normalised work quality – mean | 68.65% |
| Normalised work quality – standard deviation | 16.48 |
| Team cohesion – mean | 84.35% |
| Team cohesion – standard deviation | 14.72 |

Table 4 shows the descriptive statistics of the data related to the success measurements defined in this section.

## 6 Findings

We used scatter plots to investigate the influence of each type of diversity (language and ethnic) on each measure of team success (quality and cohesion). Table 5 shows the linear regression models for each of the four possibilities while Table 6 shows the goodness of fit ($R^2$) for each of these possibilities. The $R^2$ values are very small (<0.03). This upper bound of the $R^2$ values in this table is ten times smaller than the smallest value, which may indicate that variation in success could be explained by the variation in diversity. It is evident that the null hypothesis, namely that there is no correlation, could not be rejected in all cases.

We show and discuss only two of the four scatter plots as representative ex-amples of the rest of these scatter plots. The chosen scatter plots are those with the highest variation.

**Table 5.** Causal regression models.

| | **Quality** | **Cohesion** |
|---|---|---|
| **Language diversity** | y=-0.1182x+75.469 | y=0.0237x+82.986 |
| **Ethnic diversity** | y=+0.0115x+68.344 | y=0.1452x+80.363 |

**Table 6.** Goodness of fit ($R^2$) of the regression models.

| | **Quality** | **Cohesion** |
|---|---|---|
| **Language diversity** | 0.0112 | 0.0006 |
| **Ethnic diversity** | 0.0001 | 0.0267 |

When looking at the equations defining possible regression models, the largest positive slope is in the model describing the impact of ethnic diversity on team cohesion. Figure 7 shows the scatter plot for this case. The regression line has a very slight upward slope. There seems to be a minute increase in team cohesion as the ethnic diversity of the team increases. Team work in general is considered to be a communication-intensive action and therefore suggests that success could depend on good communication among team members. This positive slope may imply that ethnic diversity in a team has a positive impact on how well the individuals in the team work together, i.e., team cohesion increases as the team's ethnic diversity increases. This is, however, counter-intuitive. Ethnic diversity is likely to have a negative impact on communication and understanding, which may in turn lead to lower levels of team cohesion. This anomaly can be explained by the low variation in the team cohesion measures in our data.

The increase in team cohesion which correlates with the increase in the ethnic diversity is practically zero. It can therefore be concluded that the ethnic diversity in teams seems to have no impact on how well the members in these teams cooperated.

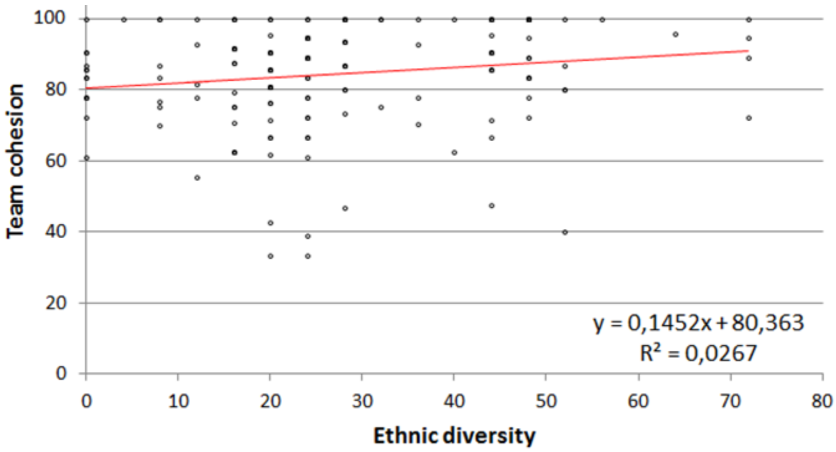


**Fig. 7.** Correlation between ethnic diversity and team cohesion.

The largest negative slope is in the model describing the impact of language diversity on the quality of the team deliverables. Figure 8 shows the scatter plot for this case. The regression line has a very slight downward slope. This could be interpreted as indicative of the negative impact of language diversity on the quality of the work done by the team. Once again, the slope is practically zero and the goodness of fit is insignificant. The null hypothesis of no correlation between these measures can thus not be rejected.

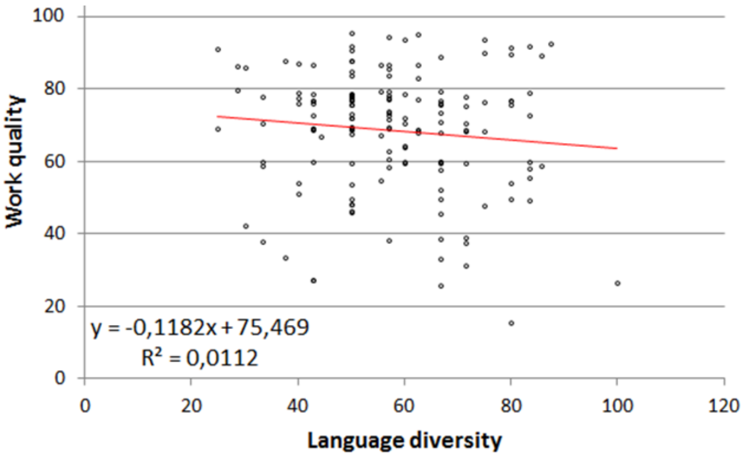


**Fig. 8.** Correlation between language diversity and work quality.

Since the data is clearly not normally distributed, and therefore not really amenable to conventional parametric correlation tests, it was decided to investigate whether the well-known Spearman's rank correlation test would reveal anything different. The correlation between the three different diversity measures and the two different measures of success. The results are shown in Table 7. In all cases, these coefficients again confirm that the null hypothesis of no correlation could not be rejected.

**Table 7.** Spearman's correlation coefficients.

| | **Quality** | **Cohesion** |
|---|---|---|
| **Language diversity** | -0.1000 | 0.0761 |
| **Ethnic diversity** | -0.0055 | 0.2272 |

We have therefore found no evidence that could lead us to believe that our measures of team diversity have any influence on the success or failure of a project defined in terms of the work quality or defined in terms of our measure of team cohesion.

## 7 Limitations

It may prove challenging to generalise the findings of this research to (i) real software development in a working environment, (ii) long-lived teams and (iii) teams performing non-SE tasks, owing to the following limitations of the research:

- Teams had to perform only the tasks required during software development.
- Teams for the research were chosen only from a single institution in a specific module setting.
- Most participants were male students in the age group 19–22 years.
- Teams were short-lived (two to four weeks).
- Teams were assigned by the lecturer.
- Teams were relatively large (five to eight members).
- Projects were relatively small and well-defined (teaching assignment vs. real-world projects).
- The success of the teams was measured by means of subjective observations.
- Real-world criteria such as cost and time to market were not considered.

## 8 Conclusion

We summarise the advantages and disadvantages of having culturally diverse teams. Educators should take cognisance of how cultural diversity may influence the classroom situation when students are required to work in teams.

We described how we teach the software engineering process by means of a hands-on series of micro projects which involve the students in the design and implementation of a software product of real-world style. This brief description and pointers to other publications about this method of teaching may enlighten educators who are involved in similar courses.

We described the techniques we employed to gather information and quantify the team attributes. We defined metrics to measure aspects of cultural diversity in teams as well as metrics for measuring team success in our context. These are based on accepted beliefs about these concepts.

We applied statistical methods to investigate correlations between the aspects of cultural diversity of teams and two measures of project success. In corroboration with criticisms by other authors [10,17,18], we originally hypothesized that cultural diversity in a software development team would dramatically decrease the communication among individuals in the team. Our research results show that this hypothesis is incorrect in our context. The results in fact show that, there is a slight possibility that an ethnically diverse team may be more cohesive than an ethnically homogeneous team. The contradictory results are not conclusive. It might be specific to the situation, so the results should be interpreted with extreme caution.

The research conducted and reported on in this paper, which was originally inspired by the research done by Hofstede et al. [14], accords with the research of other researchers such as Bradley and Hebert [3], Deshpande et al [8] and Walsham [31] that, although there may be managerial complications when composing culturally diverse software development teams, there is no reason to believe that culturally diverse teams will be worse off than culturally homogeneous teams.

Our research, however, did not corroborate the findings of other researchers who have indicated benefits [8,12,10] and drawbacks [18,10,16] of having culturally diverse teams. Instead, our research results suggest that the performance of our teams is not influenced by the cultural diversity of our teams. The observation that claims regarding cultural diversity of teams may not be applicable in our context confirms an alternate view that there is no critical need to ensure or to avoid cultural diversity in our teams.

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# Tackling Teamwork in Higher Education

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**Abstract.** The assumption is often made that Higher Education Institutions are providing students training in teamwork skills, and that graduates will be able to work productively in teams when they enter the professional workforce. However, research shows that many students still leave academia without having been taught the knowledge and skills necessary for teamwork. The aim of the study is to recommend guidelines for managing and teaching teamwork in Higher Education Institutions. Qualitative research was done, as the researchers wanted to understand the students' perceptions, and to receive recommendations on improving the process. The answers to open questions were analysed interpretively. The study describes how teaching and learning of Information Technology students in one module at a Higher Education institution in South Africa were organized. Assignments in this module were completed by teams. Feedback from students on teamwork were analysed. Guidelines for lecturers on improving teamwork were found to fall in specific groups, namely the selection of teams, guidance provided by the lecturer, the division of work, the management of the teams and the assessment of teamwork.

**Keywords:** Higher education, Teamwork, Soft skills.

## 1 Introduction and Problem Statement

In the 21st-century employment market, being able to work effectively and productively with others in teams is considered essential [12,14]. In today's dynamic, distributed, and complex workplace technical skills alone are insufficient for success in IT [7], and soft skills are becoming increasingly important. Soft skills such as teamwork and collaboration, planning and leading projects, presentation delivery, and writing skills will be critical for success in the Information Systems profession [9,13,19].

The results of research done by [5] show an expectation that universities are responsible for the development of both technical and non-technical skills. The assumption is made that graduates will be able to work productively in teams when they enter the professional workforce, and that Higher Education Institutions are providing students training in teamwork skills and capabilities [11]. There is, however, a gap between the level of teamwork skills required by employers and the level developed by students during their undergraduate courses and universities are being criticized for not preparing students with the necessary team-related skills [1]. Research shows that many



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students still leave academia without having been taught the knowledge and skills of how to work in teams [20]. Some students feel that although universities do have a role in developing skills like teamwork, students often do not get this training because team based assignments are not accompanied with appropriate training on how to work as a team. Employers continue to argue that universities need to do more to better prepare graduates to work in team-based environments [3,11].

According to Hazzan and Har-Shai [4] a Google search reveals that almost all problems associated with software development processes are connected to people and are rooted not in technological aspects but in the expression of soft skills. Research at Google shows that the top characteristics of success at Google are all soft skills: being a good coach; communicating and listening well; possessing insights into different values and points of view of others; being a good critical thinker and problem solver; and being able to make connections across complex ideas. Another research study shows that the best teams at Google exhibit a range of soft skills: equality, generosity, curiosity toward the ideas of your teammates, empathy, emotional safety and emotional intelligence.

Furthermore, there is often confusion concerning how teamwork is measured and assessed, making it difficult to develop these skills in Higher Education [2]. Reibe et al. [11] write that teamwork in higher education is challenging for both students and assessors. Unfair assessment of teamwork is a common complaint amongst students [12].

The above research shows the importance of teaching soft skills, and teamwork in particular, but also the complexity thereof. This study describes how teaching and learning of Information Technology students in a capstone project-based module at a Higher Education Institution in South Africa are organised. All assignments in this module are completed by teams. Feedback from students (on teamwork) are analysed. The aim of the study is to recommend guidelines for managing and teaching teamwork in Higher Education Institutions. In the next section the relevant terminology is described.

## 2 Terminology

### 2.1 Soft Skills

There is no globally accepted definition of soft skills. Each discipline, educational sector and country defines soft skills according to their own needs [8].

For the purpose of this study, the term 'soft skills' is used and it is defined as intra- and inter-personal skills essential for personal development, social participation, and required to function in a specific employment environment [17].

### 2.2 Teamwork

Hughes and Jones [6] define teamwork by first discussing the term team. Teams are composed of individuals who share defining characteristics: they have a shared collective identity, have common goals, are assigned interdependent tasks and have distinctive roles within the team. Teamwork can then be defined as a set of skills that individuals use to foster the success of groups or teams [6]. Effective teamwork can also refer to a successful product produced by a group of individuals [12]. For the purpose of this study, teamwork is defined as work done by a group of individuals with assigned tasks and roles, to achieve a common goal. In the next section the importance of teamwork is described, first by identifying references to teamwork in the SAQA level descriptors, and then by looking at relevant literature.

## 3 Importance of teamwork

In section 3.1 the SAQA level descriptors are examined for reference to teamwork, and in section 3.2 relevant literature is researched for reference to the importance of teamwork.

### 3.1 Soft Skills, Teamwork and SAQA Level Descriptors

The South African Qualifications Authority (SAQA) developed level descriptors for the South African National Qualifications Framework (NQF). A level descriptor describes learning achievement at a particular level of the NQF that provides a broad indication of the types of learning outcomes and assessment criteria that are appropriate to a qualification at that level. The level descriptors are designed to act as a starting point for writing learning outcomes and criteria for qualifications and for programme quality management. There are ten categories used in the level descriptors. When these are further investigated, it becomes apparent that two of these categories are relevant to teamwork, namely management of learning and accountability. In table 1 these level descriptors for NQF level five, six and seven can be seen. These are the relevant NQF levels for an undergraduate degree (first, second and third year). It is also important to notice that the level of development of these soft skills rises within each NQF level. This means that not only must these soft skills be developed on first, second and third year level at university, but the development must also be on a higher level each year.

Relevant to teamwork are: to promote the learning of others; to provide support to the learning needs of others where appropriate; to facilitate collaborative learning processes; to work effectively with and respect others; to take supervisory responsibility for others and to work effectively in a team or group. From this we can assume that the development of teamwork skills is deemed important by the SAQA authorities.

**Table 1.** SAQA level descriptors for undergraduate programmes relevant to soft skills [15]

| | NQF Level Five (First year) | NQF Level Six (Second year) | NQF Level Seven (Third year) |
|---|---|---|---|
| Management of learning | Evaluate performance (own or those of others); take responsibility for and promote the learning of others. | Evaluate performance and provide support to the learning needs of others where appropriate. | Identify, evaluate and address learning needs, and facilitate collaborative learning processes. |
| Accountability | Account for own actions, work effectively with and respect others, take supervisory responsibility for others and for the responsible use of resources. | Work effectively in a team or group, and take responsibility for decisions and actions. | Take full responsibility for own work, decision-making and use of resources, and limited accountability for the decisions and actions of others. |

### 3.2 Literature on the Importance of Soft Skills and, More Specifically, Teamwork

Different soft skills are necessary for effective teamwork. Riebe et al. [12] mention the following, compiled from several sources: managing conflict, ensuring accountability, time management, organisation, record keeping, planning, goal setting, leadership, decision making, communication, awareness of interpersonal strengths and weaknesses, understanding group norms. Hughes and Jones [6] and Hannah and Robertson [3] also mention goal setting. There is a core set of soft skills that are common to most programs. In a study by [17] a list was compiled of the most important soft skills, after a literature study of 9 different sources. These skills were: communication, teamwork, professionalism. flexibility, interpersonal relationships, leadership, problem-solving, reliability, work ethic, conflict management, courtesy, creativity, critical thinking, decision making, negotiation, self-confidence, self-management, time management, willingness to learn, client management, cross-cultural relationships, emotional intelligence, handling pressure, multi-disciplinary thinking and positive attitude. Teamwork was mentioned by 7 of the 9 sources studied. Only communication was mentioned more (by 8 of the 9 sources).

Hughes and Jones [6] write that many studies have identified teamwork as one of the most valued and necessary skills among college graduates. They also refer to the results of a study where 71 percent of employers said they wanted colleges to place greater emphasis on teamwork skills.

Results of research done in 2016 under first year, second year, third year and fourth year IT-students at a Higher Education Institution in South Africa show that students felt confident about their willingness to learn, their work ethic and their skill for self-management, but they felt least confident about their skill for cross-cultural relationships, leadership, multi-disciplinary thinking, time-management and teamwork [18].

Many recommendations for the development of soft skills found in different sources are directly or indirectly linked to teamwork, for example: Encourage students to dialog with others [13]; Students must be required to work cooperatively with others toward a common goal [13] ; Instructors should strive to find learning outcomes that involve teaming, leadership, presentations, interviews, or panel discussions [13]; Students should work with students from other courses or faculties [17,18]; More teamwork must be done, especially on projects were components of the assignment are inter-dependant [17]; When students work in a team, they must assume different roles so that a student cannot choose to do only that which he or she is comfortable with [17].

From available literature the following advantages of teamwork can be derived:

- Improving communication skills [1,3,10,16,19];
- Providing students with the opportunity to practice skills required for the workplace [1,10,16];
- Increasing productivity [16];
- Solving problems creatively by analysing from different perspectives [1,3,16,19];
- Students learn at a deeper level and retain information longer [10];
- Higher level thinking [1];
- Self-management skills [1];
- Leadership skills [1];
- Conflict management skills [3];
- Planning skills [3].

From the above it is clear that teaching and learning teamwork at Higher Education Institutions is indeed important, and that there are many advantages of teamwork. In the next section the methodology followed for this research is described.

## 4 Methodology

Qualitative research was done, as the researchers wanted to understand the students' perceptions, and collect students' recommendations on how to improve the process. The answers to open questions were analysed interpretively to group similar answers together. In section 5 a description is given of the relevant module and the way the teaching and learning in this module was organized.

## 5 The Module investigated as part of this research

This section starts with an overview of the module, followed by details, activities, communication methods, workshop and assessment.

### 5.1 Overview of the Module

The module used as example for this research forms part of the specialized modules in an Information Technology degree at a Higher Education Institution in South Africa.

This 16 credit module (1 credit = 10 hours) is presented in the second semester of the final year of the graduate degree, and it provides an opportunity for integration of the knowledge and skills from the other modules in the degree, as well as newly-acquired knowledge and skills from activities in this module. The module is presented using lectures, workshops and practical sessions, and is further supported by e-learning material. Typically lectures, workshops and practical sessions make up 24 hours of the module, with the other 136 hours dedicated to study and teamwork. The student is introduced to new developments in the field of Information Technology as well as industry-related methods and commonly used tools. The goal of the module is to teach the students to integrate knowledge and skills, to investigate new technologies and opportunities, to successfully work as part of a team while learning necessary soft skills, and to become a lifelong learner.

### 5.2 Details for 2017

In 2017 there were 107 students registered for the module. The students were allowed to form their own teams. Teams consisted of between 3 and 6 members. Some teams asked for permission to work in teams of 2 or 7. This was allowed in some cases, depending on the project proposal submitted. The 107 students divided into 20 teams. The activities set for 2017 are discussed in the next section (activities vary slightly each year, compensating for new technologies).

### 5.3 Activities

The first activity was for each student to complete an online personality, and to write a report on the common strengths and weaknesses of his / her personality as far as working with others is concerned (an overview is given on the website after the test). This was completed by each student individually. All the other activities were completed as a team. After completing the first activity a number of scenarios were given, containing specific problems. These problems were tailored to be solvable by chosen technologies, including mobile, IoT, cloud, and other new technologies. The second activity was to write a project proposal for the chosen project. Students were required to analyse a given problem and investigate possible solutions. A proposal for an adequate solution using appropriate technologies was then drafted. The proposal included a discussion of the problem and possible solutions, the motivation for the chosen solution, an overview of the chosen solution and technologies required, and an overview of relevant project management topics and team member roles in the project. Students described project management details and the chosen software development methodology (SDM) as part of the project proposal. Students submitted the proposal document for assessment and presented the proposal to a student assistant, who would either accept the proposal, or give feedback on changes that should be made.

The third activity was to implement the proposal. The student assistant as well as the lecturer were available to help if a team experienced problems. The students endeavoured to develop the solution, following the chosen management strategies and SDM. Upon completion of the development students submitted documentation. The documentation contained a technical report of the project, as well as an evaluation of the result. It also included a reflection on the technology and skills involved in the project and a discussion of the teamwork and team dynamics.

The fourth activity was the presentation of the finalized project to the lecturer, followed by self- and team evaluations. After final assessment each student handed in a document containing self-assessment and assessment of other team members. The various assessment procedures are discussed in the “Assessment” section.

The lectures were mainly class discussions and focused on the topics and technology relevant to the activities. The first few lectures focused on personality and teamwork, while the rest focused on scenarios and possible technologies that could be used, followed by guidance on writing project proposals and project management; and discussions of various technologies, their possible use, advantages and disadvantages, and comparison with other technologies.

### 5.4 Communication Methods

Three main methods of communication were used in the module in 2017. The first communication method was Slack. Students could use the Slack website and Slack mobile app. Private group channels were created on Slack for each project team and a public channel for general communication purposes. There was also a private channel for communication between the lecturer and the student assistants. Students used the group channels to discuss the projects, but could also use direct private messages for communication between members and with the student assistants and the lecturer.

The second communication method was eFundi (based on the Sakai system). This is the official Learner Information System (LIS) used by NWU. This system was used to upload student reports for assessment and also to send announcements to students. These announcements were also send using the public channel on Slack.

The third communication method was Google Calendar, used to schedule appointments and presentation of projects.

### 5.5 Workshops

Every year a company is invited to present an introductory workshop on a topic deemed important in team projects. The workshop is scheduled at the start of the module. In 2017, a company presented a two-hour workshop on the use of git for programming collaboration and version control of software. The use of git was optional in the past, but from 2017 it is required for all projects. Students were given an introduction to git in class and asked to write a short report on the use of git for code collaboration.

### 5.6 Assessment of teamwork

Assessment in the module consists of formative assessment in the form of individual reports as well as team reports; and summative assessment of the final project, documentation and project presentation. Before starting each project, the team members had to discuss a project proposal with the lecturer (or student assistant). Each member’s proposed contribution was also discussed at this time. The scope of a project was discussed and set according to the number of team members. During weekly lectures the progress of all team projects were discussed with students and students were encouraged to discuss any problems with the lecturer or student assistants. After completing the project, a work breakdown document was completed by each team member. This document contained sections on self-assessment as well as team assessment. Team members described the tasks in detail as well as the hours worked by each member, and assigned a mark for the completion of tasks, quality of work and degree of difficulty. The mark assigned to each team member was checked against the descriptions of tasks and hours listed and entered into a spreadsheet and a weight for each team member was calculated according to the percentage contribution assigned by all team members. If irregularities between the marks, task descriptions and hours were noted, the team was called in and the anomalies discussed.

The work breakdown was used during the presentation of the project artefact and project report to ensure that the team members had done their part during development of the project. After the presentation each member's contribution to the project was discussed and each member had to demonstrate knowledge and insight of his/her contribution and how that contribution relates to the rest of the project.

The mark given for a project was assigned to the team members using the weights calculated from the work breakdown. If the percentage contribution assigned by all team members for a specific member showed large variance among the team members, the team was called in and the contribution of that member was discussed. If a weight of less than 0.8 was assigned to a student, that student was called in and his / her participation in the project was discussed and evaluated.

Multiplying the final team project mark with an assigned weight for each student ensured that students who put a lot of effort into the team projects were rewarded, while penalizing students who did not do their part. The trick was to verify the marks using the task descriptions and hours worked, and having the students use objective values and descriptions.

## 6 Results

Feedback from the students in 2017 can be seen in section 6.1. From these results it was clear that students do have problems with teamwork and the managing of teamwork by lecturers, and because of this it was decided to gather more feedback from a different group of students in 2018, to further explore this issue. These results can be seen in section 6.2.

### 6.1 Feedback from students 2017

Firstly, students were asked to indicate whether they strongly disagree, disagree, feel neutral, agree or strongly agree with six statements. The number of students who participated was 25. The results can be seen in table 2 (next page).

As can be seen in table 2, 12 of the 25 students who answered the first question, strongly disagreed or disagreed that completing the personality test was helpful. The same number of students agreed or strongly agreed that it was indeed helpful. Most of the students clearly felt that not everyone in the team participated with equal effort, as only 3 students agreed with the second statement and not one student strongly agreed with this statement. There were different opinions on whether the peer review process was effective and fair, which indicates that even though specific measures were implemented to manage assessment (see section 5.6) some students still felt that the process should be improved. Most students indicated that teamwork is an important part of the module (with 22 agreeing or strongly agreeing with this statement), and most students indicated that teamwork should be an important part of the module (even though only 19 out of 25 agree or strongly agree with this statement, which is less than for the previous question).

**Table 2.** Statements on the module and teamwork.

SD=Strongly Disagree, D=Disagree, N=Neutral, A=Agree, SA=Strongly Agree

| | n | SD | D | N | A | SA |
|---|---|---|---|---|---|---|
| The personality test at the beginning of the module was helpful in understanding myself and working in teams. | 25 | 4 | 8 | 1 | 8 | 4 |
| Everyone in the team participated with equal effort. | 25 | 8 | 8 | 6 | 3 | 0 |
| The peer review process (team participation form) was effective and fair. | 25 | 5 | 6 | 3 | 7 | 4 |
| Teamwork *is* an important part of the module. | 25 | 1 | 1 | 1 | 9 | 13 |
| Teamwork *should be* an important part of the module. | 25 | 3 | 0 | 3 | 6 | 13 |
| Teamwork in this module taught me valuable lessons about working in teams in the future. | 25 | 2 | 1 | 2 | 7 | 13 |

Students were asked the following open questions:

**Question 1.** Did you have any trouble in your team? What was the cause and how did you solve the problem? Do you think it influenced your marks for the module?

This open question was answered by 17 students. Two students answered that they had no problems. Five students mentioned problems concerning communication. An example of this was: *"Yes. We had major communication issues as well as issues with getting along with each other"*.

Incompetence of team members were mentioned by two students. Interesting answers were: *"People were completely incompetent in coding, they can't do their work and they don't even try"; "Most students cannot do what is expected of them in terms of development. Thus other students have to complete their work. To solve the problem, I just did their work"*.

Unwillingness / laziness / members not doing their part were mentioned by 4 students. An interesting answer was: *"Team members were extremely lazy and did not put in any effort to try to master the new programming languages. I could not motivate them to put in more effort and I was the only one who could develop anything worth demonstrating during the 3 phases"*.

Members dropping out were mentioned by 2 students.

**Question 2.** Students were also asked what, according to them, the ideal structure of a team would be for this module (e.g. Number of members, assigned members vs chosen by team etc.).

This question was answered by 17 students. Two students answered that the ideal would be 2 members, two students preferred 3 members, and 13 students indicated numbers between 4 and 6. Five students indicated that they think students should be allowed to choose their own team members. Six indicated that teams should be assigned. One suggestion was that these teams should be assigned by mark, and students with similar marks should be grouped together. Interesting comments on the structure of teams were: *"A well-rounded team containing people who are excellent in programming as well as people who have excellent writing skills for the documentation"; "Assign members, as friendship might be a benefit at times, but it can be more troublesome in many areas such as the evaluation. Assigned teams also give experience with working with new people and learning how to deal with different people"*.

From the above feedback it is clear that students have problems with teamwork, and that there were conflicting opinions on teamwork. The decision was made to get feedback from a larger group of third year IT-students on some aspects concerning teamwork, so that this feedback can be used to improve the way teamwork is managed. This feedback will be analysed in section 6.2.

## 6.2 Feedback from students 2018

A second questionnaire was distributed in the first semester of 2018, to third year IT-students. These students also have experience with teamwork, as they have completed a software project in their second year (first and second semester) in teams, as well as other assignments in other modules. The questionnaire was distributed during a contact session of a module with 120 registered students, and was answered by 76 students. The questionnaire consisted of open questions, as the aim was to gather the opinions and recommendations of the students. The answers were analysed by grouping similar answers together. First, students were asked whether they think IT-projects at university should be completed in teams; and second they were asked if they like working in teams. The results can be seen in table 3.

**Table 3.** Teamwork yes/no.

| Question | Yes | No |
|---|---|---|
| Do you think IT-projects at university should be completed in teams? | 70 | 6 |
| Do you like completing projects as part of a team? | 52 | 24 |

From the results in table 3 it can be seen that most students realise that IT-projects at university should be completed in teams. For the 70 that indicated that they do think IT-projects at university should be completed in teams, the reasons can be divided into 6 groups, as can be seen in table 4. Not all students answered this question, and some of them gave more than one reason for their answer.

**Table 4.** Reason why IT-projects at university should be completed in teams.

| Reason | Number of participants |
|---|---|
| Because that is the way it works in the industry or real world. | 38 |
| You develop new skills, e.g. Communication skills. | 15 |
| Different skills can be combined for optimal performance. | 6 |
| When we share work we can work faster. | 4 |
| You learn more in that way / people can learn from each other. | 4 |
| You make new friends. | 1 |

From the results in table 4 it can be seen that most students realise that being able to work in teams is necessary in the IT-industry. Of the 70 students, 38 mentioned this as the reason why IT-projects at university should be completed in teams. The development of new skills was mentioned 15 times, and other reasons can be seen in table 4. Of the 6 students who indicated that they do not think IT-projects at university should be completed in teams, 4 mentioned reasons concerning team members not contributing as they should. Interesting answers were: “Everyone does not do their part”; “Some students do not care about their marks”; “Students tend to become lazy and leave it to the smartest one in the team”; “There is always a team member causing other team members to be under pressure”.

These reasons correspond to the problems mentioned by the 2017-students reported on in section 6.1. Two of the 6 students who indicated that they do not think IT-projects at university should be completed in teams mentioned that you learn more when completing a project on your own.

Of the 76 students who answered the questionnaire, 52 indicated that they like working in teams. The researchers actually expected a lower number of students indicating that they like working in teams., as teamwork is something that students generally complain about. Reasons why students like working in teams, can be divided into 6 groups, as can be seen in table 5.

**Table 5.** Reasons why students like working in teams.

| Reason | Number of participants |
|---|---|
| In teams there are more ideas, solutions and support; and you can learn from others. | 16 |
| When you divide work you can deliver a higher quality product. | 9 |
| There is satisfaction in working together towards a common goal. | 7 |
| You develop soft skills, e.g. communication and patience. | 6 |
| It is less stressful working in teams. | 2 |
| You meet new people when working in teams. | 1 |

From the results in table 5 it can be seen that the reason most mentioned by students to explain why they like working in teams is that there are more ideas, solutions and support; and you can learn from others. Some also feel that you can deliver a higher quality product when dividing work and working in teams; that there is satisfaction in working together toward a common goal and that teamwork develop soft skills. Although most students like working in teams, 24 of the students do not like working in teams. Reasons given were that not all students contribute equally (mentioned 13 times); that students get more experience / gain more knowledge when working on their own (mentioned 4 times), that it is hard to be dependent on others (mentioned 3 times); that teamwork can be intense and stressful because of differences in people; and that you can produce better work on your own. This corresponds with the reasons mentioned earlier on why IT-projects should not be completed in teams at university.

Students were also asked what skills, in their opinion, are necessary for teamwork. Not all students answered this question, and some of the students listed more than one skill in their answer. Most students mentioned communication skills (mentioned 49 times), followed by leadership (12), time management (10), hard work (8), patience (8), emotional intelligence (5), conflict management (4), self-confidence (3), flexibility (3), perseverance (2), positive attitude (2), interpersonal relationships (2) and work ethic (2). Also mentioned (once) were cultural relationships, decision making, negotiation and self-control.

When asked which of these skills most students do not have or struggle with, communication skill was mentioned 53 times. Other skills mentioned were: time management (mentioned 13 times), leadership (7), emotional intelligence (4), flexibility (4), patience (3), hard work (2), conflict management (2), self-confidence (2), perseverance (1), positive attitude 91), and work ethic (1). The only skills mentioned as necessary for teamwork that was not repeated as skills that most student struggle with, were interpersonal relationships, cultural relationships, decision making, negotiation and self-control.

**Table 6.** Guidelines for students on improving teamwork.

| Guideline | Times mentioned |
|---|---|
| Communicate with each other. Be willing to listen. | 32 |
| Find an effective way to manage time spend on the project. | 11 |
| Plan everything in detail. | 6 |
| Use the strong points of each member. | 5 |
| Choose a strong leader. | 4 |
| Stop conflict as soon as possible. | 3 |
| Choose teams wisely. | 1 |
| Be positive. | 1 |
| Schedule time for unforeseen problems. | 1 |
| Use WhatsApp. | 1 |
| Divide work equally. | 1 |
| Formulate a clear goal. | 1 |
| Work as a unit. | 1 |
| Be proactive. | 1 |

Students were also asked for guidelines they would give to other students on how to improve teamwork. These results can be seen in table 6. Column 1 contains the guideline, and in column 2 the number of students who mentioned that guideline.

Communication was once again mentioned the most. Time management and planning was next, followed by leadership and conflict management amongst others.

Lastly students were asked what, in their opinion, lecturers can do to make teamwork easier and better for students. These results can be seen in table 7 (next page). Column 1 contains the guideline, and in column 2 the number of students who mentioned that guideline. Guidelines were organised in groups, namely on selecting teams, guidance from the lecturer, division of work, managing the teams, evaluation, and others.

From the results in table 7 it can be seen that there are some conflicting opinions. Of the respondents, 17 felt that students should be allowed to choose their own teams while 8 felt that the lecturer should choose the teams. Of these 5 felt it should be done according to marks and 3 felt it should be a random process. This corresponds with the results of the 2017 group reported on in section 6.1. Students feel that they should be taught how to communicate and work in teams and not just left to figure it out by themselves. They feel that lecturers should help to manage the teams; be more involved on a regular basis and the way the work of the team is evaluated are very important to them.

**Table 7.** Guidelines for lecturers on improving teamwork.

| Guideline | Times mentioned |
|---|---|
| On selecting teams. | |
| Students must choose their own teams. | 17 |
| Lecturer must choose teams according to marks. | 5 |
| Lecturer must choose teams at random. | 3 |
| Teams must be kept small (2-3; 5). | 2 |
| On guidance from the lecturer. | |
| Students must be taught communicating and management skills. | 5 |
| Lecturers must guide team leaders. | 1 |
| On division of work. | |
| Lecturer must divide the work between students / allocate roles. | 4 |
| On managing the teams. | |
| Lecturer must manage teams on a weekly schedule / Ask for reports at intervals. | 5 |
| Lecturer must have a system to punish those who do not do their part. | 2 |
| There must be a clear channel for complaints. | 1 |
| On evaluation. | |
| A good marking scheme is a must. | 2 |
| Contributions must be checked when allocating marks. | 2 |
| Other guidelines. | |
| Use Microsoft team planner. | 1 |

## 7 Conclusion

As can be seen from the introduction and problem statement research shows the importance of teaching soft skills, and teamwork in particular, but also the complexity thereof. The development of teamwork skills is deemed important by industry, as well as by the SAQA authorities, but there seem to be a gap between the level of teamwork skills required by employers and the level developed by students during their courses. The aim of the study was to recommend guidelines for managing and teaching teamwork in Higher Education Institutions. Results of this study show that most students realise the importance of teamwork, and the reasons thereof. The top 5 reasons mentioned by students for teamwork being necessary are:

- Because that is the way it works in the industry or real world.
- You develop new skills, e.g. Communication skills.
- Different skills can be combined for optimal performance.
- When we share work we can work faster.
- You learn more in that way / people can learn from each other.

This corresponds with the advantages of teamwork mentioned in literature, as can be seen in section 3.2. However, students still experience problems with teamwork, for example: Not everyone in the team participate with equal effort; There are different opinions on whether the peer review process is effective and fair; communication is a problem; and members sometimes drop out.

There are different opinions on how teams should be chosen. Some feel that students should be allowed to choose their own team members while others indicate that teams should be assigned; either by mark or randomly. The optimal size for teams seems to be between 2 members and 6 members.

Advantages of teamwork mentioned by students are: In teams there are more ideas, solutions and support; You can learn from others; You can deliver a higher quality product when dividing work and working in teams; There is satisfaction in working together toward a common goal; Teamwork develop soft skills. Of these reasons, the first two reasons are also present in the list of advantages of teamwork mentioned in existing research, as can be seen in section 3.2.

Students were also asked what skills, in their opinion, are necessary for teamwork. Of these communication skills, leadership, time-management, conflict management, interpersonal relationships and decision making are also on the list of different soft skills necessary for teamwork mentioned in section 3.2. Added to this list are hard work, patience, emotional intelligence, self-confidence, flexibility, perseverance, positive attitude, work ethic, cultural relationships, negotiation and self-control. When asked which of these skills most students do not have or struggle with, communication skill was mentioned by most students, followed by time management, and leadership. An interesting observation is that although most students felt that other students lack communication skills, nearly half of the students specifically mentioned that their own communications skills are, in their opinion, good. Further research can be done on why students feel that others lack these skills, but do not question their own level of development of the necessary skills, and how this can be changed.

Guidelines for lecturers on improving teamwork can be grouped according to the selection of teams, guidance provided by the lecturer, the division of work, the management of the teams, evaluation and other guidelines.

On selecting teams, students had different opinions, some students preferring that students choose their own teams while others indicated that the lecturer must choose teams according to marks or at random. This seems to be very important to the students even though there are different opinions on how teams should be formed and on the optimal size of teams. This indicates that although there are no clear answers, much thought should go into selection of teams. Aspects such as the scope and size of the problem to be solved and the different roles that should be assigned should be taken into account to determine the optimal size and the way teams should be formed. Teams should be kept small (+- 2-5 members).

On guidance from the lecturer students indicated that they should be taught communicating and management skills and lecturers should guide team leaders. This can be linked back to research reported in section 1, where mention was made of students complaining that team-based assignments were not accompanied with appropriate training on how to work as a team. Lecturers should take into account the fact that different soft skills are needed for effective teamwork, and that students do not necessarily possess (all or most of) these skills. More effort should go into development of these skills. Even though students seem to mostly accept the importance of soft skills and teamwork, they should be made even more attend of the different skills necessary and the importance and advantages thereof.

On management of teams, students indicated that lecturers should manage teams on a weekly schedule. They should ask for project reports at certain intervals / deadlines. They should have a system to penalize those who do not do their part and there should be a clear channel for complaints. This can also be linked back to one of the problems of teamwork students specifically mentioned, namely not everyone in the team participating with equal effort. Lecturers must consider being more involved, especially in the beginning, in setting deadlines, monitoring work being done and handling problems.

On evaluation students indicated that a good marking scheme is a must and contributions must be checked when allocating marks. This can be linked back to one of the problems of teamwork specifically mentioned in other studies (section 1), as well as by students (section 6) namely on whether the peer review process is effective and fair. Marking schemas must be detailed and clear, and student should know exactly how individual and team contributions will be evaluated.

Even though not all students agreed that completing the personality test was helpful, about half of the students participating in that research (section 6.1) did find it helpful, so including similar activities for teamwork can also be recommended as a guideline.

From these results it can be seen that there are still problems and questions concerning the management and teaching of teamwork in Higher Education. Guidelines were derived from literature as well as from the results of this study. These guidelines can be incorporated into modules, the results can be tested and the process can be repeated for further improvement. This can lead to improvement of a part of teaching and learning, namely teamwork, that seems to be complicated but very necessary. This research can also be repeated at other institutions, and can be compared to similar results in other countries.

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# Student Experience

# Student perceptions on the use of Technology for Learning to promote student engagement

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**Abstract.** A logarithmic increase in the number of publications reporting on technology for learning has been observed over the past few decades. This is in part due to the advent and proliferation of smart phones and social media. An older technology used for learning, namely learning management systems, still feature predominantly among institutions of higher learning in South Africa. The four main pillars underpinning such systems include content, assessment, communication and administration. The purpose of this paper is to highlight student perceptions on the use of a learning management system where online self-reflective assessments are completed, which falls under the pillar of assessments. The target population is first-year students enrolled for an electrical engineering module called Electronics 1. On average, 239 students register for this module in the first semester and 110 students register in the second semester of each year. A total sample size of 698 students is drawn from four semesters between 2016 and 2017 as part of the time-lag study that is used in this research. Quantitative data was derived from an online self-reflective assessment featuring a number of close-ended questions that were posed to the target population. Results indicate that the majority (72%) of first-year engineering students were very happy to complete the online assessments via the BlackBoardTM platform, as opposed to written classroom tests. This is noteworthy as many of the students come from previously disadvantaged backgrounds with little prior experience in the use of a learning management system. It must be emphasized that all these students were required to complete these online assessments as it forms part of their course grade. A key recommendation is to create awareness among academics about the benefits that arise from using technology for learning to promote student engagement.

**Keywords:** Self-reflection, Reflective practice, Online assessments.

## 1 Introduction

“If we teach today as we taught yesterday, we rob our children of tomorrow”. These words, by John Dewey [6], clearly indicate that both teachers and academic lecturers cannot teach in the same way as they were taught. It cannot be business as usually when it comes to teaching. Traditional teaching (chalk and talk as some call it) needs to be complemented with more modernized teaching methods where the student takes centre stage (the academic becomes the guide on the side instead of the sage on the stage).



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Teacher-centred learning must be replaced with student-centred learning, where the student becomes more active, taking more responsibility for his or her own learning.

An added reason for modifying our pedagogy as academics involves the arrival of the so-called “digital natives”. A digital native refers, in general, to those born since the 1980s and who have been growing up surrounded by technology [23]. The majority of students fall into this category today, especially if they are first-year or freshmen students entering university for the first time. These students have become proficient at using different types of technology, as they navigate the digital highway of the Internet. Academics who complement their pedagogies with technologies for learning (educational technologies) are more likely to touch a receptive cord among these digital natives.

However, the efficient use of various educational technologies requiring the Internet does pose challenges in certain developing countries, including South Africa. Some of these challenges include high Internet access costs, limited financial means for new computer technology, slow Internet penetration, poor e-skills of students [26], students with limited financial resources to afford data packages, poor Internet connectivity in rural communities and quality assurance of online assessments [27]. Two research questions thus arise: “Do first time entering university students prefer to complete online assessments on a learning management system (LMS) as compared to written classroom tests? Could these online assessments help students to better engage with the course content? Online self-reflective assessments require students to answer a number of online questions relating to previous work, and then engage in reflective practice as they decipher where they went wrong in their thinking or actions based on the immediate feedback given to them by the LMS [28,29,31].

The purpose of this paper is to highlight student perceptions on the use of a LMS where online self-reflective assessments need to be submitted. A time-lag study is used with descriptive statistics of the quantitative data. Literature pertaining to the brief history of a number of technologies for learning is firstly presented. The context of the study is then clarified along with the research methodology. Quantitative results are depicted in a number of figures with relevant discussions.

## 2 Technologies for Learning

A Google Scholar search (see Fig. 1) was done for a number of educational technologies to highlight the logarithmic increase in research and publications related to this field of study. Specific terms where inserted along with the word “education”. Results were limited to only the title. For example, when searching for Web3.0 technologies that have been used in education, the exact Google Scholar phrase was “allintitle: education Web3.0”. This was repeated for virtual reality, gamification, MOOC (massive open online courses), LMS (learning management systems), computer-based learning (CBL) and clickers. The term “Virtual Reality” (VR as the accepted acronym) was first coined in 1987, and is widely attributed to Jaron Lanier, founder of “VPL” (Visual Programming Languages) research [35]. However, it was not until late 2012 that VR started to attract headlines again after over a decade of silence with the enormous success of Oculus VR Kickstarter campaign, raising over $2.4 million [9]. Virtual reality is defined as the technology that allows three dimensional animations and shape creations using computers to interact with these objects in addition to giving them the feeling of being in a real environment in the mind of the individual by using technological tools [21]. It usually excludes computer-based learning and gamification. From Fig. 1 it is evident that VR has received the most attention over the past two decades in terms of educational technologies. This may very well be linked to the key benefit of so called "hands-on" training linked to hi-risk and dangerous environments, including flight and medical simulators along with high power distribution networks.

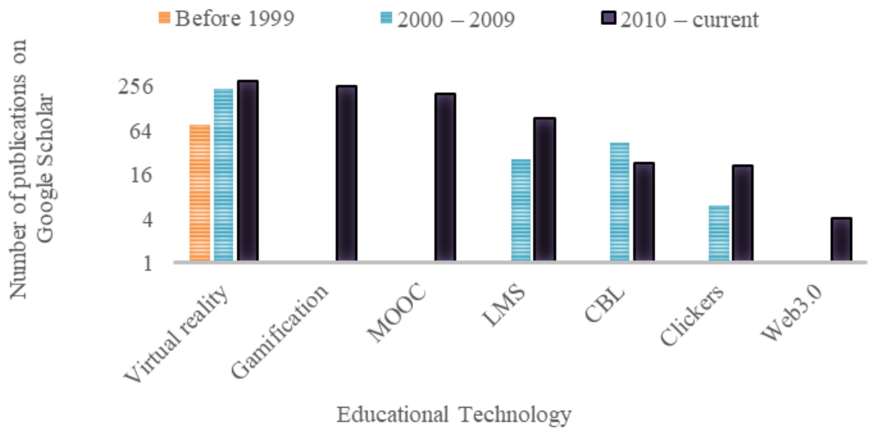


**Fig. 1.** Google Scholar counts for various educational technologies.

The term "gamification" was coined in 2003 by Nick Pelling, but was not commonly used to describe gaming in training and education until 2010 [22]. It is evident from Fig. 1 that research into this field boomed after 2010, with it being the second most reported on technology for this decade. The proliferation of smartphones and tablets should have given further impetus to this, as developers seek to provide a diversity of educational apps designed to help young children, teenagers, students and adults better understand various fields of study.

The acronym "MOOC" (it may also be an acronym for massive online open courses) was coined by Dave Cormier and Bryan Alexander in 2008 as a response to the swelling enrolment in an online course offered by George Siemens and Stephen Downes, called "Connectivism and Connective Knowledge" [16], developed at the University of Manitoba [10]. Research into the challenges and benefits of MOOC's has also soared during this decade, with much literature focusing on the large enrolment numbers and low completion rates.

The history of "LMS" (learning management system) dates back to around 1996 when Internet development enabled teachers to manage their learning resources in a virtual environment [20]. A LMS may also be termed a course management system, a personal learning environment or a virtual learning environment. LMS became popular in South Africa during the start of the 21st Century, with BlackBoard™, Sakkai and Moodle dominating the market [27]. Criticism has been levelled against LMS as being a content dumping sight. However, there are some academics who are making use of all four pillars that underpin these systems, to the benefit of universities and students [29]. From Fig. 1, it is shown that research into LMS started in the decade between 2000 and 2009, with a notable increase in the current decade. This technology forms the basis for this study, as it is used extensively by the author and vigorously promoted by the author's institution.

According to Woolley [36], early computer-based learning models and techniques were brought forth in the 1970s and 1980s. Computer-based learning was initially limited mainly to technological fields such as mathematics, engineering, and design. However, many current computer laboratories are likely to be frequented by students in linguistics, geography, history, or business [32]. This form of technology has seen a drop in the number of publications since the previous decade, which may be attributed to the rise in virtual reality and gamification, which has a few similar characteristics to that of computer-based learning.

Kay and LeSage [12] state that "clickers" were first introduced in 1966 at Stanford University but were not commercially available until the 1990's. Clickers are also known as audience response systems, electronic response systems or personal response systems. The main advantages of this type of technology is that it provides a voice to each student in a classroom, thereby contributing to a satisfying learning experience. It may further contribute to students becoming active participants in their own learning, enabling them to feel valued and empowered–important features of agency and ownership [30]. Research into the use of clickers in education has also increased over the past two decades (see Fig. 1), which may be attributed to the drive of replacing passive learning (teacher-centred) with active learning (learner-centred) within classroom environments.

The core software technology of Web3.0 is artificial intelligence, which can intelligently learn and understand semantics [13]. Web3.0 draws on Web2.0 and Web1.0 information to make specific decisions. Web2.0 is a general designation of new Internet applications which differ significantly from those classified under Web1.0 [11]. The main feature of Web1.0 was one-way communication, or single duplex communication, where users can get information through an Internet browser. However, Web2.0 pays more attention to the interaction among users, making two-way communication, or full duplex communication, instantly and simultaneously available. One notable feature of Web2.0 that deserves mention is the fact that it is no longer limited to the PC platform, according to the seminal work of O'Reilley [19], thereby indicating its extensive use among tablet and smartphone users. Fig. 1 indicates that research into using Web3.0 in education is still in its infancy stages, with only four publications during the current decade.

As this study considers a LMS, it would be beneficial to discuss benefits and challenges relating to it. Watson and Watson [34] define a LMS as an infrastructure that delivers and manages instructional content, identifies and assesses individual and organizational learning goals, traces the progress towards meeting those goals, and collects and presents data for supervising the learning process as a whole. A LMS cannot replace the academic as he or she still needs to interact with the students via the LMS, identifying and addressing gaps in knowledge and thinking over the course of the semester. Student thinking needs to be both constructed and re-constructed, especially if possible judgemental errors exist. Subsequently, LMS play a major role in supporting or complementing traditional teaching pedagogies used in classroom or laboratory environments [1]. A LMS can also increase student motivation to learn and support active learning and problem-solving of real-life problems [17], which is required in many fields of education. A LMS further enables the provision of synchronous and asynchronous learning, furnishing tools that scaffold and support reflection on the learning process [7] while also expediting student feedback on submitted assignments or self-assessments for examination purposes [24,25].

However, there exist challenges in the effective use of a LMS. According to Vrasidas [33], one limitation of a LMS is that it does not necessarily support constructivist learning, as it does not always provide academics and students with the tools needed to engage in constructivist learning. It also lacks tools to support authentic assessment. However, a LMS can still support the teaching and learning process by extending the physical walls of a classroom to beyond a concrete building, promoting student engagement with the course content [29]. It is in this support role, that a LMS may find its greatest benefit.

Other challenges to using a LMS in SA include the high costs of Internet access, students with limited financial resources, slow Internet penetration, low levels of ICT access, poor e-skills by students and quality assurance of online assessments [27]. However, with many universities rolling out free on-campus Wi-Fi access for their students and establishing open-computer laboratories after hours could help to alleviate many of the aforementioned financial and access challenges.

## 3 Study Context

Electronics 1 is a compulsory offering in the National Diploma: Engineering: Electrical qualification in South Africa. This Diploma is a NQF (National Qualifications Framework) Level 6 qualification that requires students to obtain a minimum of 360 credits. The majority of modules in the Diploma have a credit value of 12 that indicates that students should dedicate at least 120 notional hours to each module. On average, 239 students register for this module in the first semester of the year and 110 students register in the second semester (each 14 weeks in duration).

The syllabus of Electronics 1 covers seven main sections, which include the operation and application of the oscilloscope, electrical basics, Thevenin's Theorem, resistors, capacitors, diodes, transistors and the design of power supplies and amplifiers. The structure of the module is shown in Table 1, where the practical work is also defined. The syllabus is divided into seven units, with each unit being discussed consecutively over a period of one week (2 classes per week, each 90 minute in duration). Once a unit is complete, then an online self-reflective assessment is made available for 6 days to further engage students with the content. The first five online assessments contribute to Test 1, and counts 25% towards the course grade. A main test is written in week 9, which serves to prepare students for the final summative exam. Students need to obtain a course grade of at least 40% to gain entry into this final exam. The weightings of the various assessments are shown in Table 2, where the final exam (written in a controlled laboratory with online Internet access) carries a weighting of 60%.

**Table 1.** Structure of Electronics 1.

| Theoretical work | Practical work |
|---|---|
| Unit 1 – Unit 7 presented consecutively over 7 weeks | Power supply operation and resistor circuits |
| Seven online assessments completed by the end of week 8 | Testing semiconductors and diodes |
| First five online assessments contribute to T1 | Oscilloscope and oscillator operation |
| Main test written in a computer laboratory in week 9 | Half-wave rectifier construction and analysis |
| University recess during week 10 | Full-wave rectifier construction and analysis |
| Review of content for week 11–13 | Transistor testing and switching circuits |
| Practical work completed and course grades assigned in week 14 | Practical assessment completed |

**Table 2.** Assessment weightings for Electronics 1.

| Assessment | Weightings |
|---|---|
| Test 1 (T1): 5 online assessments + 1 peer assessment | 25% |
| Practical grade: 3 experiments + 1 practical assessment | 35% |
| Main test (T2): First 5 units written in a laboratory | 45% |
| Course grade total | 100% |
| Weighting of course grade to final grade | 40% |
| Exam grade | 100% |
| Weighting of exam grade to final grade | 60% |

## 4 Methodology Used in This Research

This research incorporates a time-lag study using a non-experimental descriptive design. Descriptive research occurs where a specific situation is studied to see if it gives rise to any general theories, and a time-lag study determines the impact of a particular event on a group of students over a specific period of time [5]. The specific situation is the use of online self-reflective assessments via a LMS and its impact is considered by gathering student perceptions with regard to its benefits.

The period of interest is from 2016 to 2017, covering four semesters where all registered students for Electronics 1 had to complete the online assessments. Descriptive statistics, rather than inferential statistics, are used as the results are interpreted with regard to specific engineering students enrolled at a university of technology in South Africa. These descriptive statistics include the student profile and student perceptions highlighted as quantitative data in a number of figures.

The target population was restricted to all engineering students enrolled for the module Electronics 1 during 2016 and 2017 (four semesters of data where each semester is 14 weeks in duration). No sampling technique was used as data was gathered from all students who completed the 6th online assessment. This specific assessment included three close-ended questions designed to obtain student perceptions on the use of technology in teaching. The total sample size was 698. Student demography is also shown in order to contextualize the results.

Each of the seven online assessments featured an average of two close-ended questions that sought student input, or perceptions, on various aspects. These aspects include the following; student demography (Unit 1); what work had been covered in the classroom (Unit 2); if the student had purchased the prescribed textbook (Unit 3); if the student had registered late for the module (Unit 4); if students were using their cell phones to access course content (Unit 5); student views on the use of the online assessments (Unit 6); and which pillars of the LMS had students used in this course (Unit 7). The prescribed textbook [18] and cell phones [14] may also be classified as educational technologies. The quantitative data for this study was derived from the online assessment for Unit 6 which considered the value of these online assessments. The questions posed were drawn from the literature review on the benefits of using a LMS. Two key benefits relate to supporting reflection on the learning process and expediting student feedback on completed online assessments. This suggests that an online assessment should help students reflect back on the theory that was discussed in the classroom, providing them with immediate feedback on their thinking process which is not always possible with a classroom based assessment. No separate online questionnaire or survey was released to the students at the end of the semester, which at times does prove problematic in terms of low student response rates.

## 5 Results and discussions

The profile of students registered for Electronics 1 are shown in Fig. 2 (home languages), Fig. 3 (gender) and Fig. 4 (age brackets). The major home language was Sesotho for all four semesters (this corresponds to other research in this area [31]). The number of Sesotho students in the first semester of 2017 was 121, while 38 students were registered in the second semester of 2016. The minority of students are female (see Fig. 3 were the percentage fluctuates between 14% and 33% with an average of 23.3%), which is one of the reasons why a global drive exists to encourage more women in engineering. Each circle represents a different semester, with the inner circle representing 2016 semester 1 and the outer circle 2017 semester 2. The majority of students were younger than 25 years (see Fig. 4), which validates them as freshmen engineering students (first time entering students) who have recently completed their secondary or high school career. The average age for Grade 12 learners in South Africa is 18 years [17].

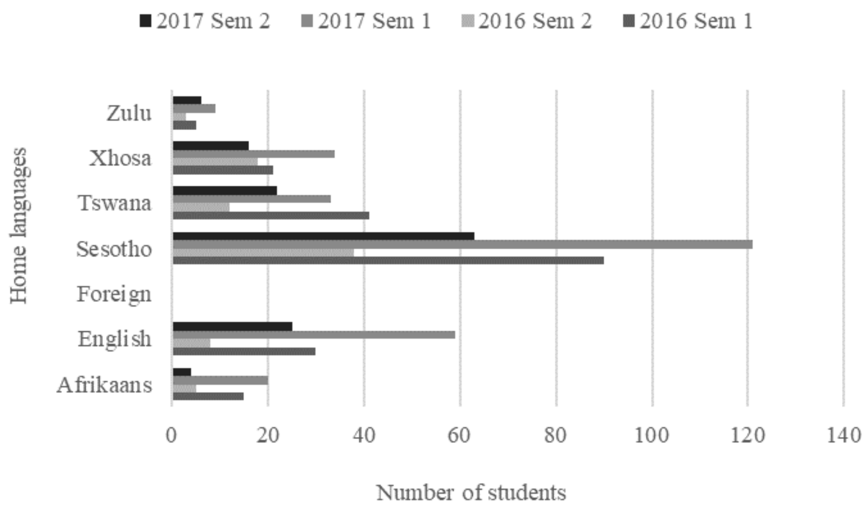


**Fig. 2.** Home languages of the undergraduate students.

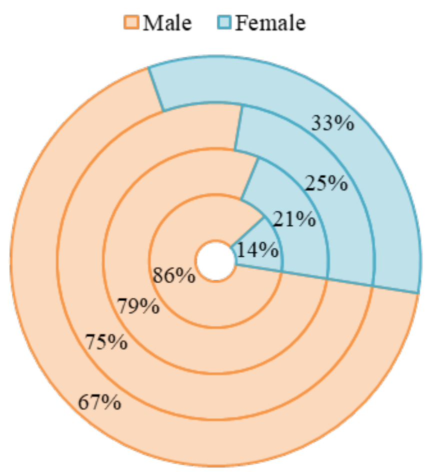


**Fig. 3.** Gender of students.

Fig. 5 through Fig. 7 shows the responses of students to three close-ended questions which were asked during the online self-reflective assessment for Unit 6. At this time, students had been exposed to approximately 86% of the syllabus, having completed five previous online assessments. The students were thus in a good position to comment on the usefulness of these assessments, and if they would prefer them in contrast to written classroom assessments. Fig. 5 indicates that the majority of students (on average 42% strongly agreed and 54% agreed) felt that the online assessments were relevant to the theory covered in the classroom (each bar represents a different semester). This links back to the literature review where it was noted that a LMS can enable reflection on the learning process (students thinking back on the theory in the classroom). One of the many ways in which students can engage in reflection includes reflecting on feedback [3], which is intrinsic to online self-assessments which were identified in the literature review as an advantage of a LMS. It is noteworthy to mention that the pass rates of students across these four semesters averaged more than 70%, which is about 20% higher than previous years where online self-reflective assessments were not used.

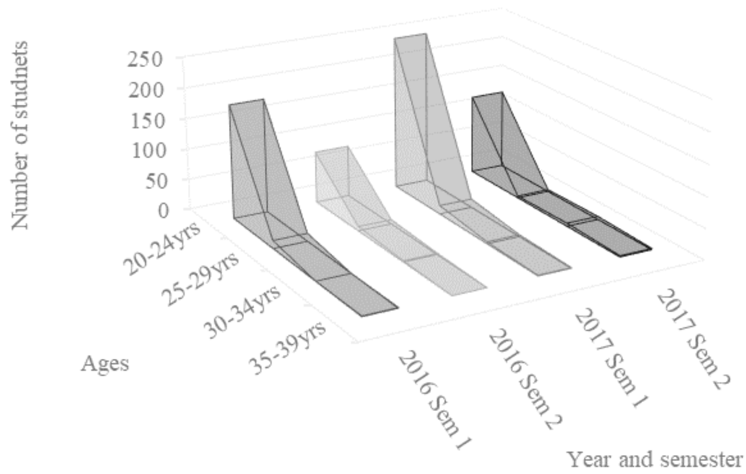


**Fig. 4.** Age brackets of the registered students.

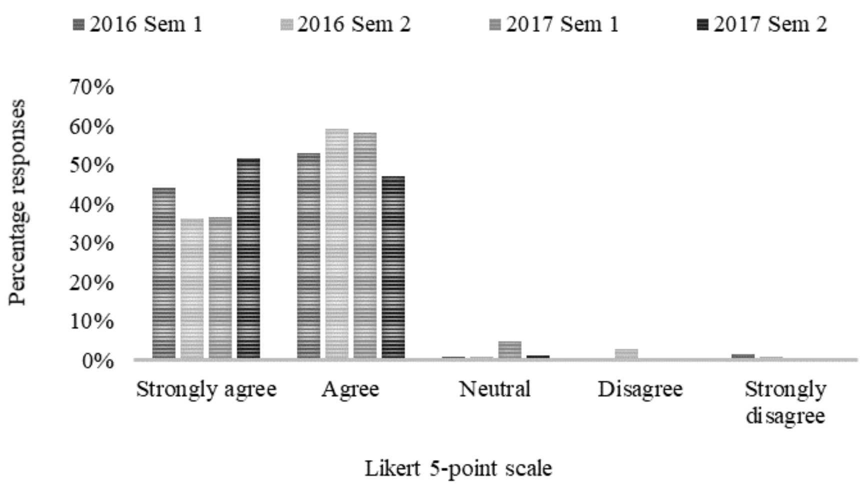


**Fig. 5.** Please indicate if you agree that the self-reflective assessments have been relevant to the theory presented in the classroom?

Fig. 6 further corroborates the results of Fig. 5, suggesting that online self-reflective assessments outside of the classroom environment does promote further student engagement with the course content (on average, 38% strongly agreed and 53% agreed). This links back to the literature review where one key advantage of a LMS was identified, that of promoting student engagement with the course content outside of the classroom environment. Furthermore, student engagement outside of the classroom contributes to student development, student success and student retention [15]. These student voices highlight that this type of educational technology provides more time-on-task, which engineering students tend to prefer [8]. Increased time-on-task means students' practice more [4]. Practice with theory or practical is vital for students to attain success, as they regularly and systematically work through design and mathematical equations relevant to the course content. The old adage still holds true "Practice makes perfect" or "practice makes progress".

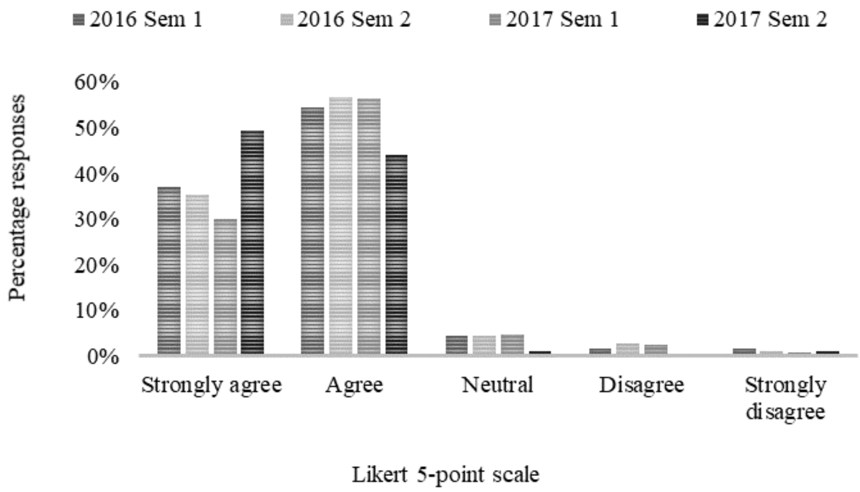


**Fig. 6.** Please indicate if you agree that the self-reflective assessments have helped you to better engage with the theory presented in the classroom?

Fig. 7 presents the results of student perceptions on whether a written classroom test should rather be used instead of multiple online self-reflective assessments. The majority of students (percentage ranging from 68% to 78% with an average of 72%) stated that they would prefer the online self-reflective assessments. This result is corroborated by other research that indicates that students prefer online assessments [2]. It also links back to the literature review in that the identified challenges of using a LMS are not really as relevant today, as this would have had a bearing on these student responses. In follow-up discussions with the students, the author determined three key reasons for this selection, namely multiple attempts, immediate feedback and correcting mistakes. Students indicated that the online self-reflective assessments provide them with three attempts to complete the questions, with immediate feedback given on each attempt as to which questions were answered incorrectly. Students are thus given an opportunity to learn from their mistakes and improve their thinking and actions with each subsequent attempt.

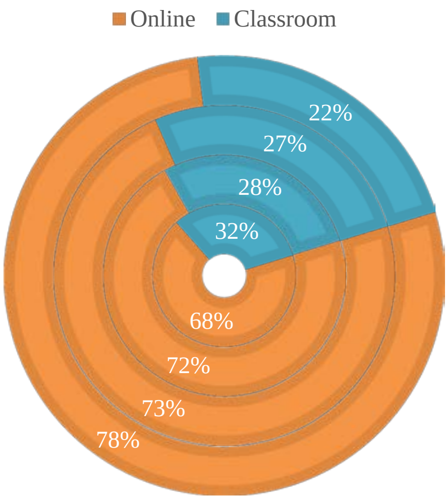


**Fig. 7.** Please indicate if you would rather prefer a written classroom test than all these online self-reflective assessments!

## 6 Conclusions

The purpose of this paper was to highlight student perceptions on the use of a LMS where online self-reflective assessments are completed, which falls under the pillar of assessments. Results from 698 first-year engineering students from 2016 and 2017 revealed that the majority (average of 72%) of these students prefer online self-reflective assessment as compared to written classroom tests. These students further feel that these online assessments are relevant to the theory given in the classroom and that they provide additional opportunities for student engagement with the course content. A key limitation is that it is limited to one module in Electrical Engineering offered by one academic. Having more academics adopt this educational technology in other modules will give rise to more data that may be used to further substantiate the statement that online self-reflective assessments promote student engagement across multiple disciplines. A key recommendation of this study is to create awareness among academics of the many benefits that arise from using technologies for learning to enhance student engagement.

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# The Impact of Educational Technologies on the Learning Experiences of Students

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**Abstract.** Even though the use of technologies in teaching and learning is widely advocated, one question that needs to be asked, however, is: What is the impact of the use of educational technologies on the learning experiences of students? In this study, a questionnaire was completed by 738 students in an introductory Excel course where an eBook and a Specialized Learning Management System (SLMS) were used. The UTAUT theoretical framework was used as a lens in the qualitative analysis in order to make sense and obtain a deeper understanding of the impact of using the educational technologies on the students' learning experiences. It was found that students had a positive experience with the use of these technologies, but not surprisingly, there were opposing views regarding the benefits and drawbacks of the use of the eBook and the SLMS. Not only did the educational technologies impacted positively on students' learning experiences, but in addition, life-long skills, such as time management and taking responsibility for their own learning were acquired. The challenge remains to ensure that students' learning is actively enriched by the technologies.

**Keywords:** Educational technologies, SLMS, eBook.

## 1 Introduction

In the rapidly evolving computer environment of today, it cannot be denied how far reaching the impact is. Computing lecturers are quite often required to upgrade the prescribed textbooks for their courses. Publishers bombard lecturers with a variety of options, not only in terms of content, but also in the way in which the content is presented. Progressively, the traditional hardcopy textbook is replaced by an eBook that is further linked to a specialized learning management system (SLMS). The SLMS in this study is an interactive, online learning environment that helps students to master Microsoft Excel and other computer concepts.

Despite the potential benefits of information technology in teaching and learning, one cannot disregard the copious number of drawbacks to the integration of instructional technology into higher education [20]. This might be particularly true for institutions in developing countries like South Africa that are hampered by scarce resources, a lack of access to technology and educational inequalities. This begs the question: What is the impact of educational technologies on the learning experiences of students?



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# 2 Theoretical Framework and Related Work

In this section, the theoretical framework that was used as a lens in this study is discussed, followed by studies relating to the use of educational technologies.

## 2.1 Theoretical Framework

Venkatesh, Morris, Davis, and Davis [19] reviewed and synthesized eight theories/models of technology use and formulated a unified model, named the Unified Theory of Acceptance and Use of Technology (UTAUT). Since UTAUT is the most recent model applicable to our study, we used it as a lens to investigate the impact of educational technologies on the learning experiences of students. The UTAUT was developed with the following underlying factors: performance expectancy, effort expectancy, social influence, facilitating conditions, self-efficacy, anxiety, attitude towards using technology and behavioral intention. The definitions of the factors are given below in Table 1.

**Table 1.** The UTAUT model.

| Factor | Definition |
|---|---|
| Performance expectancy | The degree to which a person believes that using the system will help him/her to better his/her performance and therefore enhance the quality of his/her work [19] |
| Effort expectancy | The degree of ease that is associated with the use of a certain system [19] |
| Social influence | Refers to the degree to which a person experiences interpersonal influence to use a system from important people within his/her social environment [18] |
| Facilitating conditions | "the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system" [19] |
| Self-efficacy | A person's belief in his/her own ability to succeed in a specific situation or in accomplishing a task [2] |
| Anxiety | A sense of worry, nervousness, or unease about something with an uncertain outcome [12] |
| Attitude towards using technology | A person's overall affective reaction to using a system [19] |
| Voluntariness of use | "the degree to which use of the innovation is perceived as being voluntary, or of free will" [10] |
| Behavioural intention | An individual's intention to use an innovation in the future, whether or not he or she used it currently [1] |

The factors of UTAUT were used in the statistical analysis of the quantitative data, as well as in the thematic analysis of the qualitative data of this study.

### 2.2 Students and Technology

The Horizon Report for Higher Education annually shares trends, challenges and developments in educational technologies predicted to have an impact on colleges and universities in the USA. From the 2016 and 2017 reports [3,8], the following themes of educational change applicable to our study emerged:

- Universities have an obligation to integrate technology in meaningful ways in order to deliver deeper, active learning experiences and skills-based training. Real-world skills are needed to strengthen employability and workplace development [3,8]. Ben-Ari [4] confirms the notion that knowledge is actively constructed by the student, not passively absorbed from textbooks and lectures.
- Despite the spread of technology and online learning materials, access is still imbalanced. Across the world, socioeconomic status, race, ethnicity, and gender gaps persist that are obstructing students from successfully completing their university degrees. In addition, sufficient Internet access continues to be uneven [3]. In South Africa, Internet penetration for households in 2016 was 53%, (in 2012 the percentage was far lower at 25.5%). It is evident that there was a significant rise in Internet use in South Africa over the past few years and it can be directly linked to the rise of mobile broadband subscriptions, which was 26 per 100 citizens in 2012 and increased to 58.6 per 100 citizens in 2016 [16, 17].
- Adaptive technologies are needed that support personalization of students' learning experiences and play a larger role in measuring learning [3,8]. The SLMS used in this study is an example of such an adaptive technology that specifically assists students to master Microsoft Excel and other computer concepts. Rößling et al. [14] also commented in their study that most systems are by default not ideally prepared to address specific demands of Computer Science (CS) education and they report on how they adapted Moodle to better support CS education.
- Digital literacy is more than just understanding how to use technology. Universities should not only teach isolated technology skills, but ensure students' mastery of responsible and appropriate technology use, including online communication etiquette and digital rights and responsibilities in blended and online learning settings [3, 8]. Nash [11] assessed the computer skills of over 4 000 first-year students at a South African university and found that many students entering South African universities for the first time are not adequately equipped with the necessary computer skills during their first year of study. Moreover, African students are most at risk of being disadvantaged by their lack of prior skills. Parker and Van Belle [13] found in their study that the majority of students indicated that technology within courses has not only allowed them to learn and develop added skills, but it also plays a critical role in course-specific learning tasks, as well as facilitating communication.
- For universities, the integration of online, mobile, and blended learning approaches are critical for their survival. However, it is essential to investigate how these models are actively enriching learning outcomes [3, 8]. Thota and Whitfield [15] reported on the development and evaluation of a Computing Augmented Learning Management System (CALMS) in the context of an introductory programming course in

order to enrich learning and the results indicate returns for students and instructors in terms of improved learning and teaching.

- "*Lifelong learning is the lifeblood of higher education. Institutions must prioritize and recognize ongoing learning — both formal and informal — for their faculty, staff, and students*" [3,8].

From the above it is clear that universities have to make informed choices about technology to improve, support, or extend teaching and learning, but more importantly, universities should investigate the impact of educational technologies on the learning experiences of students.

## 3 Methodology

The research project used the UTAUT as a lens and the aim of the project was twofold: firstly, an investigation of students' intentions to use digital technologies and secondly, to make sense and obtain a deeper understanding of the impact of educational technologies on the learning experiences of students. The results of the first part of the project was presented and discussed in [5] and the second part is presented in this paper.

### 3.1 Settings and Participants

This study was conducted in South Africa at the North-West University. The participants were students in a first-year ICT course called "Introduction to Computers and Programming".

Table 2 provides a summary of the biographic data of the participants.

**Table 2.** Profile of participants (n=738).

| Criteria | Categories | Number (%) of students |
|---|---|---|
| Gender | Male | 492 (66.7%) |
| | Female | 246 (33.3%) |
| Access to a computer since Grade 1 | Yes | 397 (53.8%) |
| | No | 341 (46.2%) |
| Wireless Internet (Wi-Fi) access at home | Yes | 409 (55.4%) |
| | No | 329 (44.6%) |
| Access to a mobile phone with Internet access | Yes | 723 (98.0%) |
| | No | 15 (2.0%) |

The gender profile is similar to most ICT classes with only 33.3% of the respondents being women. These students report a lack of access to technology because only 53.8% of them had access to a computer from a relatively young age. Moreover, only about half of the students have wireless Internet (Wi-Fi) access at home. However, only 2% of these students do not have access to a mobile phone with Internet access.

Two types of digital technology were introduced at the beginning of the semester, namely a specialized learning management system (SLMS) and an eBook. This was the first course at the university to introduce an eBook as a textbook. The SLMS and the eBook are mutually supportive with the SLMS referencing the eBook and vice versa. Students had the opportunity to download the eBook on their own devices.

For the SLMS, all students had to be registered on the system and obtained a username and password specifically for this application. The weekly process of using the SLMS progressed as follows:

- The lecturer scheduled tutorials (called “trainings” in the SLMS) where students observed live applications, then practised these applications and thereafter applied their skills in short questions. These tutorials were available for revision throughout the semester.
- After the scheduled tutorials, the lecturer presented the main topics in a face-to-face lecture, which implied students came prepared to the lecture.
- Practical projects were scheduled that entailed the solution of real-life applications in an Excel environment. Deadlines for submissions were set and a variable number of resubmissions of the solutions, as determined by the lecturer, was allowed.
- Directly after submission of a solution, an auto-grading system graded the projects and a reporting tool gave immediate feedback, providing the students with an opportunity to make corrections and resubmit a number of times as set by the lecturer.
- The SLMS keeps record of everything done by the student (the tutorials and projects) in a gradebook to use as part of the course marks.

### 3.2 Data Collection, Instrument and Analysis

An online questionnaire was sent via the e-learning system to the 978 students taking the course and a total of 738 usable responses were received, indicating an overall response rate of 75.5%.

The first section of the questionnaire gathered information on the biographic data of the respondents as shown in Table 2. The second section investigated students’ intentions to use the eBook and SLMS based on Venkatesh et al. [19] and Hardgrave, Davis, and Riemenschneider [7]. The third section of the questionnaire is the focus of this paper and contained the following five open-ended questions:

- Please list any benefits of the eBook.
- Please list any drawbacks of the eBook.
- Please list any benefits of the SLMS.
- Please list any drawbacks of the SLMS.
- Please discuss how the eBook and SLMS impacted on your learning experience in this class.

According to Bhattacherjee [6], qualitative analysis can aid in making sense and obtaining a deeper understanding of a phenomenon. For the analysis of this qualitative data, the ATLAS.ti 8.0 computer program was used. Content analysis was conducted on all responses from the open-ended questions and thematic analysis of text data segments was utilized to classify and categorize responses, keeping the factors of UTAUT in mind. Since the product of qualitative research is richly descriptive, some results are presented in the form of quotes from the participant comments.

## 4 Results and Discussion

The results of the first part of the project [5] showed that students intend to use digital technologies. However, to make sense and obtain a deeper understanding of the impact of educational technologies on the learning experiences of students the qualitative data was analysed.

The qualitative data revealed rich and insightful views on the impact of using the SLMS and the eBook on students' learning experiences. Not all the students viewed the educational technologies as beneficial. For the eBook, 4.7% of the students and for the SLMS, 3.1% of the students indicated that they do not think that there are any benefits attached to the use of these technologies. However, a significantly larger group of students claimed that the technologies have no drawbacks; for the eBook 10.0% and for the SLMS 21.7%.

Tables 3, 4, 5 and 6 show the qualitative results of the open-ended questions regarding the benefits and drawbacks of both the eBook and SLMS. Although certain themes were covered in the second section of the questionnaire, some of the themes, such as EfEx, Att, PEx and FC emerged again in the qualitative data.

**Table 3.** Benefits of the eBook.

| **Theme** | **Quote** |
|---|---|
| Effort expectancy (EfEx) | It's easy to use, information is made easy to find and it's understandable<br>It is easy, quick and nice to use |
| Attitude towards using technology (Att) | Very nice and fun to have<br>Makes work more interesting |
| Performance expectancy (PEx) | It helps you to do your task more efficiently and helps me to achieve better marks<br>Learning properly, easy studying.<br>Made studying faster. |
| Facilitating conditions (FC) | |
| -Affordability | I do not have to buy the actual book and I can download it for free.<br>It's a cheaper alternative as even those who can't afford textbooks now had one. |
| -Accessibility | Easily accessible, Covers all, You walk with where ever you go (on your phone, tablet, etc.)<br>It is on the computer, just as all my other work in ITRW is, therefore it is suitable for this module |
| -Functionality | Very precise instructions and a lot of useful tips.<br>It has most of the features that I would use when working with a normal textbook. |
| -Convenience | No need to carry around heavy books |

| | |
|---|---|
| | Don't have to worry about the book getting lost or stolen. Can download it anytime. Takes up less space compared to printed books<br>I can’t forget it like a textbook |
| -Navigation | Bookmarks and indexes enable me to find chapters fast with the click of a button<br>You can locate info you need quick and easy |
| Ecological | Good for the environment that paper does not have to be used.<br>It is more environmentally friendly |

**Table 4.** Drawbacks of the eBook

| **Theme** | **Quote** |
|---|---|
| Effort expectancy (EfEx) | A lot of effort to get into the eBook and use it<br>It is sometimes difficult to understand |
| Attitude towards using technology (Att) | I enjoy studying more when I have a hard copy of a textbook in front of me<br>I like to use a hard copy of the book. Don’t like it to use the computer. |
| Performance expectancy (PEx) | Slows me down<br>Decreases productivity<br>It is harder to study from a device where you can't make necessary notes or even add extra information to it. |
| Facilitating conditions | |
| -Affordability | Costly, not all of us have access to Internet or Wi-Fi 24/7<br>Not everyone can afford internet when they live on their own |
| -Accessibility | A lot of effort getting logged in and set up<br>It cannot be accessed without an electronic device<br>You need internet connection to access the eBook.<br>There isn't always and everywhere good internet connection.<br>Using the eBook requires power, difficult when the power is out.<br>You don't always have access to the book if you didn't download it |
| -Functionality | I cannot look at the eBook and your work at the same time without experiencing difficulties.<br>It leaves a lack of screen space, if it (eBook) and Excel is both showing at the same time. Otherwise you need to switch between the two, which is inefficient. |

| | |
|---|---|
| | Text can't properly be seen on my mobile device. |
| -Convenience | It's hard for me to study from a textbook on a computer screen.<br>I like making notes on what I read, now have to click on the *add a note button* and on top of that, type in the note, it takes much of my time. |
| -Navigation | Selecting a specific page is difficult and it takes long to navigate to the right page.<br>It is time-consuming because one has to flip from one application to the next and scroll down in order to read the instructions during a practical whereas I could just glance down if it was a hard copy. |
| -Ergonomics | The use of electronic devices is bad for my eyes and can cause headaches.<br>Looking at the computer screen all day is bad for your health |
| Distraction | I am lazy to study when am using an electronic device. So with eBook I can't fully concentrate on studying.<br>Because it is on my phone, I get easily distracted. |

**Table 5.** Benefits of the SLMS

| **Theme** | **Quote** |
|---|---|
| Effort expectancy (EfEx) | It's super easy to use and you learn a lot from so little effort.<br>Easy to use, practice runs makes it easy to understand |
| Attitude towards using technology (Att) | Nice and easy, new way of learning, which I enjoyed.<br>Fun way of learning. |
| Performance expectancy (PEx) | Increases learning productivity<br>It provides a fast way of learning new tasks.<br>I had the opportunity to improve my marks |
| Facilitating conditions | |
| -Accessibility | Easy to access on any computer<br>It's easy to access, anywhere, at any time |
| -Functionality | I love the way they explain the work and that you can go forward and backwards, the fact that you can see where your mistakes are and what they are, is pretty amazing, I love the fact that you can submit more than one time and to get my result so fast.<br>Videos are interesting and practical exercises are an easy way to learn<br>Immediate feedback on assignments. |

| | |
|---|---|
| | It is an interactive way of learning where you can physically practise things learnt throughout the module |
| -Convenience | Can work and learn at own pace and any time.<br><br>You can complete your work at anytime, anywhere. |
| -Independent learning | Is beneficial to students because it teaches the students to be more responsible and independent from the lecturer<br>Helps you to learn and you don't need a lecturer |
| Skills development | Encouraged time management.<br><br>It helps you gain responsibility.<br><br>It helps you to develop your computer skills. |

As can be expected, the students had contradicting views on the benefits and drawbacks of the eBook. Some found the eBook easy to use, while others indicated that it requires a lot of effort to use it. Numerous students showed a positive attitude towards the use of an eBook, but several students reported their preference for a hard copy textbook and their dislike of the eBook. Some students stated that the eBook improved their efficiency and caused more rapid learning, whereas other students felt that the eBook decreased their productivity and slowed them down.

Under the theme “Facilitating conditions”, the following emerged. Although the cost of the eBook was included in the course fee, the students were under the impression that it was free, and complained about the costs incurred when accessing the eBook through the Internet even though they could download and access it offline. With the reported high cost of data in South Africa, many students cannot afford to use Internet-based technologies from home and it is not ideal for students to do all their studying on campus.

Another criticism was the fact that students had to possess a suitable device for accessing the eBook from outside the computer laboratory. This was countered by students who owned a device and commended the fact that they could use the eBook anywhere. Students criticized the functionality of the eBook by stating the difficulty of having to split the screen between the eBook and the Excel sheet they are working on. In addition, the screen size of some students' own devices posed an even greater challenge. The students found the fact that they did not have to carry a heavy textbook around that takes up a lot of space, to be a great convenience. On the other hand, some students were greatly inconvenienced by the way note taking in the eBook works. Some students liked the navigation features of the eBook; however, not everybody was impressed and claimed that it was time consuming to navigate to specific pages in the eBook, as well as between the different applications. Several students objected to the eyestrain caused by the use of the eBook and other ergonomic factors influencing their health and well-being.

A positive contribution from these young people is their concern about the environment, since they view the fact that an eBook being paperless as a benefit.

It was interesting to learn that students easily get distracted by all the temptations offered to young people on the Internet. Le Roux and Parry [9] also reported that using media for non-academic purposes during lectures has become the normal mode of functioning for university students. They acknowledge the possibilities of digital media in learning, but argue for a balanced perspective, which recognizes both the positive and negative results that stem from digital media use in academic contexts.

**Table 6.** Drawbacks of the SLMS

| **Theme** | **Quote** |
|---|---|
| Effort expectancy (EfEx) | If you aren't computer literate, then accessing *SLMS* will be an incredibly hard task for you.<br>It is hard to use. |
| Attitude towards using technology (Att) | The training is somewhat slow and not fun at all.<br><br>*SLMS* is tedious. If you click incorrectly it gets really irritating. I really disliked the entire process. |
| Performance expectancy (PEx) | It's not useful<br><br>SLMS requires a lot of my time, which makes my schedule less provided to other modules I need to pass. |
| Facilitating conditions | |
| Accessibility | Requires an electronic device that has access to the internet<br><br>May cause problems during power outs, etc.<br><br>Difficult to access when there is no internet connection or when the internet is down. |
| Functionality | It sometimes marked my answers incorrect when they were correct<br>It is marked with code, not a physical person, so marking does not leave tolerance for spelling errors or case errors.<br>The SLMS training videos were an overload of information.<br>Training: It is easy to rush through and not to learn anything. |
| Convenience | I sometimes struggle to complete tasks on the computer given the fact that I am more of a writing down and making notes and scribbles person.<br>SLMS can only accept one way of doing a specific task, while there is a lot of other ways to do the specific task.<br>The training is extremely time-consuming considering the fact that accidentally miss clicking would cause the error to pop up, and you need to wait for it to disappear to continue. |
| Independent learning | All the responsibilities regarding training lie in your hands.<br><br>A drawback can be that a student sometimes wants a lecturer to tell you why something is done in a certain way |
| Ergonomics | It can give you headaches.<br><br>It hurts my eyes if I stay behind the computer for too long |

When considering the comments regarding the SLMS, it was clear that a significantly larger group of students viewed the SLMS in a more positive light than the eBook. Similar to the eBook, students also had contradicting views on the benefits and drawbacks of the SLMS. Students also found the SLMS easy to use; however, it was clear that the use of the SLMS was more challenging for students who were not computer literate when entering the course. Numerous students showed a positive attitude towards the use of an SLMS, while some students reported their dislike of the SLMS. Some students reported that the SLMS increased their productivity, but others felt that it was time-consuming and not useful.

The theme "Facilitating conditions" brought the following to the fore. Students liked the fact that they could access the SLMS anywhere, at any time. However, students indicated that access to the SLMS was hampered by lack of a suitable device, electricity and Internet availability. Even though 98% of the students in this study own mobile phones with Internet access, the SLMS is not suitable for use on a smart phone and students are therefore limited in the utilization of the SLMS. To a lesser degree, there are still challenges regarding sufficient supply of electricity, especially in rural areas in South Africa. To provide advanced technologies, such as the SLMS and eBook without the basic availability of electricity, is completely futile.

The videos, interactive way of learning, immediate feedback on assignments and the tutorials were all viewed as great assets of the SLMS, but by contrast, the students criticized the functionality of the SLMS, especially when it came to the automatic assessment of assignments. Students became utterly frustrated that seemingly correct answers were marked wrong, but due to the nature of automatic assessment even a misplaced space might influence the awarding of marks. Similar to the eBook, students found it convenient that the SLMS makes it possible to study at your own pace, anywhere and at any time. On the other hand, students were inconvenienced by the scrupulous manner of completing and marking assignments in the SLMS.

Students noted the benefit of independent learning, however not everybody was impressed and claimed that they would appreciate input from a lecturer at all times. Again, students complained about the ergonomic factors influencing their health and well-being.

The students reported that the use of the SLMS not only improved their computer skills, but also time management skills and in addition, they learned to take responsibility for their own learning.

The responses to the open-ended question: "Please discuss how the SLMS and SLMS impacted on your learning experience in this class" echoed the responses of the students presented in Tables 3 to 6 and will thus be discussed below.

The quantitative data [5] indicated a positive attitude towards the eBook and SLMS. Furthermore, from the qualitative data it emerged that for some students the digital technologies were a life-saver.

> *When I started doing this module I feared for my life. The SLMS and the eBook have helped me to quickly grasp this module. I have not done IT at school, but through the help of the SLMS I have achieved far more than I would have ever imagined.*

Students commented on the impact of the educational technologies on their learning experience by pointing out several positive aspects and benefits.

Improved marks:

- *If it was not for SLMS and eBook, I think I could have had very low marks.*

Feedback and independent learning:

- *Using an eBook and SLMS was a complete new experience for me. I liked the way the SLMS clearly stated what mistakes I made and told me exactly how to amend them. In class, during a lecture my lecturer might not have been able to give me this type of feedback and attention. The eBook and SLMS also made preparing for classes easier and self-study was more bearable than in other subjects. In class I was able to work at my own pace if I already knew how to do the tasks the lecturer taught during the lesson.*
- *It helped me to accomplish tasks on my own rather than having it spoon fed to me.*
- *I could work at my own my own pace and if I fell behind with work it made it easier to catch up.*

Convenience and independent learning:

- *I don't have to write anything down to make sure I don't forget anything, it's already been given to me and I can go back to it and go through everything before exams and not be stressed that I have lost any pages or important information.*

Learning experience:

- *They both improved my work in computers; they have a lot of information; which normal books could not offer. Lots of jobs requires a skill in computers and working with an eBook and SLMS made me to get used to the computers and never get bored while using them. This really impacted on my learning experience in a positive way.*
- *What I like the most about the SLMS is that it illustrates how to do each and everything concerning Excel using videos.*

Although a large number of students was positive about their overall learning experience with the educational technologies, it emerged that students prefer a hard copy textbook. From the quantitative data analysis, it was found that 44.6% of the students indicated that they prefer a hard copy and a further 20.6% had a neutral stance regarding the eBook. The qualitative data analysis also revealed some students commenting on their dislike of using the eBook.

- *I didn’t really like the eBook, but SLMS was okay. If I had a choice, a normal textbook would have been the better option to use.*
- *The SLMS videos were very nice to watch but the eBook I did not enjoy because I don’t like online books; I prefer the old fashion textbook.*

As a contrast, a few students were positive about the eBook, but the lengthy explanations of the SLMS did not appeal to them.

- *eBook explained certain procedures really well. The SLMS was very monotonous and unengaging.*
- *The SLMS is slow learning, while the eBook is more to the point. The SLMS, however, is very good at teaching things more in detail if I had a specific problem.*

Despite the fact that the majority of students were optimistic about the impact of the technologies on their learning experiences, there were students who expressed their view that these educational technologies still have to evolve and for others it simply does not appeal to their taste.

- *I simply feel that I would personally prefer using a normal textbook even though I know that the future is using sites like SLMS. But most of the content on SLMS is also explained on free sites like YouTube which I used last year in Matric IT. I felt this benefited me more than what SLMS has. This is why I feel that the online education still has a way to go for it to replace normal textbooks and teaching methods.*
- *It helped me a lot and is a great way of studying, but it is simply not for me!!!!!*

A student reported: "*It is easy to rush through and not to learn anything*", which should raise the red flag that the impact of the educational technologies on his/her learning experience was that no learning took place.

Finally, it is satisfying to report that students expressed their gratitude for the opportunity to use these educational technologies and for some it was a magical experience.

- *The eBook and SLMS helped me ease into a foreign subject easily. It made the learning experience more interesting, helping me to learn quicker and catch on easier. I am grateful for the way our course was presented to us.*
- *It made it a magical time.*

## 5 Conclusions and Recommendations

In general, the educational technologies had a positive impact on the learning experiences of students; it was confirmed in both the qualitative results of this paper and the quantitative results in Benadé and Liebenberg [5].

As can be expected, some drawbacks and benefits regarding the use of the eBook and SLMS emerged. The students realized the benefits of the eBook; always available, not necessary to carry around, cannot be lost, easy navigation and environmentally friendly. However, the moment when they started to use the eBook, they preferred a hard copy. They experienced problems with accessing the eBook, especially in terms of Internet access, screen size while using both the eBook and Excel, making notes and the strain on their eyes. The SLMS posed several benefits; it is an enjoyable way of learning, they get immediate feedback, working at their own pace and independent of a lecturer. In spite of this, students complained about the rigid way in which automatic assessment takes place, lack of Internet access and tedious explanations.

It became clear that the contradicting views of the students were often caused by their level of computer literacy. It seems that students who had a high level of computer literacy, such as those who had IT as a school subject were frustrated with the seemingly oversimplified and lengthy explanations in the SLMS and eBook. However, those students with a low level of computer literacy might initially have viewed it as a great challenge and threat, but they eventually experienced the benefits of having the opportunity to work at their own pace, receive immediate feedback and learn independently from the lecturer.

Not only did the educational technologies impact positively on their learning of subject content, but in addition, they acquired life-long skills, such as time management and taking responsibility for their own learning, which are essential skills in this rapidly evolving environment of today.

Students commented on everything they learned through the use of the educational technologies, but for students ultimately, it is all about the marks they obtain; this explains their frustration with the rigid marking of the SLMS. On the other hand, the educational technologies had a positive impact on the marks of students.

Since 98% of the students have access to a mobile phone with Internet access, it can strongly be recommended that the developers of educational technologies should design it to be smart phone friendly.

Courses making use of educational technologies as in this study might require more activities that students have to attend to than in a traditional lecture, but as one student commented: "*You have to work harder, but it's fun*"

In conclusion, it can be observed that students had a positive experience with the use of the educational technologies, but universities, as well as developers of educational technologies are challenged to ensure that students' learning is actively enriched by the technologies and not narrowly focused on the administration of learning instead of the learning itself.

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# Students’ Access to an ICT4D MOOC

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**Abstract.** The author introduces an Information and Communication Technologies for Development (ICT4D) Massive Open Online Course (MOOC). A literature review details concepts relating to ICT4D, MOOCs and institutional learning management system technologies, presenting aspects relating to what the pedagogy underlying the course was, and how the course was adapted to a MOOC. A section follows describing the research methodology regarding the design used, and the data collected in student course evaluations of the MOOC. The results discuss demographic particulars for the samples including 2842 respondents from twenty countries. The author e.g. describes what students’ overall experience of the course was, and how they communicated with their teaching assistants. Results further highlight students’ access to computers, devices and the internet. A results summary concludes the paper.

**Keywords:** Information and Communication Technologies for Development (ICT4D), Massive Open Online Course (MOOC), Student access.

## 1 Introduction

According to Marshall [25], multiple Institutions for Tertiary Education (ITE) have offered online courses for numerous years, especially so for those involved in Open and Distance e-Learning (ODeL). Huan, Shehane and Ali [19], however, warned that the success of open and distance e-learning has driven institutions for tertiary education to increase the number of courses accessible online. In agreement, Michels and Joosten [28] pointed out that teaching computer courses to students could present quite a challenge. If this, however, happened in an open and distance e-learning context for students who are not together physically and follow different learning programs – according to Marshall [25], when teaching computer courses, there is typically high levels of interaction and demonstrations between the computer lecturer and their students. In open and distance e-learning contexts, Huan et al. [19] further pointed out that drop-out and failure rates were elevated in entry-level computer courses.

Pieterse and Stallmann [33] added that the organization of a course presented at an institution of tertiary education showed prevalent **problems**, which became **significant** when the course size increased meaningfully. The author of this paper will therefore present problems that could be associated with teaching such large courses, as well as **proposing** several **solutions**. An attempt was also made towards addressing such **prob-**



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**lems** in the presentation of a first-year Massive Open Online Course (MOOC) introducing Information and Communication Technologies for Development (ICT4D) with an average enrolment of over 15 000 students per semester. The paper will report on outcomes related to different aspects of managing such a large course.

The research question being answered in this paper is: What options do students have in terms of computers and other devices to access the internet and specifically an ICT4D MOOC, in order to cope with being part of such a large enrolment at a non-residential institution for tertiary education?

Introductory computer courses such as the one under discussion in this paper are confronted with various additional challenges. One of the components that the introductory computer course that serves as the basis for this paper discusses includes the influence of technology on societal and ethical issues relating to computers, which are perceived as challenging to teach successfully. Van Hentenryck and Coffrin [44] agreed that teaching such skills was challenging: Students need to learn not only core technical skills, but also the ability to think creatively, for selecting and adapting a paradigm for solving the problem at hand. Apart from therefore learning how to solve complex problems, Marshall [25] observed that the curricula content tended to be diverse and could include single or combined outcomes, including with regard to using basic software.

With similarities to what was described by Michels and Joosten [28] and Pieterse, Thompson, Marshall and Venter [34], the author of this paper will firstly describe how she became involved in the design and tuition of an introductory ICT4D MOOC.

The paper will introduce the design of this course over a period of around eighteen months using a team approach, including, for example, an expert from a leading institution for tertiary education in the United States of America (USA), as well as internal support departments. In line with what was described by Van Hentenryck and Coffrin [44], this paper will also attempt to shed light on how problem-solving skills can be taught in such a MOOC. In line with what was suggested by Marshall [25], this paper will also look at how massive open online courses could be leveraged for enabling students to improve their performance in their first study year.

Similar to what was presented by Marshall [25], in the literature review section of this paper, an overview will be given of MOOCs, together with discussing the role players, who provide these courses. This section also documents concepts related to ICT4D and institutional learning management system technologies, as well as presenting aspects related to how the teaching philosophy (epistemology) behind this course had been adapted for implementation in a MOOC setting [44]. Although themes with regard to renewing curricula and computer lecturers’ teaching practices will be touched upon, and like Rogier and Van Der Veer [36], in the domains of Information and Communication Technologies for Development, especially students’ experiences and access will be the focus of this paper. Similar to what was reported on by Pieterse [32], an effort was made to gather success factors and identify concerns related to assessment, by analysing other researchers’ experiences, which they reported when they designed and used the assessment of assignments and interpreted their applicability in MOOC contexts.

This is followed by a section that describes the research methodology in terms of how research design was implemented, as well as how the data, enabled by a wealth of information that had been gathered in Student Course Evaluation (SCEs) of the MOOC undertaken by the Directorate of Institutional Research in May/June and October/November of 2014 and 2015 [44]. Similar to what was reported on by Pieterse, et al. [34], an analysis of information on how these students behaved in their groups, as well as with regard to what they had experienced while they participated in this ICT4D MOOC, are provided.

A discussion of the results starts with some demographic details for the samples including 2842 respondents from 20 different countries. The author then describes e.g. how students communicated with their Teaching Assistants (TAs), and what students' experience of the course had been like. Succinct highlights from qualitative results, especially detailing what students enjoyed most about this course with regard to the ICT4D aspect of it, are also provided.

In particular, a discussion of the results indicates several key components of the success of this MOOC, which contributed to it being highly popular amongst the undergraduate students who had been involved in the surveys, which are reported on in this paper [44]. These also enabled the ICT4D course to provide a valuable learning experience that used institutional learning management system technologies, for validating the design decisions that had been taken with regard to the MOOC version of the course [44]. Along with Goosen and Breedt [14], the **contribution** of the study reported on in this paper, and relevance to this Southern African Computer Lecturers' Association (SACLA '18) conference, was justified in terms of the frequent changes associated with learning management system technologies that computer lecturers have to contend with. Finally, like that of Pieterse, Thompson, Marshall and Venter [34], the paper will be concluded with remarks on the potential success of possibly improving teaching strategies, concise sections on further research possibilities and a summary.

## 2 Literature Review

### 2.1 Information and Communication Technologies for Development (ICT4D)

A paper by Goosen and Van Heerden [16] explained how project-based assessment influenced the pass rates of an Information and Communication Technologies (ICTs) course at an open and distance e-learning institution for tertiary education, while their article [17] described project-based learning and assessment of an Information Technology (IT) course in an open and distance e-learning context. For the introductory course discussed in this paper and for which the author was the primary computer lecturer, and similar to aspects mentioned by Rogier and Van Der Veer [36], one of the focus areas in this paper is on open and distance e-learning, with examples for Information and Communication Technology for Development design. This ICT4D MOOC covers concepts including, but not restricted to, agriculture and poverty alleviation, education, health and gender. Penzenstadler and Bauer [31] pointed out that although Information and Communication Technology systems can offer impressive support for the promotion and enablement of sustainability in society, this could result in developing environmentally and/or socially sub-optimal solutions. To unlock this potential, Penzenstadler and Bauer [31] are sensitizing their students with regard to such issues by gradually introducing these concepts into their curriculum.

### 2.2 Massive Open Online Courses

According to Marshall [25], Massive Open Online Courses made an appearance as educational buzzword around 2012 and has since been enjoying extensive media exposure in the popular press. Unlike tailor-made courses, which are usually facilitated by the computer lecturer, MOOCs are open to all of the world, and access to the computer lecturer is limited. Marshall [25] further explained that MOOCs are typically presented by a professor in the context of tertiary education institutions, who, instead of teaching her course to only a select few in her classroom, was making these experiences available to others for viewing online, not necessarily in real-time. Furthermore, MOOCs have shifted the learning responsibility from the computer lecturer to the student. Therefore, there was a shift from a constructivist pedagogical approach to a behaviouralist approach. In this context, Marshall [25] indicated that good online courses should:

- take into account different learning styles;
- encourage contact between computer lecturers and students, and between students;
- provide feedback and encouragement according to expectations;
- schedule activities; as well as
- fostering a convincing sense of fitting in online, as learning in such an environment can be very lonely.

Similar to what was described by Garcia, Campbell, Dovi and Horstmann in [8] and Tang, et al. [42], around the start of the second semester of 2011, the author committed to design and teach a MOOC on introductory computer and basic ICT4D concepts, hosted on the institutional learning management system technologies, for many thousands of students.

According to Marshall [23], when developing a curriculum, different requirements needed to be considered, so that the curriculum and outcomes could both be accepted locally and internationally – this also makes it possible, according to another paper by Marshall [24], that a real-world curriculum could be compared to others.

With aspect similarities to what was described by Van Hentenryck and Coffrin [44] and [13], several important choices in terms of exemplifying excellence in course design were implemented, which are believed to have had a significant influence on the success of the ICT4D MOOC as discussed in this paper.

As had been set out in the institutional framework for implementing a team approach to design curriculum and learning development, and also detailed in [12], for example, a distinguished Professor of Mathematical and Decision Sciences, as well as Engineering Systems at the Rensselaer Polytechnic Institute, USA specifically worked as external specialist as part of a United States team consulting on the design and development of the course.

In order to engage with and motivate students, as had also been reported by Tang, Rixner and Warren [42], the course environment was entirely web-based. Van den Berg

[43] is of the opinion that the conceptual foundations for critical reasoning and student engagement in open and distance e-learning are thus secured.

Also similar to what was described by Campbell in [8] and Sahami, Guzdial, Martin and Parlante [37], for the six semesters from the first of 2013 to the second of 2015, the author has co-taught this massive open online course called 'Ethical Information and Communication Technologies for Development Solutions', with the assistance of a team of secondary computer lecturers and teaching assistants. The initial offering of the MOOC during the first semester of 2013 has since been repeated during the second semester of 2013, the first and second semesters of 2014, etc. There had been over 92 000 registrations across these six offerings of the course.

Like Guzdial, in [37], the author is very optimistic about this MOOC! Similar to what was described by Tang, et al. [42], the MOOC for which the author was the lead course designer and primary computer lecturer, these six semester offerings of the course were a substantial success, as it received several thousand positive reviews (see, for example, Table 3 in the results section of this paper).

Similar to what was described by Haag, Horsmann, Karsch and Vranken [18], in a paper in the context of open and distance e-learning, groups of students could complete assignments related to computers, with each student progressing at their own pace in the learning management system.

Although for some students, the MOOC experience is not positive for all, and some of them do express confusion and frustration, as was also admitted by Campbell in [8], for many other students, the MOOC experience was one of Passion, Beauty, Joy and Awe (PBJA) and computer lecturers witnessed this in the discussions, where 'Aha!' moments were celebrated, mentor-mentee relationships were fostered, and gratitude was expressed. Campbell in [8] also emphasized that opportunities for such experiences seem to hinge mainly on community and communication. Students needed appropriate support at the appropriate time – research such as what was carried out by Gatsha and Evans [9], on the perceptions and experiences of open and distance students in Botswana in terms of e-learning support, is therefore essential. In this same vein, Dennen and Wieland [5] investigated moving from interaction to inter-subjectivity when facilitating online group discourse processes in open and distance e-learning contexts, while Nel and Ndeya-Ndereya [29] also highlighted the role of communication in enhancing online social presence.

Van Hentenryck and Coffrin [44] pointed out that the buzz and community that motivated students in a face-to-face classroom was fostered by combining challenging problems, encouraging teamwork, and iterative, continuous assignment feedback. In order to similarly build a sense of community in these MOOCs, several feedback mechanisms were employed for communicating the outcome of assessments to students. Warren, Rixner, Greiner and Wong [47] also mentioned concerns with regard to the availability of relevant and timely feedback.

The enabling and supportive roles provided for students' development have the implication of creating a learning community, where participants were willing to learn from one another and able to exchange ideas and share suggestions [10].

According to Köppe and Pruijt [21], assignments and exercises remain an essential part of computer education. A variety of these assignments are usually required for covering the wide range in terms of educational objectives desired, as defined in Bloom's revised taxonomy. [11] also pointed to the importance of assessment to address the challenges relating to effective teaching and meaningful learning in an ICT4D MOOC.

Like Garcia, et al. [8], the course materials were structured with the 'Digital Generation' in mind, with each learning unit containing e.g. video lectures, graded Multiple-Choice Questions (MCQs) and independent practice assignments. Teaching assistants were trained to act as coaches for the students, with a gradebook interface for monitoring student progress. With about 200 registered students allocated to each teaching assistant, a good auto-grader, which allowed for quickly marking hundreds of assignments, was also essential. In support of the latter statement, in her position paper, Pieterse [32] argued that MOOCs could benefit from applying automated assessment to assignments.

Similar to what was outlined by Campbell in [8], the video lectures for the MOOC corresponds to a 15-week semester computer course. Also in agreement with what was detailed by Schofield, Erlinger and Dodds [38], in terms of the video content and other additional learning resources, in contrast to many other MOOCs, the videos were not central, but supplemental, to the curriculum of the MOOC reported on here.

Stuurman, Eekelen and Heeren [41] indicated that Open Educational Resources (OERs) seemed a natural fit for an open and distance e-learning institution for tertiary education: open resources were in line with the mission of the institution for tertiary education for providing access to academic education, many materials were available in digital form, since even the names of such open and distance e-learning institutions for tertiary education often contain the word 'open'. Rogier and Van Der Veer [36] therefore showed how their teaching practice allowed them to develop a view towards providing and structuring such open e-learning resources.

In answer to the question: "What was the most interesting computer education finding/resource you have found recently?", posed by Kauchak [20] and quoting from an interview with Szabo, she replied that researchers at her school were putting up a MOOC for educating computer lecturers on how to teach computers – she thought that their efforts would benefit the community tremendously.

Korhonen, et al. [22] predicted that (massive open) online courses supported by digital courseware would radically alter institutions for tertiary education in ways that cannot be predicted. New learning management system technologies, such as those being implemented in MOOCs, have generated interest in novel knowledge delivery models. Sahami, et al. [37] similarly pointed to MOOCs as a way for enhancing learning, including models to make online instruction more effective.

Finally, another interesting element to discuss is the implications of MOOCs for the computer lecturer. So-called behaviourist or xMOOCs present difficulties regarding their pedagogical models, while connectivist MOOCs (cMOOCs) can easily end in a chaotic situation. There are good approaches to try to combine both orientations, for example, as described by Fidalgo-Blanco, Sein-Echaluce Lacleta and García-Peñalvo [7]. In an earlier conference paper, Fidalgo-Blanco, García-Peñalvo and Sein-Echaluce Lacleta [6] proposed a methodology for developing adaptive cMOOCs, while Rapp [35] discussed the use of adaptive learning in a Spanish MOOC, with regard to teaching and blended and online learning. Sein-Echaluce Lacleta, Fidalgo-Blanco, García-Peñalvo and Conde-González [39] also discussed adaptive MOOCs, this time as it related to the iMOOC platform, whereas Sonwalkar [40] presented a case study on a pedagogical framework and scalable cloud architecture for a first adaptive MOOC.

### 2.3 Institutional Learning Management System (LMS) Technologies

Goosen and Naidoo [15] reported on how computer lecturers used their institutional Learning Management System (LMS) for Information and Communication Technology education in the cyber world. In terms of other course contexts, Breetzke [1] provided a critique of institutional learning management system technologies for Geographic Information Systems (GIS) in South Africa, while Michau [27] described an engineering drawing case study at the University of Johannesburg adapted for an open and distance e-learning context. While Van Rooyen [46] integrated the MXit technology into an open and distance e-learning Accounting course, a paper by Cloete, de Villiers and Roodt [4] explained how Facebook was being used as an open and distance e-learning technology for computer lecturers.

According to Cant and Bothma [3], podcasting refers to the use of short audio clips (or videos, in which case it is also known as vodcasting), which are delivered to students via their iPods, smart/multimedia phones or online. In this regard, Van Heerden and Goosen [45] reported on how vodcasts were being used to teach programming in an open and distance e-learning context.

## 3 Research Methodology

Similar to what was explained by McMillan and Schumacher [26], an evidence-based research inquiry into how a number of technologies were being used in an open and distance e-learning context is described in this paper. Oosthuizen, Loedolff and Hamman [30] also used an opinion survey amongst students to determine students' perceptions with regard to the importance of, and their satisfaction with, certain features for supporting learning in an open and distance e-learning context. Gatsha and Evans [9] likewise used a survey to establish which student needs, expectations and aspirations are critical for designing and developing quality learning support. For developing a generic understanding on designing for adult learning, Rogier and Van Der Veer [36] chose action research as their empirical investigation technique.

One of the purposes of this paper is to disseminate selected results from student course evaluations undertaken by the Directorate of Institutional Research in May/June and October/November of 2014 and 2015. The applicable surveys were conducted online across all of the six colleges at the institution at the time, encompassing a total of up to 81 courses. The course discussed in this paper is presented in semester format.

**The purpose of these surveys** was to evaluate courses such as the one being discussed in this paper, which these students had studied during the first and second semesters of 2014 and 2015. The student course evaluation reports provided were intended to help this institution for tertiary education by providing an overall picture of students' views and experiences of the courses, and in order to provide data to course coordinators for the purposes of course evaluation and improvement.

All students, who had been registered for the course at the time when each of these surveys were conducted, were invited to participate in the surveys.

Similar to what was reported by Brown, Kölling, McCall and Utting [2], the start and end date(s) and times of students' survey completion sessions were recorded, with the average time that they used to complete the survey for the course addressed in this paper having been just more than two hours. Given the typical dropout rates experienced when it takes respondents this long to participate, this information might indicate that participants, being online, did not literally sit down for a solid two hours, but, instead, that this time might include breaks for coffee, etc. In terms of structure, the surveys reported on here consisted of 56 Linkert-type questions, and six open-ended ones.

## 4 Discussion of Results

As similarly reported on in [12], although the overwhelming majority of respondents for each run of the surveys were from South Africa – reflecting the composition of the course populations – respondents from other Southern African and African countries, as well as from across the world, participated in these surveys – see Table 1 for the full list of 20 countries.

Less than a third of respondents were repeating this course during the first and second semesters of 2014 and 2015. In a previous conference paper [11], the author reported that for a sample in the first semester of 2014 showed that 618 (30%) of students were repeating this course – combined with the results in Table 2, this seems to indicate that the application of creative assessment strategies is leading to improved student retention and success, as the percentage of students who are progressively repeating the course show a generally downward trend.

Although students in the study as reported by Van Hentenryck and Coffrin [44] found that the course materials were challenging, their overall experience had been very positive. Also comparable to what the latter authors related, more than half of the students either agreed or strongly agreed that they had had an overall positive experience in this course (see Table 3) – similar to the study reported on by Van Hentenryck and Coffrin [44], this result could be interpreted as indicating that many of the applicable aspects had been successfully reconstructed in the MOOC version of the course.

Please note that numbers and percentages as indicated for the second semester of 2015 in Tables 4 to 6, as well as 9 and 10, were calculated by the author from the data files as provided, as these had not been provided as part of the reports for these surveys, as was the case for all other information sets provided.

More than half of all respondents either liked the online approach to this course very much or 'Extremely' (see Table 4)!

Eighty-five percent and 86% of the respondents for the first and second semesters of 2015 respectively deem a digitised education very important or extremely important in preparing them for the 21st century workplace (see Table 5). Although similar totals for the second semester of 2014 are slightly lower, the latter still represent more than three-quarters of all respondents.

Please note that for data presented in Tables 6 to 10, students were requested to select all options that applied – totals therefore are larger than the number of respondents who had completed these data sets.

Respondents for both 2015 semesters indicated that 82% of them had access to laptops, even if it was not their own – percentages for the second semester of 2014 are slightly lower, but the latter still represent around three-quarters of all respondents. Around two-thirds of all respondents also have access to a smart phone, while more than half of all respondents across these three surveys had access to a desktop computer.

**Table 1.** Sample students' countries of residence.

| | S2-2014 | | S1-2015 | | S2-2015 | |
|---|---|---|---|---|---|---|
| South Africa | 1506 | 96% | 513 | 95% | 411 | 91% |
| Zimbabwe | 26 | 1.7% | 4 | 0.74% | 16 | 3.5% |
| Namibia | 6 | 0.38% | 3 | 0.55% | 6 | 1.3% |
| Botswana | 9 | 0.57% | 5 | 0.92% | | |
| Swaziland | 8 | 0.51% | 3 | 0.55% | 2 | 0.44% |
| Angola | 2 | 0.13% | 2 | 0.37% | 1 | 0.22% |
| Lesotho | 2 | 0.13% | 2 | 0.37% | 1 | 0.22% |
| Zambia | 3 | 0.19% | 1 | 0.18% | | |
| Malawi | 3 | 0.19% | | | | |
| Kenya | 2 | 0.13% | 1 | 0.18% | | |
| Ethiopia | 2 | 0.13% | | | 1 | 0.22% |
| United Arab Emirates | 1 | 0.064% | 2 | 0.37% | | |
| Brazil | | | 2 | 0.37% | | |
| Saudi Arabia | 1 | 0.064% | | | 1 | 0.22% |
| Canada | 1 | 0.064% | | | | |
| Germany | 1 | 0.064% | | | | |
| Democratic Republic of the Congo | 1 | 0.064% | | | | |
| Mozambique | | | 1 | 0.18% | | |
| Sweden | | | 1 | 0.18% | | |
| United Kingdom | | | | | 1 | 0.22% |
| | 1573 | | 541 | | 451 | |
| Registered at survey time | 5458 | | 12994 | | 5049 | |
| | 29% | | 4.2% | | 8.9% | |
| Number in data file | 1755 | | 566 | | 521 | |
| | 32% | | 4.4% | | 10% | |

**Table 2.** I am repeating the course.

| | S2-2014 | | S1-2015 | | S2-2015 | |
|---|---|---|---|---|---|---|
| Yes | 334 | 23% | 133 | 26% | 79 | 18% |
| No | 1143 | 77% | 383 | 74% | 372 | 82% |

Around three-quarters of all respondents across these three surveys mostly access the computer/device(s) they specified in Table 6 from home (see Table 7). More than half of respondents for all three of the samples shown also have access to these devices from work.

**Table 3.** My overall experience of the course was positive.

| | S2-2014 | | S1-2015 | | S2-2015 | |
|---|---|---|---|---|---|---|
| Strongly Disagree | 230 | 20% | 84 | 20% | 61 | 17% |
| Disagree | 126 | 11% | 44 | 11% | 44 | 12% |
| Neither Agree nor Disagree | 140 | 12% | 38 | 9% | 42 | 12% |
| Agree | 459 | 40% | 189 | 46% | 139 | 38% |
| Strongly Agree | 187 | 16% | 60 | 14% | 78 | 21% |

**Table 4.** How do you feel about the online approach to this course?

| | S2-2014 | | S1-2015 | | S2-2015 | |
|---|---|---|---|---|---|---|
| Dislike Extremely | 138 | 12% | 46 | 11% | 39 | 11% |
| Dislike Very Much | 96 | 9% | 24 | 6% | 29 | 8% |
| Neither Like nor Dislike | 249 | 22% | 88 | 22% | 92 | 25% |
| Like Very Much | 500 | 44% | 46 | 11% | 151 | 42% |
| Like Extremely | 141 | 13% | 24 | 6% | 50 | 14% |

**Table 5.** How important is digitized education in preparing you for the 21st century workplace?

| | S2-2014 | | S1-2015 | | S2-2015 | |
|---|---|---|---|---|---|---|
| Not at all Important | 29 | 3% | 12 | 3% | 9 | 2% |
| Very Unimportant | 100 | 9% | 25 | 6% | 11 | 3% |
| Neither Important nor Unimportant | 127 | 11% | 26 | 6% | 29 | 8% |
| Very Important | 543 | 48% | 199 | 49% | 186 | 52% |
| Extremely Important | 325 | 29% | 145 | 36% | 126 | 35% |

**Table 6.** Do you have access to one or more of the following, even if it is not your own?

| | S2-2014 | | S1-2015 | | S2-2015 | |
|---|---|---|---|---|---|---|
| Computer (desktop) | 697 | 62% | 223 | 55% | 201 | 57% |
| Laptop | 830 | 74% | 334 | 82% | 291 | 82% |
| Netbook | 35 | 3% | 19 | 5% | 12 | 3% |
| Tablet | 297 | 27% | 140 | 34% | 122 | 34% |
| Smart phone | 701 | 63% | 239 | 59% | 240 | 68% |
| Other | 20 | 2% | 12 | 3% | 14 | 4% |
| I do not have access to any of the above | 33 | 3% | 13 | 3% | 6 | 2% |

**Table 7.** From which location do you mostly access the computer/devices(s) you specified?

| | S2-2014 | | S1-2015 | | S2-2015 | |
|---|---|---|---|---|---|---|
| Home | 774 | 71% | 308 | 78% | 259 | 73% |
| Work | 635 | 58% | 236 | 60% | 179 | 51% |
| Someone else's home | 56 | 5% | 23 | 6% | 25 | 7% |
| Unisa Computer Laboratory | 187 | 17% | 83 | 21% | 86 | 24% |
| Tele-centre (Unisa Multipurpose Community Centre) | 27 | 2% | 11 | 3% | 13 | 4% |
| Internet café | 144 | 13% | 50 | 13% | 52 | 15% |
| Other | 27 | 2% | 15 | 4% | 10 | 3% |

Around three-quarters of all respondents across these three surveys access the internet using a laptop (see Table 8). The percentages of respondents who access the internet using a desktop computer and/or smart phone are roughly equal across all three of these samples, and in each case, represent more than half of all respondents. It is interesting to note that almost two-thirds of the second semester of 2014 respondents accessed the internet using a desktop computer.

**Table 8.** From which source(s) do you access the internet, even if it is not on your own?

| | S2-2014 | | S1-2015 | | S2-2015 | |
|---|---|---|---|---|---|---|
| Computer (desktop) | 660 | 61% | 210 | 53% | 188 | 53% |
| Laptop | 741 | 69% | 299 | 76% | 259 | 74% |
| Netbook | 18 | 2% | 10 | 3% | 8 | 2% |
| Tablet | 245 | 23% | 115 | 29% | 92 | 26% |
| Cellphone/Smart phone | 604 | 56% | 213 | 54% | 199 | 57% |
| Other | 16 | 1% | 9 | 2% | 5 | 1% |
| I do not have access to any of the above | 2 | 0.2% | 0 | 0% | 0 | 0% |

**Table 9.** From which location do you mostly access the internet for study purposes?

| | S2-2014 | | S1-2015 | | S2-2015 | |
|---|---|---|---|---|---|---|
| Home | 739 | 68% | 280 | 71% | 250 | 71% |
| Work | 584 | 54% | 219 | 56% | 155 | 44% |
| Someone else's home | 56 | 5% | 20 | 5% | 22 | 6% |
| Unisa Computer Laboratory | 174 | 16% | 75 | 19% | 87 | 25% |
| Tele-centre (Unisa Multipurpose Community Centre) | 21 | 2% | 11 | 3% | 5 | 1% |
| Internet café | 133 | 12% | 42 | 11% | 53 | 15% |
| Other | 23 | 2% | 12 | 3% | 6 | 2% |
| Mobile device (e.g. cell phone, smart phone, tablet) | 259 | 24% | 106 | 27% | 100 | 28% |

More than two-thirds of all respondents across these three surveys mostly access the internet for study purposes from home (see Table 9)! In line with what was indicated in Table 7, around half of all respondents across the three semesters access the internet for study purposes from work.

**Table 10.** What kind of internet access does the computer/device(s) you use have?

| | S2-2014 | | S1-2015 | | S2-2015 | |
|---|---|---|---|---|---|---|
| ADSL (e.g. from Telkom, MWeb, etc) | 324 | 30% | 133 | 34% | 117 | 33% |
| Company Local Area Network (LAN) | 446 | 41% | 156 | 40% | 97 | 28% |
| 4G/LTE/3G/HSDPA modem (i.e. high-speed mobile connection) | 435 | 40% | 176 | 45% | 149 | 42% |
| Cellphone/Smartphone/ Tablet device with 4G/LTE/3G/HSDPA | 519 | 48% | 199 | 51% | 169 | 48% |
| Free public Wifi areas | 163 | 15% | 71 | 18% | 63 | 18% |
| Don't know | 63 | 6% | 14 | 4% | 22 | 6% |
| Other | 25 | 2% | 8 | 2% | 15 | 4% |

Around half of all respondents across these three surveys indicated the kind of internet access that the computer/device(s) they have used as 'Cell phone/Smartphone/Tablet device with 4G/LTE/3G/HSDPA' (see Table 10). Almost half of all respondents across the three semesters indicated that they use a 4G/LTE/3G/HSDPA modem (i.e. high-speed mobile connection). Almost half of the second semester of 2014 and first semester of 2015 respondents indicated using a company Local Area Network (LAN); this figure for the second semester of 2015 is just over a quarter. Finally, around a third of all respondents across these three surveys indicated using ADSL (e.g. from Telkom, MWeb, etc.).

**Table 11.** How did you communicate with your teaching assistant?

| | S2-2014 | | S1-2015 | | S2-2015 | |
|---|---|---|---|---|---|---|
| Discussion Forum | 747 | 52% | 308 | 61% | 253 | 57% |
| Email | 224 | 16% | 83 | 16% | 59 | 13% |
| Never tried to contact my teaching assistant | 422 | 29% | 131 | 26% | 129 | 29% |
| Could never get hold of my teaching assistant even though I tried | 172 | 12% | 32 | 6% | 49 | 11% |
| Telephone | 53 | 4% | 11 | 2% | 16 | 4% |
| Online Meetings (Big Blue Button) | 36 | 3% | 9 | 2% | 10 | 2% |
| Other | 36 | 3% | 10 | 2% | 7 | 2% |
| Social media (e.g. Facebook, Twitter, etc.) | 14 | 1% | 1 | 0.2% | 5 | 1% |
| Personal visits | 21 | 1% | 4 | 1% | 7 | 2% |
| Letters/Faxes | 1 | 0.1% | 0 | 0% | 3 | 1% |

The fact that the Discussions technology was the one most used by students to communicate with their teaching assistants could be attributed to a guideline given to students, that they should contact their teaching assistants via this learning management system technology. Warren, et al. [47] asked how a student can be successful if (s)he can never interact with their computer lecturer? One of the answers could be seen in Table 11. While Campbell in [8] indicated that in the courses she was referring to, participants on the discussion forums represented only between 5 and 10% of the students enrolled, Table 11 shows that for the course that forms the basis of this paper, up to 61% of respondents had used the institutional learning management system technologies to participate in the discussion forums!

## 5 Conclusion

The following conclusion section reviews the main points of the paper, elaborates on the importance of the work and suggest applications and extensions. The author introduced an ICT4D MOOC, with a literature review detailing concepts relating to ICT4D, MOOCs and institutional LMS technologies. A section followed describing the research methodology regarding the design used, and data collected in SCEs of the MOOC. The importance of the findings reported on in this paper lies in their application as a guideline when similar courses are planned, in order to avoid some of the pitfalls, which had been identified through these experiences, and extending those aspects that Pieterse and Stallmann [33] found useful. Pieterse [32] added that reflections on these experiences can also inform MOOC designers when they have to make decisions with regard to using assessment of assignments. This ICT4D MOOC will provide, as also described by Warren et al. [47] and discussed in this paper, online students with enhanced, valuable learning experiences. Numerous discussions of future research directions with regard to this and related fields are, however, evident.

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# Teaching and Research

# Motivating Factors and Expectations of Postgraduate Information Systems Students: A Study at the University of Cape Town

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**Abstract.** This research aims to understand the motivations and expectations of postgraduate Information Systems students. A literature review was conducted on the motivations and expectations of postgraduate Information Systems students, the value postgraduate studies have on students as well as the drivers and manners in which postgraduate studies are done. Through semi-structured interviews with students, it was concluded that the decision to continue with postgraduate Information Systems studies depends on the individual's career plan, that the expectations that students had for their postgraduate studies were generally far exceeded and that they would recommend it to all Information Systems graduates. Our results can be used to assist Information Systems departments in advising ways to improve their postgraduate programmes.

**Keywords:** Postgraduate studies, Student expectations, Drivers of postgraduate study, Postgraduate curricula.

## 1 Introduction

Postgraduate Information Systems studies may not be seen as attractive given that the technology industry offers many well-paying job opportunities which do not require postgraduate degrees. However, there are still a number of students every year who apply for postgraduate studies in Information Systems. This research attempts to uncover and understand the motivations and expectations of postgraduate Information Systems students.

Education level is seen as an important factor in determining a person's position in society. A person's education level is identified as an important factor as it illustrates personal development. A person's economic success and wealth is also seen related to their education level. In addition, individuals with a higher education level can survive better in societies by finding their appropriate jobs [10].

Motivation refers to the reason a person has that influences certain decisions [4]. Four key motivating areas for graduate students have been defined as self-development, career enhancement and changing as well as environmental factors [16]. These areas can be broken further down and understood as core motivators such as, personal goals,



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continue family traditions or expectations, peer pressure, comply with social values, gain essential qualifications according to governing laws, to obtain job security and positions across the globe and most importantly to enhance ones' knowledge and skills [16].

The motivators for pursuing postgraduate studies can also be considered to be motivators for pursuing postgraduate Information Systems studies. However, the growing technology market requires individuals that acquire tech skills, such as studying Information Systems provides. Therefore, critical skills and professional skills in the technology sector are additional major motivators for pursuing postgraduate Information Systems [6].

The specific questions which this research aims to address are:

- What are the motivations and expectations of obtaining a postgraduate Information Systems degree?
- What do students who have just completed an undergraduate IS degree expect to gain from pursuing postgraduate Information Systems (IS) studies, when entering the workplace at major firms is an attractive option?

The research is limited in scope as the research was conducted in only one University due to time constraints and practical feasibility. This allows for a constraint and thus not a clear indication of the Information Systems postgraduate students motivations and expectations. The results will not be completely representative of the entire Information Systems field in South Africa and the implications therefore means that further analysis will need to be done and compared to the finding to conclude with accurate data for South Africa.

## 2 Literature Review

### 2.1 The value of postgraduate education

Education can mean personal development and growth, however, education can also be considered a stepping stone for economic success for individuals and their family members. Therefore, the importance of education has been identified by students of many different cultures and levels [16].

Education is often seen as the only time-tested and consistent path to achieve success as it assists students to develop their highest potential for the long-term [15,7]. "*There are various motives behind one's decision in pursuing master and doctoral degrees which are sub-categorized into four main areas in this research. The motivational categories are self-development, career enhancement, career switching, and environmental factors*" [16, p.3].

The U.S.A. difference in salaries of individuals with postgraduate degrees from undergraduate degrees is around 30–50 percent, while in Thailand there is about 15–30 percent difference. However, the lower pay differential can possibly be explained by the social value of postgraduate education as this value has a powerful effect on the

Thai people [16]. In many cultures, obtaining a highest academic credential is seen as prestigious [14].

### 2.2 General Motivations and Expectations for Postgraduate Education Across All Disciplines

Motivation refers to the reason a person has that influences certain decisions [4]. Expectation refers to the strong belief that something will happen or be the case [9]. Everyone tends to value personal development, career enhancement opportunities, and a pleasant work environment, however, the value theory states that people's actions are driven by their values [16]. Some motivational variables for postgraduate education across all disciplines as shown in Table 1 [16].

**Table 1.** Motivational variables for postgraduate studies [16].

| Motivation Category | Detailed Motivators |
|---|---|
| Personal development | Satisfy the desire for self-improvement |
| | Gain more respect from others |
| | Gain more self-confidence |
| | Achieve educational goal. |
| | Improve English skill |
| Career enhancement | Earn higher compensation |
| | Provide opportunity for more challenging work |
| | Get promoted to a higher position |
| | Establish a wider connection |
| | Remain competitive in the field |
| Career Switching | Change occupational area |
| | Transition from current career path to a new one |
| Environmental | Fulfil family expectations |
| | Comply with peer pressure |
| | Obtain credentials required by law |
| | Act in accordance to social values |

The Hierarchy of Needs theory proposes that there are basic human needs which arrange themselves in hierarchies and therefore the desire for one need usually rests on the prior satisfaction of another [13]. The general motivators for **personal development** identified by [16] as inspired by the Hierarchy of Needs theory are, to satisfy the desire in self-improvement, to gain more respect from others, to gain more self-confidence, to achieve an educational goal, and to improve one's language skills.

**Career enhancement** is considered as the desire to obtain professional credentials needed for career advancement, which allows the student to maintain his/her competitiveness in the business world; but it is also an aspiration to improve one's long term income and financial stability [12]. Career enhancement in the form of job promotions are "*usually associated with more responsibility, authority, and earning which is associated with better living standards, more benefits, and better physical environment both* *at work and at home*" [16, p.30]. These benefits of job promotions through the postgraduate motivational factor of career enhancement can lead to, a higher salary, better benefits, more responsibility, possibilities for training or studies and improved workplace [16].

**Career switching** is the transition from one career path to another in order to allow one to change occupational areas [12]. Teowkul et al. [16] determined the relationship between motivations and barriers by relating the motivating factors with the reservations mentioned by prospective postgraduate students completing their postgraduate degrees. It was found that "*those motivated by career enhancement are significantly more discouraged by financial barriers than they are by application barriers and those motivated by career switching are significantly discouraged by all barriers -- application, financial, and time"* [16, p.31].

The **environmental motivators** identified by [16] include fulfilling family expectations, complying with peer pressure, obtaining law regulated credentials and to act in accordance with social values.

### 2.3 Specific Motivations and Expectations for the Information Systems Discipline

The motivating factors for postgraduate education in Information Systems align with the general motivations proposed by [16] in Table 1. However, as technology continues to evolve, the need for technology specialists as Information systems graduates are needed [17]. There is an increase in the need for the new generation academics especially in the Information Systems sector in South Africa [5]. Therefore, there may be a lack of motivation for postgraduate education in Information Systems since it is not so essential to have a postgraduate degree in a discipline where there are big skills shortages in the market place.

### 2.4 Postgraduate Education in South Africa

Postgraduate education in South Africa faces numerous challenges. These include, differentiation and diversity, the diverse purpose for postgraduate education, adequate funding from the state, intellectual spaces at South African universities, postgraduate outputs, making way for the new generation academics, remuneration of academics and the access, opportunity and success in postgraduate education [16].

**Differentiation** and **diversity** is something that that South African still face on the daily bases and the purpose of postgraduate institutions is to encourage knowledge through research and community engagement. Therefore, there should be a free interaction between students and academics to all have access to this knowledge [11]. In South Africa, however, the social inequality of gender, race and intellectual spaces at the universities are seen as either limiting or increasing opportunities especially in academia. The **gender** challenges that women face is the weight of womanhood in higher education as well as respect for women in a leadership role. South African women with postgraduate education have achieved outstanding successes but much remains to be done to assist in solving the challenges they continue to face [11].

**Race** plays an important role in South Africa and thus also affects postgraduate education. The need for adequate funding comes into effect here as well as there are limitations to funding for South African students as is prevalent with the Fees Must Fall protest actions. The promoting of access and enhancing education opportunities is of utmost importance for South Africa [2].

South Africa has difficulty with accepting and adopting to change however that is now quickly changing with the use of technology systems for ease of use. This allows for the paving of the new generation of academics for postgraduate students in South African higher education institutions. This encourages an efficient use of resources and provides greater knowledge for the students [1].

### 2.5 Constraints for Postgraduate Education

Additional inhibitors and constraints for postgraduate education as personal family restrictions, professional reasons such as entering the work place or taking over the family business using what they have learnt from their undergraduate degree [8,3].

Cultural reasons that constraint postgraduate educations included age, enter another area or new lifestyle such as marriage. A major constraint for postgraduate education is the financial reasons where postgraduate education is not affordable or entering the workplace is needed to earn to look after the family and thereafter fund personal postgraduate studies, especially in the South African context [8,3]. These are summarized in Table 2.

**Table 2.** Motivators and inhibitors for pursuing postgraduate studies [8,3].

| Motivators for pursuing postgraduate studies | Inhibitors for pursuing postgraduate studies |
|---|---|
| **Personal reasons/issues:** always a dream to obtain a postgrad degree; want to continue to learn and conduct research because of passion; study while young.<br>**Professional reasons:** studying will provide career advancement; experiencing good quality education is good.<br>**Cultural reasons:** family tradition etc.<br>**Financial reasons:** tuition funding provided; postgrad studies are required for job of choice | **Personal reasons/issues:** look after family, age, etc.<br>**Professional reasons:** enter the work place; take over family business.<br>**Cultural reasons:** age; get married; stay at home.<br>**Financial reasons:** not able to afford pg studies; needs to work to earn an income; etc. |

## 3 Research Methodology

The research objectives were:

- To identify the motivations and expectations of individuals pursuing postgraduate education in Information Systems.
- To understand to what extent were these expectations are met at and the expected benefits (or issues) from postgraduate studies.

An exploratory approach was adopted for this research. This research used a qualitative research approach since data was collected through interviews. The research time-frame was cross-sectional. Ethics permission was granted for this study by the individuals and the University.

The raw data was analysed on specific terms in the transcripts, literature and the research objectives to create refined themes. This was iterated a second time but no changes were made. The analysis was done following the headings based on the themes, rather than using any of the ‘frameworks’ listed under the literature review. The main reason is that the frameworks are not really theoretically based but empirically driven lists of barriers and motivators. Thus our questions and analysis took these factors into consideration but did not perceive them as a strong theoretical or constraining framework.

Initially we attempted to draw postgraduate students from three different universities, specifically top-ranked universities with a strong research focus and significant cohorts of postgraduate students. Sadly, we could not obtain ethics permission from the other universities so we had to limit ourselves to just one university. All Masters and PhD students in the department were emailed/invited and all those that volunteered were interviewed. This may result in self-selection bias. Two additional honours students were canvassed on a personal basis in order to see if there were major differences in motivation. Table 3 lists the students that were interviewed.

**Table 3.** Students interviewed.

| Student Code | Currently completing their … | Full-time/ part-time |
|---|---|---|
| S1 | PhD | Full-time |
| S2 | PhD | Full-time |
| S3 | Masters | Full-time |
| S4 | Masters | Full-time |
| S5 | Masters | Part-time |
| S6 | Masters | Full-time |
| S7 | Masters | Full-time |
| S8 | Masters | Full-time |
| S9 | Honours | Full-time |
| S10 | Honours | Full-time |

The main limitation in this study was that the research was only conducted in one single university (UCT) due to time constraints and practical feasibility. Even though the research sampling frame may be representative of the broader South African population of IS postgraduate students in terms of age, gender and socio-economic background, this cannot be guaranteed. Thus, care must be taken in attempting to generalize or extrapolate the findings to other South(ern) Africa universities

# 4 Findings

This section reports on the data analysis of the data collected from the students. As the students were kept anonymous for the purpose of this research, the following table lists the student codes along with the postgraduate studies they are currently completing. These codes are used when the students are quoted.

The interviews were transcribed and analysed using thematic analysis. The following refined themes emerged:

- Area which has the most interest in Information Systems
- Part-time Postgraduate degree in Information Systems
- Full-time postgraduate degree in Information Systems
- Value provided to students from postgraduate studies from a South African context.
- The role of funding in the completion of postgraduate studies
- Sacrifices made in order to complete postgraduate Information Systems studies
- Motivations for postgraduate Information Systems studies
- Expectations from pursuing postgraduate Information Systems studies
- Completion of postgraduate studies in Information Systems for the purposes of pursuing an academic career academic career
- Recommending Information Systems students to pursue a postgraduate degree in Information Systems
- Recommendations to the UCT Information Systems Department

These are discussed in turn in more detail below.

## 4.1 Area Which Has the Most Interest in Information Systems

When completing one’s postgraduate studies in Information Systems, normally an area of interest or specialization is chosen. This plays a role in the decision of completing postgraduate studies in Information Systems as it sometimes becomes the reason students pursue postgraduate education. According to the students, having an interest in a certain area is a key aspect in postgraduate studies. These interests are different for the students and indicates the differentiation between the students even though they study the same course at the same university.

Postgraduate studies require and extensive understanding of research and therefore becomes a passion for the student.

*"I have a passion for critical thinking and that's what I focus more on during my research."* (Student S1)

*"I have a passion for Information Systems. And currently my research is with SMEs so that research area is what I am currently most interested in."* (Student S2)

However, the area of specialisation also acts as a motivator for postgraduate Information Systems studies.

*"Software development is my passion and a bit of research as well. My research was on student wellness through a web app so yeah it kind of is what I like to collaborate with and my being with computer science I am able to apply that side to some degree.*" (Student S3)

*"My thing is management and the business side of it, so I really find that IT basically will get me there."* (Student S5)

### 4.2 Full-Time/Part-Time Postgraduate Degree in Information Systems

Postgraduate studies in Information Systems can be completed as part-time or full-time courses. Most students complete their studies full-time as they can give their dedication to just their studies however others have commitments as well such as working which requires them to complete their studies part-time.

*"Part-time, I didn't really have the option of doing it full-time as I am working, and it would be difficult. I need the money. Part-time allows you to do a bit of both qualification and experience which makes it better for you. Remember if you just a person with just a qualification and no experience, you will struggle on the job market. I would recommend part-time over full-time, it is more challenging but more rewarding as well." (*Student S5)

Having the advantage of experience with qualifications is something to strive for and what makes the individual unique. It is a difficult road to but does pay off in the long run.

### 4.3 Value Provided to Students from Postgraduate Studies from a South African Context.

From the literature it appeared that postgraduate education faces its challenges in South Africa. However, the finding indicates that there is a definite need for postgraduate Information Systems studies.

"*Well I would say that is when we are going. Everything is going to how people use information systems in their daily lives and I duly think that Information Systems is the way to go. There was a time when accounting and actuarial science was what everyone did but now it's Information Systems. It is worth investing into it"*. (Student S5)

*"From a South African perspective, I think it's worth it although UCT Information Systems my view the way the masters programme is structured is too theoretical for industry. My PhD I have a practical problem that I'm solving and that I am happy doing that.*" (Student S2)

### 4.4 The Role of Funding in the Completion of Postgraduate Studies

Funding plays an important role in the motivations and expectations of pursuing postgraduate Information Systems studies. Especially from a South African perspective, funding is always on the decline as we have noticed with the recent Fees Must Fall engagements.

*"Another motivation was I think that basically I get a discount so financially I'm not excluded I'm included. Financial exclusion is a big thing and I am lucky to have this opportunity."* (Student S5)

*"Yes if I can and also get good marks I will, I would not go into academics but back home there is that gap and I would go back home and go in to academics to give back."* (Student S4)

*"…you need to be competitive and previously not many people had degrees, not a lot of people had honours now because of inclusion and fees must fall. You will have a lot of people coming in and you must keep yourself competitive."* (Student S5)

The current political situation seems to indicate that funding may become less of an issue in the longer term, although it is not clear that free higher education will become a reality for postgraduate studies.

### 4.5 Sacrifices Made in Order to Complete Postgraduate Information Systems Studies

Most students experience the thought of sacrifice when completing postgraduate Information Systems Studies. These were different for most students and once again indicating the richness that even though the students were from the same university studying the same courses, their sacrifices were not always the same.

*"Well I get poorer by the minute as I am currently studying while managing an NGO, but at the same time you want to do what is more fulfilling. I would love to have a much more comfortable life but my motivation to change the state of our country keeps me going as I am very critical on its state. I have expended everything I have, I am in serious debt but yeah I am passionate about what I have set out to do."* (Student S1)

*"The usual, I've had to sacrifice time with friends and family and of course"*. (Student S7)

*"It's very challenging as working and studying you need to look after yourself, your wife and children."* (Student S5)

### 4.6 Motivations for Postgraduate Information Systems Studies

The motivations and expectation discussed in the literature mainly indicated those of personal development, career enhancement, career switching and environmental motivators. From the data collected we find that these do align and career enhancement and switching play key roles in the motivation of postgraduate Information Systems studies.

> *"To be able to be more recognised in industry"* (Student S10)

> *"I won't lie a lot of it was probably down to family pressure, you know you might as well do it now and get it done while you studying as it might be a bit difficult. I know some people who has done that and it's not easy."* (Student S3)

> *"Okay there's several things, one would be you know after you graduate you thinking about getting employed but after a while you want to maybe start doing your own thing. In order to do that you have to be someone different to everyone else and academic qualifications then show. So just to appeal and make a stance to be my own person and start my own business then so that's where the idea of doing my masters came from."* (Student S4)

However, we came across a unique situation which did not align with the literature and that was to make a difference in the world and not for personal gain.

> *"My motive for coming back to university was not to get a degree. Which is very different to most students. I became increasingly concerned about the continuous fail rate in the education systems at schools in South Africa. And being a technologist in Information Systems myself, I had some ideas for different approaches to make schools affected. I took this to the department of education and said this is the use of technology in a sensible way in terms of making schools worth. I gave them a little programme to implement and not even buy it. But they came up with a lot of regulations and were denying it and using unions and things. They however did not take my suggestions, I therefore put in an application to come and study and pursue critical research at UCT, which is research that bring emancipation to society."* (Student S1)

### 4.7 Expectations from Pursuing Postgraduate Information Systems Studies

Students who pursue postgraduate Information Systems studies expect to gain more from studying than the industry.

> *"I needed more knowledge from researching and wanted to learn more to help me start my own company. It was a bit different to gel in as my undergrad was different and did not research. I see it as a challenge and have no option. I cannot say I'm stopping now."* (Student S4)

> *"I would've always wanted to do masters at some stage and to know exactly where my field of specialisation would be and what areas I find most interesting to pursue so I thought masters would give me the space to do that. Having my honours*

*would've been quite sufficient itself but the thing is realising when you need to go back to your masters."* (Student S3)

*"Have a better understanding of research and skills that can add value to my career"* (Student S6)

During the data collection, a unique case where the expectation of postgraduate Information Systems studies differed to the literature and the other students. The core expectations remained however there was a student who manages to continue with both studying and pursuing postgraduate Information Systems studies while at the same time gain experience in the industry.

*"Challenging and have to put effort but it was what I expected. The demand is the same as honours. I do see it worth it though, as it's exceeding my expectations. Over and above. After completing your masters you would've learnt a lot. You can feel it for yourself and I must admit it's been really worth it. Part-time allows you to do a bit of both qualification and experience which makes it better for you. Remember if you just a person with just a qualification and no experience, you will struggle on the job market. I would recommend part-time over full-time, it is more challenging but more rewarding as well."* (Student S5)

### 4.8 Completion of Postgraduate Studies in Information Systems for the Purpose of Pursuing an Academic Career

The need for qualifications to be able to pursue an academic career is not the only reason students pursue postgraduate education. From the findings, it is clear that at least some postgraduate Information Systems students do intend to enter the academic field at a later stage. This again shows the differences of the students in their motivations.

*"Maybe PhD yes. I probably see myself going there I'm not too sure. I want to try industry and then maybe go into academics."* (Student S5)

*"No, research spans across academia."* (Student S8)

*"I would not go into academics after my PhD, but I might go back eventually as I now appreciate research. I do encourage people to go into academics if they have a passion for research, but you do not complete your PhD only for academics."* (Student S2)

"*No, it really depends on the individual. I myself will say that if I go into academics I would fail at what I set out to do."* (Student S1)

### 4.9 Recommending Information Systems Students to Pursue a Postgraduate Degree in Information Systems

The students showed a great passion for their postgraduate Information Systems studies and all encouraged that postgraduate education especially in Information Systems should be looked at.

*"Yes, for the students who want to make a difference rather than get a degree, I would say you need to think critically. However, the universities aren't always equipped, especially Information Systems. Information Systems is contextualised within organisations and social justice does not always happen in organisations."* (Student S1)

*"Yes, if one can do it l would advise them to do it with all their effort"* (Student S6)

*"I think masters is quite broad and gives to deeper understanding on topics you can pursue but industry is more specific. I guess it probably depends on maybe getting experience as well could be an option. One thing to remember is keep your options open. I think having a bit of experience after your honours and then continue to your masters could be advantageous or complete your master's part-time."* (Student S3)

### 4.10 Recommendations to the UCT Information Systems Department

The recommendations to the University of Cape Town Information Systems department were given by a few students and this aims to assist and improve the programmes for a better learning experience for the potential students. The findings show that there are problems or areas that need attention with the programmes and it is something UCT should look into.

*"…I think it's worth it although UCT Information Systems my view the way the master's programme is structured is too theoretical for industry. My PhD I have a practical problem that I'm solving and that I am happy doing that".* (Student S2)

*"Lecturers becoming more transparent and engaging more with students. Introducing more social class engagement sessions such as hackathons, industry visits and technology related talks."* (Student S10)

*"The awareness needs to be created to show what postgraduate education can do. Also I think funding plays a major role here as well so maybe that is something that not maybe the department but something UCT should look into."* (Student S9)

*"I would like to provide more funding for postgraduate students. To introduce co-supervision for students because some supervisors are not always available for students, the department to address social life issue that affects postgraduate students and not just academically focused."* (Student S6)

## 5 Discussion and Summary

This research aimed to reveal the reasons behind the decisions of individuals for pursuing postgraduate education in Information Systems in South Africa. These include the motivations and expectations of postgraduate Information Systems students. This allowed for the opportunity for the postgraduate Information Systems students to give their opinions on the motivations and expectations of postgraduate information systems students. The literature research that was conducted for this research provided guidance on the questions that should be asked to the students during the interviews.

From the analysis there is a noticeable relation between the motivations and expectations of postgraduate Information Systems students. For example, a motivation that was identified by student S10 that was to be more recognisable in the industry correlates with student S4's expectation of having the necessary knowledge to start their own company.

Additionally, a number of unique characteristics were defined. These characteristics included the differentiation of the students and that each individual student have different motivators no matter the institution or background. The most common and motivators that are prevalent in the postgraduate students were career enhancement and improvement in one's society ranking.

The analysis also confirmed that challenges do exist when it comes to completing postgraduate Information Systems Studies. This was confirmed by numerous students. For instance, students S5 and S7 both revealed that the biggest challenge is time management between studying and family time. However, the students have met their expectations and still believe that continuing their postgraduate studies is worthwhile.

This analysis also indicated that, even though all the students interviewed were from the same university and studying the same programmes, each student had unique circumstances and motivations.

Funding was seen as a relation that brought all the students together; all of them confirmed that they would study further given the opportunity to have fully paid scholarships or bursaries. From this it is clear that these students are passionate in what they do and are working hard to achieve their goals.

The findings of the research project correlate with the research aim and that the motivations and expectations of postgraduate Information Systems studies were obtained as well as the reasons behind them.

## 6 Conclusion

The first research objective was to identify the motivations and expectations of individuals pursuing postgraduate education in Information Systems. There were correlations between the general motivations and expectations of postgraduate studies and the motivations and expectations of postgraduate Information Systems studies, however a number of unique characteristics were uncovered. One of these is that all students have different motivators no matter the institution or background. However, career enhancement and improvement in one's society ranking are seen to be the leading motivators.

The second objective was to understand to what extent were these expectations are met at and the expected benefits (or issues) from postgraduate studies. The findings confirmed that there are challenges that come with completing postgraduate information Systems Studies. However, the expectations from the students have generally been met and they see the worth of it. Their knowledge and learnings are exceeding their expectations and all students were glad they made the decision to complete their postgraduate studies (note that no staff was involved in the interviews so as not to bias the responses).

The students also confirmed that they had to make sacrifices in order to purse post-graduate Information Systems studies but see that the knowledge and learning obtained from the postgraduate studies exceeded their expectations and that is why they would rather study than enter the workplace.

The main research limitation for this research was the sampling frame, given that only Information Systems students from UCT were sampled. Although the students were diverse in terms of age, gender, race and socio-economic background, they may still not necessarily be representative of all students at other South African universities.

This research validated most of the earlier research in this space, although it is good to see that most of these apply to a South African context as well. No new theory was created, but this was not the intention. The empirical, descriptive insights should add to the policies and strategies adopted by South African departments of Information Systems in order to attract and keep post-graduate students.

It is also hoped that this research will be a start and assist in future research papers in this area by providing a baseline and a framework to future researchers. Future research could be done quantitatively in order to acquire information from a larger ample and evaluate students from different universities or compare to students in different faculties. Another future research direction would be to include computer science and informatics for analysis and results could then be compared between the three subjects.

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# Alumni Advice on Post-Graduate Studies

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**Abstract.** Alumni from the School of ICT at the Nelson Mandela University (NMU) complete IT diplomas, BTech, MTech, MIT and PhD qualifications. Academics are frequently asked the question by students: Should I go and work in industry or should I complete post-graduate studies? The School of ICT at NMU prepares students for IT careers in call center operations, networking, software development, gaming and security. Academics are encouraging IT diploma students to continue their studies and complete BTech qualifications or related qualifications to make them more marketable, attain a more diverse IT skills set and earn higher salaries in the future.

This exploratory study focuses on the perceptions of the School of ICT's Alumni and their opinion regarding the decision to work in industry or complete post-diploma and post-graduate studies. The advantages of deciding to go and work in industry were compared to completing BTech and post-graduate studies. Completing an MTech or MIT degree versus studying a MBA was also investigated. This qualitative research study amongst Alumni (n=67) provided insight into the reasons why students at a comprehensive academic institution chose to go and work in industry or complete their post-graduate studies. Based on the results, 3rd year students are generally advised to complete at least a 4-year qualification. The decision to continue with an MTech/MIT qualification, depends on the individual's career plan. Alumni generally did not consider doing an MBA. This re-search could assist academic departments offering these qualifications in providing relevant advice to students completing their 3rd year studies from a perspective of Alumni working in industry.

**Keywords:** Industry, Post-diploma IT studies, Alumni perceptions.

## 1 Introduction

Academic departments at Higher Education Institutions (HEIs) are increasingly engaging with various stakeholders and Alumni. Stakeholder engagement ensures closer university and Alumni/industry collaboration. Stakeholder feedback obtained in various forms, specifically on academic matters, career choices and perceptions relating to working in industry or completing post-graduate studies is increasingly being analysed by academic departments.



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Academic departments have used surveys, mailing lists, web-sites and social media, such as Facebook and LinkedIn, to maintain contact and acquire information specifically from graduates (Alumni) working in industry [6,10,17]. Maintaining contact with Alumni and obtaining feedback from Alumni on academic programme quality have become an important activity at Computer Science (CS), Information Systems (IS) and Information Technology (IT) departments at HEIs and Comprehensive universities offering diploma and degree programmes [12]. Alumni further provide an important perspective and valuable source of advice on academic matters, career choices and guidance for currently registered students [1]. Departments use Alumni to educate current and prospective students about careers [11].

Research has been conducted where Alumni were asked the following question: "*What advice would you give our students who wanted to follow your career choice?*" Responses were varied but centered around the following five themes, namely: Work Internships; Development of Leadership Skills by Engaging in Extra-Curricular Activities; Improved Communication Skills; Challenge Yourself in Your Schooling and Employment Advice [18].

Students in 3$^{rd}$ year diploma programmes face the question during their final year of study: *Do I go and work in industry or do I continue with post-graduate studies?* Presently Careers24 [8] are advertising 2795 IT jobs in South Africa. CareerJunction [7] has consistently reported over the past years that the greatest demand for recruitment is in the IT sector. Companies recruiting students on campus generally indicate that students should enter the "real world" as soon as possible and gain industry experience. Recruitment agencies and industry representatives recruiting graduates generally indicate that students should consider working in industry as they would gain on-the-job training and experience and acquire the relevant industry skill sets.

Academics, on the other hand, encourage students to complete post-diploma and post-graduate studies. Completing post-diploma and post-graduate studies can have various advantages for students, such as higher starting salaries, greater exposure to different study fields in IT, improved conceptual thinking skills and assistance with promotions later in the students' IT careers [5]. Academia are competing with industry as well as the financial realities of students who need to start earning a living and who have limited funding to pay for post-graduate studies. A number of ICT related departments, such as CS, IS, Informatics, IT, etc. at HEIs have established closer collaboration with industry.

This paper provides additional supporting evidence regarding diplomate, graduate and post-graduate Alumni perceptions on the value of post-graduate studies in a comprehensive university offering IT diploma and degree programmes. The results highlight the importance of Alumni feedback and the advantages of completing post-graduate studies. The research problem, research question and the Alumni survey are discussed in Section 2. Literature on Alumni perceptions on post-graduate studies and IT positions being advertised in industry and that students can apply for are discussed in Section 3. The Alumni survey results are presented in Section 4. Conclusions and recommendations of this study, relevant to Departments offering diplomas and degree programmes at HEIs and future work are discussed in Section 5.

## 2 The Research Problem and Research Design

Industry is presently experiencing an IT skills shortage. In March 2018, CareerJunction [7] advertised 2872 IT jobs in South Africa. This included 1,901 Developer jobs, 1,292 Information Specialist jobs, 611 Computer Science jobs, 169 Business Intelligence jobs, 864 jobs requiring a BSc, 473 Analysts and 242 Business Analysts [7]. Other similar IT recruitment websites such as Careers24 [8] are advertising 3141 IT jobs in South Africa. The IT jobs most in demand are software development in C#, Java, PHP and other programming languages.

Academics are generally advising under-graduate students to complete post-graduate studies [5]. Departments of CS, IS and IT generally do not use the information provided by Alumni to evaluate the Alumni's perceptions of completing post-graduate studies. The research problem investigated in this study is based on the realisation that Alumni have different perceptions of going to work in industry or completing post-graduate studies first. Academic departments, further, have to determine the views of Alumni on completing a MTech and MIT Master's degree or completing a MBA qualification.

The Nelson Mandela University (NMU) School of ICT offers the following IT qualifications:

- Diploma in Information Technology: Software Development;
- Diploma in Information Technology: Communication Networks;
- Diploma in Information Technology: Support Services;
- Bachelor of Technology: Information Technology (Software Development);
- Bachelor of Technology: Information Technology (Communication Networks);
- Master of Technology: Information Technology;
- Master of Information Technology;
- PhD Information Technology.

The research question addressed in this study is: *What are the School of ICT Alumni perceptions of going to work in industry vs a diplomate completing a post-graduate study?*

A School of ICT Alumni questionnaire was compiled using a similar questionnaire as used by Calitz, et.al. [5] in a study for the Department of Computing Sciences at NMU. In order to determine personal perceptions and honest information, it was decided to keep the survey anonymous. The School of ICT Alumni questionnaire consisted of the following sections:

- Biographical details – Gender;
- Degree details – highest School of ICT qualification, year of completion;
- Working details – Years working in the IT industry, first job title, present job title;
- Five open-ended questions relating to industry and post-graduate studies.

The five open-ended questions were qualitative in nature. The following five questions were asked:

- Why should/shouldn't a School of ICT diplomate do a BTech qualification?
- Are there reasons why a BTech student should stay on 1-2 years and complete an MTech or MIT?
- Would you advise a BTech student to do an MTech/MIT or a MBA?
- When should a student with an MTech/MIT qualification consider doing a PhD?
- Industry vs post-graduate studies: What advice would you give to a 3rd year student?

The questionnaire was captured using the NMU on-line survey tool. The next step in the research process was contacting Alumni who had completed their studies and were working in industry. Social networks are increasingly being used and a large number of graduates are on social networks such as Facebook and LinkedIn. The School of ICT maintains a profile on Facebook. The first call for participation was distributed via e-mail to the School of ICT Alumni address list (n=732) and on the School of ICT Facebook page. The snowball sampling technique was used, requesting participants, through a referral network, to forward the survey request to other possible respondents. A total of 67 Alumni completed the survey over a two-week period with three requests for participation. The qualitative results were thematically analysed using AtlasTi.

## 3 Literature Review

### 3.1 Industry vs Post-Graduate Studies

Postgraduate qualifications are an advantage for the acquisition of more specialised jobs and streamline the recruitment process in the early selection stage [15]. Post-graduate studies create a distinct competitive advantage over other candidates, provide in-depth knowledge for specialised disciplines and develop important transferable skills [16]. A post-graduate qualification offers a platform for international career mobility through the portability of the skills set, which supports the assertion of the demand for skilled migrants in developed countries [19]. The diversity of attributes linked to an IT post-graduation qualification is transparent through the basic economics of demand and supply. The demand for this critical skill is high and asserted as a driver of technological competitiveness, notwithstanding the demand from employers for specialised and transferable skills [14,15].

The mutual beneficial relationship between universities and industry has increased and the value of post-graduate research is beneficial for both academia and industry. From a cognitive view, Ng et al. [15] argue that post-graduate studies develop the mind through the transfer and exchange of knowledge. Similarly, Wybo and Van Wassenhove [20] and Litalien, Fuay and Morin [13] assert that a post-graduate qualification is a specialisation capable of identifying and addressing problems not previously encountered. This leads to competitive advantage for the individuals owning the degree and promotes a complex skillset [3]. In complex environments, organisations face challenges and require highly talented skills to ensure protection of their brand to reduce risk from the external business environment [20].

### 3.2 Job Titles of Positions Available in Industry

Presently CareersJunction [7] are advertising 2047 software development jobs in South Africa, specifically IT positions in Mobile App development, .NET Developers, Android Developers, Back-end developers and testing software engineers. Job advertisements further include Network engineers, Business Analysts, System Analysts, IT Security specialists and Cisco Engineers. Figure 1 indicates the main jobs currently being advertised. Careers24 [8] are offering a large number of software developer positions, including Test Analysts, database specialists, Business Analysts and System Analysts.

INFORMATION & COMMUNICATION TECHNOLOGY

| | |
|---|---|
| **Software Development** | Intermediate R33,352 - R43,523<br>Senior R41,726 - R53,253 |
| **Technical & Business Architecture** | Intermediate R52,273 - R61,042<br>Senior R53,898 - R61,121 |
| **Business Analysis** | Intermediate R39,670 - R48,550<br>Senior R44,758 - R52,867 |
| **Systems Analysis** | Intermediate R34,432 - R42,423<br>Senior R46,045 - R53,656 |
| **Database Design, Development & Administration** | Intermediate R30,460 - R36,468<br>Senior R37,273 - R46,090 |
| **Systems & Network Administration** | Intermediate R28,022 - R36,168<br>Senior R36,786 - R45,278 |
| **UX & GUI Design** | Intermediate R30,857 - R42,695<br>Senior R39,398 - R49,399 |
| **IT Project Administration & Management** | Intermediate R42,021 - R50,443<br>Senior R49,683 - R61,107 |
| **Data Analysis & Data Warehousing** | Intermediate R32,704 - R40,463<br>Senior R41,125 - R49,184 |
| **Networking Planning, Design & Installation** | Intermediate R20,663 - R28,118<br>Senior R35,228 - R42,676 |
| **Telecommunication Technical Product Specialist** | Intermediate R16,722 - R27,444 |
| **IT Management** | Management R49,519 - R59,494<br>Senior Management R52,424 - R58,590 |

**Fig. 1.** Top positions advertised March 2018 on CareerJunction [7].

The School of ICT at NMU diploma and graduate programmes allow students to apply for positions in software development, communication networks and support services. Software Development allows students to apply for software development/Programmer/Coding positions, such as:

- Web Developer;
- Mobile App Developer;
- Backend Developer;
- Graphical User Interface Specialist;
- Database Designer;
- Games Developer;
- Systems Analyst;
- Software Tester;
- Business Analyst;
- Systems Engineer.

Communication networks qualifications allows students to apply for positions, such as:

- Network Administrator;
- Network Designer;
- Infrastructure Support Technician;
- Security Specialist;
- Operations Specialist;
- Customer Care Consultant.

Support Services qualifications allows students to apply for positions, such as:

- Technician;
- Infrastructure Support Technician;
- Network Administrator;
- Customer Care Consultant;
- Sales Consultant.

## 4 School of ICT Alumni Survey Results

The descriptive statistics on the graduate profiles and backgrounds are provided. The questionnaire was completed on-line and the request to participate was done via e-mail (n=732) and using social networks (School of ICT's Facebook page) and the School of ICT's email list. Standard biographical data such as income and race were not included in the survey and the provision of names and personal information were not included in order to encourage reliable and honest feedback. The results of the thematic analysis using AtlasTi for the five questions posed to the Alumni are presented.

The *School of ICT Alumni* survey was completed by NMU School of ICT (n=67) Alumni working in the ICT industry. A total of 200 viewed the survey, 132 started the survey and 67 completed the survey, a 51% completion rate. The response distribution was from 4 countries: South Africa (97%), USA (1%), Zimbabwe (1%), and France (1%). Sixteen Females (24%) and 51 Males (76%) completed the survey. The respondents' qualifications were IT Diploma (n=19, 28%), BTech (n=33, 49%), MTech (n=14, 21%) and one PhD.

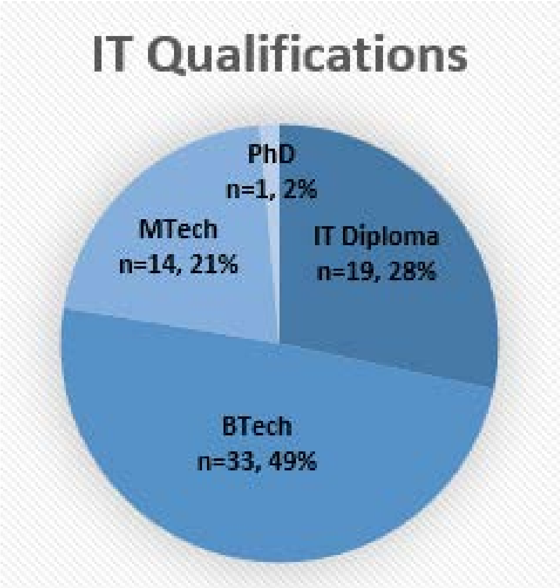


**Fig. 2.** Number of graduates and Post-graduates.

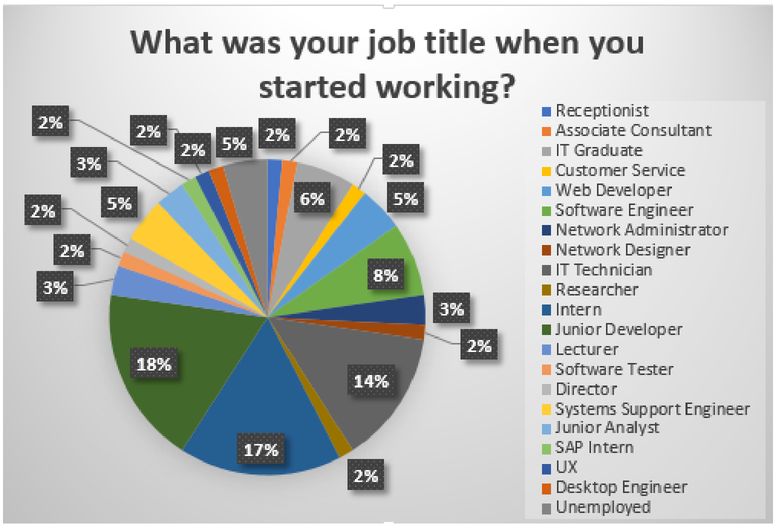


**Fig. 3.** Starting positions.

69% (n=46) of the Alumni have been working for five years or less in the IT industry, 18% (n=12) for 6-10 years, 12% (n=8) for 10-19 years and one for 20+ years. The most common starting positions were Junior Developer (n=12, 18%), Intern (n=11, 17%) and IT Technician (n=9, 14%) (Figure 3).

The most common current positions Alumni are working in or job titles are Software Developer (n=11, 17%), IT Technician (n=9, 14%), System Support Engineer (n=7, 11%), and Analyst (n=6, 9%) (Figure 4). Three Alumni were unfortunately un-employed and three Alumni indicated that they were ‘Self-employed’.

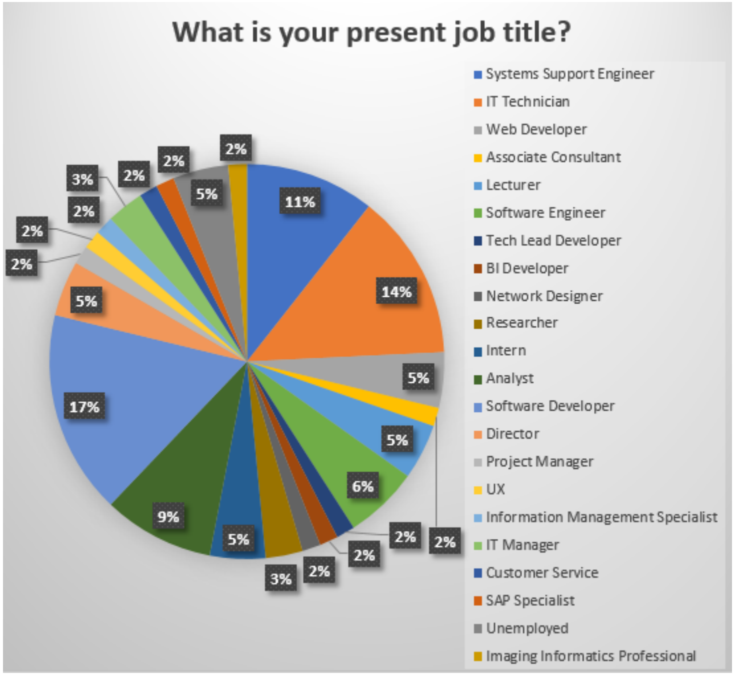


**Fig. 4.** Current positions.

**Why Should/Shouldn't a School of ICT Diplomate Do a BTech Qualification?** The results from the thematic analysis of the question indicated a positive response to completing a BTech qualification (Figure 5). The respondents (n=67) indicated that completing a BTech qualification expands your knowledge base (n=18, 27%), it opens more doors and opportunities (n=11, 17%) improves the chances of finding a job (n=10, 15%), shapes growth and competency (n=10, 15%) and creates an IT understanding from a business perspective. Nine (14%) of the Alumni indicated that they recommend that an ICT Diplomate rather focus on obtaining experience in industry.

The BTech students (n=33) highlighted the broader and more in-depth knowledge gained doing a BTech qualification, that it is easier to find work, one can study MTech, students have more career choices and it prepares you better for the IT job market. The MTech and PhD Alumni (n=15) indicated that completing a BTech you acquire better business skills, you acquire more in-depth knowledge, that employers are employing people with degrees and that students acquire a diverse IT skills set.

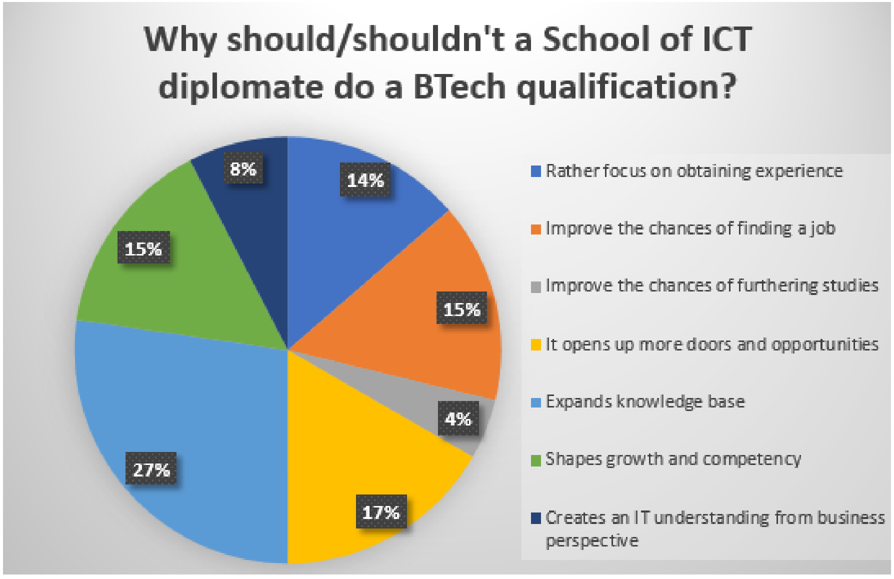


**Fig. 5.** Alumni responses to do a BTech qualification.

**Are There Any Reasons Why a BTech Student Should Stay 1–2 Years and Complete an MTech or MIT?** The overall response to this question (n=67) was that the advanced degree provides better career advancement (n=8, 12%), allows a student to compete better in the job market (n=10, 15%) and if a student wants to aspire to become an academic (n=12, 18%). Seventeen percent (=11) of respondents were unsure and a large number 21% (n=14) indicated "No, rather gain work experience" (Figure 6). The MTech graduates indicated that by completing an MTech or MIT qualification, you are better prepared for management positions, research improves your critical thinking and writing abilities, it opens doors for overseas positions and you could become an academic.

**Would You Advise a BTech Student to Do an MTech/MIT or MBA?** Thirty-seven percent (n=25) of the School of IT Alumni indicated that they would recommend doing an MTech/MIT qualification and 24% (n=16) indicated that they would recommend doing neither (Figure 7). The Alumni recommended doing an MTech/MIT if you had aspirations of becoming an academic and wanted to work overseas. A minority recommended doing a MBA if you wanted to move into managerial position and acquire different skills. The MTech graduates indicated that it depends on your future goals, however they recommended completing an MTech/MIT first and then get industry experience for a number of years and then study towards an MBA.

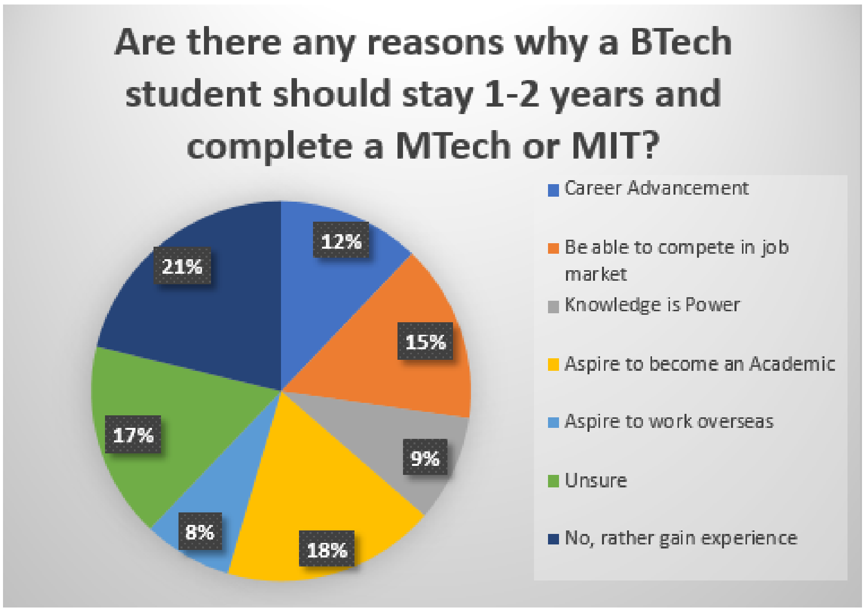


**Fig. 6.** All alumni on completing a Master's qualification.

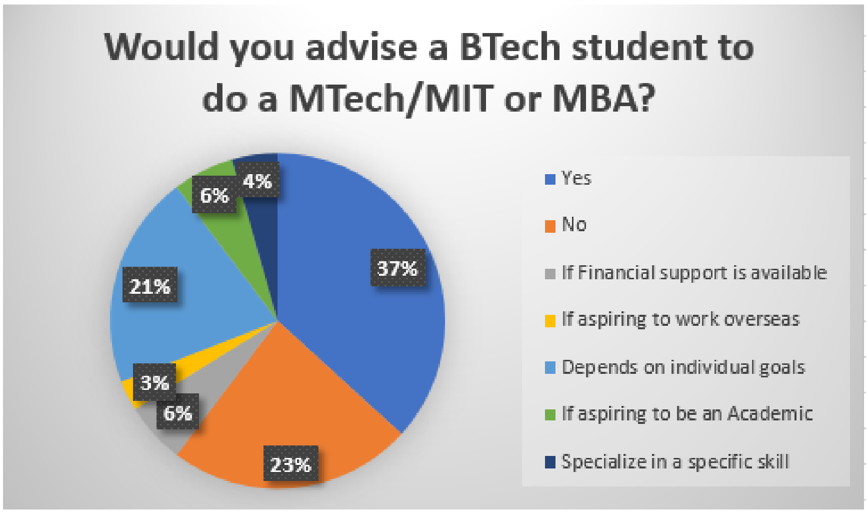


**Fig. 7.** MTech/MIT or MBA.

**When Should a Student with an MTech/MIT Qualification Consider Doing a PhD?** The overall opinion of the Alumni respondents was that students must gain work experience first before completing a PhD (n=18, 26%). The Alumni indicated by completing a PhD further allowed extensive research to be conducted and allowed the individual to become an entrepreneur or academic (Figure 8). The group further indicated that you must do a PhD as soon as possible (n=5, 7%) or after completing your MTech/MIT qualification (n=7, 10%). The MTech Alumni indicated that a student must start a PhD immediately after completing an MTech/MIT qualification and that completing a PhD made you an expert in a specific field of study.

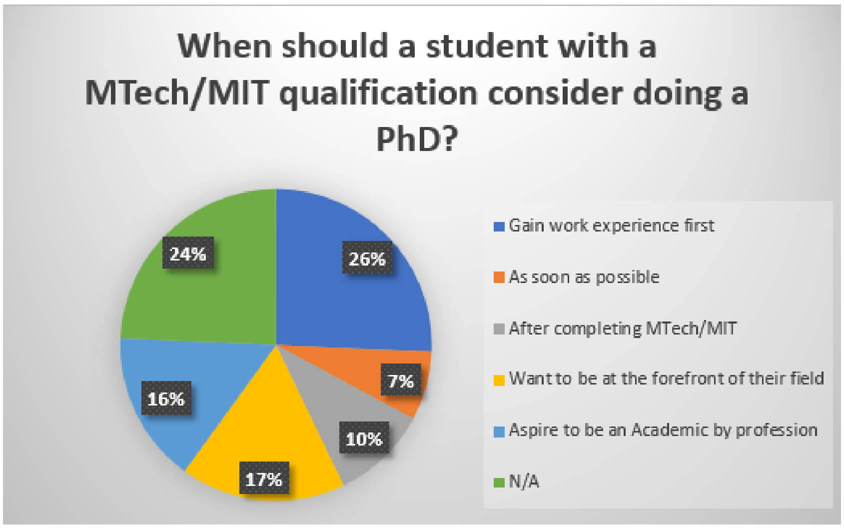


**Fig. 8.** Completing a PhD.

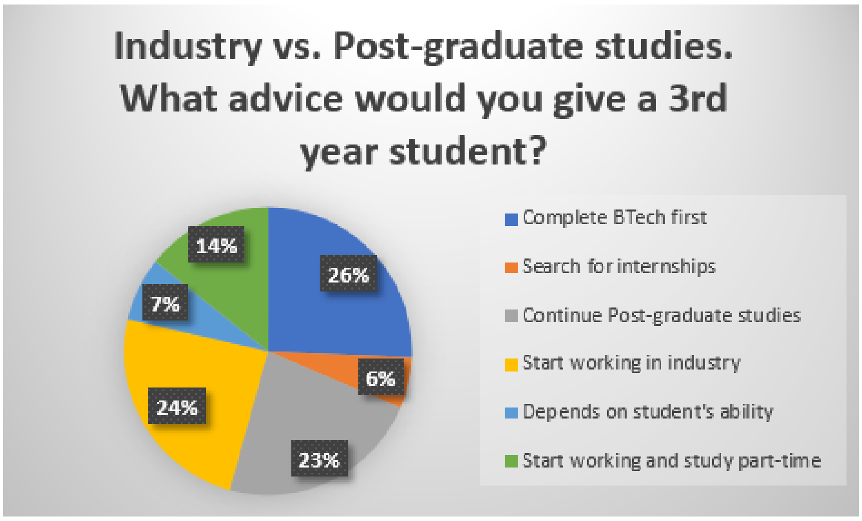


**Fig. 9.** Industry vs post-graduate studies—All alumni perceptions.

**Industry vs. Post-Graduate Studies. What Advice Would You Give a 3rd Year Student?** Figures 9 indicates the thematic analysis on the advice the different Alumni graduates would provide to a 3rd year student. The overall group (n=67) was divided on this question as 26% (n=18) indicated that 3rd years should complete a BTech first and 24% (n=17) indicated that 3rd year students should start working in industry immediately. Analysing the two different group responses further, half of the group, namely 49% (34) said complete a BTech or continue with post-diploma studies first. 38% (n=31) indicated to start working or search for internships first and continue with part-time studies later. The respondents who completed a BTech qualification (n=33), 70% (n=23) indicated that 3rd year students must complete a BTech first and 30% (n=10) indicated that 3rd year students should start working in industry immediately to gain relevant industry related experience.

The MTech respondents (n=14) indicated that a 3rd year students must definitely do a BTech first or complete post-diploma studies. One respondent indicated that 3rd years "must not be short sighted to not pursue a post-graduate qualification". They emphasised the importance of a four-year qualification and industry job requirements.

**List Three Words Explaining Your Experience in the School of ICT.** The Alumni (Figure 10) indicated that their experiences in the School of ICT at NMU were *Challenging* (n=15, 17%), *Fun* (n=9, 10%, *Informative* (n=8, 9%), *Knowledge* (n=5, 6%) and *Rewarding* (n=5, 6%). The majority of the MTech students described the School of ICT as *Challenging*, *Fun*, *Informative* and *Enriching*.

## 5 Conclusions

Graduates studying IT diploma and degree programmes at HEIs or Comprehensive universities in South Africa are faced with decisions regarding post-graduate studies and different IT career opportunities. Industry is experiencing a large skills shortage and recruitment agencies and industry representatives are encouraging young diplomate and graduates to enter the IT job market. Academics try to encourage young diplomate studying IT to complete BTech or equivalent studies. Academics highlight the importance of completing at least a 4-year qualification to improve their skill sets and better prepare them for different positions in industry.

3rd year students do generally not receive information from Alumni working in industry and are faced with the question: *Should they complete post-graduate studies or start working in industry?* This study focused on this gap, providing valuable information from Alumni, with different IT qualifications, regarding questions faced by 3rd year IT diploma students.

The results from the thematic analysis of the first question relating to completing BTech qualification indicated a positive response to completing post-diploma BTech or similar qualification. Alumni indicated that a BTech qualification provides better job opportunities, provides in-depth knowledge of specific subject areas, distinguishes you in the market place and creates an IT understanding from a business perspective. Post-graduate Alumni indicated that by completing a post-graduate qualification a student have more career choices, acquire a more diverse skill set and that employers are seeking people with post-graduate qualifications.

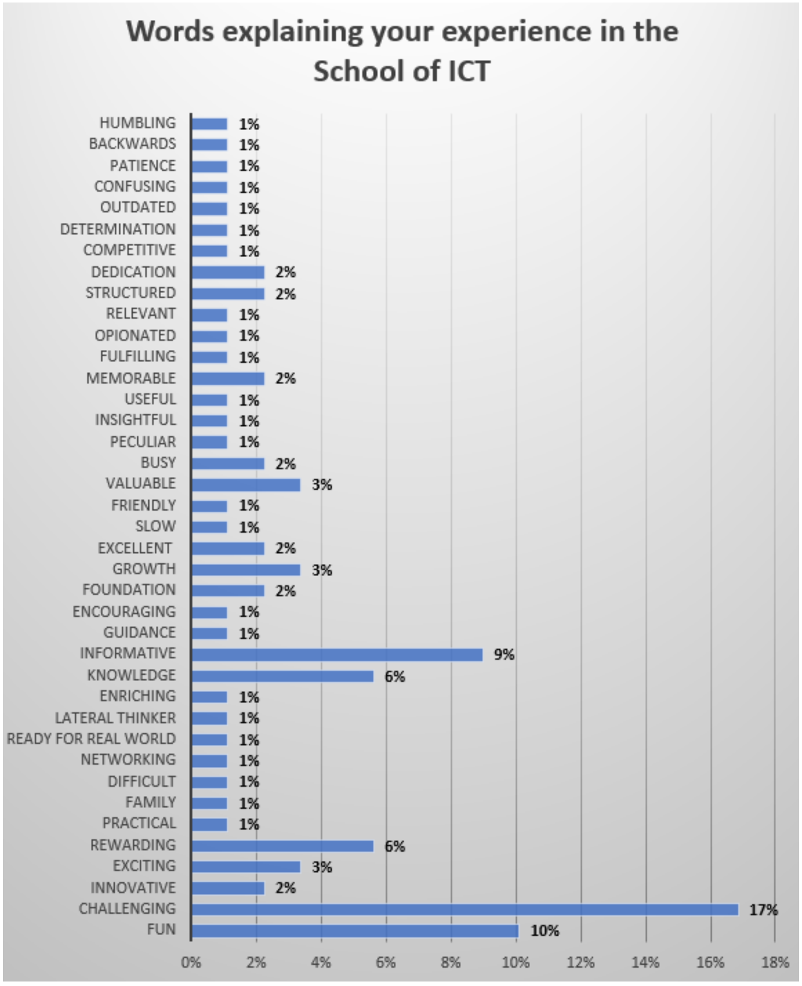


**Fig. 10.** Words alumni used to describe the school of ICT at NMU.

On completing an MTech or MIT master's degree, the Alumni were more inclined to suggest that students must *rather gain work experience*. The MTech Alumni mentioned that a Master's qualification provides better job opportunities, broadens your knowledge, you can earn higher salaries and prepares you better for management positions. The question relating to completing an MTech/MIT qualification or a MBA provided interesting feedback. The literature highlighted the importance of MBA degrees and Master's degrees [2,4,9]. A quarter of the respondents indicated to do neither and rather gain work experience. 37% indicated they would recommend an MTech or MIT and only 4% indicated that they would recommend an MBA after working for a number of years.

The advice the different Alumni graduates would provide to a 3rd year student raised some interesting points. The Alumni (n=67) were divided on this question as 26% (n=18) indicated that 3rd years should complete a BTech first and 24% (n=17) indicated that 3rd year students should start working in industry immediately.

Alumni are a rich source of information about career advice and industry trends. Obtaining input from Alumni on the quality and relevance of their education can provide a department with valuable information and assist with continuous improvement and self-evaluation. Alumni surveys can provide information relating to academic programme quality and relevance, Alumni experiences and specifically employment success. Maintaining contact with Alumni is essential for obtaining information on course relevance and industry requirements. This exploratory study has provided the foundation for continuous Alumni feedback and stakeholder engagement. Valuable opinions and information regarding career decisions and post-graduate studies were obtained from Alumni working in industry. Future research will evaluate the Alumni's satisfaction with the School of ICT at NMU.

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# Introducing Research in the Undergraduate Information Systems Curriculum*

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**Abstract.** Research is an integral aspect of any discipline. It is thus surprising that research is only taught as a subject in undergraduate Computer Science and Information Systems (CS&IS) curricula at two of the top ten teaching universities in South Africa. The literature provides many reasons why universities or academics may be averse to teaching research in the undergraduate curriculum, but the main challenge appears to lie in the difficulty of *teaching* research as opposed to students *learning* to do research in postgraduate (PG) studies. This paper examines a case of introducing a research experience in the third-year UG curriculum at the University of the Western Cape. In the process, a group of eleven students produced a conference paper and simultaneously indicated significant personal growth and learning in the process. Such an approach offers a novel way, at least for CS&IS in SA, in which research skills may be incorporated in the UG curricula. The benefit of such an approach is jointly to reduce the workload of PG supervisors and to prepare students to conduct independent research projects of their own in PG studies and in industry as well as to increase the institutions research output.

**Keywords:** Teaching, Research, Undergraduate curriculum.

## 1 Introduction

The significance of research in any discipline is undisputed. Research is necessary for maintaining the identity and recognition of a discipline 12,4]; for the growth and development of a set of core properties or nomological nets [7]; as a means of communicating its theories and practices [9]; for the hiring, promotion, tenure and pay scales of academics; as well as being used to rank departments and institutions based on their research output [20,36].

It is therefore not clear why there is limited inclusion of research as a core competency in the undergraduate (UG) Computer Science (CS) and Information Systems (IS) curriculum in South Africa (SA) and that it is only at a PG level where research methodology courses gain some traction. Jenkins emphasises that "*teaching students to be*

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*enquiring or research-based in their approach is not just a throwback to quaint notions of enlightenment or liberal education but central to the hard-nosed skills required of the future graduate workforce*" [21].

Some of the benefits of introducing research in the undergraduate curriculum (RUGC) are that it improves student retention, i.e. students continue on to PG studies without fear of struggling with research, they learn to work independently and in a team, it boosts their confidence in gaining new knowledge and skills that are required in industry and academia and provides them with a broader view of the discipline [6]. Faculty also see research experiences at an UG level as predominantly positive, especially in terms of the students' personal development and their subsequent continuance in PG studies [47]. Another aspect that justifies introducing RUGC, is the transitioning of HEI's from teaching-led to research-based institutions. This new direction for primarily teaching-led institutions requires academics to connect IS students with the future of research, for academics to conduct research, supervise students, teach research, research their teaching, and create and enhance a research culture in their departments and institutions [25].

Paradoxically, however, faculty shy away from introducing RUGC due to perceptions of increased workload, lack of recognition for UG research mentoring, lack of knowledge in the areas that the students research, and/or lack of knowledge on how to teach research [6]. It is suggested that the teaching of research requires a different approach to teaching than that of teaching subject knowledge expertise, and that this lack of knowledge on how to teach research is what keeps academics away from introducing RUGC [10].

Due to the paucity of a research modules in the UG curriculum in SA, it is suggested by the authors that examples of how such research can be introduced may be of value to CS&IS curriculum designers and academics wanting to transition to a research-based curriculum. The question that this research attempts to answer is 'how to introduce research in the UG IS curriculum?' as well as 'whether it is possible for this cohort of UG IS students to publish a paper from their research'. The first question addresses the process of such an activity and the second provides a benchmark for evaluating the quality of the output.

## 2 Research in the UG CS&IS Curriculum

There appears to be general agreement at HEI's in SA that research does not belong in the UG curriculum. This observation is based on a review of the most recent CS&IS UG model curricula [43,1] as well as the 2017 curricula from CS&IS departments at the top ten teaching universities in SA [2].

The last official IS curriculum (2010) does not cater for research in the curriculum [43]. The IS 2002 curriculum does indicate a number of analytical and critical thinking skills that undergraduates need to possess [13], yet does not directly address research as a necessary skill for industry preparation or PG research. Some authors have attempted to address the lack of RUGC in IS in terms of collaborative workplace skills [28].

The 2012 ACM CS curriculum [1] recommends independent and group research projects; research on topics such as the application of computing to environmental issues, emerging technologies, artificial intelligence; presenting, evaluating and critiquing of research papers. Although the CS curriculum does not include a formal research module, research seems to be mainly included in professional development seminars and student-faculty research projects that contribute a fixed percentage to their grade. Research does not however gain any traction in the UG CS curriculum, even as an elective subject where "'Reading', 'Research', and 'Thesis' courses do not normally satisfy the elective requirement" for a CS major [12]. This lack of research skills and competencies in the CS&IS model curricula is equally missing in the 2017 CS&IS curricula in South Africa.

In a survey of the ten top teaching HEI's in South Africa in 2017 as derived from the respective departments course guides, there is a distinct lack of research and/or related modules in the CS&IS UG curriculum. Only two of the universities in South Africa offered a course in UG CS&IS research. The University of the Western Cape's IS department offers a third-year course in research methods and philosophy and the University of Cape Town's CS department a 2nd year course in ``Independent research in CS" that is offered to academically strong students. The University of Johannesburg offers a first-year course on language and skills for science, whereas Stellenbosch and NWU has a module on business communication skills and UKZN has a course on IS & Technology Professional Skills.

## 3 Related Work

Even though the importance of research is recognised in the CS&IS disciplines, there are still doubts whether UG students are able to acquire the required research knowledge and skills by the time they get to PG level [47]. There are also doubts about whether faculty have the requisite project management and organisational ability to launch such a significant research program with UG students in conjunction with their high teaching workloads [33,34]. Another concern is the sourcing of funding to conduct such projects, especially in non-research or primarily UG institutions [35,34]. Further experience by the authors indicate that academics in SA consider research skills to be unproblematic or commonplace i.e. that it does not need to be taught. This perception might come from their own UG experiences, as they were most likely not taught how to do research at an UG level but learned it at a PG level under the apprenticeship or guidance of a senior researcher or supervisor.

One of the earliest studies to report on RUGC in CS&IS is Selin [40] who emphasises that "*research skills need to be seen as integral to the acquisition of knowledge and the habits of mind central to the academic purposes of undergraduate education*". Davidson [10] suggests that IS as a discipline needs to promote RUGC through their own professional associations such as the Association for Information Systems (AIS), share experiences of teaching research at an UG level through conferences and professional publications as well as learn from other fields such as natural and CS's and engineering that are engaged in RUGC.

At a university or at institutional level academics need to work with student chapters of professional associations to develop RUG, increase participation of UG students in IS projects, target shorter and smaller courses for research (knowledge discovery) as opposed to teaching (knowledge transfer) or employee readiness. At a course level, faculty are encouraged to bring their own research into the classroom, encourage alternative genres for dissemination of research and engage UG students in local research projects that are of interest to students, such as social networking or online gaming. When research is directed at the UG level, students can be seen as primary researchers, research assistants, research aids, and active or passive subjects of research [19]. The main emphasis for teaching RUGC is to develop students as primary researchers.

An important development for RUGC was the establishment of a birds of a feather (BOF) in the CS education special interest group (SIGCSE) targeting research experience for undergraduates (REU) in 2006 [18]. This BOF provided a platform for discussions on the introduction of research in the UG CS curriculum that has resulted in a number of initiatives and research outputs in the following years [47,35,34,18,17]. Unfortunately, the impetus from this group have not translated into the formal CS curriculum.

Further support from national organisations in the USA such as the ‘Council of Undergraduate Research’ and ‘National Science Foundation’s’ Undergraduate Research programs also encourage and provide funds and resources for HEI’s to conduct RUGC [6].

## 4 Approaches to Teaching Research

The activity of research remains the same, whether it is conducted at an UG or PG level. The main difference in terms of offering research at an UG level is that there is more teaching involved than at a PG level, where students are mostly supervised. Likewise, funding and efforts are mainly directed at PG studies [19].

There are different ways of conceptualising the teaching of RUGC [5,44]. Part of the challenge is the distinction between what is traditionally considered to be teaching, and what is deemed to be research, due to the broad definitions of these concepts [14]. At the intersection of teaching and research is a third concept where these two overlap, often referred to as the teaching-research nexus (TRN) [15].

When one considers the link between teaching and research, one can envisage teaching as being research driven, or the creating of a conducive culture towards research, both for students and academics, and also as the integration of teaching and research at a departmental or classroom level [32]. The model proposed by Griffiths [14] seems to have become the de-facto standard for explicating this nexus [21,11,15]. An adaptation of the model by Elsen [11] (In Fig. 1), presents two axes, with the x-axis emphasising teaching versus research, and the y-axis whether the curriculum is teacher or student focused.

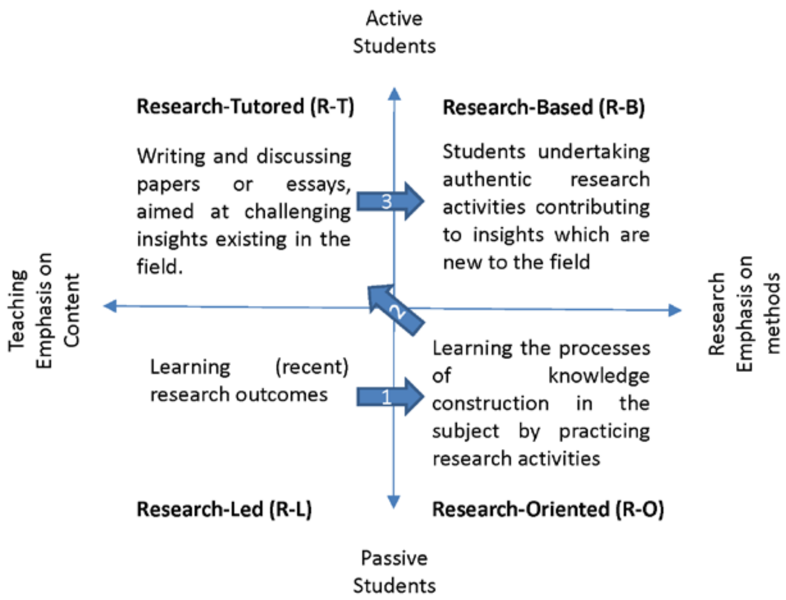


**Fig. 1.** Teaching-Research nexus [11] adapted from [21].

Curriculum interventions can be targeted at any of these quadrants, depending on the objectives of the course. Elsen [11] proposes a number of interventions for strengthening RUGC, specifically by means of interventions such as group assignments, research projects, workshops and training on specific research skills, as well as presenting student research to peers and faculty. The approach that was adopted in this case was a gradual progression from 1. Teaching students recent research outcomes (R-L), 2. Teaching students aspects of research (R-O) such as conducting a literature review and doing an interview, 3. Presenting their findings to the broader class and lecturer (R-T) and 4. For one group of students, the research experience of a practical research project (R-B).

## 5 Research Context

At South African universities, there is still a divide between teaching and research, despite the active encouragement of leading universities through access to national research funding to become research-led institutions [22,16,37]. The University of the Western Cape (UWC) has openly proclaimed its transition to a research institution [3] with clear policy support for research in its Institutional Operating Plan [IOP] and its Teaching and Learning strategies [8] to support and encourage a research culture. It is also one of the few universities in SA that has a dedicated research methods and philosophy module in IS (IFS352 Research Methods and Philosophy). The course requires students to “understand the philosophical principles of academic writing and publishing in IFS, and be able to apply them” and the final assessment is a “literature review and research proposal”. Furthermore, the Faculty of Economics and Management Sciences has a specific first year module that is dedicated to the development of academic literacy for commerce (ALC) that focuses on the development of academic reading, writing and critical thinking skills that all contribute to the practical skills that are required for research. The class comprised 70 third year students; however, only eleven participated in the voluntary assignment of writing a research paper. The other students conducted a literature review on a topic that was approved by the lecturer concerned.

## 6 Research Methodology

This research report resulted from a broader programme designed to develop critically reflective practitioners in IS. The value of developing critically reflective students is that that it assists in problem-solving [29], which is one of the key attributes of expert practitioners, and also to “*challenge presuppositions, explore alternative perspectives, transform old ways of understanding, and act on new perspectives*” [29]. Developing critically reflective practitioners goes beyond teaching subject knowledge to ``ensuring new practitioners (that) are empowered to question, and potentially improve upon, *what* they are doing or *why* they are doing it" [41].

As such, the approach entailed both the students and the lecturer concerned critically reflecting on what they were doing and what they learned from the process by means of a reflective journal or diary [31]. These experiences were journaled, and the students were required to submit their course reflections as part of their final assessment report. Course reflections allow for the reporting of diverse opinions and experiences, rather than forcing student evaluations into rigid standardised response categories.

This resulted in eleven course reflection documents that were loaded in NVivo 11 for analysis. Document statistics indicate an average of 2441 words or approximately 8 pages per student, an average of 62 paragraphs and an average of 440 nodes coded per report. In addition, the lecturer’s own reflections were also coded. From the data, five broad themes were coded, namely how students perceived and experienced the project, what they learned, and how they performed the tasks and activities. This paper, however reports only on the process of introducing research to these students and not what was learned or experienced by them.

A case study approach was followed in documenting the case [42,48] in terms of what was done, when it occurred and how tasks and activities were performed [29]. Permission for the study was obtained from the Head of the Department, and the students were asked to provide their consent for the use of their research in the final paper, as well as their reflection reports for further analysis and research.

## 7 Teaching Research to Undergraduates

During the semester, the lecturer gave the students an assignment to pilot a questionnaire that they had developed in class during the semester. The inspiration for this survey came from the article “Is mobile email functional or dysfunctional: Two perspectives on mobile email usage” [30] The question that the students research explored was ``what students are using their phones for and how much time were they spending on them". In order to give the class a real-world experience, they were given an assignment to interview one random student on campus. From this survey, 57 completed questionnaires were returned which were then analysed by the cohort of eleven students.

The course requirements at the time specified that students needed to conduct a literature review as their exam assignment (in preparation for Honours). One of the students (TG), suggested that we capture the questionnaires and analyse the data. The students were then asked in class if there were any other students who wanted to participate (voluntarily) in the project, but that it wasn’t for marks. Ultimately, eleven students signed up for the project. Initial feedback by the project leader was that morale was low amongst the students as there was no reason for them to do the research other than that it was voluntary and that it added to their existing full workload. Again, after discussion with the group, the idea took shape of doing the data analysis and writing a group paper as part of their exam assignment. The idea at the time was to collate the research, analyse the data that the class had collected, and write a conference paper which one of the students could present. Permission for this was obtained from the HoD. The change in the purpose of the research project as an exam assignment greatly motivated the students. Following are some reflections by the lecturer (the first author).

> *[At the start of this project,] I had no specific investment in terms of the outcomes. I thought it would be a nice opportunity for the students to gain real-world experience in writing up a conference paper format and that they could add this experience to their CVs as an extracurricular project* (WU).

YS encapsulated this well by recognising that the main aim of the course was to learn by doing, and not by reading about, research. This kind of learning has a different value from book learning. These are explored in theories of authentic learning [27], situated learning [26], experiential learning [24] and active learning [38]. Little did I realise that the project would allow the students to gain cohesion in the group as well as a greater sense of self-identity.

In the conceptualisation of the research project, the need for a few roles were identified, namely the research director (the lecturer), a project manager (TG), the secretary (AM) and a reference manager (GJ). The group was structured and tasks allocated according to the following structure in Fig. 2 during the first formal meeting with the group.

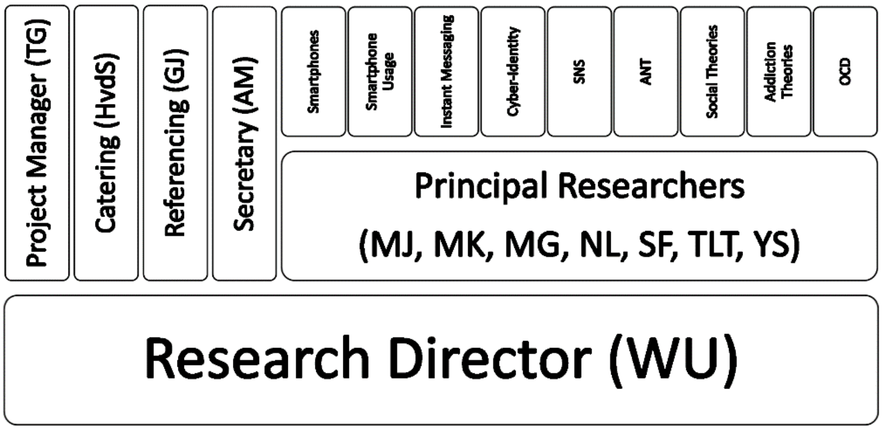


**Fig. 2.** Research team structure.

The project manager (TG) was prepared for the task of managing the project by providing him with a copy of a research article on visionary leadership [45]. He was asked to read the article critically and discuss how best he thought the project should be managed with the research director (the first author). The research team then then met and discussed the possibilities of the project.

From the second meeting of the group, the team came up with the following ideas in terms of their vision, mission and reasons for conducting a practical research project (TG).

1. To gain new knowledge, to gain experience in general and for further education (Honours, Master's).
2. The enjoyment and support of group work.
3. Gaining exposure in the academic community from Journal articles and conferences.
4. The need to accomplish something recognisable and be credited for it.
5. Challenging the ways in which we are conditioned and that we have been taught.
6. It is an opportunity that needs to be grabbed, not to be lazy.
7. Getting guidance from Walter who has a good academic background.
8. The research is quite relevant to the team as youth, it is real and has a real effect.
9. That from the single data document, multiple publications can be produced.
10. Interrogating society, defying the norm.
11. Passion to do this kind of research.
12. To learn to do proper and quality research.

The team realised at the start of the project that there were a number of uncertainties, and therefore set an audacious goal in order to motivate the students to overcome any possible challenges that may occur.

> *The goal we should aim at is to publish the paper as a group of eleven students and myself in a peer-reviewed academic conference that is approved by the DoHET.*

The research team also decided that an Agile approach would best suit the project delivery [23]. An Agile approach accepts the fact that projects change and draws on the fact that groups or organisations learn as they go along (they essentially become learning organisations). Agile project management [23] also recognises that humans are "*not particularly capable at estimating how much time a given task or group of tasks requires*" as is evident from numerous software development project overruns and failures to deliver projects on time or within budget.

> *Agile project management assisted in our project by allowing us to embrace change; we unknowingly applied concepts from agile management, and its effectiveness showed through the quality of the final work product* (HvdS).

Regular meetings were set up along the principles of Agile sprints in order for the students to provide feedback and reflect on the progress in the project [39]. This approach also established a specific rhythm and process of meeting with the research team (over a cup of coffee). After the nth cup of coffee/meeting, one of the students were assigned the responsibility for *catering* as part of their contribution to the project (HvdS). Although the student was not happy with this role at the beginning, he realised its value at the end of the project.

> *In conclusion, peace of mind and acceptance of suffering will ultimately allow one to move forward. I used this in my approach to handling the refreshment station. Gaining humility and accepting my role as one of support enabled me to learn that there is more than one way of project support and one does not always have to lead from the front i.e. project leader position* (HvdS).

The primary topic of '*Smartphone usage amongst students at a South African University*' was fixed in advance; however, the secondary topics for research emerged during team discussions, and there was no way that the team could know beforehand which area to research until they had discussed it amongst the group. Assigning tasks was done through a combination of volunteering or appointment by the research director during the meetings. The *principal researchers* were responsible for researching the literature on these topics. Some of these topics were; smartphone usage constructs, mobile web usage, smartphone application usage, stationary web usage and the constructs of a smartphone itself (YS), Instant messaging applications, clients and integrators (TG), the concept of cyber-identity (NL), social networking systems (SNS), teamwork, gratification theory and social norms of mobile devices (MJ), Actor Network Theory (ANT) and for one of the students to conduct an experiment for herself on switching her cell phone off for 24 hours (MK).

> *All of these tasks were great challenges because with all of them I had no idea what to expect from this project. I had no idea of the scope of the project. I went*

> *into the project blind. However, I have learnt a lot since then about independent thinking...as the topics we researched we were never taught before and they were just 'thrown' at us* (MK).

For example, TLT had to conduct research on social theories, smartphone usage, and energy balance, as well as represent the group at a seminar on mindful meditation, as well as deliver a book to UCT. MG looked at theories of addiction and specifically technology addiction, self-perception, text-dependency and internet dependency as well as assisting in structuring the final document. AM did not have a specific portfolio and helped with most of the other tasks as well as researching obsessive compulsive disorder (OCD), qualitative data analysis methods and facilitating the lucky prize draw.

The research method for the student project was also pre-determined. This comprised a quantitative survey (questionnaire) on smartphone usage amongst students, as well as the quantitative analysis of the captured data using Statistica. For further details on the research methodology that the students conducted see [46]. The other activities that the team shared amongst themselves was to clean up the data, capture it and analyse it in order to write up the research report.

## 8 Reflections During the Process

The approach that was followed in the development of the research project was primarily one of action and reflection [29]. This process allows for determining goals and continuously adjusting the process along the way in order to achieve these goals. Through the process the students learned more about the research process, but more importantly they learned more about themselves.

> *Considering the fact I have encountered various problem-solving situations and acceptance towards many different aspects, I can say that it contributed to my need for self-actualization. Our team building activities have added to my need for self-esteem and belonging* (MG).

> *As I have stated throughout this course, each process that I go through makes me feel that I was enlightened. It reminded me to be honest in my actions and truthful in my thoughts, factual with my data and, with most difficulty, be unbiased in my research* (HvdS).

Part of the reason for this was the lecturer's continuous insistence that the students take responsibility for their own learning.

> *Another basic duty of the members of the group which was an underlying and unstated duty was the duty of being independent or logical. I can't explain it in words but it is what I believe to be a characteristic of the group members to take the initiative and try to understand concepts or theories on their own and not always ask for direction but find it to the best of our abilities and try to stay as*

> *close to the overall direction of the group itself in relation to our task specific duties and any other research which was asked of us* (YS).

Another realisation from the team's perspective was that the lecturer was also learning from the project together with them as we went along.

> *The problem with this approach was that we all thought that Walter knew what needed to be done since he has a vast academic history, but this was not the case. After the data analysis it became apparent that he was learning as much from the experience as we were and that he by no means had all the answers to many of our unanswered questions* (TG).

This aspect of teaching requires the lecturer to be vulnerable within a group of students. The lecturer needs to adopt the role of a research supervisor, more than that of a lecturer. This requires the guiding the students to the conclusion of their project as if it was entirely theirs, even though the study is conceptualised by the lecturer.

Practically, there were a number of challenges in the project, such as inadequate office space for the students (they initially used the lecturer's office and later gained access to a tutor's office), the structuring of the project, and running over time for the exam, which meant that the project extended into the holiday period. Fortunately, the conference deadline was pushed forward, so the team managed to make the deadline by working into the holidays. The first conference to which the paper was rejected due to various concerns. These were addressed and submitted to another conference for which it was accepted [46]. In this way, the second objective of the research project was achieved, and thereby also the students' aims in the process.

> *Certainly a first by third year students of this IS Dept*. (HoD, Teaching Excellence Award (ETEA) Nomination)

## 9 Reflections on the process

There are many diverse ways of teaching research. At a PG level, this mainly encompasses the teaching of a research methodology course and the supervision of individual research projects. Only a few universities in SA in CS&IS offer RUGC. However, students at an UG level are frequently expected to conduct a literature review or write an essay on a particular aspect or topic of a course. The problem is that students are given this task without sufficient training or preparation on basic research skills such as conducting a literature review, research or writing skills. This lack of training in basic research skills is most sorely felt at the PG level and results in high supervisory workload and students struggling to complete their research projects. In this way research is perceived as difficult, and the effect is that students elect to enrol in PG courses that have a minimal or no research component attached to them.

As an alternative to the current untaught scenario, this study has presented a case of introducing RUGC. In this case, students were provided with the necessary research skills to publish a conference paper in a structured way that is practical and fun. This was done by substituting the mainly theoretical semester examination with a group research project. The teaching approach adopted has more in keeping with PG supervision of a cohort of students [27] than with lecturing. With the main difference versus lecturing being the supervision of a group of students that are researching a particular topic. Due to the limited research experience that students have at an UG level, it is suggested that the lecturer pre-specifies the topic and research problem, the research methodology to be followed as well as how students will be evaluated. This reduces the workload on the lecturer and allows for a more focussed research effort from the students. The scope of the project should also be predetermined, i.e. how many participants will be surveyed, how and who will be doing the capturing and analysis of the data as well as the scope of the final research report or paper.

During a semester there may not be sufficient time to teach students all the different kinds of research methods, and a choice should be made on these at the beginning of the semester as well. In this case the students were required to quantitatively analyse the surveys that they performed. They were also required to qualitatively reflect on the course experiences in their journals [15]

More importantly, in order to allocate marks, each student's contribution to the project needs to be evaluated. This can be done by means of a peer-review process, by student self-reporting or writing a reflection, or a combination of these. In this case students were asked to keep a notebook diary of all the tasks and activities as well as reflect on these for the final, end of the year, semester exam. In this way, each individual's contribution was determined from the individual reflection or project report, and the quality of the research project was evaluated in order to determine an overall mark or percentage for the group. The mere fact that the research article that was developed by the students was accepted at an international peer-reviewed conference in IS speaks to the quality of their work.

Some of the challenges that were experienced with this approach were the high workload of regular research meetings with the groups of students, the lack of a project or work area for the students, the amount of available time in the semester for a full research project, and the lack of bespoke funding for research efforts and presenting at conferences.

Limitations of this study are that it represents the result of an ad-hoc voluntary activity of providing a single group of students in a single course with a research experience. Consideration needs to be given as to how this can be expanded to include the other students in the class or integrate these activities in the curriculum. A subsequent study resulted in the allocation of ten groups of students to other academics in the faculty depending on their subject area of expertise. The findings of this approach are yet to be published so it cannot be compared yet. A final experiment was for the entire class to conduct a survey on campus and to contribute to sections of a research report. There are advantages and disadvantages to each approach that will be examined in-depth in future.

The successes of this approach were numerous but primarily in the area of student development and their self-confidence in their own abilities to do research for PG studies. Furthermore, a range of interpersonal and communication skills were developed during this process that respond directly to the institutional graduate attributes. Lastly, this approach resulted in the publication of a conference paper that contributed directly to the body of knowledge on the topic as well as to the university's research output and associated funding from the Department of Higher Education and Training (DHET) in SA.

## 10 Conclusion

This study documents the teaching of a cohort of eleven third year UG students from a class of 60 on how to conduct research as a practical project. Through the process, the students engaged with various topics in the field, piloted a questionnaire, analysed the results and prepared a conference paper. In the process, the students developed greater team working skills and a greater sense of self-esteem and belonging. By doing their own research, students learned to take responsibility for their own learning and development.

Due to the need for critical research skills, both in industry and PG studies, CS&IS curriculum developers and implementors may need to consider the inclusion of research in an already full curriculum. An approach of introducing a practical research experience may be a good way to develop students as researchers and for educators to research their teaching. By combining this with a reflective practice and teaching and evaluating students on the writing of reflective diaries provide a further possibility of developing critically reflective practitioners.

Future research should examine how RUGC are able to develop self-directed learners, its potential to contribute to the field through publications both for the student and academic concerned and how students may benefit from RUGC in their PG studies and future careers.

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# Student Competition Teams: Combining Research and Teaching

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**Abstract.** Teaching and research are the two core tasks of universities. In this paper we show how these two tasks can be combined and synergy effects can be created through building up a student team that participates in international competitions. Furthermore, we share the lessons learned from building up our own team and explain what is necessary to make the team last over more than ten years. Therefore, we focus on the aforementioned synergy effects and discuss the advantages and disadvantages of such a tight coupling between teaching and research.

**Keywords:** Research and teaching, Student teams, Robotic competitions.

## 1 Introduction

Universities should create new knowledge through research activities and transfer knowledge and methodological capabilities to students. Although it seems like this should go hand in hand and a lot of synergy effects between teaching and research should exist, this is sometimes not as easy as it sounds for several reasons. Let us consider a typical structure of universities that are separated in different faculties, which itself are separated into departments. Our focus is on departments from technical faculties like computer science, electrical engineering, or mechanical engineering. They are often led by a professor supported by post-doctoral employees and PhD students. Please note, that we assume that PhD students are part of the scientific staff with a Master Degree in a related field of their department.

The areas of responsibility for PhD students and post-docs are often separated into three parts: Their own doctoral research or habilitation, teaching activities, and assisting their professor in other duties. Often their thesis and habilitation has the highest priority. Unfortunately, this is not completely in line with the university aim, as formulated above.

In this paper we show how we have almost solved this dissent and thereby, taken our teaching and research activities to a new level. We make it possible that teaching and research go hand in hand from a PhD student's perspective and point out the potential synergy effects that can be created. Furthermore, we share our experience of building up and running a student team for 12 years until today.



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The remainder of this paper is organized into the following sections. In Section 2 an overview is given to related formats for building up a student team. In Section 3 we share our experience of building up our own student team *Carpe Noctem Cassel* and point out the requirements for running such a team over several years. Sections 4 and 5 show how we empower the students to handle research tasks almost autonomously and how we teach topics relevant for our research to our students. In Section 6 we discuss the advantages and disadvantages of our approach and conclude this work in Section 7.

## 2 Related Work

There are many different kinds of competitions and events where students can participate and compare their skills and abilities. Most of them seem to be very similar, but not all of them suit for building a long-term student team. In this section, we take a look at the different formats and discuss whether they work well for building up a student team. We summarize our evaluation in Table 1.

### 2.1 Formula Student

The Formula Student format requires a student team to build a racing car and race against other teams at different competitions each year[1]. Focus of Formula Student is to give the students, no matter what their discipline is, practical experience for working in the automotive industry. The number of students per team and financial support for Formula Student teams are much bigger compared to our soccer robot team, as the automotive industry is the key industry in Germany. At our university a Formula Student team, named *Herkules Racing Team*, exists since 2011. The team is composed of students only and its average size is more than 30 students. This is very remarkable, as the students often stay only for one or two seasons in the team. Furthermore, the competition rules require the teams to rebuild their car every year. Note that a car costs roughly 150.000€. However, the scope of activities of a Formula Student team is not only building the car, but also public relations, fundraising, financial controlling, and race driving. As a result, the Formula Student empowers students to work in the automotive industry, but the research departments that support the teams with their expertise, do not get much benefit out of the support for their research activities.

### 2.2 Carolo Cup

The Carolo Cup is an annual national competition for autonomous RC (radio-controlled) cars [21]. The challenge is to drive through realistic environments and show certain skills like parking, racing, driving in usual road traffic, reacting to moving obstacles. The student teams need to build a car on their own and are allowed to improve it over the years. Nevertheless, the teams need to be composed without PhD students, thereby, limiting the participation and potential benefits for departments. Similar to

[1] http://www.formulastudent.com [last accessed 22nd February 2018]

Formula Student, the focus is on educating students with regards to industry requirements.

### 2.3 DARPA Challenges

The *Defense Advanced Research Projects Agency (DARPA)* is a research agency of the U.S. military. It poses challenges that are known to be extremely demanding, while it offers a considerable amount of prize money. From 2004 to 2007 the DARPA Grand Challenge [2,3] was hold annually. Its objective was to stimulate the development of autonomous cars.

The DARPA Robotics Challenge took place from 2012 to 2015. Its focus was to improve the semi-autonomous operation of robots in environments that are hazardous for human beings [8]. It had a huge impact on research about autonomous robots in general. The participating teams in both challenges did not include students, but were composed of (collectives of) research institutes around the world. Our impression is, that these kind of challenges are not suitable for building up student teams, for the following reasons. At first the utilized hardware is too costly. Further, the injury risk for untrained personnel when operating such hardware is too high. In theory, the students could be trained and supervised accordingly, but in practice, the challenges did not last long enough to build up a student team with undergraduates. This is, because DARPA is interested in giving new technology an extra amount of impetus to actually make a difference compared to state-of-the-art technology and is not interested in sustainably supporting the education of people that build these technologies. Finally, we want to emphasize that two critical ingredients for a successful student team are the team members and its financial support. Participating in a military competition could raise problems in acquiring both of it, for ethical reasons.

### 2.4 RoboCup Middle Size League

In the RoboCup Middle Size League each team has its own kind of modus operandi. Let us give two examples that significantly differ from the way, we run our team. We consider students as well as scientific staff as team members and every team member should be able to generate benefits out of its membership (see Sections 3-5). The *Paderkickers* from the University of Paderborn in Germany were a team tightly integrated into the curriculum of the department for *Design of Distributed Embedded Systems* [11]. A lecturer allowed a project group, including 12 students, to work on the robots of the team for two semesters. The idea was to teach the students all they needed to know about the robots in the first semester and afterwards, let them program the complete team strategy and introduce minor hardware modifications in order to participate at the next competition. Thus, knowledge transfer from one group to the next group was limited and the team's performance at the competitions solely depended on the students' prior knowledge. Having a functioning team of robots as testbed for the work of the scientific staff of the department is clearly a benefit, but the students were not directly engaged in research. In our opinion, this limited the synergy effects between research and teaching.

Another example is given by the team *Tech United* of the Technical University of Eindhoven in the Netherlands [9]. The team includes much more scientific staff than *Carpe Noctem Cassel* which limits the number of students that can actually participate in competitions for cost reasons. Nevertheless, from our point of view synergy effects between research and teaching are present in the team. Furthermore, they have generated a lively alumni network that supports the team's efforts. Former students and scientific staff are welcome to further participate during the weekly team meetings and industrial sponsors are also acquired through this social network. As a result, the team's huge financial resources help to always provide the students with state-of-the-art technology and allow them to build and experiment with prototypes independent of their applicability in competitions.

### 2.5 Other Formats

Finally, there are also other formats like hackathons, hacker spaces, Google Summer of Code and communities around interesting open source projects that could also be suitable for building up student teams [18]. The difference is that the teams do not directly compete with each other. Nevertheless, if such a format creates enough long-term motivation for students to participate, the outcome could also be very fruitful. Another advantage of these formats is the reduced costs for operating such a team compared to the aforementioned competitions.

**Table 1.** Valuation Summary of Related Formats (Scale: --, -, 0, +, ++).

| Format | Cost | Initial Hurdle | Research Relevance | Sustainability |
|---|---|---|---|---|
| Formula Student | - | + | -- | ++ |
| Carolo Cup | + | ++ | -- | ++ |
| DARPA Challenges | -- | -- | ++ | -- |
| RoboCup MSL | - | + | + | ++ |
| Other | ++ | ++ | - | 0 |

## 3 Building up a Student Team

In this section, we describe our robotic soccer team *Carpe Noctem Cassel*, how a student team is successfully built in general, and how it is possible to run the team over several years in the university context.

### 3.1 RoboCup Middle Size League Explained

The RoboCup and its competitions are separated into different leagues like Humanoid League, Rescue League, Standard Platform League, Small Size League, Simulation League, and Middle Size League [16]. *Carpe Noctem Cassel* is a Middle Size League team. To convey an idea of the dimensions of this league some differences to a normal football match are described here. Since 2009, each team consists of five robots, i.e., one goalkeeper and 4 field players. Each robot is about 80 cm high and must fit into a square of 50cm x 50cm. The field is 12m wide and 18m long. One match lasts two equal periods of 15 minutes. Depending on the team's hardware, a robot can drive up to 5m/s and can shoot the ball over a distance of 16m. Based on that velocity and shooting range it is obvious that there are ever-changing situations during a RoboCup football match, forcing the robots to quickly adapt their behavior to the situation.

The field of expertise, necessary to run such a team of robots, is very wide. It can only be covered by fusing disciplines like computer science, mechanical engineering, and electrical engineering in one team. The development team needs to have competencies in image processing techniques for the localization, ball and obstacle recognition of the robots. They need solid knowledge in control engineering for implementing precise movement capabilities. In order to compete with the top teams sophisticated AI and team coordination techniques need to be applied. The list is much longer, but not the focus of this paper[2].

In Figure 1 a group picture from the last international tournament in Portugal is shown.

### 3.2 Foundation Phase

Building up a student team is similar to building up any other team. Nevertheless, in the university context there are certain peculiarities that should be taken into account, as discussed in the following paragraphs.

Our focus is on creating synergy effects between research and teaching. This differs from student teams whose sole purpose is to attract students to a certain discipline or provide the students with practical experience that makes them more attractive for future industrial employers. In contrast to this, the next employer of our students should be a university or research institute itself.

In our opinion, the most significant ingredient for a successful team are the people that form it. In case of a student team, we expect it to be composed of a majority of undergraduate students and some graduate and PhD students. Motivating student groups to spend some of their free time in a student team, although their highest priority is to graduate, can be difficult. Moreover, the team's foundation phase demands extra effort from all participants, whereby the extra effort is often neither accredited with credit points nor is it easy to convince a dissertation advisor that such a team improves a dissertation's quality or represents an advantage for the department's research activities.

When *Carpe Noctem Cassel* was founded in 2005, the two founding PhD students not only asked their advisor for permission, but also for financial and organizational support. The funding for *Carpe Noctem Cassel* was even more critical, because the team had to build a complete new set of soccer robots, in order to participate in the next RoboCup World Championship. As difficult as it was to finance such an effort, the successful funding exceedingly motivated the team members and let them invest even more of their time. In this case, it even affected the team's naming. If needed, all team

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[2] The interested reader may have a look at http://www.uni-kassel.de/eecs/carpe-noctem-cassel/publications.html

members were willing to work through the night and on weekends, because the founding gave them the feeling that they work for something that will last. In the beginning of *Carpe Noctem Cassel* these three things, people, funding, and motivation were the key ingredients that within 10 month led to the 7th place out of 32 teams at the RoboCup Championship 2006 in Bremen, Germany.

**Fig. 1.** *Carpe Noctem Cassel* at the Portugese Open 2017.

### 3.3 Running the Team

After the successful founding and participation at the World Championship the question arised how to move on with *Carpe Noctem Cassel*. The team was excited about their achievements and as the RoboCup Foundation also organizes local events like the RoboCup German Open, the team's next goal was to participate at the German Open the next year. The participation in at least one competition per year turned out to be helpful for the team's motivation on the long run. The *joint goal* to improve their performance from year to year provides a continuous challenge and motivation, and fostered the team spirit at the same time. Apart from having a common goal, the team's motivation also consists of the *benefit that each individual team member* draws from her or his contribution to the development. Although it is nice to be part of a team that achieves good results at international competitions, we experienced that it is very important to make clear the individual benefits for every team member. The details of these individual benefits are explained in Section 4, as they are the actual reason, we have in mind for running a student team.

Regarding the organization of *Carpe Noctem Cassel*, its *hierarchy was always very flat*. That lowered the barrier for joining the team and allowed new team members to contribute their ideas. In the university context, the *personnel fluctuation* for a student team is relatively high, because students graduate and leave the team continuously, while new students join. Here, a low entry hurdle helps to recruit new team members and guarantees a more or less constant team size. Furthermore, flat hierarchies facilitate creative processes by giving new ideas enough room to be tested. We could name some more benefits of a flat hierarchy, but it is also important to note that flat hierarchical structures are vulnerable to slow decision making processes. Therefore, the PhD students of *Carpe Noctem Cassel* share responsibility for the team management, financial control over the team budget, and being involved in all critical decisions, in order to guarantee a certain level of progression.

Finally, there is one last point that is essential for running a self-managing student team over several years. As mentioned above, the personnel fluctuation in the university context is relatively high. Therefore, it is even more important to have a steady knowledge transfer from old to new team members. Over the years, the developed robots and software packages get more and more complex and harder to maintain. Thus, for new team members the hurdle rises to comprehend even parts, e.g., motion or image processing, of the whole framework. Often single persons with specific knowledge about certain parts emerge. As useful as their expert knowledge is, as critical it is when they resign. Therefore, it should be every team member's responsibility to document or at least transfer her or his knowledge to younger team members' months before they leave.

Paying attention to all the points above by learning from our mistakes, we were able to run *Carpe Noctem Cassel* from 2005 until today. Note that we are currently the last active RoboCup Middle Size League team in Germany.

### 3.4 Bringing Students into Research

In this section, we present how the team explicitly encourages the students to autonomously participate in research and develop working methods suitable for scientific application. We also describe how the student team is involved in the research of the department.

Depending on their field of studies and their personal preferences, the students specialize in different aspects of the robotic soccer topic. It is inevitable that the fields of expertise fluctuate over the years with the changing composition of the team. We intentionally let the differing expertise influence the set of issues that are tackled by the team. As a best practice, we regularly analyze, with all team members, the overall performance that was achieved during a tournament, in order to benefit from the complete range of viewpoints and expertise and make all existing issues visible. Because of the high complexity of the tasks, regarding both soft- and hardware there is always a high number of open issues and possibilities for optimization. When the students recognize an issue by themselves during the analysis, they are often motivated to jump directly into solving the issue. They take responsibility for "their" issue and start to look for solutions on their own. Whenever possible, we actively support these efforts by offering topics for study projects or theses. Thereby students provide a benefit for the team and at the same time make progress in their studies. They also feel more connected to the topic, because the motivation for the project was not just assigned to them, but they identified the problem by themselves. This can be seen as a preparatory exercise in identifying relevant research questions like PhD students need to do.

When a study project or thesis is assigned to improve the performance of the team, the students understand the necessity for proper working methods, namely careful requirement specification, documentation and intense testing and validation. This is because a lot of our students experienced that insufficient documentation of previous works leads to difficulties in maintaining the code or makes it completely useless for the team. As a result, the students are prompted to work in a proper scientific manner. This includes documenting both the decisions made during the design process as well as the functioning of the elaborated solutions.

We also strengthen the scientific orientation of student contributions by pointing the focus to the work of competing teams. There are two main motives in the RoboCup competition. The obvious motivation is winning in the direct competition. The second motivation results from the regular workshops where competing teams come together. They present their progress to the others and work together on connecting elements. Adopting the solution of other teams and developing them further is not regarded as fraud but as good practice to bring the performance of the league forward. This is also enhanced by the open source character of the league. Therefore, when a team presents a well-documented and tested solution, this can result in other teams taking this solution instead of further developing their own. We always encourage the students to scan the affiliated works of the competing teams and objectively compare them. We regard this as a good exercise for later scientific work. It includes the intrinsic motivation to present something new, because insufficient literature research will be pointed out by the other teams at the next workshop. The autonomous work on a robotic soccer issue in the team can thereby be regarded as a safe trial for the later work in a scientific context.

Students, who get involved in the team as described above, are more experienced in scientific working methods. We observe this by the increased complexity of theses they can handle and the quality of the results [5,12,19,13,4,14]. After some time, the students are able to directly assist the research of the PhD students, even if it is not directly connected to a topic from the robotic soccer domain. These students are also often recruited as undergraduate research assistants and later pursue a PhD at our department. While the German ratio between engineering graduations and engineering dissertations was only 11.1% in 2016 [17], 37% of our graduated former team members received a doctor's degree. Moreover, the following PhD theses shaped and were shaped by our robotic soccer team.

Philipp A. Baer and Roland Reichle, who founded the team in 2005 used the application of robotic soccer to test the algorithms, they were working on for their dissertations. Their research focused on issues related to teams of robots, so the application fit well [1,10]. Later on Hendrik Skubch and Andreas Witsch wrote their PhD theses completely motivated by the requirements of the robotic soccer domain [15,20]. Still their results apply to any homogenous or heterogeneous team of robots and are used for many applications in the department. Others like Dominik Kirchner used the excessive amount of log data produced by the robots during training and tournaments as a testbed for their dissertation [7]. One could say, that distributed robotic applications and thereby the student team became a centerpiece of the department's research over the years.

## 4 Bringing Research to the Students

In this section we present the affiliated courses, where both students and lecturers benefit from our robotic soccer team.

The exciting and multifaceted topic of robotic soccer and the existence of an active team leads to a higher quality of lectures. The lecturers active in the team gather a holistic viewpoint and real-life experiences in the robotic field. The teaching content becomes both more grounded and more inspiring when the lecturer actively works on all aspects of the presented subject area. It also reduces the preparatory effort for the lecturers, when the lectures cover the topics, they are working on. The students benefit from the sound and applicable teaching rather than dealing with abstract and hard to test concepts.

We designed three courses around the topics associated with the robotic team:

The lecture *Autonomous Mobile Robots* revolves around all major design aspects of an autonomous robotic system. It starts with sensors and measurements, advances with sensor fusion and feature recognition to autonomous decision making, proceeding over control engineering to actuation. We thereby model the structure of a full MAPE-cycle [6], always taking the soccer robots as an illustrative real example.

The lab course *Cooperating Distributed Robotic Systems* is designed to guide the students through a hands-on development process of an autonomous application on existing robot hardware or in a simulator. The sessions alternate freely between conceptual work and free coding and testing. The exact functionality and structure of the application is developed together with the students in an informal iterative manner with emphasis on small, but running solutions to keep up the motivation. The lecturer helps out when difficulties occur and presents best practices to proceed in such situations with little external help, encouraging the development of independence.

The practical course called *Teamwork* was born out of the observation that our students often lack the experience and the skills for working in teams having heterogeneous study background. The necessity of solving a common task often does not suffice to tackle serious team issues in study projects. Therefore, we designed a course that belongs to the *soft-skill section* of the curriculum, where the solving of team issues is explicitly credited. We think that the robotic application, which naturally touches several fields of study is perfect as a trial for learning interdisciplinary teamwork.

All three courses shall prepare students for successfully participating in the team in case it caught their interest. These courses are one of our most important pillars for drawing new students into the team.

## 5 Discussion

We regard our student team as a good combination of research and teaching interests, which creates synergy effects and benefits for both students and PhD candidates. Nevertheless, there are some downsides to it, which we will elaborate further in this section.

One of the downsides, we already touched several times in this paper is the relatively high initial hurdle when joining the team as a new member. We often tell interested students at open house days that everyone who can hold a screw driver at the right end can participate and contribute. This turned out to be not entirely true. The framework and the hardware we created over time needs quite some time for familiarization. Some students, which were both motivated and achieving good grades in their studies showed difficulties in learning the basics independently. Incorporating these students causes extra effort to the team members and management. Other students lost their motivation, because achievements won't come as fast as they expected. The maintenance of the right team size by acquiring new members therefore needs quite some personal supportive effort, which does not guarantee to result in performance improvement for the team.

The other downside of the interrelation between the student team and the department's research is that students and research staff become more dependent on each other. PhD students often instruct one or two undergraduate students to help them with their dissertation and assign self-contained parts as projects or theses. This makes dependencies clear and simple. Through the complex dependencies between the research and the student team, publications and team performance rely more than usual on a smooth cooperation. This makes the research process more complicated but in our eyes also more realistic regarding work in the industry or in bigger research networks.

Regarding the downsides, we still draw a positive conclusion, as they are outweighed by the positive effects, we will shortly recall.

Most important to us are the synergy effects between research and teaching, which bring both the fascination of research to the students and reduce the effort for lecturers to deliver good education. The student team also improves the research in the department, because the research staff works closer together towards the common goal. Moreover, the students in the team are better trained to help with the research than their fellow students.

Nevertheless, to achieve these synergies between the student team and the department's research, the format and mode of operation of the team has to be chosen carefully (see Section 2). Which competition or format is beneficial for the department depends on the department's research interests.

## 6 Conclusion

We have made very positive experiences with our student team approach and we highly recommend this kind of approach as it benefits both the research of the department and the education of students. Participation in international tournaments can also be a flagship project for the university, which draws attention to both the university and the department. Clearly, it bears some efforts, financially and regarding workload to build up and maintain such a team. The focus of the team has to be chosen carefully to match the department's research interests. Nevertheless, we were able to generate a significantly higher proportion of dissertations, to create synergy effects between research and teaching, to strengthen the team spirit between our scientific staff, to provide every team member with an extra amount of practical experience in their field of research and last but not least to have a lot of fun at tournaments and in meetings.

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# Reflection

# The Effects of Study Buddies and Study Hours in a First-Year Course on Operating Systems

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**Abstract.** Many university students, especially first-year students, struggle to efficiently manage their study time which results in lower academic achievements. This paper empirically examines the effect that the number of self-preparation hours of students has on their final grade. In addition, the influence of studying with a friend in preparation for tests and exams is analysed, in order to determine if it has any notable impact on students' academic performance. Five tests and exams of a first-year computer science module, namely operating systems, which is considered a difficult subject by students, were analysed for this study. Students were recommended to prepare for a certain number of hours, and before each test, students were asked how much they actually studied and whether or not they prepared together with a friend. It was found that students who studied with a friend had a higher pass rate for all the tests compared to those who studied alone. Additionally, academic performance is by-and-large a matter of investing the recommended number of study hours, while in reality most students come to the exams underprepared. Students who passed the course had typically put in more preparation hours than their failing counterparts. Borderline students were also not able to substantially increase their marks with additional preparation.

## 1 Introduction

Operating systems (OS) are perceived by many students as a ‘difficult’ topic [8,11], especially at our university where OS are already taught to computer science (CS) and computer engineering (CE) students in their first year of study.[1] To support our first-year students in coping with these difficulties, we continuously reminded them of putting enough study hours into the preparation of their various tests, and we also recommended the formation of pair-studying with a so-called ‘study buddy’ for mutual motivation and preparation time control among the two members of a study pair. At the end of the course we wanted to know how effective our advice has been, such as to be able to decide whether or not to continue such practice in the future.

[1] For comparison, we are aware of several other institutions in which OS are presented only in the third study year.



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In this paper we explain the 'design' of our investigation, report our observations, and draw conclusions concerning recommendable future practices. Our initial assumption — simply as a matter of common sense — was that very weak students will not benefit from even the highest numbers of study hours, whilst highly intelligent students will always do well even with little preparation, hence it should be the 'mediocre' students, who are neither very weak nor very bright, for which some extra efforts in preparation time can have the most rewarding effects.

This paper firstly recapitulates what other experts have discovered in this context in section 2, followed by the design of the case study in section 3. The observations are listed in section 4 with the discussion and recommendations for future educators given in section 5. Finally, the conclusion is presented in section 6.

## 2 Related Work

The effects of intrapersonal factors, such as stress [6] and motivation [7], on students' academic performance has been widely studied. Especially first-year students struggle with the transition from secondary to tertiary institutions due to a change in required skills, learning styles, and time management [9], which in turn leads to higher stress levels, reduced motivation, and lower academic achievements. Blair found that the workload and independent learning is broadly in line with students' expectations when entering a university, however, students do not fully comprehend what is expected from them in various assessments and therefore often do not manage their time properly [2]. This section discusses existing research with regard to two primary factors impacting students' academic performance, namely the time spent on self-study, as well as studying with fellow students in preparation of upcoming assessments.

### 2.1 Impact of Study Hours

An important factor influencing the academic performance of students is the time spent on preparing for classes and exams. Besides the extracurricular activities of most first-year students in South Africa, the available study time is further reduced by a lack of financial support, requiring students to get a part-time work to pay their bills and support their families at home. A study in the Western Cape and the Free State found that both students and lecturers rated the support from home and other financial issues as two of the main factors influencing academic performance [9]. On the other hand, class attendance and preparation hours were ranked lower than the financial factors.

A study at the University of Johannesburg found that outside their regular class attendance, between 50% and 60% of students put less than 15 hours per week into their academic work [15]. Between 25% and 36% of students studied for 15 to 25 hours per week, with only around 15% to 19% studying more than 25 hours a week. Similar observations were made by the Indiana University where a survey found that on average students utilized 13.8 hours a week for studying and class preparation, with a standard deviation of 8.1 hours [4].

When considering the study hours, it is important to determine if there is a statistical correlation between the time students spent preparing for assessments and the corresponding grades they obtain for those assessments. A 20-year study at various German universities found that the time spent on attending courses was positively associated with grades for females, high ability students, and students of social sciences, hard sciences, and engineering [5]. Spending time on self-study was positively correlated with grades for almost all students.

Contrary to the German study, a single year survey at 413 universities in the United States found that there was no statistically significant influence of the time spent on self-study, as well as the time spent on outside work, on the final semesters grades of the students [10]. Below average students performed slightly worse with more study hours compared to fewer study hours. Medium ability students had no notable difference in their grades when working for longer or shorter periods of time. Only high ability students had a statistical significant grade increase when studying longer.

A study at the Colorado State University and Front Range Community College investigated the ratio of self-study hours to lecture hours required to achieve a certain exam mark [1]. The study determined that students had to study between 3 to 4.4 hours for the exam to achieve the average class grade. Additionally, the study found that in order to achieve a 90% exam mark, the ratio of self-study to lecture hours should be between 1.5 and 2.1. In addition, a study at the University of Uyo found that students who studied longer had a significantly higher academic achievement than their counterparts studying for shorter periods of time [14]. A recommendation was made that students should at least study for two to three hours a day outside regular lectures.

### 2.2 Impact of Study Groups

Some students prefer studying alone, while others engage with fellow students, also known as study buddies, in preparation of assessments. Naong found that about half of the students consider the ability to work independently as having a noticeable impact on their performance, with only a third of the students considering it having a great impact [9].

A study at the University of Washington noticed that especially engineering students tend to study alone, either by choice or as a result of feeling like an outsider [3]. The authors argued that those students who study alone due to feeling like an outsider are more likely to drop out of university. A small survey across four United States universities observed that engineering and computer science students typically start the semester by working alone [16]. After realising that their expectations of the work difficulty are unrealistic, many students seek out a study buddy, therefore starting the semester alone and ending the semester together.

A study at the University of South Australia investigated the effect of studying with a fellow student, as well as the effect of hierarchical senior tutoring, on students' pass rates [13]. The survey found that 74% of students with a study buddy passed, whereas only 49% of students studying alone passed. Similarly, Reid et. al. found that students at risk of failing who participated in a study buddy support program improved their academic performance by 28%, compared to non-participants who only gained an 8% improvement [12].

On the other hand, the previously mentioned 2-decade study at various German universities found that devoting time on work groups was negatively correlated with grades for science and engineering students, and students with below average abilities [5].

## 3 Case Study Design

During the observed semester our first-year OS students had to write several tests in each of which we also asked the students to voluntarily provide some answers about their own study behaviour before the tests. Several tests were thus evaluated by us, namely:

**During the semester,** the so-called *semester tests* were assessed, two of which were compulsory for every student as follows:
- First semester test: compulsory,
- Second semester test: compulsory,
- Aegrotat test: optional only for those students who had been ill with a medical certificate, or who were otherwise engaged with a valid justification, during any of the two previous tests.

**After the semester,** several types of *final exams* were written only by those students who had sufficiently high semester marks to be allowed into the final exams (i.e. weak students excluded). Those exams were the:
- Normal exam: compulsory,
- Aegrotat exam: optional only for those students who had been ill or otherwise unavailable with a valid medical certificate during the final exam,
- Supplementary exam: optional only for those students who had failed the final exam with a sub-minimum grade of 40%–49%. All even weaker students were excluded from taking part in this supplementary exam,
- Special final-chance exam: optional only for those students who had failed the final exam with a sub-minimum mark of 40%–49%, who had also failed the subsequent supplementary exam within 40%–49%, and who only needed to pass this one course (OS) in order to obtain their entire bachelor degree. This special exam is thus written only by students who had repeatedly failed and re-failed the OS course during several preceding years of studying.

Due to the insignificantly low participation, the *aegrotat* exam for the previously ill students (with only 12 participants) and the *final-chance* exam for the ‘degree aspirants’ (with only 3 participants) are not taken into account in the subsequent analyses.

All in all, we will assess three semester tests and two after-semester exams (subsequently called ‘the five tests’) in which the participation numbers were large enough to yield sufficiently reliable observation results.

During the semester we had the highest proportion of weak students in the cohort, including those ones who were eventually not allowed to sit in the final exam. After the semester we had the relatively weakest students accumulated in the supplementary exam.

For each of these five tests, we lecturers had released a study time recommendation — based on our many years of academic experience — of $n$ hours, whereby the value of $n$ could vary from test to test, due to different quantities of covered study material, and/or different levels of difficulty. In each test paper we asked the students to voluntarily indicate to us whether or not, or to what extent, they had adhered to our previously provided study time recommendation[2], and whether or not they had studied together with a 'study buddy'.

For the remainder of this paper we use the following encoding of the data which we have gathered as mentioned above.

**Preparation Hours:** For a specifically given advice $n$ concerning 'highly recommended' number of preparation hours (for example: $n := 30$), the students' (self-indicated) actual preparation hours $h$ are encoded as follows.
- **A** for $h > n + 5$ (highly diligent),
- **B** for $n - 5 \leq h \leq n + 5$ (diligent),
- **C** for $n - 10 \leq h < n - 5$ (negligent),
- **D** for $h < n - 10$ (very negligent),
- **?** for no voluntary answer provided.

**Study Buddies:** Only the follow three possibilities needed to be encoded.
- **Y** for 'I prepared myself together with a study buddy',
- **N** for 'I prepared myself alone without a study buddy'
- **?** for no voluntary answer provided.

**Academic Success:** Along the lines of the 'tradition' of our university, we encode a student's academic achievement $aa$ on the basis of percentages ($p$%) as follows, whereby $100\%$ is the absolutely highest mark which a student could possibly obtain.
- *A* for $aa \geq 75\%$ (pass with distinction),
- *B* for $50\% \leq aa \leq 75\%$ (pass),
- *C* for $40\% \leq aa < 50\%$ (sub-minimum failure),
- *D* for $aa < 40\%$ (severe failure).

## 4 Observations

In the following section we measure the effects of study buddies and preparation hours *separately* for two methodical reasons:

- A combined analysis with two input variables (buddies and hours) would have been too cumbersome, i.e. obfuscating which output effect is due to which input variable;
- The study buddy scheme turned out to be not very popular, i.e. most of our students indicated that they had preferred to study alone; see [3] for comparison. Hence the

[2] Students had thus the opportunity to be untruthful when providing answers; this is from a methodological point of view a 'weak spot' in our 'design'.

very small number of study buddies among our entire cohort might have distorted the significance of our findings altogether if combined with the study hour variable.

The details are described in the following paragraphs for each of our five tests.[3]

### 4.1 About the Effect of Study Buddies

In each of the following five test cases we first show the *proportion* of study buddies (code **Y**) in the entire cohort, followed by a comparison of how well the study buddies were faring academically in comparison against the single students (code **N**) and the no-answer students (code **?**).

**Test 1.** Our observations from this test are captured in tables 1 and 2. We see that the study buddies (code **Y**) seem to have had a noteworthy performance gain over the single workers (code **N**) especially at the academic ability level $B$ (pass) — although our observations might have differed if the many students who did not provide an answer (code **?**) had provided explicit responses.

**Table 1.** Groups of participants of test 1, in absolute numbers, sorted: study buddies are the minority with $\frac{73}{566} \approx 13\%$ of all participants.

| **N** | **?** | **Y** | all |
|---|---|---|---|
| 375 | 118 | 73 | **566** |

**Table 2.** Academic Performance of study buddies versus others in test 1: study buddies seemed to be most beneficial for students at performance level $B$. Incompetence at performance level $D$ is especially frequent among the non-answerers (code **?**).

| Group / Performance | $A$:pass | $B$:pass | $C$:fail | $D$:fail | all |
|---|---|---|---|---|---|
| **Y** | $\frac{1}{73} \approx \mathbf{1\%}$ | $\frac{23}{73} \approx \mathbf{32\%}$ | $\frac{18}{73} \approx \mathbf{25\%}$ | $\frac{31}{73} \approx \mathbf{42\%}$ | $\approx 100\%$ |
| **N** | $\frac{10}{375} \approx \mathbf{3\%}$ | $\frac{94}{375} \approx \mathbf{25\%}$ | $\frac{89}{375} \approx \mathbf{24\%}$ | $\frac{182}{375} \approx \mathbf{49\%}$ | $\approx 100\%$ |
| **?** | $\frac{2}{118} \approx \mathbf{2\%}$ | $\frac{18}{118} \approx \mathbf{15\%}$ | $\frac{24}{118} \approx \mathbf{20\%}$ | $\frac{74}{118} \approx \mathbf{63\%}$ | $\approx 100\%$ |

**Test 2.** Our observations from this test are captured in tables 3 and 4. The results are reasonably similar to the ones of the foregoing test 1, whereby the large number of non-answerers (code **?**) brings some uncertainty into this result. Among the non-answerers were also, again, the highest proportion of incompetent students at academic performance level $D$.

[3] All data sheets, with all their internal further details, can be obtained from the authors via e-mail request.

**Table 3.** Groups of participants of test 2, in absolute numbers, sorted: study buddies are the minority again with $\frac{75}{507} \approx 15\%$ of all participants.

| N | ? | Y | all |
|---|---|---|---|
| 280 | 152 | 75 | **507** |

**Table 4.** Academic performance of study buddies versus others in test 2: Again the buddy system seemed to be most beneficial for students at academic performance level *B*.

| Group / Performance | *A*:pass | *B*:pass | *C*:fail | *D*:fail | all |
|---|---|---|---|---|---|
| **Y** | $\frac{6}{75} \approx \mathbf{8\%}$ | $\frac{55}{75} \approx \mathbf{73\%}$ | $\frac{11}{75} \approx \mathbf{15\%}$ | $\frac{3}{75} \approx \mathbf{4\%}$ | $\approx 100\%$ |
| **N** | $\frac{38}{280} \approx \mathbf{14\%}$ | $\frac{152}{280} \approx \mathbf{54\%}$ | $\frac{45}{280} \approx \mathbf{16\%}$ | $\frac{45}{280} \approx \mathbf{16\%}$ | $\approx 100\%$ |
| **?** | $\frac{12}{152} \approx \mathbf{8\%}$ | $\frac{66}{152} \approx \mathbf{43\%}$ | $\frac{29}{152} \approx \mathbf{19\%}$ | $\frac{45}{152} \approx \mathbf{30\%}$ | $\approx 100\%$ |

**Test 3.** This was the aegrotat test for those students who had been missing any of the two foregoing tests due to illness. Because of the rather small number of participants, our result observations in this case might have to be taken with a pinch of salt as far as their significance is concerned: see tables 5 and 6 for the details.

**Table 5.** Groups of participants of test 3, in absolute numbers, sorted: study buddies are the minority again with $\frac{2}{42} \approx 5\%$ of all participants.

| N | ? | Y | all |
|---|---|---|---|
| 29 | 11 | 2 | **42** |

**Test 4.** As explained above, this test was the first after-semester exam, for which the weakest students from the foregoing semester tests had no entry permission. This explains the somewhat lower total participation number. The details of our observations from this exam are summarised in tables 7 and 8.

**Table 6.** Academic performance of study buddies versus others in test 3, with similar observations as in the two foregoing tests.

| Group / Performance | *A*:pass | *B*:pass | *C*:fail | *D*:fail | all |
|---|---|---|---|---|---|
| **Y** | $\frac{1}{2} \approx \mathbf{50\%}$ | $\frac{1}{2} \approx \mathbf{50\%}$ | – | – | $\approx 100\%$ |
| **N** | $\frac{2}{29} \approx \mathbf{7\%}$ | $\frac{12}{29} \approx \mathbf{41\%}$ | $\frac{10}{29} \approx \mathbf{34\%}$ | $\frac{5}{29} \approx \mathbf{17\%}$ | $\approx 100\%$ |
| **?** | $\frac{1}{11} \approx \mathbf{9\%}$ | $\frac{6}{11} \approx \mathbf{55\%}$ | $\frac{2}{11} \approx \mathbf{18\%}$ | $\frac{2}{11} \approx \mathbf{18\%}$ | $\approx 100\%$ |

**Table 7.** Groups of participants of test 4, which was the first after-semester exam, in absolute numbers, sorted: study buddies are the minority again with $\frac{76}{428} \approx 18\%$ of all participants.

| N | ? | Y | all |
|---|---|---|---|
| 225 | 127 | 76 | **428** |

**Table 8.** Academic performance of study buddies versus others in test 4, which was the first after-semester exam, *without* participation of the weakest students from the foregoing tests. Again the buddy system seemed to be most beneficial for students at performance level *B*.

| Group / Performance | *A*:pass | *B*:pass | *C*:fail | *D*:fail | all |
|---|---|---|---|---|---|
| **Y** | $\frac{3}{76} \approx$ **4**% | $\frac{49}{76} \approx$ **64**% | $\frac{19}{76} \approx$ **25**% | $\frac{4}{76} \approx$ **5**% | ≈ 100% |
| **N** | $\frac{13}{225} \approx$ **6**% | $\frac{122}{225} \approx$ **54**% | $\frac{58}{225} \approx$ **26**% | $\frac{32}{225} \approx$ **14**% | ≈ 100% |
| **?** | $\frac{5}{127} \approx$ **4**% | $\frac{58}{127} \approx$ **46**% | $\frac{31}{127} \approx$ **29**% | $\frac{33}{127} \approx$ **26**% | ≈ 100% |

**Test 5.** This was the above-mentioned optional supplementary exam (second chance) only for the weak students at level $C$ (however not for the very weak *D* students). Hence the number of participation in this test was rather small. Our observations are summarised in tables 9 and 10. For the first time the non-answerers (code **?**) were in the majority in this test, seemingly indicating some correlation between academic weakness and not answering the voluntary survey question.

**Table 9.** Groups of participants of test 5, which was the second-chance after-semester for our weak students, in absolute numbers, sorted: study buddies were the minority again with $\frac{5}{115} \approx 4\%$ of all participants, whereas the non-answerers (code **?**) were now for the first time in the majority.

| ? | N | Y | all |
|---|---|---|---|
| 57 | 53 | 5 | **115** |

**Table 10.** Academic performance of study buddies versus others in test 5, which was the second-chance exam for our weak students.

| Group / Performance | *A*:pass | *B*:pass | *C*:fail | *D*:fail | all |
|---|---|---|---|---|---|
| **Y** | – | $\frac{2}{5} \approx$ **40**% | $\frac{1}{5} \approx$ **20**% | $\frac{2}{5} \approx$ **40**% | ≈ 100% |
| **N** | – | $\frac{5}{53} \approx$ **9**% | $\frac{21}{53} \approx$ **40**% | $\frac{27}{53} \approx$ **51**% | ≈ 100% |
| **?** | – | $\frac{7}{57} \approx$ **12**% | $\frac{24}{57} \approx$ **42**% | $\frac{26}{57} \approx$ **46**% | ≈ 100% |

**Intermediate Summary: Pass Rates of the Study Buddies.** If our students have provided truthful answers in the voluntary survey, then we can see that the *pass rates* (*A* and *B* combined) of the study buddies (code **Y**) was notably the highest in all our five tests:

- Test 1: buddies' pass rate = 33% (**Y**) versus 28% (**N**) and 17% (**?**)
- Test 2: buddies' pass rate = 81% (**Y**) versus 68% (**N**) and 51% (**?**)
- Test 3: buddies' pass rate = 100% (**Y**) versus 48% (**N**) and 64% (**?**)
- Test 4: buddies' pass rate = 68% (**Y**) versus 60% (**N**) and 50% (**?**)
- Test 5: buddies' pass rate = 40% (**Y**) versus 9% (**N**) and 12% (**?**)

Nonetheless only a small minority of our students participated this beneficial study buddy scheme.

### 4.2 About the Effects of Preparation Hours

In each of the above-mentioned 5 test cases we will now first show the proportion of diligence-levels in the entire cohort (codes $A$, $B$, $C$, $D$), followed by a comparison of how well the more-or-less diligent students were faring academically in comparison against each other and against the no-answer students (code **?**).

**Test 1.** With the same participants as described above, our observations of the relations between preparation hours (codes **A**, **B**, **C**, **D**, **?**, with regards to some given number $n$ = 'strongly recommended') and the resulting academic performance levels ($A$, $B$, $C$, $D$) are summarised in tables 11 and 12. Here it is interesting to note that the long-time preparers (code **A**) did *not* reach the highest academic level $A$: the highly intelligent students at the academic top level $A$ are probably *not in need* of overly many preparation hours, due to their being 'gifted' with 'natural' intelligence.

**Test 2.** Our observations in this test, similar to the previous one, are summarised in tables 13 and 14.

**Test 3.** Our observations in this aegrotat test, with only few participants, are summarised in tables 15 and 16.

**Table 11.** Participants of test 1, in absolute numbers, grouped by their self-inflicted levels of preparation diligence. Diligent (code **B**) and highly diligent preparers (code **A**) were in a small minority: $\frac{8+64}{566} \approx 13\%$.

| **A** | **B** | **C** | **D** | **?** | all |
|---|---|---|---|---|---|
| 8 | 64 | 207 | 145 | 142 | **566** |

**Table 12.** Academic performance of diligent preparers versus others in test 1: Highly diligent long-time preparers (code **A**) did *not* reach the academic level $A$; very high diligence levels are especially indicative of academic level $B$. The highest pass rate was observed at diligence level **B**. Incompetence at performance level $D$ was especially frequent among the negligent students and the non-answerers. The performance effects of diligence (or lack thereof) are clearly visible throughout the entire table. Only a few very intelligent students did not need many preparation hours to obtain the highest performance level $A$.

| Diligence / Performance | $A$:pass | $B$:pass | $C$:fail | $D$:fail | all |
|---|---|---|---|---|---|
| **A** | – | $\frac{5}{8} \approx$ **63%** | $\frac{2}{8} \approx$ **25%** | $\frac{1}{8} \approx$ **13%** | ≈ 100% |
| **B** | $\frac{4}{64} \approx$ **6%** | $\frac{19}{64} \approx$ **30%** | $\frac{15}{64} \approx$ **23%** | $\frac{26}{64} \approx$ **41%** | ≈ 100% |
| **C** | $\frac{4}{207} \approx$ **2%** | $\frac{55}{207} \approx$ **27%** | $\frac{53}{207} \approx$ **26%** | $\frac{95}{207} \approx$ **46%** | ≈ 100% |
| **D** | $\frac{2}{145} \approx$ **1%** | $\frac{34}{145} \approx$ **23%** | $\frac{35}{145} \approx$ **24%** | $\frac{74}{145} \approx$ **51%** | ≈ 100% |
| **?** | $\frac{3}{142} \approx$ **2%** | $\frac{22}{142} \approx$ **15%** | $\frac{26}{142} \approx$ **18%** | $\frac{91}{142} \approx$ **64%** | ≈ 100% |

**Table 13.** Participants of test 2, in absolute numbers, grouped by their self-indicated levels of preparation diligence. Diligent (code **B**) and highly diligent students (code **A**) were again in a small minority: $\frac{23+59}{507} \approx 16\%$.

| **A** | **B** | **C** | **D** | **?** | all |
|---|---|---|---|---|---|
| 23 | 59 | 122 | 140 | 163 | **507** |

**Table 14.** Academic performance of diligent preparers versus others in test 2, with similar observations as in the foregoing test, although here the highest pass rate was achieved at diligence level **B**, (*not* **A**). The difficulty of this test (in Bloom's taxonomy) was somewhat *easier than the difficulty of the foregoing test*, such that reasonably high pass rates could be achieved also with rather low preparation effort.

| Diligence / Performance | $A$:pass | $B$:pass | $C$:fail | $D$:fail | all |
|---|---|---|---|---|---|
| **A** | $\frac{2}{23} \approx$ **9%** | $\frac{14}{23} \approx$ **61%** | $\frac{4}{23} \approx$ **17%** | $\frac{3}{23} \approx$ **13%** | ≈ 100% |
| **B** | $\frac{8}{59} \approx$ **14%** | $\frac{37}{59} \approx$ **63%** | $\frac{10}{59} \approx$ **17%** | $\frac{4}{59} \approx$ **7%** | ≈ 100% |
| **C** | $\frac{9}{122} \approx$ **7%** | $\frac{76}{122} \approx$ **62%** | $\frac{23}{122} \approx$ **19%** | $\frac{14}{122} \approx$ **11%** | ≈ 100% |
| **D** | $\frac{25}{140} \approx$ **18%** | $\frac{72}{140} \approx$ **51%** | $\frac{19}{140} \approx$ **14%** | $\frac{24}{140} \approx$ **17%** | ≈ 100% |
| **?** | $\frac{12}{163} \approx$ **7%** | $\frac{75}{163} \approx$ **46%** | $\frac{29}{163} \approx$ **18%** | $\frac{48}{163} \approx$ **29%** | ≈ 100% |

**Table 15.** Participants of the aegrotat test 3, in absolute numbers, grouped by their self-indicated levels of preparation diligence. Diligent (code **B**) and highly diligent students (code **A**) were again in the minority: $\frac{2+2}{42} \approx 10\%$.

| **A** | **B** | **C** | **D** | **?** | all |
|---|---|---|---|---|---|
| 2 | 2 | 13 | 12 | 13 | **42** |

**Table 16.** Academic performance of diligent preparers versus others in test 3.

| Diligence / Performance | *A*:pass | *B*:pass | *C*:fail | *D*:fail | all |
|---|---|---|---|---|---|
| **A** | $\frac{1}{2} \approx$ **50%** | $\frac{1}{2} \approx$ **50%** | – | – | ≈ 100% |
| **B** | $\frac{1}{2} \approx$ **50%** | $\frac{1}{2} \approx$ **50%** | – | – | ≈ 100% |
| **C** | – | $\frac{6}{13} \approx$ **46%** | $\frac{4}{13} \approx$ **31%** | $\frac{3}{13} \approx$ **23%** | ≈ 100% |
| **D** | – | $\frac{5}{12} \approx$ **42%** | $\frac{5}{12} \approx$ **42%** | $\frac{2}{12} \approx$ **17%** | ≈ 100% |
| **?** | $\frac{1}{13} \approx$ **8%** | $\frac{7}{13} \approx$ **54%** | $\frac{3}{13} \approx$ **23%** | $\frac{2}{13} \approx$ **15%** | ≈ 100% |

**Test 4.** As mentioned above, this test was the regular after-semester exam from which the weakest students were already excluded. Tables 17 and 18 summarise our observations of this test.

**Table 17.** Participants of test 4 (the first after-semester exam), in absolute numbers, grouped by their self-indicated levels of preparation diligence. The weakest students from the foregoing tests were excluded from participation. Diligent (code **B**) and highly diligent students (code **A**) were again in the minority: $\frac{24+60}{428} \approx 20\%$.

| **A** | **B** | **C** | **D** | **?** | all |
|---|---|---|---|---|---|
| 24 | 60 | 102 | 108 | 134 | **428** |

**Test 5.** This was the second-chance exam which our university grants (as mentioned above) to the weak students who had found themselves in the academic range $C$ after the foregoing regular exam. Tables 19 and 20 summarise our observations of this test.

**Intermediate Summary: Pass Rates of the Diligent Students.** If our students have provided truthful answers in the voluntary survey, then we can see that the *pass rates* ($A$ and $B$ combined) of the most diligent students (preparedness codes **A**, **B**) were notably high in many of our five tests, whereby some exceptions to this observation can be explained by varying circumstances: highly intelligent students do not need many preparation hours to do well, whilst desperate students can spend many futile hours of hopeless cramming if their intellectual capacity is not sufficient to grasp the materials to be studied for the tests. However, in spite of the generally well visible advantages of diligence in preparation time, only a small minority of our students listened and obeyed to our repeatedly uttered warnings about the importance of diligence and a sufficiently high number of preparation hours before every test. The large majority of our students did not follow our advice for any of those 5 tests.

**Table 18.** Academic performance of diligent preparers versus others in test 4, the first after-semester exam from which the weakest students were already excluded. Again we see that the highest level of preparation time (code **A**) does *not* guarantee highest academic achievements (level *A*). Classified in terms of Bloom's taxonomy, this exam was moderately difficult.

| Diligence / Performance | *A*:pass | *B*:pass | *C*:fail | *D*:fail | all |
|---|---|---|---|---|---|
| **A** | – | $\frac{15}{24} \approx$ **63**% | $\frac{5}{24} \approx$ **21**% | $\frac{4}{24} \approx$ **17**% | ≈ 100% |
| **B** | $\frac{3}{60} \approx$ **5**% | $\frac{29}{60} \approx$ **48**% | $\frac{20}{60} \approx$ **33**% | $\frac{8}{60} \approx$ **13**% | ≈ 100% |
| **C** | $\frac{2}{102} \approx$ **2**% | $\frac{58}{102} \approx$ **57**% | $\frac{31}{102} \approx$ **30**% | $\frac{11}{102} \approx$ **11**% | ≈ 100% |
| **D** | $\frac{10}{108} \approx$ **9**% | $\frac{64}{108} \approx$ **59**% | $\frac{20}{108} \approx$ **19**% | $\frac{14}{108} \approx$ **13**% | ≈ 100% |
| **?** | $\frac{6}{134} \approx$ **4**% | $\frac{64}{134} \approx$ **48**% | $\frac{32}{134} \approx$ **24**% | $\frac{32}{134} \approx$ **24**% | ≈ 100% |

**Table 19.** Participants of test 5 (second-chance exam for the weak students), in absolute numbers, grouped by their self-indicated levels of preparation diligence. Diligent (code **B**) and highly diligent students (code **A**) were again in the minority: $\frac{14+19}{115} \approx 29\%$.

| **A** | **B** | **C** | **D** | **?** | all |
|---|---|---|---|---|---|
| 14 | 19 | 10 | 14 | 58 | **115** |

**Table 20.** Academicperformance of diligent preparers versus others in test 5, the final-chance exam for some of the weak students who stood at academic level *C* after the foregoing regular exam. Stronger students did not participate in this test any more. For the weakest students in this cohort even the highest numbers of preparation hours (code **A**), preseumably spent in panic, are futile.

| Diligence / Performance | *A*:pass | *B*:pass | *C*:fail | *D*:fail | all |
|---|---|---|---|---|---|
| **A** | – | $\frac{2}{14} \approx$ **14**% | $\frac{3}{14} \approx$ **21**% | $\frac{9}{14} \approx$ **64**% | ≈ 100% |
| **B** | – | $\frac{2}{19} \approx$ **11**% | $\frac{11}{19} \approx$ **58**% | $\frac{6}{19} \approx$ **32**% | ≈ 100% |
| **C** | – | $\frac{3}{10} \approx$ **30**% | $\frac{3}{10} \approx$ **30**% | $\frac{4}{10} \approx$ **40**% | ≈ 100% |
| **D** | – | $\frac{1}{14} \approx$ **7**% | $\frac{3}{14} \approx$ **21**% | $\frac{10}{14} \approx$ **71**% | ≈ 100% |
| **?** | – | $\frac{6}{58} \approx$ **10**% | $\frac{26}{58} \approx$ **45**% | $\frac{26}{58} \approx$ **45**% | ≈ 100% |

### 4.3 Did the Buddies Prepare Themselves More Diligently?

In the foregoing two sub-sections we had seen

- that the overall pass-rate was notably high amongst members of the study buddy scheme,
- and
- that the overall pass-rate was notably high amongst diligent students with many preparation hours, too.

Hence the question arises whether there was perhaps some connection between being a diligent preparator and being a member of the study buddy scheme? This was, after all, the basic idea of the study buddy scheme: that the buddies motivate and monitor each other to be more diligent.

In order to find an answer to this question we had to retrieve from our data sheets about our above-mentioned five tests the information whether the *proportion of diligence* (codes **A**, **B**) among study buddies (code **Y**) was notably higher than the proportion of diligence within the remaining cohort. That is the topic of this sub-section, whereby all the subsequently presented findings must be taken with a pinch of salt because the *both* number of buddies *and* the number of diligent preparators were so very small in comparison with the large size of our entire cohort: statistical reliability is not to be expected under such circumstances. Again the following evaluations also suffer from the possibility of wrong information being provided by the students in their voluntary survey answers, and again our observations might be somewhat obscured by the high frequency of non-answerers (code **?**) in all our tests.

In the following paragraphs, $pd_{\mathbf{AB}}(\mathbf{Y})$ denotes the proportion of diligence at preparation-hours level $\{\boldsymbol{A},\boldsymbol{B}\}$ among study buddies, whereas $pd_{\mathbf{AB}}(\mathbf{N?})$ denotes 'ditto' for all the other students.

**Test 1.** For this test we can retrieve from our data sheet:

- $pd_{\mathbf{AB}}(\mathbf{Y}) = \frac{20}{73} \approx \mathbf{27}\%$
- $pd_{\mathbf{AB}}(\mathbf{N?}) = \frac{52}{566-73} \approx \mathbf{11}\%$

Which is a noteworthy difference, *although* the *majority* of the buddies ($\approx 73\%$) was not particularly diligent either. Nonetheless, at least in some cases of preparation in pairs the mutual motivation idea seems to have worked.

**Test 2.** For this test we can retrieve from our data sheet:

- $pd_{\mathbf{AB}}(\mathbf{Y}) = \frac{27}{75} \approx \mathbf{36}\%$
- $pd_{\mathbf{AB}}(\mathbf{N?}) = \frac{54}{507-75} \approx \mathbf{13}\%$

All in all, also in this test the study buddies were notably *less negligent* than all other participants.

**Test 3.** For this test we can retrieve from our data sheet:

- $pd_{\mathbf{AB}}(\mathbf{Y}) = \frac{2}{2} \approx \mathbf{100}\%$
- $pd_{\mathbf{AB}}(\mathbf{N?}) = \frac{2}{42-2} \approx \mathbf{5}\%$

These observations must be taken with a pinch of salt again, due to the rather small number of participants in this test.

**Test 4.** For this test (the after-semester exam) we can retrieve from our data:

- $pd_{\mathbf{AB}}(\mathbf{Y}) = \frac{30}{76} \approx \mathbf{39}\%$
- $pd_{\mathbf{AB}}(\mathbf{N?}) = \frac{54}{428-76} \approx \mathbf{15}\%$

Which makes a noteworthy difference with apparent significance.

**Test 5.** For this test we can retrieve from our data:

- $pd_{\mathbf{AB}}(\mathbf{Y}) = \frac{2}{5} \approx \mathbf{40}\%$
- $pd_{\mathbf{AB}}(\mathbf{N?}) = \frac{31}{115-5} \approx \mathbf{28}\%$

Even in this final-chance opportunity most students were negligent with their preparation hours, although also in this case the level of negligence was considerably less among the study buddies than among the other students.

**Intermediate Summary.** All in all, we might thus tentatively conjecture some triangular or ternary connection — even if it is not very strong from a rigorous statistical point of view — between the three properties of 'being diligent', 'having a study buddy', and 'achieving good marks' in a forthcoming test.

## 5 Discussion and Recommendations

The number of preparation hours and the buddy system were studied separately, due to the low number of participants in the buddy system. It would be false to mingle the two aspects together, because the collected sample sizes diverge too much. This study is qualitative in nature in which the precise numbers were not in the foreground of our interest.

The reliability of our results is on the one hand somewhat threatened by the comparatively large number of non-answerers (code **?**) in every test, and on the other hand also by possibility for the students to provide false answers in the voluntary survey. Nonetheless we seem to be able to see from those five tests that poor academic performance is by-and-large a matter of not investing the recommended number of home study hours on the side of the students, regardless of how fashionably 'technologized' and 'electronically equipped' our lecture halls are. During 4 of our 5 tests, maximally 20% of students came well prepared, in number of actual study hours $h$ versus the recommendation $n$ provided as pre-test advice by the lecturers. During those tests, at least 80% of the students came underprepared into every test, in spite of the many warnings and reminders which they had received again and again during the ongoing course. The only exception was test 5, the second-chance exam for the week students who are typically desperate. This situation motivated about 30% of the participants to prepare themselves really diligently, however, about 70% came still underprepared into this very last opportunity for them to pass the OS course.

In addition to what had already been mentioned in other literature, this shortage of preparation hours at the students' home is perhaps due to overloading of the BSc-CS curriculum with too many course modules to be done in one academic year, and with too many assessments (written assignments, programming practicals, etc.) being demanded of our students in each and every course.

As far as the study buddy scheme is concerned, from what we have seen we may conjecture tentatively that studying with a friend improves the chances of passing. For each of the evaluated tests, students who studied alone had between 5% and 52% lower pass rates. Similar to [16] we observed that as the semester progressed, more and more students sought out a friend to assist them with the test preparation. Even with this increase during the semester, only about 13% to 18% of students participated in the buddy system.

We also conjecture that most of the non-answering students (code **?**) might have been all too well aware of their own 'academic poverty' in these tests, and might thus have felt too frustrated to answer the voluntary survey questions especially for this reason.

For the future we recommend other educators to encourage students to seek out help from a friend as early as possible. Especially engineers and students of hard sciences lean toward introversion and therefore prefer studying alone. This is detrimental to students who struggle to understand the work on their own. Educators should also motivate students to put in more effort and longer study times. However, due to most students having a fully packed schedule, both academically and socially, this encouragement will mostly fall on deaf ears.

## 6 Conclusion

This paper investigated the correlation between the academic performance of students, and their preparation hours in addition to whether or not they studied with a friend. The data of more than 500 students in a first-year computer science course was evaluated. It was found that although the study buddy system is unpopular amongst computer science and engineering students, it did indeed increase the pass rate of the participants. A higher number of study hours also had a notable impact on the pass rate. However, the majority of students came to the tests underprepared and studied less than the recommended preparation hours.

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# Guidelines for using Bloom's Taxonomy Table as Alignment Tool between Goals and Assessment

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**Abstract.** In academia lecturers are often appointed based on their research profile and not their teaching and learning (T&L) experience. Although universities do emphasize T&L, it might often not even be mentioned during interviews. In the field of education lecturers are more aware of using tools such as Bloom's Taxonomy during their T&L activities. However, in the field of information systems limited academic papers are available on how lecturers can align their goals with the assessment in their courses. In this paper Bloom's Taxonomy Table was used to evaluate the alignment of goals of the case and the assessment done on a fourth-year level subject offered in the information systems field. The purpose of the paper was firstly to reflect on the practice of using Bloom's Taxonomy Table as an evaluation tool and then secondly to provide a set of guidelines for lecturers who want to use Bloom's Taxonomy Table in alignment studies.

**Keywords:** Bloom's Taxonomy, Bloom's Taxonomy Table, Evaluation of assessment.

## 1 Introduction

"Publish or perish" – a phrase already coined by Coolidge in 1932 [3], is often heard these days when one visits a university where grant funding, h-factors and publication avenues are the focus of discussions. Staff at universities are experiencing pressure to publish more in reputable outlets to support the universities to raise in the rankings. This is a world-wide phenomenon discussed at some of the top conferences in the information systems field, and, my colleagues assure me, also other fields.

Although we do not negate the importance of research, we do observe staff being under immense pressure in terms of publication, to the extent where it then sometimes results in negligence of their teaching activities. "Good teaching" is accepted as a given and often not even mentioned in appointment committees, but teaching is actually an art and the lecturer needs all the tools at their disposal to also be successful in the classroom. Good teaching practices are found in an overwhelming number of publications and many courses exist for the novice lecturer. One of the tools used in education to guide lecturers is Blooms Taxonomy, developed in 1956 by Benjamin Bloom as a



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framework for categorizing educational goals – the Taxonomy of Educational Objectives [2].

Bloom's Taxonomy [2] defined six major categories in the cognitive domain. The categories were *knowledge*, *comprehension*, *application*, *analysis*, *synthesis*, and *evaluation*. The framework was revised 45 years later by Anderson et al [1], who added another dimension to the taxonomy after realizing that a category such as *knowledge* embodies both noun and verb aspects. The new taxonomy allowed for the noun and the verb to form separate dimensions, "the noun providing the basis for the Knowledge dimension and the verb forming the basis for the Cognitive Process dimension" [5, p.213]. The knowledge dimension consists of *factual knowledge, conceptual knowledge, procedural knowledge* and *metacognitive knowledge*.

Our research interest was in investigating whether the Bloom's Taxonomy Table could be used as evaluation tool to get an indication of the alignment between outcomes defined for an information postgraduate course and the assessment used for the course. After conducting a case study, our contribution in this paper is a set of guidelines that course coordinators can use to support them during alignment of goals and assessment.

In this paper we provide background on Bloom's Taxonomy in section 2, followed by the method followed in section 3, as well as how we used Bloom's Taxonomy Table as evaluation tool. In section 4 we provide the alignment data, followed by a discussion on the value of using Bloom's Taxonomy Table in section 5. In section 6 we offer a proposed set of guidelines. The conclusion is provided in section 7.

## 2 Background

### 2.1 Bloom's Revised Taxonomy

The goal of the founders of Bloom's Taxonomy was to develop a "method of classification for thinking behaviors" and consisted of the cognitive, affective and psychomotor domain. Bloom's Taxonomy focused on the cognitive domain and was published in 1956 [4], with several levels of thinking and six levels of complexity. The levels were often seen as a ladder, where the learner moved through the different levels to acquire a higher level of cognition. The first three levels were knowledge, comprehension and application, followed by the higher levels of cognition, namely analysis, synthesis and evaluation (Figure 1) [4]. In the revised taxonomy the *cognitive process* dimension was changed to *remember*, *understand*, *apply*, *analyze*, *evaluate* and *create* (Figure 1).

In Table 1 we summarized the cognitive process dimension where the first level, *remember*, focuses on recall and the type of questions the instructor will ask himself is: 'Can the student recall or remember the information?' [7]. On the second level, *understanding*, the question of importance to ask is, 'Can the student explain ideas or concepts?' For *applying* the question is, 'Can the student use the information in a new way?' while for *analyzing* the instructor asks if the student can distinguish between the different parts. On the fifth level, *evaluating*, the instructor asks the question, 'Can the student justify a stand or decision?' while regarding creating the question the instructor asks is whether a student can create a new product or point of view [7].

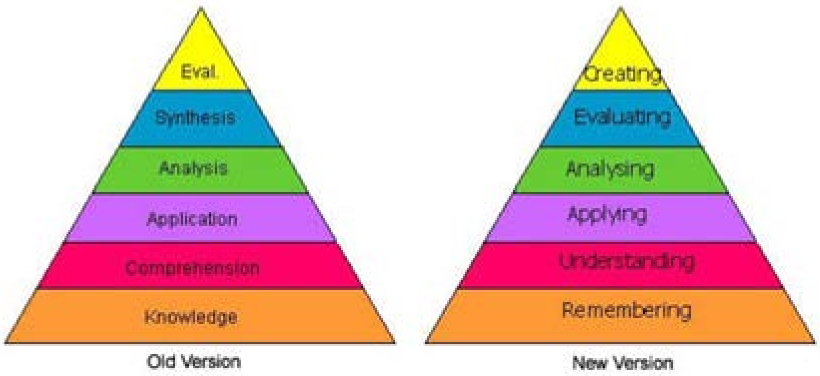


**Fig. 1.** Original and revised Bloom's taxonomy.

**Table 1.** Cognitive process dimension of the revised taxonomy [5].

| Cognitive Process Dimension | Consists of |
|---|---|
| **1. Remember** – Retrieving relevant knowledge from long-term memory. | 1.1 Recognizing<br>1.2 Recalling |
| **2. Understand** – Determining the meaning of instructional messages, including oral, written, and graphic communication. | 2.1 Interpreting,<br>2.2 Exemplifying,<br>2.3 Classifying,<br>2.4 Summarizing,<br>2.5 Inferring,<br>2.6 Comparing,<br>2.7 Explaining |
| **3. Apply** – Carrying out or using a procedure in a given situation. | 3.1 Executing<br>3.2 Implementing |
| **4. Analyze** – Breaking material into its constituent parts and detecting how the parts relate to one another and to an overall structure or purpose. | 4.1 Differentiating<br>4.2 Organizing<br>4.3 Attributing |
| **5. Evaluate** – Making judgments based on criteria and standards. | 5.1 Checking<br>5.2 Critiquing |
| **6. Create** – Putting elements together to form a novel, coherent whole or make an original product. | 6.1 Generating<br>6.2 Planning<br>6.3 Producing |

As mentioned, the revised taxonomy consists of two dimensions. The first is the cognitive process dimension where, the focus is on the process used to learn. The second dimension is the knowledge dimension (or the kind of knowledge to be learned). The knowledge dimension consists of *factual knowledge*, *conceptual knowledge*, *procedural knowledge* and *metacognitive knowledge.* As described by Anderson [1], *Factual Knowledge* "refers to the basic elements that students must know to be acquainted with a discipline or solve problems in it." Knowledge of terminology and of specific details and elements is important. *Conceptual knowledge* "refers to the inter-relationships among the basic elements within a larger structure that enable them to function together" [1]. The focus is on knowledge of classifications, categories, principles, generalizations, theories, models and structures. *Procedural knowledge* relates to "How to do something; methods of inquiry, and criteria for using skills, algorithms, techniques, and methods" [1]. For procedural knowledge, the knowledge of subject-specific skills, algorithms, techniques, methods and knowledge of criteria for determining when to use appropriate procedures are significant. Lastly, *metacognitive knowledge* focuses on the self and cognition in general where strategic knowledge and knowledge about cognitive tasks plays a role.

### 2.2 Objectives and Assessment

In education it is imperative that the lecturer aligns the objectives defined for the course with the different assessments. Alignment, according to La Marca et al. [6], refers to 'bring[ing] into a straight line; to bring parts or components into proper coordination or … into agreement'. Webb [8] states that in education alignment refers to how the elements in a system work together in order to create a learning environment that guides instruction and student learning. It is possible to improve the efficiency and effectiveness of the education system by aligning the goals and assessments for a course [6]. It is possible to work more effectively and set priorities if the assessment is aligned with the objectives of the course.

La Marca et al. [6] provided six guidelines that can be seen as the foundations of an aligned system of standards and assessment. Below we adapted the guidelines to be specific for higher education:

1. Improvement of student performance;
2. Classroom instructional practices be based on a curriculum;
3. Alignment of educational practices and philosophies and educational agencies;
4. Where applicable, visible and unguarded external assessments;
5. Periodic and continuous process evaluated regularly; and
6. Valid decision-making based on data, depending on the degree of alignment between objectives and assessments.

The research discussed in this paper assists with guideline no. 6 above, namely ensuring that objectives and assessment align.

## 3 Research Design

For this research we followed an interpretive approach and used a case study. The case was a postgraduate course where the purpose was to investigate if the use of the Bloom's Taxonomy Table could support the lecturers to establish how the goals of the study aligned with the assessment used at the end of the course. Bloom's Taxonomy Table (discussed in section 3.1) was used as guideline to evaluate the alignment of goals and assessment after the course ended in 2017. For the alignment exercise an iterative approach was taken – we first established the goals and then aligned them with the assessments done. During the process, guidelines were identified as presented later in the paper.

In section 3.1 we provide the user with the Bloom's Taxonomy Table used during the research to map both the goals and the assessment. In section 3.2 an overview is provided on the postgraduate module used as the case study.

### 3.1 The Bloom's Taxonomy Table

The Bloom's Taxonomy Table uses both the *cognitive process* and *knowledge dimension* in a two-dimensional table to map elements of a course. For example, if we want to map the goal, "Objective 1: Remember the different enterprise architecture frameworks", the first part, *remember*, uses a cognitive process and the second, *different enterprise architecture frameworks*, is then a sub-category of factual knowledge (Table 2) and is therefore mapped in A1.

**Table 2.** Cognitive process dimension of the revised taxonomy [5].

| | **Cognitive Process Dimension** | | | | | |
|---|---|---|---|---|---|---|
| **The Knowledge Dimension** | **1 Remember** | **2 Understand** | **3 Apply** | **4 Analyze** | **5 Evaluate** | **6 Create** |
| A. Factual Knowledge | Objective 1 | | | | | |
| B. Conceptual Knowledge | | | | | | |
| C. Procedural Knowledge | | | | | | |
| D. Metacognitive Knowledge | | | | | | |

### 3.2 The Case Study Module

The advisory board of the department argued that there was a need for training students in disruptive technologies at postgraduate level, and it was decided to include a capita selecta module on disruptive technologies. The module carries a weighting of 15 credits, indicating that on average a student should spend around 150 hours to master the required skills (including time to prepare for tests and examinations). Eight contact sessions of 1.5 hours each were scheduled during the semester and because of the limited duration of contact sessions, a blended learning approach was adopted, where students had to submit preparation assignments before class on the material to be presented during the session. The preparation assignments were open-book automated assessments that mainly tested understanding. Preparation beforehand allowed for discussion opportunities during class, thus focusing on application, analysis and evaluation (the higher cognitive processes).

Since no applicable handbook on disruptive technologies could be found, we compiled the course from selected publications and books, as well as online content. A selected reading list was provided, as well as additional content. The module topics we decided to include with associated module objectives are depicted in Table 1.

**Table 3.** Course syllabus and objectives.

| Topic | Objective and description |
|---|---|
| 1) Fundamentals, concepts and definitions | Objective 1: Understand what disruptive technologies are, as well as what is meant with terms such as *disruptive innovation, digital disruption, digital transformation and disruption revolution*. |
| | In this section a summary of the literature on disruptive technologies, as well as the associated terms and how these terms are related, was presented and discussed. |
| 2) Technological landscape for disruptive technologies | Objective 2: Understand the technological landscape and the unique characteristics of modern technological developments that support and underpin disruption. |
| | In this section technological development as well as the various perspectives on what makes a technology disruptive were presented and discussed. Students were expected to be able to classify a technology (or compare technologies), given the perspectives. |
| 3) Disruptive business models | Objective 3: Understand the characteristics of business models that are typically threatened by disruptions or that are able to harness the advantages of disruptive technologies. |
| | In this section the business models of 'unicorn' companies were explored and contrasted with traditional business models. |
| 4) Theories of Disruption | Objective 4: Understand and be able to apply the relevant theories to evaluate disruption. |
| | This section focused on the theory of disruptive innovation and how to evaluate a disruptive technology given the theory. |
| 5) Design Thinking | Objective 5: Be able to apply design thinking to disruptive problems for innovation. |
| | This section of the course introduced the design thinking methodology of Stanford University, given the context of disruptive technologies and business models. |

Assessment during the course consisted of formative assessment using four preparation assignments that students had to submit before class, as mentioned. Summative assessment was done through a mid-term semester test assignment on the first three topics, as well as the final examination assessment, which was a 48-hour take-home assignment. The examination assignment consisted of six questions on the whole syllabus, but was somewhat biased towards the last topics, since the first topics had already been assessed. The examination assignment used the context of a case study of universities of the future and the possibilities of disruption of higher education, given technologies such as MOOCs and online learning platforms. The paper followed the design thinking methodology and expected students to apply the knowledge presented in the course, given the future higher education context.

## 4 Case Study Evaluation

Our first task was to map the objectives of the module to the Bloom Taxonomy Table. The first objective for the module was '*Objective 1: Understand what disruptive technologies are, as well as what is meant with terms such as disruptive innovation, digital disruption, digital transformation and disruption revolution*'. For this objective the student needs to *analyze* and differentiate between concepts. Only *factual knowledge* is needed and it is therefore mapped on the Bloom's Taxonomy Table in cell A4, abbreviated as O1 (Objective 1). Objective 2 (O2) was defined to be 'Understand the technological landscape and the unique characteristics of modern technological developments that support and underpin disruption.' For this objective a student should be able to classify, explain and compare facts, using factual knowledge. O2 is therefore mapped to cell A2.

Similarly, 'Objective 3: Understand the characteristics of business models that are typically threatened by disruptions or that are able to harness the advantages of disruptive technologies', expected students to compare and explain matters using factual knowledge and was therefore also mapped to cell A2. For Objective 4, 'Understand and be able to apply the relevant theories to evaluate disruption', we expected the students to apply the theory in order to evaluate a disruptive technology. The mapping was done in cell B5 where the knowledge domain is conceptual. Lastly, for Objective 5, 'Be able to apply design thinking to disruptive problems for innovation', we expected the student to use the design thinking methodology to create a solution, given the context of disruptive technologies and business models. The knowledge needed for this type of requirement is procedural knowledge, where the methods are playing a role. The focus is on the creation and therefore we plotted the objective in C6.

**Table 4.** Mapping of the course objectives.

| | **Cognitive Process Dimension** | | | | | |
|---|---|---|---|---|---|---|
| **The Knowledge Dimension** | **1 Remember** | **2 Understand** | **3 Apply** | **4 Analyze** | **5 Evaluate** | **6 Create** |
| A. Factual Knowledge | | O2<br>O3 | | O1 | | |
| B. Conceptual Knowledge | | | | | O4 | |
| C. Procedural Knowledge | | | | | | O5 |
| D. Metacognitive Knowledge | | | | | | |

In order to link the goals and the assessment with one another, our next step was to map the summative assessment done using Bloom's Taxonomy Table. For the mid-semester assessment students had to complete an assignment and for the final assessment students were given a 48-hour take-home assignment. They could use any resources available to complete the assignments and all submissions were checked for plagiarism using TurnitIn.

In the test assignment students were asked to choose either blockchain or crypto currencies as a disruptive technology. Test question 1 (TQ1) asked students to do a thorough literature review on the chosen technology with proper citations and referencing. TQ2 and TQ3 asked students to do an evaluation of the chosen technology given two distinct methods included in the syllabus. TQ4 asked students to apply the theory of disruptive innovation to the technology.

For the examination assignment students received a case study describing the possibility of disrupted higher education given the characteristics and demands of millennials as well as the unique profile of South African students. The first two questions, Examination Question 1 and Examination Question 2 (indicated as EQ1 and EQ2) requested the student to provide short literature reviews of the higher education institution and the student of the near future. Examination Question 3 (EQ3) requested the student to "Apply the five modes of the Stanford Design Thinking methodology to the scenario described …" and to "summarise each mode with reference to the future of South African higher education and how you would execute each mode". EQ4 requested students to 'Execute the Empathy Mode of the Stanford Design Thinking methodology ...' and to 'develop two composite character profiles'. EQ5 requested the student to use the results of his/her empathy mode and execute the define mode of the Standford Design Thinking methodology by using the point-of-view (POV) Madlib method card to *develop* a POV for disruptive higher education in South Africa. EQ6 asked the student to use the results of his/her empathy and define modes, and then to *execute* the ideate mode of the Stanford Design Thinking methodology. Q6.1 asked the student to identify applicable disruptive technologies and argue why they are disruptive, and for EQ6.2 the student needed to propose solutions to the identified POV of the previous questions. EQ7 expected the student to apply the theory of disruptive innovation and evaluate his proposed solution. The last question, EQ8, requested the student to use the results of his/her executed modes of the Stanford Design Thinking methodology, and design an exponential organization.

In order to map the assessment to Bloom's Taxonomy Table, we first had to map questions to objectives. We immediately realized that for the first questions in both assessments (TQ1, EQ1 and EQ2) we expected students to do literature reviews where we assessed synthesis of the literature and referencing, but we never set a course objective for these skills. The remainder of the questions where mapped by placing the objective before the question, e.g. because TQ2 and TQ3 asked students to evaluate disruptive technologies, they mapped to Objective 2 indicated by O2:TQ2 and O2:TQ3. All the assessment questions were thus mapped to course objectives.

For placement of the questions along the knowledge dimension, we categorized the literature review questions as factual knowledge. The students were required to be able to organize and differentiate maps to analyze cognitive process dimension, and the questions were plotted in cell A4. The placement is shown as TQ1, EQ1 and EQ2 in Bloom's Taxonomy Table (Table 5).

**Table 5.** Mapping of the assessment questions.

| | Cognitive Process Dimension | | | | | |
|---|---|---|---|---|---|---|
| **The Knowledge Dimension** | **1 Remember** | **2 Understand** | **3 Apply** | **4 Analyze** | **5 Evaluate** | **6 Create** |
| A. Factual Knowledge | | | O5:EQ4 | TQ1, EQ1, EQ2 | | |
| B. Conceptual Knowledge | | | O5:EQ3 | | O2:TQ2, O2:TQ3, O4:TQ4, O2:EQ6.1, O4:EQ7 | O5:EQ5, O5:EQ6.2, O3:EQ8 |
| C. Procedural Knowledge | | | O5:EQ3 | | | |
| D. Metacognitive Knowledge | | | | | | |

Regarding the test assignment, all the questions (TQ2, TQ3 and TQ4) required an evaluation given conceptual knowledge of different topics or objectives. For placement on the knowledge dimension we selected cell B5 and indicated the placement with O2:TQ2, O2:TQ3 and O4:TQ4, indicating that TQ2 and TQ3 assessed Objective 2 and TQ4 assessed Objective 4.

Regarding the examination assignment, EQ3 requested the student to “Apply the five modes of the Stanford Design Thinking methodology to the scenario described …”, and further to “summarise each mode with reference to the future of South African higher education and how you would execute each mode.” For our placement on the knowledge dimension we argued that conceptual knowledge is needed since the interrelationships among basic elements within a larger structure plays a role. For the cognitive process dimension, the student was involved in understanding and applying the work and therefore we place the question (EQ3) in B3 as O5:EQ3 (indicating that we were assessing Objective 5). However, the student was also required to apply procedural knowledge to the case study, which places the question in cell C3 (the application of procedural knowledge).

EQ4 requested students to execute and develop given Design Thinking (Objective 5) and this question was placed in cell A3, since the expectation related 3.1, executing, and 3.2, implementing, as described in Table 1. EQ5 requested the student to use previous results and execute and develop, using a given method card. Regarding this question, creation played a central role, where different concepts from Objective 5 needed to be related in answering the question and therefore we placed it in cell B6 as O5:EQ5. For EQ6.1 the student was expected to use previous results and then to execute, thus looking for relationships between characteristics of disruptive technologies (Objective 2). The question therefore maps towards conceptual knowledge. The student furthermore had to evaluate and therefore the placement was in cell B5 as O2:EQ6.1. For EQ6.2 the student needed to propose solutions to a problem and the question was placed in B6. EQ7 expected the student to apply and evaluate, given the theory of disruptive innovation (Objective 4) and O4:EQ7 was therefore placed under conceptual knowledge and evaluation in cell B5. The last question, EQ8 requested the student to use previous results and design an exponential organization (Objective 3). We placed the question on B6 as O3:EQ8, since the student was required to link concepts and then to create a solution.

The next step in our alignment of the objectives and assessment was to illustrate on one single table both the objectives and the assessment questions in order to discuss the alignment (Table 6). This table can be used to do an evaluation of the alignment of course objectives and summative assessment. Alignment is present when the objective and assessment appear in the same cell. The results will be discussed in the next section.

**Table 6.** Alignment of objectives and assessment.

<table>
<tr><th></th><th colspan="6">Cognitive Process Dimension</th></tr>
<tr><th>The Knowledge Dimension</th><th>1<br>Remember</th><th>2<br>Understand</th><th>3<br>Apply</th><th>4<br>Analyze</th><th>5<br>Evaluate</th><th>6<br>Create</th></tr>
<tr><td>A. Factual Knowledge</td><td></td><td>O2, O3</td><td>O5:EQ4</td><td>O1,<br>TQ1,<br>EQ1,<br>EQ2</td><td></td><td></td></tr>
<tr><td rowspan="2">B. Conceptual Knowledge</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">O5:EQ3</td><td rowspan="2"></td><td>O4<br>O4:TQ4,<br>O4:EQ7</td><td>O5:EQ5,<br>O5:EQ6.2</td></tr>
<tr><td>O2:TQ2,<br>O2:TQ3,<br>O2:EQ6.1</td><td>O3:EQ8</td></tr>
<tr><td>C. Procedural Knowledge</td><td></td><td></td><td>O5:EQ3</td><td></td><td></td><td>O5</td></tr>
<tr><td>D. Metacognitive Knowledge</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

## 5 Discussion

According to Anderson et al. [1], it is possible to determine one's degree of alignment by correlating one's objectives, instruction and assessment. In our case we used Bloom's Taxonomy Table similar to some examples provided by Anderson et al. [1] to determine how the objectives and assessment questions align (Table 6). Given the case study and mapping of objectives to assessment, we detected some alignment, as well as substantial misalignment, as will be indicated in the list below. We also include remediating actions in the list.

- TQ1, EQ1 and EQ2 asked students to complete a literature review, but the ability to do such a review was never formulated as an objective. Since this is a postgraduate course, students will be exposed to literature reviews; however, if the ability is assessed, it should be a course objective and such a course objective was added for 2018;

- Similarly, Objective 1 (O1) was placed in A4 but never assessed during summative assessment. We realized, however, that O1 was assessed during the preparation assignments, but summative assessment of this objective should ideally also be included in 2018.
- Objectives 2 and 3 (O2, O3) were placed in cell A2; however, these were assessed in cells B5 and B6, which indicates substantial misalignment. The objective only stated that the factual knowledge of the content should be understood. However, during assessment we expected students to be able to evaluate and create using conceptual knowledge of the content. After consideration of what we wanted to achieve with this course at postgraduate level, we decided to reformulate the objectives for 2018 judiciously to ensure placement in cell B5 at least – a movement of a row on the knowledge dimension and 3 columns on the cognitive process dimension. We also decided that the assessment criteria should be carefully reconsidered with regard to the 'create cognitive dimension' since possibly only evaluation is necessary for a course at Honors level.
- Objective 4 (O4) was assessed correctly, possibly because the topic concerned the application of theory and it was assessed as such in both assessments.
- Objective 5 (O5) was mapped as C6 but assessed in A3, B3, C3 and B6. We therefore originally expected the student to be able to create or produce new procedural knowledge, but we only assessed creation on the conceptual level (B6). The A3, B3 and C3 assessment is not problematic, as it assesses building blocks of Objective 5. We scrutinized the reasons for the misalignment of O5 and its assessment, and realized that it is a challenge to assess the creation of procedural knowledge with written assignments. Assignments are more suitable for the assessment of conceptual knowledge, hence the B6 mapping. Procedural knowledge could be assessed, for example, using a practical implementation.

## 6 Guidelines for Using Bloom's Taxonomy Table to Align Objectives and Assessment

As mentioned in section 3, we used an iterative post-module presentation approach to align the objectives with the assessment. As evaluation tool this worked perfectly well, but if one wants to use the table as guiding tool, it is imperative that the tool should be used at the beginning of the course when the objectives are set. During the evaluation process we made notes on practices used took part in a discussion session where these notes were formalized into guidelines. For novice users of Bloom's Taxonomy Table, we advise the following:

- Always use Bloom's Taxonomy Table at the beginning of the course to identify objectives that fit the level of learning required on the cognitive process dimension for the course (for example in South Africa NQF levels are used to indicate the level of learning).

- Bloom's Taxonomy Table assumes that the columns further to the right in cognitive process dimension include the preceding processes in columns to the left. Assessment questions need to be mapped to the appropriate cognitive process dimensions, but in the beginning of the course it might be appropriate to assess lower levels of cognitive process dimensions, as long as the final assessment aligns with the dimension set by the course objectives.
- If misalignment occurs on the cognitive process dimension, the implications are that lower assessment levels benefit students, however the lower assessment levels affects the quality of the course since objectives are not appropriately assessed.
- All knowledge dimensions included in the objectives need to be assessed during the course.
- The semantics of terms used in objectives and assessment, e.g. understand, apply and evaluate need to be used appropriately. Careful wording with descriptions should be used so that misunderstandings and misalignment are prevented.

## 7 Conclusion

Education is one of the oldest fields in research and one of our core responsibilities at higher education institutions is to be involved in teaching and learning. Staff teaching information systems often teach without prior training in education practices and find the available tools overwhelming. In this paper we firstly provided a synopsis of how Bloom's Taxonomy Table can help the information systems lecturer to offer a course at the right level and then to evaluate how the goals align with the assessment. The value of the case study is that we often understand better when we see examples related to our own field of study. Secondly, we provided a set of guidelines to be used by lecturers interested in using the Bloom's Taxonomy Table as alignment tool. As lecturers we found the tool valuable and it gave us insight into how we should reconsider our goals set for the course. It also showed us the value of using the right semantics during your goal setting and assessment in order to ensure alignment. We will recommend its use as an evaluation tool, but mostly as a planning tool during goal setting and alignment of assessments.

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# An Exploration of Levels of Learning and Levels of Reflection in a South African Higher Education Experiential Learning Assignment

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**Abstract.** Reflection is fundamental to experiential learning. Observations from an experiential learning assignment in a business process management course at a South African university found that learners' understanding of reflection was inadequate. Furthermore, for reflection assignments, learners exhibited multiple levels of understanding of the requirements. This paper takes a constructionist grounded theory approach to explore similarities between levels of learning, reflection, inquiry, listening and observed data. A theoretical lens set was derived from the theories and data, and confirmed through further observations. The outcome confirms the existence of levels of learning and levels of reflection that are relevant to learners. The levels range from understanding knowledge as an absolute truth to truth itself being contextual. However, the observed level of reflection differed to the level of learning for the learners. Guidelines are presented for recognising the present level at which the learner operates.

**Keywords:** Levels of reflection, Levels of learning, Experiential learning, Constructionist grounded theory.

## 1 Introduction

This paper emerged from a longitudinal action research study into the effect of reflection in an experiential learning assignment for a business process management course at a third-year and fourth-year university course. A desire to improve grades in the final examinations of the two courses motivated the original study. The courses were similar and based on the foundational principles of experiential learning for which Kolb's Experiential Learning Theory (KELT) is one of the best known [10,16]. KELT posits that experiential learning provides higher levels of learning.

The business process management course comprised a period of training followed by an assignment in a work situation at sponsor companies before the final exam for the year. The fundamental assumption was that the experiential assignment would enhance classroom learning and lead to higher grades in the final examination. Although this premise was observed to be true before the study, the improvement in grades was lower than anticipated. For example, in 2015, third-year level learners attained 56.2% before the assignment, 63.7% for the assignment, and 57.3% for the final examination.



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Post-graduate learners attained 64.0% before the assignment, 60.3% for the assignment, and 65.9% for the final examination.

Due to an extraordinary situation in 2016, some learners were tested two months after the official examination where they attained lower average grades (44.1%, n=29) than the average for the official final examination (52.7%, n=46). One of the later-examined learners was examined verbally and had retained insufficient to attain a pass mark for the examination. This indicated that retention of knowledge was limited and not improved through the experiential assignment as posited.

Interventions were planned and undertaken to improve reflection amongst the learners without making fundamental changes to the course. During these interventions, it was noted that learners required varying levels of support. Some learners required formulas while others sought mere guidelines. Some learners asked for assistance, some required affirmations and others refused to complete the sections on reflection.

This paper set out to explore the levels of learner learning and reflection observed during three action research cycles. The paper aimed to identify what levels of learning and reflection existed amongst learners during an experiential learning assignment. Two questions were set: What levels of learning of learners can be identified during the experiential-learning assignment? And, how do these levels relate to observed levels of reflection? A sub-question considered how the individual levels are recognised by educators.

To answer these questions, a constructionist grounded theory-guided approach [3] was used to combine theory and practical data into a coherent map of learning levels juxtaposed with levels of reflection.

This paper contributes to knowledge by determining four levels of learning and linking them to four levels of reflection in an experiential learning assignment. The hope is for dialogue for further research in other subject areas and teaching methods.

The paper proceeds as follows. In section 2, background to the research is provided. Section 3 supplies an overview of constructionist grounded theory as the methodology for the paper, followed by a literature review leading to the development of a theoretical lens for the research in section 4. Section 5 applies the theoretical lens to the third action research cycle before the conclusion in section 6.

## 2 Background

Reflection is an essential component of experiential learning [16]. However, during our research it was found to be taken for granted by learners who applied little effort in doing reflection. Consequently, an intervention was designed around the reflection phase of the experiential learning assignment. Low reflection grades were initially ascribed to low marks allotted for the section on reflection (5%), the difficulty of self-reflecting, and time-pressures on the learners. Each of these issues applied to the assignment as a whole. According to one learner, “the assignment is very long, the sections might have relatively little marks allocated but the work one is required to put [in] is quite a lot”, Learner 2A.

Reflecting on feedback from learners, it appeared that learners had difficulty in reflecting and were looking for a formula. This resulted in them either providing a perfunctory report or ignoring the reflection section. To counteract this, changes were made in the first action research cycle: the allotted marks for reflection were increased to 9%; the learners were supplied the marking rubric; and were requested to self-grade their work. Even with the increased allotted mark, several learners did not undertake the reflection part of the assignment. The outcome of this intervention resulted in a 70.0% grade before the assignment, 59.2% for the assignment excluding the reflection component, and 52.4% for the final examination. Thus, instead of improving, the grades weakened.

The underlying belief at that stage was that the learners required motivation for their reflection. The findings were analysed for indications of motivation in completing the assignment and were presented at a conference [9] and are summarised here. Some learners went to great lengths to prove that effort or understanding motivated them, others that they had followed the task, and some that they had done a quality or aesthetically pleasing piece of work.

- **Task.** Tasks are also referred to as assigned goals [18], and are fundamental to assignments. "… compiled a report of which we believe covers the brief …", Team D.
- **Effort.** Effort was a recurring concept. "Great effort … Major effort … Lots of effort …", (Team K). "… we put in weeks and weeks of hard work …", Team R.
- **Understanding.** Explicit use of the word 'understanding' was frequent: "good understanding"; "in-depth understanding"; and to "gain a better understanding". The learners appeared to be aware of something deeper than pure knowledge or an absolute truth as their need for understanding emerged only after the initiation of the assignment. "… we had to sit together and try and work out what was required by us and how we could provide a solution …", Team F.
- **Quality.** Some teams considered quality as necessary, using terms such as "quality", "comprehensive", "clear", and "orderly". "… to work hard producing a quality presentation", Team L. It was inferred that the aim was to go beyond purely completing the task.

Varying degrees of the four motivations were also combined by learners, with the most effective being effort and understanding [9].

It was noted that the reflections were only done at the end of the assignment during the preparation of the deliverable rather than being maintained during the assignment, thus they were in the form of reflection-on-action. In the subsequent cycle, an intervention was undertaken to encourage the maintenance of reflective journals for reflection-in-action. A special training session was held to present what reflection is, what journals are and options to complete them. This intervention proved to be unpopular with the learners with only half of the class completing journals; mostly on an irregular basis. From the training session and journals, it was once again noted that many learners sought guidance on how to present their reflections. This led to the presentation of a reflective practice formula. While some followed the formula, it limited their freedom for reflection. The outcome of the cycle showed a mix of demanding a reflection formula, the need for more knowledge, and a realisation that there may be multiple ways to answer the question. They showed some appreciation for contextual processes, but overall the learners sought a correct or 'true' answer.

While some learners supplied minimal responses, others engaged with their reflection. Nevertheless, the learners conflated the reflection and operational parts of the assignment. Consequently, where guidance was sought or issues encountered there was often no differentiation between reflection and action.

- **Reflection formula**. Some learners sought fixed guidelines from the educator on how to do reflection. "It took me several hours as I had to consider rules around BPMN, and notations, labelling tasks and ensure everything is according to the business process as-is as opposed to what I think should be happening", Learner 2G. "I felt isolated being so far away from [the university] where I can get guidance from a lecturer or use the [university] facilities", Learner 2G. "It is important to me that I have a clear understanding and that Professor knows and understand my process", Learner 2J. "What went well? The template given to us to do our reflective journals didn't know where to even start without this template", Learner 2N.
- **Need for more knowledge and dependence on educator**. Other learners realised that they needed additional knowledge and were reliant on the educator to supply it. "I do require some assistance/ revisiting on some of the Assignment sections which seems to be a bit 'tricky'", Learner 2A. "The document/spec for the assignment was a little confusing as to what format is required", Learner 2G. "Finding the right questions to ask the interviewees … Would have liked a list of questions to ask", Learner 2N.
- **Multiple realities.** In contrast to those learners who assumed that they lacked knowledge, some learners noted that their understanding of a situation did not necessarily reflect the reality of that situation. "It took me several hours … [to] ensure everything is according to the business process as-is as opposed to what I think should be happening", Learner 2A. "They believe that the discussions should have been facilitated [by] management, this is a reflection of the company's organisational structure which promotes working in silos, hierarchical and functional", Learner 2J.
- **Context**. – Albeit limited, some learners went further in noting that context is important. "[The people] interviewed are not willing to change or open to any improvement suggestions, they feel or believe that the process has been working for long and if I was interviewing them with the view to change it I must not interfere with their work. They feel that they understand the process [with] few issues caused by resources need to be resolved, they were only looking at the problem from one perspective not understanding the entire business process", Learner 2J.

Reflecting on the preceding, it was evident that KELT was not operational. Firstly, the cycle was incomplete with only the experience and reflection phases being utilised, and secondly, the learners' limited evidence of understanding of reflection. Not completing the cycle was not an issue as KELT is misunderstood as a cycle although each phase is independent [22], or 'polarised' according to Mezirow [20, p.6]. To provide a clearer understanding of these observations and to make sense of the observations, a literature review was undertaken. As this review was based on data anomalies and existing theory, the constructionist grounded theory proposed by Charmaz [3] was considered appropriate to guide the review and the subsequent research.

## 3 Constructionist Grounded Theory

Constructionist grounded theory is based on the belief that knowledge is socially constructed and contextual and that social activities must be retained when developing theory. It resembles objectivist grounded theory in its realist approach but differs from its naivete. Realism in objectivist grounded theory means that generalisation is possible and useful for explanation and prediction. Data is considered generic and thus ignores context. On the other hand, the constructionist view not only acknowledges context but incorporates the data. This is accomplished by constructing data categories rather than determining theory that could emerge from the data [3].

The constructionist precepts encourage the incorporation of existing knowledge and theory into the research. Active participation of researchers, the data and the participants is encouraged as is reflection by the researcher. Together this enables answering questions of not only what and how, but also of why [3]. Consequently, the research is a combination of exploration (what and how) and explanation (why) which is based on the radical humanist and interpretive quadrants [2,4]. However, according to Burrell and Morgan [2] and Cronje [4], the two are mutually exclusive. Nevertheless, Charmaz [3] regards understanding (which equates to Cronje's exploration) and explanation as 'not entirely mutually exclusive' (p. 398). This resonates with the view of Garbutt [8] who suggests that each of the quadrants exist in part within each of the other quadrants providing that in each case the primary quadrant remains dominant.

### 3.1 Principles for Doing Constructionist Grounded Theory

Charmaz [3, p.403] provides a set of principles for constructionist grounded theory which she calls assumptions. Central to her assumptions is awareness of the effect that context and interactions of the researchers and participants play in the research.

- **Assumption 1**. Reality is constructed, contextual, multiple, and processual.
- **Assumption 2**. The research process develops through interactions between researcher and participants.
- **Assumption 3**. The contexts of researcher and participants are taken into consideration.
- **Assumption 4**. Data is co-constructed as a research outcome and not purely observed.

In all, this requires that constructionist grounded theory research be neither a prescribed nor a rigid process but critically examines knowledge construction in a reflexive and dependent manner.

### 3.2 Guidelines for Doing Constructivist Grounded Theory

Based on the above principles, Charmaz [3, p.403] provides four guidelines for constructionist grounded theory.

- **Guideline 1**. Manage the research process as socially constructed as grounded theory is neither a set of rules nor a recipe. It must be recognised as emergent with new understandings being constructed on existing knowledge.
- **Guideline 2**. Examine research decisions and guidelines as thinking and reflexivity are fundamental in constructing understanding from the emergent concepts.
- **Guideline 3**. Improvise methodological and analytic strategies throughout the research process as emergence and reflexivity are not linear and may require improvisation for analysis and knowledge construction.
- **Guideline 4**. Gather sufficient data to understand research participants' philosophies (ontology and epistemology) as to effectively co-construct knowledge it is necessary to understand the worldviews of the participants.

As with all research, reliability needs to be addressed. In this paper, triangulation is obtained from literature and validity through the literature review process. To limit the potential researcher bias, reflection played a significant role in the research [17].

## 4 Learning and Reflection Literature Review

The literature review began with Kolb's experiential learning and its critics. This led to the identification of two forms of learning, informing or transforming. Experiential learning, including reflexivity, is considered part of the latter, however, information is required before transformation.

### 4.1 Kolb's Experiential Learning Theory

KELT was developed as a 'holistic model of the experiential learning process and a multi-linear model of adult development' [16, p.194]. Although KELT is typically represented as an emergent cycle, Miettinen [22] disagrees with this view. According to him, KELT was established to support Kolb's learning styles and that the Lewinian cycle is misleading as each phase is distinct as stated by Kolb himself. Although Miettinen [22] stresses the influence of Jean Piaget, John Dewey, and Kurt Lewin, Kolb and Kolb [16] include William James, Carl Jung, Paulo Freire, Carl Rogers, and 'others'. From these authors, Kolb and Kolb [16] synthesise six experiential propositions.

- **Proposition 1**. Learning is a process in which learners need to construct knowledge through continual engagement with experience.
- **Proposition 2**. Learning is relearning requiring reflective integration of existing knowledge with new concepts.

- **Proposition 3**. Learning occurs through resolving conflicts between existing knowledge and new concepts which imposes the alternation between action and reflection and thinking and feeling.
- **Proposition 4**. Learning is internally holistic, requiring the whole person to be involved in the process of integrating perceiving, acting, thinking and feeling.
- **Proposition 5**. Learning is externally holistic, between the person and their environment as a synergistic relationship with the person influencing their environment and being influenced by it.
- **Proposition 6**. Learning creates knowledge in a constructivist manner through creating and recreating social knowledge from personal experience contrary to the typical educational view of the transmission of knowledge.

Overall, KELT is transformational with reflection at its crux which has been extended by some authors. For example, in Gibbs' reflective cycle theory and practice is considered as an iterative cycle [24].

### 4.2 Criticism of Experiential Learning

KELT has been severely criticised to the extent that Kolb and Kolb [16] endeavoured to improve KELT through appealing to neuroscience. According to Schenck and Cruickshank [26], this has resulted in an 'epistemic fallacy' or epistemological contradiction which conflates the stages of the learning cycle stages and the modes of learning. They use the term 'interchanging' stages with modes (p.75). The primary issue is that the model conceptualises cerebral cortex activity as a single process which cycles through each stage of learning.

Miettinen [22, p. 54] describes KELT as 'Kolb's eclectic method of constructing his model of experiential learning. It studies how Kolb introduces and uses the Lewinian tradition of action research and the work of John Dewey to substantiate his model'. Thus, Lewin's action research is perceived as a focal theory and Dewey's as instrumental theory. A focal theory is central to activity whereas instrumental theories instantiate the focal theory and provide mechanisms against which to test its veracity [6]. However, Miettinen [22] concludes that Kolb interprets Dewey's thought incorrectly, and thus he believes that KELT's concrete experience is epistemologically problematic.

For Miettinen [22, p.56], 'eclectic' means heterogeneous, miscellaneous, varied, diverse, but not wide-ranging. Furthermore, he considers KELT as being built on incorrectly interpreted data. Although Kolb calls his cyclical model 'Lewinian', he does not cite Lewin according to Miettinen [22, p.57]. While Miettinen acknowledges the quality of Kolb's source Ronald Lippit, he deems Kolb to have used the data 'very selectively' [22, p. 57]. Miettinen quotes Kolb as referring to each phase as 'a different form of adaptation to reality', a 'learning mode', and a 'separate individual ability' [22, p.61]. In so doing the phases are distinctive and, in contrast to the typical KELT diagram, not interconnected. Consequently, experience and reflection are distinct entities.

Kolb refers selectively to Dewey which is problematic for Miettinen [22, p.64] as Dewey is used out of context in support of Kolb's learning styles. Even though learning styles have been in vogue for many years, there is a strong belief amongst educators that they are ineffective. Some authors, such as Kirschner [14], go so far as to say that they should be done away with as there is no evidence of them leading to improvement of learning outcomes. A decade earlier Kirschner had suggested that experiential learning was failing due to inherent minimal instruction [15].

In contrast to KELT, Dewey's model of reflective thought and action which Kolb refers to as 'experiential learning' [22, p.64] is interconnected. As a pragmatist, Dewey regards everyday material activities as distinct from experience which takes two forms, material and reflective. Material experience involves non-reflective habits based on material activities while reflective experience occurs when these habitual experiences are disrupted.

For reflection to occur, Daudelin [5] suggests that three things are required: (a) an understanding of the process of reflection; (b) an understanding of which reflective processes best construct knowledge from experience; and (c) tools that help to use reflection as a technique for learning. Accordingly, reflection needs to be developed.

### 4.3 Developmental Learning – Informational Learning and Transformational Learning

Knowledge building through developmental learning comes in two forms: informational learning, which adds knowledge to that which is already known; and transformational learning, which first changes what is known before adding new knowledge. Whereas informational learning is limited by personal philosophy, transformative learning can overcome limitations by inducing change to the underlying philosophy which may result in increased capacity for informational learning [12].

Mezirow [21] describes transformational learning as an epistemological form of metacognitive reasoning that transforms 'frames of reference' [21, p.58]. A frames of reference is 'a set of assumptions that structure the way we interpret our experiences' [20, p.1]. Frames of reference comprise two dimensions, habits of mind and points of view. These impact levels of learning through the evolution of understanding of activity that leads to changes in subsequent actions [20]. This evolution of understanding comprises two processes: meaning-forming; and reforming-meaning [12]. Meaning-forming is the process of constructivism which involves constructing meaning from internal or external experiences combined with prior experiences. Reforming meaning, on the other hand, is a meta-process that changes not only the meaning but the method of forming meanings [12]. Dirkx [7] provides a holistic stance for transformational learning. He suggests the use of both logos and mythos to combine analytical logic with the symbolic contemplative consciousness of 'soul' which is nourished through aesthetics and supports imagination in the expansion of self-knowledge. Dirkx [7] centres on experience and culture change through reflection towards a higher level of self-awareness and societal consciousness.

However, not all authors support transformational learning. Newman [23], for instance, suggests that the term 'transformational' learning should be replaced with 'good' learning. Transformation through learning must be verified by the learner which makes it highly subjective and according to Cranton [in 23] the only appropriate method for research. Thus, objective research into transformational is not appropriate, and generalisation of findings is questionable. Our observations reflect Newman's [23] reasoning and resonate with the lack of empirical findings of improvements in learning through transformational learning programs [1]. To be effective, transformative learning requires reflection, reflective action, and reflexivity [1,20,21]. However, reflection must be learnt. Consequently, reflection is not in itself transformative and must be treated as informational learning where it is subject to levels of learning.

### 4.4 Levels of Learning

Helsing, Drago-Severson, and Kegan [11] suggest the use of a Piagetian developmental approach as a form of transformational learning to introduce new concepts such as reflection. Through the analysis of five adult learning models, they define four levels of development learning. Helsing et al. [11] support their espoused levels with learners' perceptions of the educator. They suggest that the learners' evaluation of the educator provides a rubric which could indicate the level of the learner. Knowledge of the learner's developmental level assists the educator in providing methods suitable to the individual. However, although the levels appear to be distinct, they are interconnected by multiple transitional steps which may be observed as the learner moves between levels.

- **Level 1 – Absolutist**. Learners take an absolutist stance to knowing based on a dualist philosophy. For them, knowledge is directly observable and either true or false. At this level, educators are expected to be sources of clearly communicated, accurate knowledge which is provided with clear instructions and rules on how to obtain the true answers.
- **Level 2 – Transitionalist**. Transitional knowing disrupts the dualist view with learners having an awareness of incomplete knowledge. Learners advance beyond pure knowledge acquisition to understanding and seek opportunities to apply their new knowledge. Learners tend towards a more emotional interaction with educators, seeking acknowledgement and encouragement for their learning and rapport with the educator.
- **Level 3 – Relativist**. Learners begin to recognise that rather than a simple lack of knowledge, truth itself is relative. They realise that multiple non-finite versions of truth exist. This level is characterised by openness to new ideas and provides the basis for critical thinking. Nevertheless, learners need to develop reflective practices and methods for evaluating multiple considerations of truth. Learners tend to develop their own perspectives and seek opportunities to share them with peers. In turn, they recognise peers as knowledge sources, but they do not trust their interpretations of acquired knowledge. Relativist learners seek affirmation from educators who must support learners and encourage independent thinking.
- **Level 4 – Contextist**. The level 4 stance extends beyond the relativist in taking cognisance of the context of knowledge creation. Learners evaluate the background to information and the process by which it was acquired. They acknowledge authorita-

tive sources but do not take them as determinants of absolute truth. They take responsibility for their learning and have developed methods for self-evaluation of their own complex ideas. Contextist learners require educators to facilitate learning by using multiple teaching strategies and to encourage corroborative argumentation.

### 4.5 Levels of Inquiry

The levels of learning resonate with levels of inquiry proposed by MacKenzie and Bathhurst-Hunt [19] in their forthcoming book. They define four types of learner inquiry which they designate in increasing levels of freedom of choice as structured, controlled, guided and free. The four types have a reducing scaffolding requirement as they progress from lower to higher levels.

- **Level 1**. Structured inquiry has the highest level of scaffolding with learners' dependent on specific guidelines for learning.
- **Level 2**. Controlled inquiry requires less scaffolding with learners deepening understanding through the educator's provision of multiple contextually similar resources.
- **Level 3**. Guided inquiry further reduces scaffolding with learners providing their own resources to answer guided questions from the educator.
- **Level 4**. Free inquiry provides the lowest level of scaffolding with learners providing both the questions for inquiry and resources necessary to answer the questions and the educator acting as facilitator.

The involvement of educator resonates with Mezirow [21] who sees the need for direct intervention by educators in promoting critical reflection in learners which leads to critical thinking.

### 4.6 Levels of Reflection

Mezirow [20] defines multiple forms of reflection advocating critical reflection as the most effective form of reflection that could lead to transformation. However, the potential for action is not the same as taking action, and consequently, Mezirow [20] acknowledges that people must be motivated to understand their situation better. The potential for levels of reflection is seen in his consideration that critical reflection goes beyond 'how' and 'how-to' of action to concentrate on the 'why' [20].

Kember et al. [13] empirically tested four levels of reflection: habitual action/non-reflection; understanding; reflection; and critical reflection.

- **Level 1**. Habitual action takes place when a process, which has been undertaken many times before, is followed automatically without further consideration. It is associated with surface learning and called non-reflection as the learner may not understand the process, and consequently, no alternatives are considered. Learners at this level are absolutists and paraphrasing is common, often with evidence of plagiarism.
- **Level 2**. Understanding occurs when learners seek to comprehend subject matter and look at what the author of the subject matter means. Understanding, typically, does

not require reflection and consequently is not put into practice. New knowledge is either not assimilated into the learners understanding or has a short half-life. Learners' work may accurately reflect theory, but there will be no application in practice.

- **Level 3**. Reflection allows the learner to understand information by relating it to personal experience and applying it in practice. Together knowledge and experience form personal meaning of the subject matter with learners including personal insights into their knowledge.
- **Level 4**. Critical reflection is the domain of Dewey, Mezirow and Habermas. Critical reflection has transformative properties and can change the learners set of beliefs and presumptions and are most commonly seen in learners in the early understanding stages of a concept before assumptions become entrenched.

### 4.7 Levels of Listening

The practice of reflexivity, however, is best suited to analytical methods and is not as useful in solving unstructured or wicked problems. To this end, Potter [24] suggests the combination of Gibbs' Reflective Learning Model, which extends KELT, and Scharmer's Theory U. Theory U proposes four types of 'listening': downloading, factual, empathic, and generative [25, pp.2–3].

- **Type 1**. Downloading is the form of listening that reconfirms habitual judgments. "Yeah, I know that already."
- **Type 2**. Factual listening is object-focused and pays attention to facts and new or disruptive data without judgment. The focus is on what differs from what is already known and is the fundamental mode of science where the data is paramount. "Ooh, look at that!"
- **Type 3**. Empathetic listening is deeper than factual listening and is aware of the movement from the objective world of facts (the "it-world") to a living and evolving self. It extends into how others feel and begins to see the world with other eyes. "Oh, yes, I know exactly how you feel."
- **Type 4**. Generative listening connects us to a deep 'realm of emergence' which is listening 'from the emerging field of future possibility' and leads to an altered state. 'Communion' or 'grace' is maybe the word that comes closest to the texture of this experience. "I can't express what I experience in words. My whole being has slowed down. I feel more quiet and present and more my real self. I am connected to something larger than myself".

### 4.8 Theoretical Lens Model

The literature shows a series of levels against which to measure the effects of informational learning on reflection in the business process management assignment. The four levels of learning [11] map to the four styles of learner inquiry [19], the four levels of reflection [13], the four levels of listening [25], and the four motivations [9] as shown in Table 1.

**Table 1.** Comparison of the four levels of learning, inquiry, listening, reflection, and motivation.

| Level | Four Levels of Learning [11] | Four Styles of Inquiry [19] | Four Levels Reflection [13] | Four Levels of Listening [25] | Four Motivations [9] | Implications / Keywords |
|---|---|---|---|---|---|---|
| 1 | Learners take an absolutist stance and expect clear instructions and rules on how to obtain true answers. | Structured inquiry has high levels of scaffolding and learner dependency. | Habitual action takes place when a process is followed automatically without further consideration. Learners are absolutists and paraphrasing is common. | Downloading is the form of listening that reconfirms habitual judgments. | Task | Habit, Absolutist knowledge |
| 2 | Learners recognise the relative and incomplete nature of knowledge and seek to understand with opportunities to apply the new knowledge and acknowledgement from educators. | Controlled inquiry requires less scaffolding with learners requiring multiple contextually similar resources. | Understanding occurs when learners seek to comprehend subject matter but do not include reflection. Learners reflect theory without application in practice. | Factual listening is object-focused and pays attention to facts and new of disruptive data without judgment with focus on what differs from what is already known. | Effort | Knowledge and Knowledge gaps |
| 3 | Learners recognise multiple non-finite versions of the truth. Reflective practices are essential for learners seeking affirmation from educators. | Guided inquiry reduces scaffolding with learners providing their own resources | Reflection allows the learner to understand information by relating it to personal experience and applying it in practice. Learners include personal insights. | Empathetic listening is deeper than factual listening. This extends to how others feel, and learners see the world with other eyes. | Understanding | Reflection, knowledge of self |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | Learners evaluate the contexts of information and the process by which it is acquired. Educators facilitate learning by using multiple teaching strategies and encourage argumentation. | Free inquiry provides the lowest level of scaffolding with learners providing questions for inquiry and resources to answer the questions with the educator acting as facilitator. | Critical reflection is the domain of Dewey, Mezirow and Habermas. Critical reflection has transformative properties and is most common in the early stages of understanding before assumptions become entrenched. | Generative listening connects to 'the emerging field of future possibility' and leads to an altered state. | Quality / Aesthetics | Critical, going beyond self, Aesthetics |

## 5 Findings and Discussion

The intervention in the third cycle required the preparation of a reflection-for-action document in addition to reflection-on-action.  These were administered by tutors who were supplied with sets of guidelines.

Once again, the learners struggled to complete the reflections. Most of the reflection-for-action reports showed a simple project plan. Although this was anticipated in part, the hope existed for the learners to consider a more holistic view. One of the issues arose from the researchers' expectations from the tutors whom themselves had minimal reflection experience.

Positive emotion was observed in the reflective writing of the learners which contradicted the views of the tutors who were concerned with levels of conflict within the groups. The tutors believed that the learners limited their discussion of conflicts through concern that their grades may be penalised. In this, we see the need for affirmation required from the educators by the learners which reflects a potential for the awareness of multiple versions of the truth. Together with the overall reflections, this fitted into the theoretical model by the learners as shown in the examples below.

- **Level 1 – Absolutist**. An absolutist stance was observed in the desire to follow the provided guidelines to the letter. "We also need to speak to our facilitator and ask what she expects to see on our folder on the day of the facilitator's evaluation", Team 316.
- **Level 2 – Transitionalist**. Understanding was prevalent for some teams. "[We] gained a better understanding of the course as a whole. We felt that our attitude was very slack and relaxed at the beginning, but after receiving some humbling advice from the presentation, our attitude shifted, and we focused more on and dedicated more time to the project and included more and further communication with the

stakeholder in order to better understand the process and receive resources to better our final report", Team 307.

- **Level 3 – Relativist**. The acknowledgement of multiple realities was perceived in cases of not reporting conflict as it may not fit with the educator's reality.
- **Level 4 – Contextist**. Acknowledgement of context was less prevalent. Although there was lack of evidence of critical reflection, the potential for changing future actions was reflected in the write-up. "What we will do next time is have an agenda ….. We could have set clear goals … we could accurately assess whether or not we really got what we needed from the meeting. We [should] retroactively reflect on the meetings, which could [sic] potentially lead us to seeing the meeting as more successful than it actually was", Team 306.

Team 306 was one of three teams who stood out. They asked for assistance in understanding reflection and how to do it. At that point they were at Level 2 (Transitionalist) of the levels of learning [11]. The first researcher dedicated several hours to the group and yet they did poorly in their reflection grade. Appealing to emotion, the team appeared to be seeking affirmation for not following the prescribed guidelines but producing their own methods. A large part of their reflection write-up was in justifying their assumed poor performance and describing their method of interviewing. "This led to us feeling confused and frustrated … further compounded by an unpleasant first meeting … Due to not being adequately prepared, we did not have agendas for our first meetings … after our first facilitator evaluation that we realised how helpful having an agenda was. In our meetings to follow we drafted an agenda and questions we had beforehand, and we saw a significant change … we also found it useful to meet before meetings and after as a team to discuss and this helped highlight areas of uncertainty or areas where we had different understandings of what was required. We saw the importance and benefit of being 'on the same page' and knowing where we as a team were headed", Team 306. Unwittingly, they had moved into Level 3 (Relativist) of the levels of learning [11] which seeks affirmation from their educators for multiple versions of the truth.

Team 308 also requested assistance, although this took minimal time due to external issues. However, they did very well in their reflection process even though; they were positioned between Levels 1 (Absolutist) and 2 (Transitionalist) [11] which equates to the levels of non-reflection and understanding [13]. "Meetings with [the sponsor] happened quite a few times, and meetings with educators and the super admin were had to ensure we got a better understanding of their roles in the process. These meetings helped us, and we are glad that we were able to have them. If we could change anything, it would have been that we actually see the educators and super admin do the tasks which they do within the process. Getting a proper viewing of this would have made us understand the process far more [sic]", Team 308. This quote highlights the learners need to find 'true' answers while acknowledging that their knowledge of reality is limited and needs to be augmented.

Team 320 provided a novel reflection process by internally surveying each other albeit with mediocre grade results for their reflection. The reflection write-up reflected Level 1 (Absolutist) [11], following the provided formula in bullet-form. However, they produced elements of Level 4 (Contextist) in their survey through supplying their own resources and their own questions. Furthermore, the team survey hinted at contextuality: "We met whenever we felt there needed to be a group consensus on an issue … Given how busy the members of [the sponsor company] were, I am relatively satisfied … We were able to reference the project plan frequently and ensured we were in line with what we set out for ourselves from the start", Team 320.

For grading of the team reflections, the four levels of reflection; non-reflection; understanding; reflection; and critical reflection [13] were used as a guide. The results showed that for those learners that provided reflective feedback, 56% (n=9) reflected at a level of understanding and 44% (n=7) at a level of reflection [13], representing levels two and three respectively. Thus, slightly more than half of the learners confined themselves to understanding without practical application, and less than half were observed to be personally involved with the reflection.

This revealed that the level of reflections on the assignment did not correlate to the levels of learning of the assignment for these teams. Nevertheless, our understanding of the process of reflection improved incrementally through acknowledging the diverse levels of learning and levels of reflection.

- At level one, the task is paramount. Learners expect explicit instructions that result in an absolute version of the truth. Habit, surface learning and non-reflection characterise this level. Paraphrasing and plagiarism are frequent with a 'know-it-all' attitude.
- Level two is effort-oriented with a need to increase absolute knowledge. Learners tend to apply new knowledge with emotion. They seek acknowledgement and encouragement from educators who should provide examples of similar situations. Learners may not reflect at this level but are fascinated by alternative solutions.
- At level three learners begin to understand that truth is relative. They are open to new ideas on which they need to reflect but may need to develop reflective practices. Although they may recognise peers as knowledge sources, they seek affirmation from educators. This level includes emotion and the awareness of others and the ability to see the world from others' perspective.
- Level four approaches and extends into meta-cognition with conscious awareness of aesthetics and quality. Learners recognise that truth is contextual while acknowledging authoritative sources from a contextual perspective. They require freedom to make their own inquiries with facilitation by educators. Learners are critical in reflection and transformation is evident in their lives. They take a future-oriented view recognising that the world is emergent and larger than themselves.

## 6 Conclusion

Observations of learner difficulties in reflection during an action research project into an experiential learning assignment in a business process management course in a South African university led to the development of this paper. Based on a constructionist grounded theory [3] approach, observed data were compared to four theories found in the literature. Similarities were observed between the levels of learning, reflection, inquiry, and listening and our data. A theoretical lens model was derived from the theories and data and confirmed through further observations. Co-construction of data and theory is supported by the constructionist grounded theory approach [3].

The outcome shows that levels of learning, as well as levels of reflection, are relevant to learners undertaking an experiential learning assignment. The four levels of learning, inquiry, reflection, and listening were comparable to the four levels of motivation found in the data. Using the naming convention from Helsing et al. [11], the four levels are absolutist; transitionalist; relativist; and contextist. These range from understanding knowledge as an absolute truth to truth itself being contextual. Although the levels across the theories are analogous, the level of reflection were observed to differ from the level of learning for the learners. Consequently, a learner with an absolutist worldview may reflect at a higher level than their worldview. Guidelines are presented for recognising at which level of learning and reflection the learners function in a situation.

Limitations of this research exist in the use of a single course at one university and analysis of the data is only validated with reference to existing data. Further research to validate the findings in broader contexts is indicated.

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# Regular Self-Assessments in a Learning Management System Negates the Ebbinghaus ‘forgetting curve’

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**Abstract.** Regularly reviewing classroom work is vital if students are to understand, retain and apply information. In this way, the Ebbinghaus ‘forgetting curve’ may be negated that states that scholars forget as much as 76% of what they have heard in a classroom within a one-week period. The purpose of this paper is to highlight how this may be negated by scheduling regular online self-assessments in a learning management system. This further promotes student engagement with the course content, as students engage more with reflective practice and active learning and less in surface learning and rote learning. Four cohorts of first-year students were asked to complete weekly online reflective self-assessments via a learning management systems, after having completed specific sections of the syllabus. The final pass rates of these students averaged 79%, which is approximately 18% higher than previous years where this approach was not used. A recommendation is to continue to create awareness among teachers and academics about the key benefits of the assessment pillar with institutional learning management systems that promotes reflective practice, student engagement and a negating of the Ebbinghaus ‘forgetting curve’.

**Keywords:** BlackBoard$^{TM}$, Theory, Practice, Pass rates.

## 1 Introduction

“Find what's hot, find what's just opened and then look for the worst review of the week. There is so much to learn from watching a restaurant getting absolutely panned and having a bad experience. Go and see it for yourself.” These words, by Gordon Ramsay, well known Scottish chef, suggest that one can learn so much from reviewing what is bad. It stands to reason then that one can learn even more from reviewing what is good. Reviewing the experiences of others and of ourselves may well be linked to the principle of reflection, which was originally proposed by Dewey [5] as a particular form of thinking. Reviewing, or reflecting or meditating, on knowledge that is good, or factual, may lead to an improved retention of such knowledge, making it easier to recall it and eventually apply it in every-day life.

A key pedagogy that academics may use in helping their students to fuse their theory with practice is that of reflective practice. Reflective practice has been defined in many ways. In fact, a simple Google Scholar search for the exact phrase “reflective practice



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is defined as" reveals some 33 different results since 2014 alone, with prominent reference to John Dewey and Donald Schön. Dewey [5] defined reflective practice as "active, persistent, and careful consideration of any belief or practice in light of the reasons that support it and the further consequences to which it leads". Schön [16] states that it is "the ability of individuals to reflect systematically on actions in order to learn continuously". Note the thought of further consequences and to learn continuously that implies that reflective practice must be used to improve or enhance one's own practice. This is also reflected by Imel [9] who states that "reflective practice links thought and action, because its objective is to improve one's professional practice". Linking theory and practice is fundamental to engineering students, as they seek to advance technology to the benefit of humanity. Students must be encouraged to reflect, or meditate, on their newly acquired theoretical knowledge, in order to correctly apply it in their practice [20]. One of the many ways in which students can engage in reflective practice includes reflecting on feedback [3], which is intrinsic to online self-assessments which are included as one of the many features in learning management systems (LMS) [19].

LMS are truly ubiquitous, allowing students to engage in collaborative discussions, online activities and synchronous assessments from any Internet connection [19]. However, many academics make use of only one of the four pillars that underpin these systems, being called content, with the other three pillars (administration, communication and assessment) seldom being used. The latter is of cardinal importance, as it provides opportunities for additional student engagement with the course material outside of the classroom environment where students may receive immediate feedback on their learning on a regular basis. These online assessments further provide opportunities for reflective practice, which is vital if students are to engage in deep learning [20]. Another key benefit relates to review, as students may regularly review course material and classroom work in preparation for their final assessments. These benefits should be of interest to the SACLA community that provides a forum for the discussion of original research and practical experiences in teaching and learning of Information and Computer Systems, as well as the use of software tools in support of education more broadly [14].

The purpose of this paper is to highlight this specific benefit that comes from scheduling regular online self-assessments in a LMS that may overcome the Ebbinghaus 'forgetting curve'. This further promotes student engagement with the course content, as students engage more with reflective practice and active learning and less in surface learning and rote learning. A time-lag study is used with descriptive statistics of the quantitative data. The origin of the Ebbinghaus 'forgetting curve" is firstly discussed. The research context of the study is then provided, followed by the research methodology, results and conclusions.

## 2 The Ebbinghaus 'forgetting curve'

In the late 19th century, a German psychologist, Hermann Ebbinghaus, was interested in determining how the ability of the brain to retain memory decreases over time. He conducted a series of tests on himself, which included memorization and forgetting of meaningless three letter words. He memorized different nonsense words such as “KAF”, “WID”, and “ZOF. He then tested himself to see if he could retain the information after different periods of time. The results consequently obtained were plotted in a graph, which is now referred to as the ‘forgetting curve’ [15]. Ebbinghaus theorized that humans start losing the memory of learned knowledge over time, in a matter of days or weeks, unless the learned knowledge is intentionally reviewed time and again [1].

There exist various studies that applied the Ebbinghaus ‘forgetting curve’ in higher education [17]. For example, a group of 56 MIT seniors who took mechanics as freshmen were given a written test similar to the final exam they took in their freshman course. Students scored 60% lower on the written analytic part of the test than they did as freshmen [12]. Furthermore, a study tested the nature of forgetting of 125,000 students learning Spanish that used the Rosetta Stone® foreign-language instruction tool. Students were tested on a lesson after its initial study and were then retested after a variable time lag. Forgetting by these students was observed to be consistent with power function decay at a rate that varies across lessons but not across students [13]. Moreover, a review study that was conducted on the retention of basic science knowledge in medical education suggested that about two-thirds to three-fourths of knowledge was retained after one year, with a further decrease to slightly below 50% in the next year [4]. Figure 1 illustrates the typical Ebbinghaus ‘forgetting curve’.

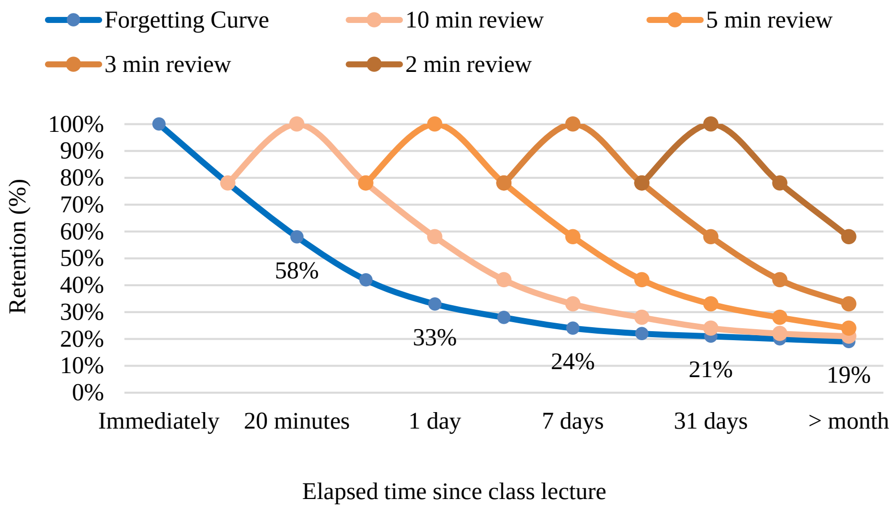


**Fig. 1.** Overcoming the Ebbinghaus ‘forgetting curve’ [15].

It is evident that students may forget up to 79% of firsthand information which they receive in a classroom environment within 31 days. However, if they were to regularly review the information (in only small-time blocks), then they would be able to retain up to 80% of the firsthand information after 1 month. For example, only a 10-minute review is required after 1 day, while a 2-min review would suffice after 30 days. This is of course applicable to each new concept discussed in the class lecture, and not to all the information presented during that time.

## 3 Research Context of this Study

The context of this study is limited to an Electrical Engineering module termed Electronics 1. Undergraduate engineering students need to complete this compulsory module in the first year of their National Diploma in Electrical Engineering. This Diploma is a NQF (National Qualifications Framework) Level 6 qualification that requires students to obtain a minimum of 360 credits (equates to 3600 notional hours over a three-year period). The majority of modules in this Diploma have a credit value of 12, including Electronics 1. Approximately 300 students register for this module in Semester 1 of each year, with about 150 registering in Semester 2 (each semester is approximately 14 weeks in duration). The syllabus of Electronics 1 covers seven sections or units focusing on the oscilloscope, electrical basics, Thevenin's Theorem, resistors, capacitors, diodes, transistors and the design of power supplies and amplifiers (see Table 1).

**Table 1.** Structure of Electronics 1.

| Time period | Theory<br>2 x 90 minutes / week | Assessment online | Weightings | Practical<br>1 x 90 minutes / week |
|---|---|---|---|---|
| Week 1 | Unit 1 – Oscilloscope | Student support – anywhere | 6 online self-assessments make up Test 1 (T1) which contributes 25% to the course mark | Assignment 1 |
| Week 2 | Unit 2 – Electrical basics | Unit 1 – anywhere | | |
| Week 3 | Unit 3 – Semiconductors | Unit 2 – anywhere | | Assignment 2 |
| Week 4 | Unit 4 – Diodes | Unit 3 – anywhere | | |
| Week 5 | Unit 5 – Power supplies | Unit 4 + Unit 1 – anywhere | | Assignment 3 |
| Week 6 | Unit 6 – Transistors | Unit 5 + Unit 2 – anywhere | | |
| Week 7 | Unit 7 – Amplifiers | Unit 6 + Unit 3 – anywhere | 35% to the course mark along with Assignments 1, 3 and 5 | Practical Test |
| Week 8 | Review | Unit 7 + Unit 4 – anywhere | | |
| Week 9 | University recess | | | |
| Week 10 | Review | | | Assignment 4 |
| Week 11 | Main Test | Units 1 – 5 – controlled lab | 40% to the course mark | |
| Week 12 – 14 | Review | | | Assignment 5 |
| Week 15 – 18 | Summative final exam | Units 1 – 7 – controlled lab | 60% to the final grade | |

The results of this paper focus only on Test 1 (T1), as it comprises six online self-assessments where students engage in reflective practice. The assessments are compiled in Respondus (a PC based software for setting and managing online tests and surveys), and then uploaded to the institutions LMS. Students are afforded three attempts to complete the assessment, with their highest grade being used for the course mark. This provides them with the opportunity to improve on their first attempt, as the individual scores per question are revealed at the end of each assessment. This feedback prompts students to engage in reflective practice (reflection-in-action), as they think back to their original answer (which may be wrong) and seek to understand where they went wrong in its formulation. The three attempts are often sufficient for students to identify and rectify any misconceptions or errors in their current thinking, as many students significantly improve on their first attempt grades.

The online self-assessment for Week 5 is designed to review not only Unit 4 (7 days after the classroom), but also Unit 1 (31 days after the classroom). This same principle applies to Week 6 through 8. Day 1 review occurs in class, as students cover much theory in the Tuesday class, with more practical examples and problems given in the Wednesday class (two periods per week of 80 minutes each scheduled in the time table). In this way, students are encouraged to complete 3 out of the 4 reviews listed in the Ebbinghaus ‘forgetting curve’, with only the 20 minutes’ review after class being left for them to complete on their own.

## 4 Research Methodology

A time-lag study is used with a non-experimental descriptive design. Descriptive research occurs where a specific situation is studied to see if it gives rise to any general theories, and a time-lag study determines the impact of a particular event on a group of students over a specific period of time [7]. The specific situation is the use of regular online self-assessments (enabling the review of the course material) while its impact would be negating the ‘forgetting curve’ (achieved if many students pass their final summative examination).

Descriptive statistics are typically distinguished from inferential statistics. With descriptive statistics we are simply describing what is or what the data shows [6] while with inferential statistics we are trying to reach conclusions that extend beyond the immediate data alone [8]. In this study, quantitative data is presented in graphs and interpreted with regard to specific undergraduate African engineering students.

Four cohorts of first-year undergraduate African engineering students from 2016 and 2017 were asked to completed weekly online self-assessments posted on BlackBoardTM, the institutions adopted LMS [19]. This equates to four semesters of data (duration of 14 weeks per semester) and a total sample size of 1001 students. The grades achieved by these students in their online self-assessments as well as in their final summative examination are analysed.

The self-assessments feature random questions from a predefined questions files that is posted online two days after completing a specific section of the syllabus that covers 7 units within 7 weeks (see Table 1). These questions encompass a balance of lower-order and higher-order questions, which is required if students are to develop logical reasoning and critical thinking [18]. The online self-assessments are made available for 1 week after the classroom work is complete, thereby satisfying the third review required in Figure 1 (3 min on day 7). The fourth review (2 min on day 31) is achieved by incorporating key questions from Unit 1 into Unit 4's questions file, and so forth. So, if Unit 1 is completed at the start of February, then Unit 4 will be completed at the end of February, and its questions file will encompass questions from Unit 1. The second review (5 min on day 1) is usually done in the classroom, as the academic reviews the theoretical work from the previous day, building on it by means of problem-based learning using practical examples and problems. Students are only expected to personally engage with the first review on their own, being 10 min at home. Regression analysis is used to exam the relationship between the online self-assessments and the final summative examination grades of the students. Student demography is presented to contextualize the results.

## 5 Results and Discussions

The profile of students registered for ELE11 and ELE12 reveal that the dominant home language was Sesotho (indicative of the Free State province in South Africa [11]) while the dominant age group was between 20 and 24 years of age. This age group validates them as first-year undergraduate students who have completed their secondary or high school career (average age for Grade 12 learners in South Africa is 18 years [10]). Males outnumbered females by 3 to 1, which is one of the reasons why a global drive exists to encourage more women in engineering [2]. The total number of students who registered for Electronics 1 over the four semesters were 708 students. The maximum, median and mean grades of the students completing Test 1 are shown in Figure 2 for the four semesters. It is noted that students could attain more than 89% for each semester, indicating that the online self-assessments were neither difficult nor tricky to complete. The mean values are lower than the median values, suggesting that the distribution is negatively skewed, with a longer tail close to 0%. The average Kurtosis value of -0,73 supports this, indicating that 50% of the students achieved more than 59% for their online self-assessments (median value for 01-2017).

The individual final grades of the students are compared to their grades for Test 1 (six online self-assessments) by means of a regression analysis (see Figure 3 where a R-squared value of 0.6177 is visible). This analysis indicates a strong correlation according to the following scale proposed by Wilson et al. [21]: strong relationship ($0.50 \le r \le 1.0$); moderate relationship ($0.3 \le r < 0.5$); weak relationship ($r < 0.3$).

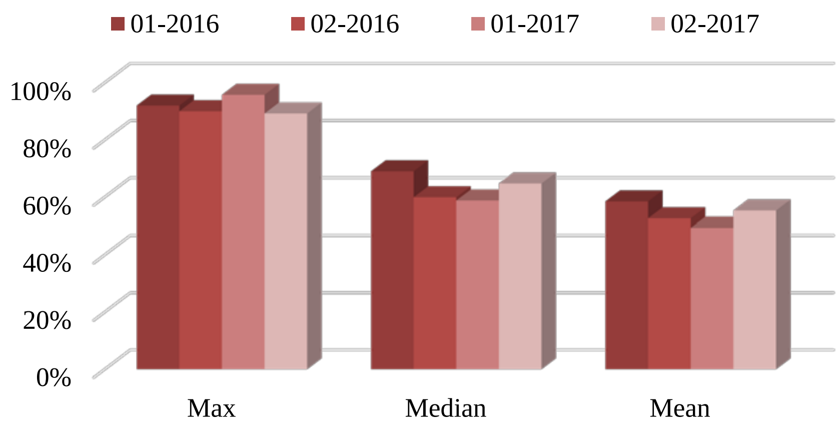


**Fig. 2.** Descriptive statistics of the student grades for Test 1.

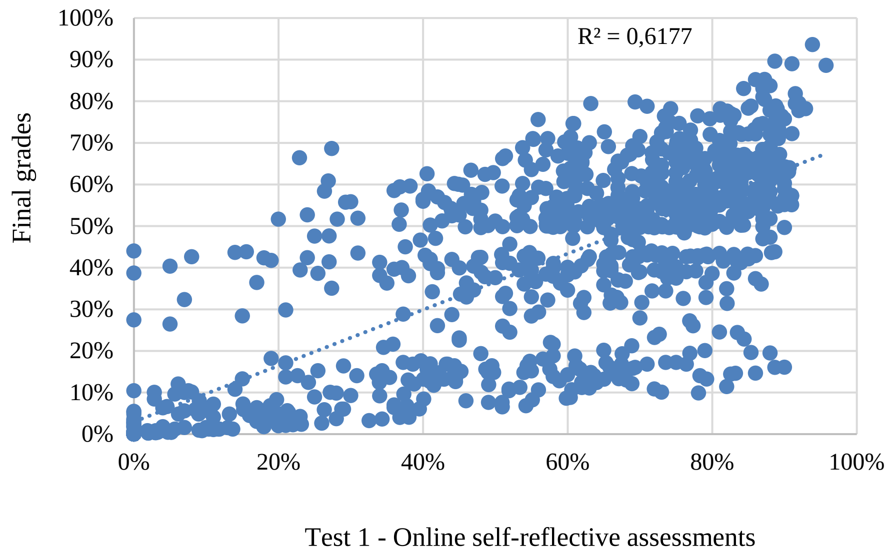


**Fig. 3.** Regression analysis of the final grades to the online self-assessments.

## 6 Conclusions

Students must be motivated to engage in regular review sessions if they are to retain information over an extended period of time, thereby negating the Ebbinghaus ‘forgetting curve’. One way of doing this is by scheduling regular online self-assessments in a LMS which must contribute to the final grades of the students. The assessments were structured to help students review information within specified periods of time (after 1 day, 7 days and 30 days). Results from this study show a strong correlation ($R^2$ = 0.6177) between the online self-assessment grades and the final grades of the students, suggesting that student were able to review and retain the information over the period of the semester. “Repetitio est mater studiorum”, a Latin proverb stating that ‘repetition is the mother of learning’, was again demonstrated in this research. This is not new to education. However, the way of achieving it in using regular online self-assessments in a LMS warrants publication, so that more academics can make use of the assessment pillar in their institutions LMS, which will promote further student engagement with the course content at any time or any place where Internet connectivity exists.

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# Schools and Mobiles

# The E-Classroom Forum: Bridging the Public and Private School Socio-Economic Education Factors in Rural Areas

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**Abstract.** In the past few years, the South African education system and the quality of basic education has come under constant scrutiny, both from the government and non-governmental societies. The most perceptible reason for this inquiry being the lack of educators and quality teaching, particularly in the rural locations. Inconsistent yearly Matric pass and failure rates for matriculants and other grade learners has motivated researchers to investigate probable innovative education and learning solutions for basic education in the province and subsequently for the country at large. Information and Communication Technology infrastructures have encouraged the introduction of e-Services for rural communities to effortlessly provide access to learning, government, judiciary, and business services. This research focused on the implementation of an e-Learning platform through the development of an e-Classroom service for high-school learners in the Eastern Cape. The e-Classroom service was implemented to bridge the socio-economic factors in education between public and private school learners. The research methodology used for this paper was qualitative. The study followed a qualitative approach, sampling high school learners in an effort to collect and record subjective assessment of attitudes, opinions and behaviour of the users of the implemented e-Classroom system. The study further used interviews and questionnaires for data collection. The e-Classroom forum was developed using the proto-typing model. The end-users that tested the e-Classroom forum, found it to be very useable. The platform provided a means for learners to interact and engage in peer-to-peer learning.

**Keywords:** Education, E-Learning, e-Classroom, ICT4E.

## 1 Introduction

The omnipresence of Information and Communication Technology (ICT) in our dispensation has transformed various aspects of day to day activities for many people [6]. ICT innovations have influenced business activities such as online meetings, conferences and telemedicine. Aspects of these technological advances have also penetrated


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the education system with the introduction of computer-based learning. Computer based learning has broadly expanded learning opportunities and facilitated learning activities for learners within the same learning environment as well as those who are separated by time and space [2]. ICT based learning technologies have been the basis for the effective delivering of content to learners and teachers, allowing for virtual interaction in a manner similar to the traditional physical classroom [4]. Various methods of educational demonstrations have been utilized such as simulations, video and audio presentations and virtual laboratories. However, despite the benefits brought about by technological advances, there still remains an immense discrepancy between learners from different socio-economic backgrounds [22].

Curriculum Assessment Policy Statements (CAPS) stipulates that every subject in each grade will have a single, comprehensive and concise policy document that will provide details on what teachers need to teach and assess on a grade-by-grade and subject-by-subject basis [10]. The policy document provides standardization and consistency on how teaching should be conducted, thus schools in South Africa normally reference to the same or similar curriculum [10]. The sharing of a similar curriculum suggests that learners from various different public and private schools should be able to form study groups, not limited to geographic or academic scope. However, attitude, language, culture, and medium for communication continually pose as a constant limitation to the globalization of online teaching, learning, and study groups [19].

Differences in learner competences, teaching styles and philosophies present a challenge in the creation of study groups and interaction platforms [29]. These challenges greatly affect learners in public learning institutions were the intrinsic levels of teaching and learning are low. A study by Cener [1], showed that learner-to-learner interaction and learner-to-teacher interaction is relatively poor in public schools as compared to private schools. Furthermore, the study showed that interaction in higher in online-based learning systems as opposed to the traditional classroom [1]. This suggest that online-based learning and teaching systems offer wide coverage that takes into consideration the differences in learner personas and educator pedagogical styles.

In their study, Frenette [11] revealed that, the majority of learners in high school, have little to no experience when it comes to using forums, blogs and other related E-learning platforms for educational purposes [11]. E-learning defines any kind of instruction and learning system in which the leaners and teachers do not meet physically, but rather are separated by time, distance, or both and are bridged with the help of ICTs [14]. E-learning demands a degree of computer literacy from the learners. However, most of the high school learners, particularly from rural areas, are computer illiterate, and as such struggle with interacting with computer-based learning technologies, and this subsequently limits their ability to access digital learning resources [1]. This difficulty in interacting with technology is even more visible amongst learners from rural backgrounds who predominantly attend school in public schooling facilities where there are limited digital resources [18]. Since most learners from rural backgrounds have limited access to educational resources, they tend to perform less adequately as compared to learners coming from an urban area [13]. According to [23], most learners from the urban areas attend private schools. These private schools expose their learners to learning technologies and such the learners normally have prior experiences with computers and thus have little to no difficulties when it comes to using E-Learning platforms.

This study was aimed at investigating the introduction, deployment, and usage of an e-Classroom as an additional resource for improving the quality of education and learner pass rates in high schools, particularly those in rural areas. The proposed e-Classroom was set to encourage interaction amongst learners from public and private schools for bridging the academic knowledge gap that exist between learners in public schools and those in private schools.

The rest of this paper is structured as follows; Section 2 discusses the related literature, section 3 presents the methodology, section 4 presents the findings and discussion, the paper concludes with section 5, conclusion and future work.

## 2 Related Work

The need to acquire education and develop the power to make learned decisions has become an essential part of life, and this has been enforced as a universal human right [15]. Subsequently, academic measures of performance have been adopted as standards for employment acquisition and overally as an indicator of governments' commitment towards bettering the quality and standard of lives for their citizens [26, p.5–6]. However, the adoption of academic performance as a measure for employment has subjected learners to immense pressure to achieve higher grades. In most cases, the motivations for achieving higher scores and grades has been the desire to attract employment opportunities.

The employment market has also complemented this culture by not imposing strict follow-ups on the quality of education that prospective employees present on their resumes. In the career world, no one seemingly cares about education acquisition process, instead attention is diverted to the proof of academic achievement as presented on academic reports and graduation certificates. According to [11], the effects of this high-grades culture seem to be more amplified in third world countries where employment opportunities are greatly limited. In most cases there exists an oxymoronic scenario where learners have high grades but very poor quality of education. However, the use of learning technologies could help consolidate the expanse that exist between education quality and academic scores and grades.

### 2.1 E-Learning

E-learning is one of the learning tools that emerged from Information and Communication Technology (ICT). E-Learning refers to the use of technology to select, design, deliver, administer, facilitate and support learning [14]. E-learning enables learners and teachers to further improve the quality of education in the teaching-learning process by making learning more effective and efficient [2, 5]. The flexibility offered by E-learning platforms allows for the support of synchronous and asynchronous learning [14]. Synchronous learning requires learners and teachers to be online concurrently. Learning sessions occur at a specific time in organized sessions. Asynchronous learning on the other hand, does not require learners and teachers to be online at the same time. The teachers provide materials to be worked on such as tests and assignments and learners complete those tasks within a specified period of time. While synchronous learning models provide a class-like setup for learning, there tends to be minimal participation from learns when they are aware of the online presence of teachers and tutors [20]. Asynchronous learning becomes the mode of choice when confronted with learning from diverse socio-economic backgrounds as it offers an environment in which varying personas can interact and learn without being cognizant of the presence of teacher or tutor supervision [8].

E-learning platforms have been around and in use for some time particularly in tertiary learning institutions [3]. Although e-Learning platforms are popular amongst most tertiary institutions, there is minimal research on teachers' and learners' attitudes and perceptions toward these environments [1]. Furthermore, socio-economic diversity in the education system poses a challenge in evaluating the effects and benefits of these learning technologies amongst teachers and learners [6]. There exists a loosely agreed fact that learners in private schools are offered better quality education as compared to learners in public schools [9]. This perception is largely based on the idea that there exists a great difference in socio-economic factors in education between private learning institutions and public learning institutions. The main observed socio-economic factors include [29,16]:

- Availability of learning resources such as libraries and computer laboratories.
- Provision of a conducive school environment.
- Academic achievement such as language skills and reading.
- Motivation to learn.
- Financial background

Based on these socio-economic factors, it can be argued that learners in public schools mainly suffer from the lack of adequate educational resources. The continued dilapidation in the academic standards of the public schools' system as a result of socio-economic factors and the deplorable nature of public schools' infrastructure has led to the mass movement of learners to private schools. According to Harold [28], it is believed that the expensive private schools offer enriched academic opportunities through the provision of exceptional and challenging educational experiences through extracurricular activities; advanced placement courses, and the provision of E-learning resources. This perception has also lead to the high demand for quality education and educational resources. The demand for quality and sufficient educational resources is often confronted by the lack of stable and sustainable financial resources in learners from public learning institutions, and as such there is need for the development of learning solutions that bridge this divide, allowing for the sharing of knowledge and resources amongst learners from public learning institutions and learners from private learning institutions.

Traditionally, E-learning platforms have been integrated in University programmes through the implementation of platforms such as MOODLE, Blackboard, Dokeos and Khan Academy amongst others [16]. This is contrary to the situation in high schools where ICT-assisted learning has not been widely implemented [28]. The use of e-Learning technologies as an aid to teaching and as educational platforms has recently penetrated into high school education. The rapid evolution in technology and subsequently E-Learning platforms has witnessed the birth of other forms of E-learning tools that offer improved support for both learners and teachers [29]. The new generation of E-Learning tools offer more interactive and intuitive methods of teaching and learning thereby improving on the E-learning teaching and learning experience. These tools have greatly simplified learning methods, making them a favorable tool for learners with limited access and computer literacy.

### 2.2 Peer-to-Peer Learning on Social Media

Peer-to-peer learning is defined as the mutual beneficial concept in which all participants are recognized as being both learners and educators [25]. Peer-to-peer learning facilitates continuous development by encouraging individuals to engage into knowledge sharing activities through networking, discussion, and collaboration. This cost-effective approach to teaching and learning was adopted by social media platforms. Social media platforms allow users to create and share content in a social manner. The use of social media in education has been on the rise [19]. However, in order to the use peer-to-peer learning on social media for in a pedagogically meaningful manner, there is need for educators to explore new teaching and learning approaches. Salmon [24], suggested that encouraging learners to use social media actively in their learning and research improves learners' ability to become self-directed learners and expand their potential to develop skills necessary for facilitating peer-to-peer learning. A study by Tapscott [12], showed that social networks can significantly improve student learning and knowledge acquisition, enabling mutual interaction, cooperation, active participation, sharing resources and critical thinking.

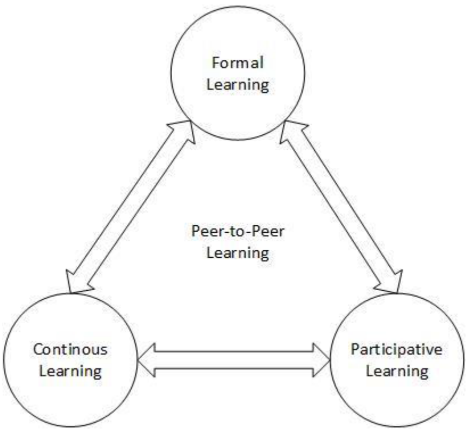


**Fig. 1.** Peer-to-peer learning components.

Peer-to-peer learning consist of three components. Figure 1 shows the components of peer-to-peer learning. Formal learning is derived from the typical classroom. This aspect introduces the learner to the importance and perceived value of learning in a controlled environment. Formal learning plays an important role in introducing core concepts and ideas, ensuring understanding and enabling group participative learning [27]. Participative learning describes the practical or experimental learning which is inspired by the core concepts introduced in formal learning. Thirdly, peer to peer learning facilitates for continuous learning, in hic the learner utilizes the information gained in formal learning and participative learning to synthesizes or reason out new knowledge.

The growth in the use of the social media platforms means that peer-to-peer learning will continue to inspire learning and pedagogical methods. Lessons learnt from social media-based peer-to-peer learning can be harnessed and incorporated into the development of a moderated academic e-Learning platform in the form of an e-Classroom.

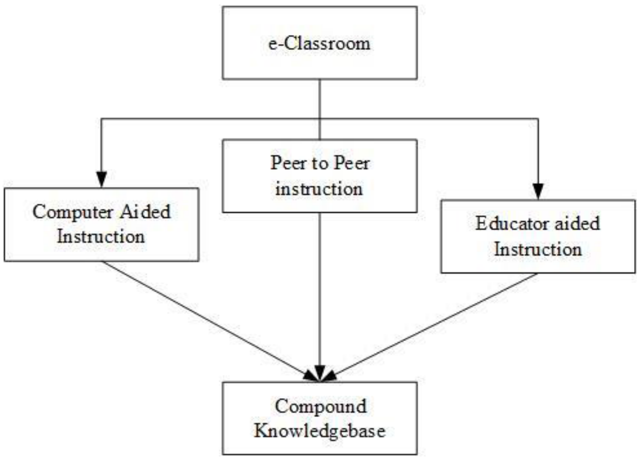


**Fig. 2.** Components of the e-Classroom.

### 2.3 The e-Classroom Concept

The e-Classroom describes an online learning environment where online tuition and course materials are coupled with periodic testing and interaction so as to mimic the traditional classroom setup [16]. Learner activities are monitored and moderated and subsequently scored if necessary. E-Classroom architecture often includes, but not limited to the following components; computer-aided instruction, peer-to-peer instruction, educator-aided instruction and a compounded knowledge base. Figure 2 shows the components of the e-classroom and how they contribute in building a compound knowledge base.

### 2.4 Developmental Objectives

The philosophy of this study builds on the need to provide a platform that can facilitate friendly interaction between educators, tutors and learners. Motivated by the findings unearthed in the literature, this paper seeks to address the following objectives:

- Provide a distributed platform for interaction between educators and learners.
- To improve the accessibility of educational resources and online peer assistance across learners in public and private schools.
- Allow users to conduct monitored educational group discussions and peer-to-peer interactions.
- Motivate learners to share information and knowledge assisting learners in limited access to educational facilities and resources.

## 3 Methodology

The methodology for this study was set around the above-mentioned development objectives. The study followed a qualitative approach, sampling high school learners in an effort to collect and record subjective assessment of attitudes, opinions and behaviour of the users of the implemented e-Classroom system. The study further used interviews and questionnaires for data collection.

**Table 1.** Development activities.

| **Prototyping Model Stages** | **Implementation Activity** |
|---|---|
| Initial requirements | Obtain the initial requirements by asking the potential users of the system what they would like the system to be able to do.<br>Observing other existing online learning management systems. |
| Design | User interface wireframes developed. |
| Prototyping | Construct the first prototype using HTML, CSS, JavaScript and PHP, based on the preliminary design. |
| User evaluation | Potential users evaluate the prototype, noting the strengths and weaknesses of the prototypes and it could be improved.<br>Collect and analyse potential users' remarks. |
| Review | The first prototype was modified, based on the remarks made by the users. Another prototype was constructed.<br>The new prototype was evaluated the same way that the first prototype was evaluated. |
| Development | Final system is constructed based on the final prototype. |
| Testing | The final system was thoroughly evaluated and tested.<br>Users to try to use the system, whilst interviewing them.<br>Users also required to fill in questionnaires for more feedback. |
| Maintain | The system has to be maintained continuously so as to prevent large-scale failures and minimise down-time. |

The e-Classroom forum was developed using the prototype model. The prototype model was chosen because it ensures that the end users constantly interact with the system during its development and provide feedback which can be used in developing further system functionality, thus making the system more useable. Prototyping works best in scenarios where not all of the project requirements are known in detail ahead of time, thus providing a way to model the overall system functionality, incrementally defining he specific functions and operations.

### 3.1 The Prototyping Process

Table 1 summarizes the activities carried out during the development of the e-Classroom forum based on the Prototyping development model.

### 3.2 Technology Description

**System Architecture.** The e-Classroom forum architecture adopted a three-tier architecture used in Web development which includes the client, server and the database tiers. The client-tier consists of the web browser-based clients, the Web server tier handles all the users' requests and processes them to provide feedback while the database tier provided a storage for information accessed and presented by the Web server tier. Figure 3, shows the three-tier architecture used in the development of the e-Classroom forum and how these tiers communicate with each other.

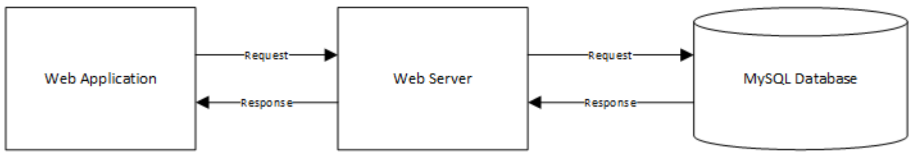


**Fig. 3.** System architecture.

The client tier is the top most visible layer and it consists of the web browser-based clients. In this tier, HTML (Hypertext Markup Language), CSS (Cascading Style Sheet) and JavaScript were used to create an interactive user interface. The server tier utilized PHP and the XAMPP server [17]. XAMPP is an open source cross-platform web server solution stack package that comes mainly with Apache HTTP server, MySQL database, PHP and Perl. PHP is a technology for developing web pages that supports dynamic content. The database tier manages data in the e-Classroom forum. This includes storage and retrieval of data, as well as managing updates, allowing simultaneous access by more than one middle-tier process, providing security, ensuring the integrity of data and providing support services such as data back-up [17].

**Database Design.** The database used for the storage of e-Classroom information was made up of six tables. The *users table*, which was used to store the forum members' details. The *forums table*, stored the details of a particular forum topic. The *sub_categories* table contained topics under the forums. The *threads* table contained the posts made to the forum. The *replies* table contained the replies or comments made to particular posts. The *message* table contains the private messages between users.

**User Interaction.** The user interaction was modelled in the form of a flowchart. For a user to gain full access to the system, they are required login first. If a user does not have an account, then the user would have to sign up for access to the forum(s). Users that are yet to register can only view the forum(s) and posts. The users are restricted from adding new posts and posting comments on existing posts, unless they sign into the forum(s). This role was described as the Guest role.

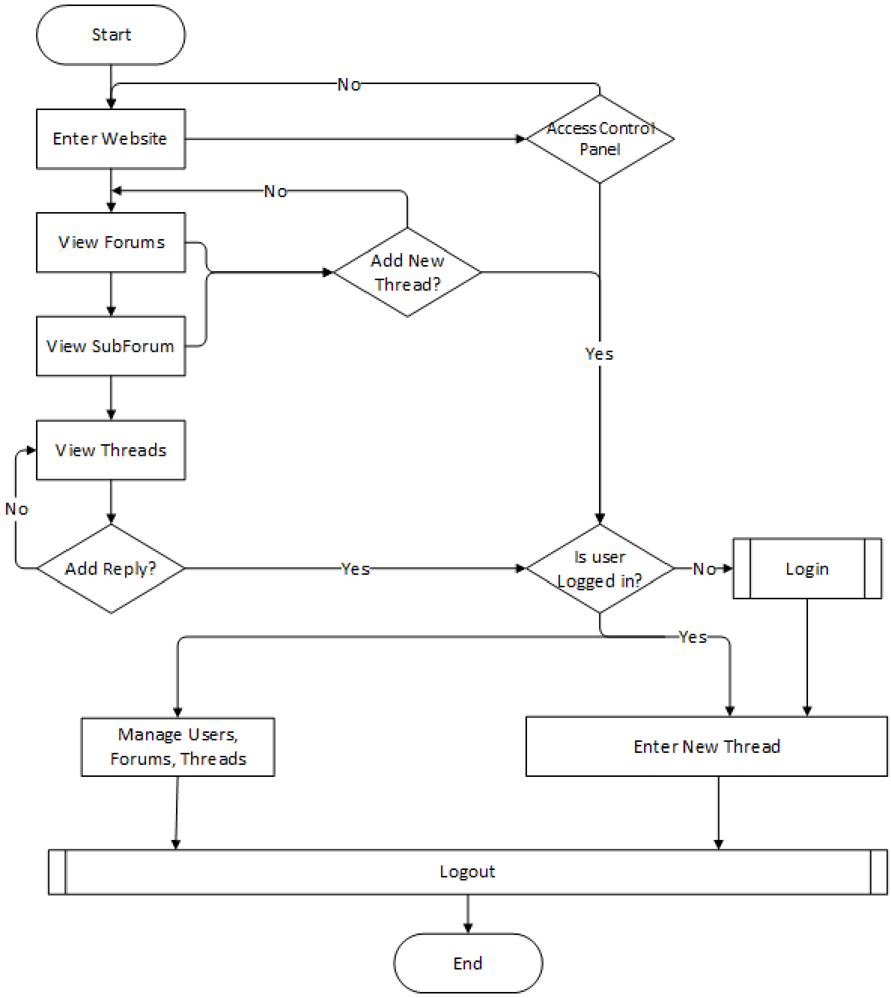


**Fig. 4.** Activities forum flow chart.

When users sign in, they can make posts to the forum(s), and also create private messages to other users, in cases where one-to-one interaction is needed, for example, between a teacher and a learner. This role was made especially for the learner role. In addition to the things that the learner role could do, the teacher role was allowed to have control over certain forums. The administrator role had all the rights to the forum including managing the users of the forum.

The flowchart in Figure 4 shows the user interaction processes on the forum.

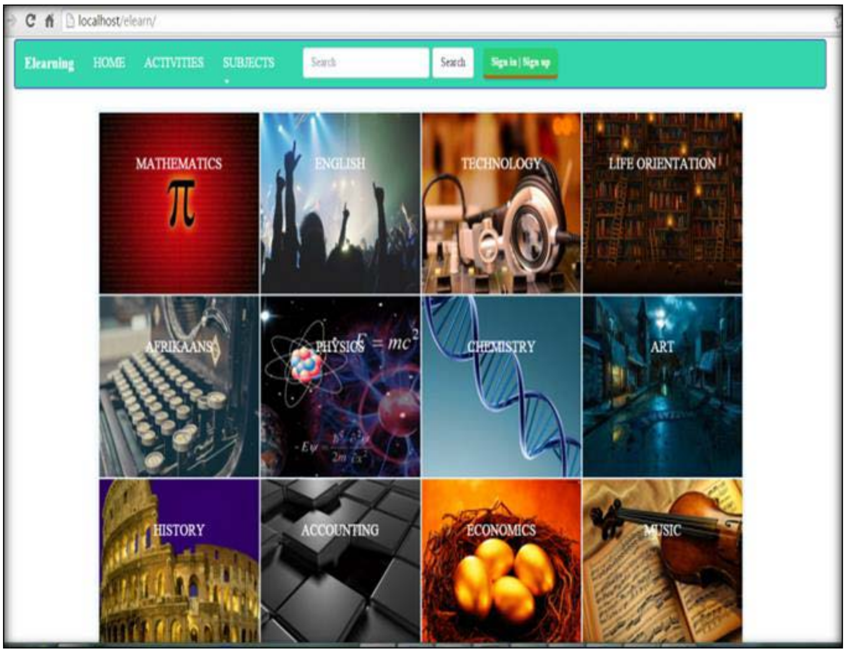


**Fig. 5.** E-Classroom landing dashboard.

**User Interface.** The design of the user interface followed a minimalistic approach only exposing the relevant functionality to the user. This was so as to ensure ease of use and improved navigability in the e-Classroom system. The design of the interface is counter intuitive allowing users to provide input with minimal cognitive load. Figure 5 shows the landing dashboard screen of the e-Classroom after logging in.

Figure 6 shows the portal for posting questions onto forums within the e-Classroom.

## 4 Findings and Discussion

The study surveyed learners from Alice, Eastern Cape, South Africa. The survey population was composed of learners from public rural high schools and private high school learners. The respondents were selected using stratified random sampling. The study population was composed of 131 respondents, of which 63% were females and 37% were males.

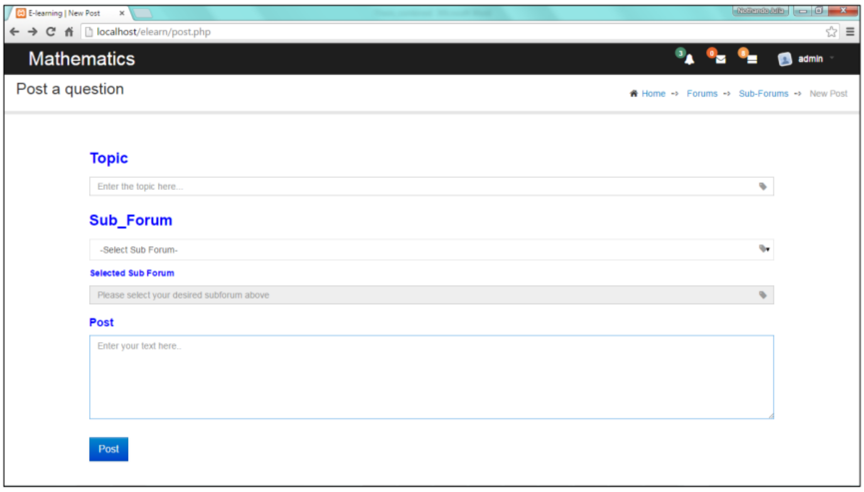


**Fig. 6.** Portal for posting questions.

### 4.1 Technical Evaluation

The technical aspects of the deployed system were measured based on Nielson's usability's heuristics [21]. The following variables were considered; ease of use, user satisfaction, navigability, clarity and efficiency. The findings in Figure 7 show that, 92.3% of the users agreed that navigation was easy,76.9% agreed that the system was efficient, 84.6% agreed that the system interface was clear and instructions were straight forward, 76.9% of the users where satisfied with the system while 53.8% of the responses showed that the system was easy to use. The results show that the deployed e-Classroom could potentially be implemented as a fairly useable platform for interaction.

The analysis of results from the interviews with learners sowed that learners appreciated the design of the e-Classroom forum and that they were comfortable with using the system once they got familiar to it.

### 4.2 Pedagogical Evaluation

The deployed e-Classroom forum was also evaluated against pedagogical practices based on the responses solicited from interviews with the survey population. The pedagogical aspects allow for the evaluation of the system that relate to teaching and learning as well different leaner persona's preferences. The findings showed that teachers often adopt a transformative teaching pedagogy when they interact with leaners on the e-Classroom forum. Ardito [4], argues that transformative pedagogy permits teachers to actively participate in the teaching-learning process. This approach to teaching empowers the learner to critically examine value and knowledge with the goal of developing a reflective knowledge base and an appreciation for multiple knowledge perspectives. This implies that leaners exposed to the e-Classroom forum were more open to receiving knowledge from various moderated sources thereby exposing themselves to the opportunity of improving their quality of education.

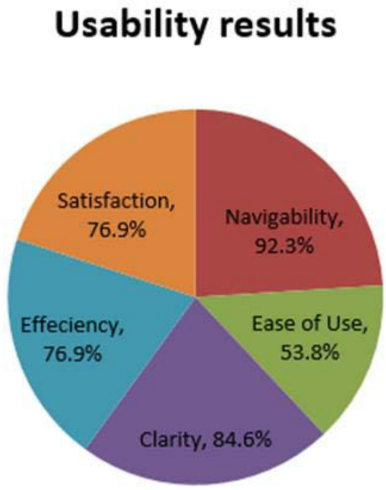


**Fig. 7.** Usability testing chart.

### 4.3 Learner Perceptions

The observation from the learners showed that a significant degree of interaction was achieved, this was observed by observing how learners formed groups on the platform. Private messaging was also employed by some learners to privately communicate with peers as well as tutors. Learners asserted that the quality and quantity of information they were exposed to on the e-Classroom forum was more than what they were being given in the traditional classroom. The presence of tutors and teachers on the e-Classroom forum enabled learners to get responses to troublesome tasks and questions thereby boosting their confidence in the e-Classroom forum.

## 5 Conclusion and Future Work

This study discussed the findings of the e-Classroom forum developed and implemented for high school learners enrolled in various subjects to become part of an academic community dedicated to educating and learning from each other. The e-Classroom forum was used as a means of bridging the education quality gap between public schools and private schools. The study explores some of the literature related to the learning technologies. The study also described the development considerations of the proposed e-Classroom Forum and how it was implemented. The development and deployment of the e-Classroom forum was a success. The e-Classroom was implement on a dedicated server and was accessible through the Internet. Users were able to create and share content and reply to other users' posts. Users could also engage in private messaging which was useful in facilitating the exchange of educational coaching and material specific to an individual's needs. User feedback was then analysed and a set of findings were put forward and discussed.

Proposed future developments to the e-Classroom Forum could be to enable Rich Site Summary (RSS) feeds to allow users to receive posts notifications via email or text messages from subscriptions made to specific forums. We also hope to model and develop a mobile device application that implements the e-classroom allowing for increased access to the e-Classroom forum. Pedagogical developments such as persona mapping are also proposed to allow for the classification of learners based on their learning style preferences allowing the system to deliver customised content.

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# High School Learners' Adoption and Use of Mobile Devices for Learning Outside the Classroom: Case of Cape Town, South Africa

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**Abstract.** High school learners are intrigued by mobile devices and constantly use them. Society has labelled this constant use of mobile devices as misuse and inappropriate. South Africa provides different challenges due to uneven development that has affected high schools with shortage of teachers and shortage of teaching and learning material. Based on independent learning approach, technology is advocated as one of the options in reducing the shortages. Mobile devices are one of the technologies that can be used inside and outside the classroom. Outside the classroom use of mobile devices assists with accessing content and as a tool to acquire learning material from. To this end, the research investigated learners' adoption and use of mobile devices for learning outside the classroom in a high school in Cape Town, South Africa.

The research used the theory of diffusion of innovation as a lens to understand learners' adoption and use of mobile devices. A high school in Cape Town provided for a contemporary phenomenon and was used as case study. Questionnaires were distributed to 92 Grade 12 learners, 15 of whom were interviewed. Findings reveal that all learners own (have access to) at least one mobile device, and only a few of these do not have Internet access. Learners use mobile devices to search for information and for academic purposes. Learners use YouTube, maps, camera, video and Google search to enhance knowledge acquired in classroom.

While learners use social and knowledge networks for learning, some learners suffer consequences of mobile device confiscation and disciplinary action based on assumption of misuse or using them within school compound. Outside the classroom, teachers tap into the social and knowledge networks learners have and provide support, guidance and facilitate learner's use of mobile devices for learning. This research contributes to the theory by providing empirical evidence from a high school in a developing country. The research also contributes to the body of knowledge on education and adoption of technology outside the classroom.

**Keywords:** Learners' use of mobile devices for learning, Developing countries, Learners in South Africa, Outside the classroom learning, Grade 12 learners.



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# 1 Introduction

High schools in developing countries suffer from shortage of teachers and shortage of teaching and learning material [22,2]. South Africa is one such country experiencing uneven development leading to these shortages [22]. Despite shortage of teachers being a government and stakeholder concern, nevertheless, learners are the most affected. Shortage of learning material impacts learners immensely as they fail to grasp basic concepts during classroom interaction [4]. Researchers suggest independent learning as one approach to aid and enhance learning [30].

Independent learning is key in the 21st century in developing countries to aid with self-development. High school learners are expected to depict independent learning by providing examples and relating questions posed to surrounding context as part of learner centred learning approach. Outside the classroom, independent learning supports the notion for lifelong learning [40]. Lifelong learning requires learners to be equipped with skills and knowledge they can employ for life. One way to attain independent learning is using Information and Communication Technologies (ICTs).

Use of ICTs is advocated to aid and enhance acquiring and distribution of learning materials for learners [28]. Mobile devices are among the ICTs that aid with access to learning material and enhance learning. Some developing countries, including South Africa, have banned use of mobile devices in classroom [28]. However, private schools have started employing mobile devices inside the classroom as projects. The main problem with projects has been discussed by Ampofo et al [1] to be sustainability at the school upon project completion. Hence, any study on adoption and use of mobile devices for learning should begin with outside the classroom. To this end, the research poses the question, *how are high school learners adopting and using mobile devices for learning outside the classroom in South Africa?*

This paper is structured as follows; the section that follows discusses literature in relation to the educational system in South Africa and its challenges leading to theory of diffusion of innovation as theoretical lens used for the study. The use of case study is justified in the third section along with data collection and analysis techniques followed by findings. Finally, the paper provides a discussion and concludes with contribution and area for future research.

# 2 Literature Review

## 2.1 South Africa Educational Problems

The educational system in South Africa, as is with developing countries, is affected by shortage of teachers and shortage of teaching and learning material. Unpacking issues that account for shortages and relating how mobile devices can aid in acquiring learning material is imperative.

**Shortage of teachers**. In South Africa, vacant positions left by teachers that retire, ill, or deceased are often not filled [18]. This is besides schools having few teachers. The situation is aggravated by the fact that some teachers fail to report to the allocated schools by the department of education [41]. Reasons for not reporting include; school being in rural area where transport, electricity, water and housing are scarce resources, delay in promotion and provision of allowances. As a result, teachers result to seeking employment in private schools or other sectors.

Governments provide solutions by offering teachers training and employing new teachers. Researchers argue that new teachers have little grasp of content, lack confidence in classrooms, and are not motivated [41]. These arguments are supported by claims that teachers are not well trained, and that they enter teaching colleges with low qualifications [7]. In addition to the said competency challenges, these teachers lack adequate resources to teach.

Unless the economic situation changes and governments in developing countries increase their education budget, most high schools will continue facing shortages of teaching and learning materials. This investment is supported by the argument that quality education leads to increased socio-economic development [29]. Supporting initiatives that complement formal learning in high school education will contribute to this development.

**Shortage of teaching and learning materials**. Shortage of teaching material affects developing countries tremendously. Learners struggle with basic concepts as aiding tools are in short supply. Teaching material such as; printed and supplementary material, sound and visual tools, pictorial representation, timelines, atlases, plant and animal specimen, apparatus and chemicals are at best limited and worse, not available [7].

For learners, learning material aid understanding of content. Learning material include; textbooks, television programs, flat pictures, maps, chalkboard, CD and real objects. Learning materials assist learners develop a link between their environment and that narrated by the teacher.

Learners relate to content through reading, writing, thinking, visualizing, evaluating, discussing and reflecting [5]. Different learning materials assist learners hold interviews, run presentations and create judgement.

Shortage of teaching and learning material mean learners fail to relate to content resulting in cramming. Simple concepts are assumed complex, especially if the teacher does not have a good command of the concepts, or failed to teach adequately. This problem is more prevalent in disadvantaged schools. Privileged learners with access to mobile devices, and skills on how to use them to find complementary study materials, can overcome this shortfall.

### 2.2 Learners' Use of Mobile Devices for Learning

The use of mobile devices for learning engages, enhances, extends and enriches learners' knowledge acquisition, skills development and creation [14]. Mobile learning offers learners ability to multitask, peer learn, accommodates preference of audio, visual and graphical information and supports learner-centred approach [21].

Mobile learning offers convenience to learners [11]. When learners are on the move, so are mobile devices. Learners access different content on the Internet, choose what and where to learn from. Convenience provides learners ease of learning environment that is not cluttered by organization and set expectations. Learners own mobile devices and use is not at an additional cost which supports sustainable development.

Several reasons account for learner's use of mobile devices for learning. Learners enjoy using mobile devices for learning as it gives confidence [23], assist in reflective learning [36], and enriches learning environment [3]. To this end, the research adopts diffusion of innovation as a lens to explain high school learner's adoption and use of mobile devices outside the classroom in South Africa.

### 2.3 Theory of Diffusion of Innovation (DOI)

The theory of diffusion of innovation sees adoption and use of a technology as a new idea. The newness is based on the individual discussed from, not when the technology was created [32]. With newness comes uncertainty and perceived risk. Information is required for one to overcome uncertainty and risks, and adopt the innovation [9]. The innovation argued for is mobile devices and its use for learning.

As a communication theory, diffusion of innovation greatest contribution is viewing innovation as a social process [19]. Social in how individual aids in accepting or rejecting an innovation. Individuals apply ideas, use and experiences of an innovation in deciding to adopt. Adoption of mobile devices and use for learning is contributed by peers, friends, teachers and parents. Each learner makes personal decision to adopt a mobile device outside the classroom.

The theory of diffusion of innovation encapsulates four concepts; innovation, social systems, communication and time. This research employs innovation and social system to explain learner's adoption and use of mobile devices outside the classroom. As an innovation, access and use of mobile devices for learning outside the classroom includes several characteristics; relative advantage, trialability, compatibility, observability and complexity.

**Affordances of Mobile Devices Adopted for Learning**. Learner's use of mobile devices for learning outside the classroom offers several relative advantages. These are; an opportunity to understand concepts better, equip learners with knowledge and assist to overcome shortage of teachers and shortage of teaching and learning materials in schools. Learner's use of mobile devices for learning outside the classroom is motivated by need to contact family and social status [12].

Before adopting a mobile device and using for learning, learners try from peers, friends, sibling, parents or at shops [9]. The more a mobile device is easy to try, the easier a learner adopts it. Learners trialability is guided by ease of use and affordances [42].

As humans, we compare an innovation to current context and argue for applicability. Mobile device use for learning outside the classroom compatibility is in relation to curricula. Both, emphasize on learner's ability to acquire books, book chapters, notes and examinations [42] creating lifelong learning.

Trying a mobile device before purchasing assists a learner with quickly adopting it. What sparks trying, is observing another learner using a mobile device for learning [17]. Outside the classroom learners use mobile devices for different purposes. Little do learners know; peers are observing. Based on observations, peers inquire and ask to try. Observing a peer use a mobile device for learning, assist in shaping learners' thoughts towards or against the mobile device.

A mobile device that is viewed as complex, deters a learner from adopting [37]. Learners adopt mobile devices that are simple to use and assist in daily activities. Learners have several subjects to focus on. Learners do not require complex mobile devices that do not align to needs. If a mobile device is difficult to understand and use, this increases complexity and deters learners from adopting.

A social system is defined as "a set of interrelated units engaged in joint problem solving to accomplish a common goal" [31, p. 24]. In South African schools, the common goal is providing education. The problems in South African high school's context is issues emergent in and out of schools that affect learners.

The units that exist in these high school contexts include; curricula, learners, teachers and parents. Mobile device affordance and use for learning is a social process emerging from these units and informing others. The intention of informing peers is to understand mobile devices and their benefits for learning. Three characteristics are important; the norm, network interconnectedness and consequences.

**Role of Societal Norms in Adoption of Mobile Devices for Learning**. The norm in the society plays a vital role in adoption or rejection of an innovation [38]. Adoption of mobile devices for learning outside the classroom is meet with challenges. Parents and teachers centre learners discipline in the way a learner talks to elders, walks and upholds themselves. Learners view this as being controlled. Mobile devices have helped learners escape control by chatting to peers in conversations that turn to learning.

Learners have networks assisting each other daily. Networks include; social network and knowledge network [10,33]. Learners use social networks to acquire and distribute information on social aspects. Knowledge networks allow learners to communicate with peers in quest of information assisting with learning new concepts or explanations. Using Internet, learners extend immediate physical networks to those online. With Internet on learner's mobile devices, learners are not confined to physical networks.

Using mobile devices, learners face consequences. Consequences include; confiscation of mobile devices (both, at school and home), expulsion from school and labelled as misusing mobile devices [23]. Observing consequences assists or hinders a learner from deciding to acquire a mobile device and using for learning outside the classroom.

# 3 Methodology

## 3.1 Case Description

The high school in Cape Town is a high academic performing school. The school is in Zonnebloem district in Cape Town. Zonnebloem is predominantly a black African neighbourhood by race. Languages used in the area are English, Afrikaans and isiXhosa. The high school is situated 1.2 KM from Cape Town city centre, and began operating in 1951 as a college and around 1980's the name was changed. The name is of an education activist who fought for equal rights of black South Africans in accessing quality education.

The school is owned by the Western Cape department of education and is certified as a safe school. A safe school has a teacher (or nurse) to operate first aid, trained safety representative, fire extinguishers, fire fighter representative and an evacuation marshal. Schools in South Africa are organized in quintiles from 1 to 5 with 1 being under resourced and 5 being affluent schools [30]. The high school used for data collection is categorised as quintile 4.

## 3.2 Justification for Choosing the High School for Case Study

The school was selected as it requires learners to attain an average of 40% pass in academic year to proceed to next Grade. The school was also selected as it is in top 10% of high performing schools in the city. High school in South Africa starts at Grade 8 and completes Grade 12 [34].

This research uses Grade 12 learners as source of data. The school caters for Grade 12 subjects including isiXhosa, Afrikaans, English, pure mathematics, mathematics literacy, physical science, life orientation, Computer Application Technology (CAT), accounting, business studies, economics, history and geography.

## 3.3 Ethical Consideration

Before data collection, permission was requested from relevant authority. A meeting was organized with principal where the research was explained. The principal was informed of research purpose, data collection methods and reporting procedure. The principal was issued with a copy of the proof of ethics clearance from University of Cape Town and Western Cape department of education.

## 3.4 Data Collection Approach

A mixed method approach was used for data collection. Data collection was undertaken between September and October 2015. All Grade 12 Learners were provided with self-administered questionnaires and thereafter, semi-structured interviews were scheduled. The school has 110 Grade 12 learners. 92 learners completed the self-administered questionnaires.

Interviews were scheduled upon learners completing questionnaires. Learners were asked to volunteer for individual interviews. Learners were informed interviews will occur at the school. 17 Grade 12 learners volunteered from 3 classrooms. 15 learners were interviewed as two did not attend booked interview sessions. Learners were asked to select date and time convenient for interviews. Learners organized with peers (fellow interviewees). Learners discussed access to school and venue for hosting interviews. The researchers allowed learners to select venue for comfortability. Semi-structured interviews were recorded upon acquiring permission from learners.

A geography teachers' classroom was used for interviews. Learners stated "the teacher is our friend and we are happy to use her classroom for interviews. We can even ask her questions on geography results". Learners exchanged phone (and WhatsApp) numbers with researchers for ease of communication. Learners had mobile devices at school.

### 3.5 Data Analysis Techniques

Questionnaires were coded and entered on Epi Info 7 for analysis. Descriptive statistics was used to summarize survey data. Descriptive statistics can be performed on quantitative data with an intention of identifying frequencies, percentages, mean, median, mode and standard deviation [10]. Frequencies were used for this research. Questions asked emerged from the theory of diffusion of innovation and reflect learner's response to concepts.

Semi-structured interviews were edit transcribed using Atlas.ti 7 and stored on a computer. Each interview was coded with learner's reference. For example, first learner to be interviewed was male and coded S1M. This research used thematic analysis to analyse interviews.

Thematic analysis approach used follows six steps as identified by [6]. Thematic analysis offers flexibility and ease of application of steps in analysis leading to theme explanation. The six steps are; familiarizing with data through transcription and reading transcripts, generating of initial codes through identification of words, sentences and paragraphs that relate to concepts identified from theory of diffusion of innovation, searching for codes that have an overarching representation and labelled a theme, reviewing themes to ensure internal homogeneity and external heterogeneity, defining and naming each theme and producing a report.

## 4 Findings

Based on analysed questionnaires, Grade 12 learners have 47 male and 45 female learners. Subject combinations are distributed as follows; 16 learners pursue art subjects, 27 pursue commercial subjects, and 38 pursue science subjects. 11 learners did not choose any combination and this can be explained as lack of clarity from researchers to explain what a combination is. At Grade 12, learners are expected to have chosen a combination for matric examinations. Some learners have subjects from different combinations and that could be the reason.

In terms of age, 45 learners recorded their age as being 18 years, which is the average age for Grade 12 learners in South Africa, while two learners recorded their age as being 20 years. The two learners were found to have repeated grades because of poor academic performance, some of which were attributed to challenging circumstances at home.

In total, 90 learners demonstrate owning mobile devices for personal use. Of the two learners without a personal mobile device, one shares with a relative, sibling or parent. One learner does not have a mobile device. 91 learners use mobile data for internet access on their mobile devices. Access to resources such as search engines, websites, blogs, social media, instant messaging applications and email is through Internet. 84 learners have email addresses, 73 of whom use Gmail. Learners choose multiple email companies. No learner illustrated owning other email address.

Learners spend between half an hour and 18 hours on mobile devices including Internet. The significance of time spent by learners on mobile devices and social media is learners are active creators and receivers of information. Learners read and create information on social media. Learners share information with peers using social media.

## 4.1 Innovation

As an innovation, a mobile device comes with uncertainty. Information available on learner's use of mobile devices depict adoption of the innovation. Learners have adopted mobile devices and use daily. Several affordances and use as depicted on Table 1.

**Table 1.** Learners' view on using a mobile device.

| Concept | Characteristics and aspects | Frequency | | |
|---|---|---|---|---|
| | | Yes | No | Total |
| Innovation | | | | |
| | Relative advantage | 74 | 18 | 92 |
| | Compatibility | 86 | 6 | 92 |
| | Trialability | | | |
| | Google search | 90 | 2 | 92 |
| | YouTube | 47 | 45 | 92 |
| | Camera/Video | 66 | 26 | 92 |
| | Map | 23 | 69 | 92 |
| | Observability | 64 | 28 | 92 |
| | Complexity | 55 | 37 | 92 |

**Relative advantage**. Learners argue receiving relative advantage from mobile devices. Table 1 shows 74 learners perceive receiving relative advantage. Learners get an advantage compared to peers not using mobile devices. S11F receives an advantage from using a mobile device. S1M elaborates that using mobile devices affords access to different sources of information. Both learners focused on using mobile devices for academic purposes.

> "Because the work we are doing at school, it's not everything and when you use the device you get more information on certain topics and I think that is an advantage. Because you get to know more than what you have been given at school". S11F

> "I think it's a good feeling, because you know you could do a lot, you could get lots of information from a lot of different sources. It's so easy to get anything from the Internet". S1M

The advantage learners receive from using mobile devices is not only on academic issues, but other communication. Other communication includes socializing, contacting peers and family. Through socializing, learners contact peers and share information on academic and non-academic issues.

> "I was searching for History and it was for a cousin of mine. She did not know the person she was supposed to do a research about and I also did not know the person. So, I asked her to give me the information and I was going to search for her and then I took it and then I used my phone and I searched about that person". S7M

Learners help siblings with academic content through mobile devices. S7M explains how he assisted a cousin to acquire information in relation to history. While assisting the cousin, he also learnt. Contacting is not limited to communication, it extends to learning.

**Observability**. Learners observe peers using mobile devices and are interested in adopting. Table 1 illustrates 64 learners observed peers and were interested. Using prior knowledge on mobile devices and enquiring from peers, learners adopt mobile devices of choice.

> "I saw someone using it. A friend of mine had it. The friend had the iPhone 5 and since I previously had iPhone 4S, then I wanted to go bigger and ended buying the 5S. The iPhone 4S was a black-market product and it didn't work. So, this time I decided to buy from the shop". S15F

Peers offer advice and technical support. Still, learners adopt mobile devices of choice. S15F observed a peer using a mobile device she likes. The learner had prior knowledge of iPhones. The learner bought iPhone 5S which was an updated version.

> "Because sometime my friend told me to look at the iPhone 6c which has 64 GB on the phone. I told her that is like R 13,000-16,000, but she was looking at the black-market phones. I also looked for one. iPhone space is really good and the Internet is fast and everything". S10M

Learners use different approaches to adopt mobile devices. S10M identifies technical details on where to buy mobile devices. The learner bought an iPhone through black-market.

**Trialability**. Learners try mobile devices observed from peers and family. Learners enquire on affordances mobile device offers and try. Learners try mobile devices in stores. Table 1 illustrates 90 learners trying Google, 47 YouTube, 66 camera and videos and 23 maps on mobile devices. When trying mobile devices, learners have different preferences. Learners use mobile devices to access affordance. S4F describes trying a mobile device from a peer.

> "Yes, I tried it in store, Edgars. Also, a friend had it before". S4F

The learner tried the mobile device for the second time at a store. Some learners do not try mobile device before adoption. When a learner is satisfied with details of a mobile device, they may adopt without trying.

> "Well, if I happen to use my phone instead of the textbook and the other learners is using a textbook, they won't get videos from the textbooks. I can watch videos of the information. For example, a play by Othello. A book that we are reading. I can go to the Internet and watch a video about Othello, while they are reading a book so I will have a better understanding than he/she has". S6F

As part of trying, respondent S6F uses multimedia on mobile device to understand content. The learner argues, a mobile device is less boring. Learners prefer observing than just reading. Content explained through multimedia captures learners understanding.

**Compatibility**. Learners view mobile devices compatible with traditional classroom. Compatibility is by complementary contribution mobile devices offer. Using mobile devices for learning is compatible with traditional classroom as both provide life-long learning. Table 1 proves 83 learners view mobile devices compatible with traditional learning as a supplementary source of material.

Learners use mobile devices to enhance content from class. Using mobile devices, learners access search engines and websites providing convenience in acquiring content on the Internet. S7M uses a website, Wikipedia that provides comprehensive content.

> "The reason being, if something is in a book, it does not have more information than what you will get on the Internet. In terms of Wikipedia that is if you want to learn about everything. For instance, there is an assignment for history and we must search about someone. I will get more information than those people because they give me more information about a certain person". S7M

The learner is sceptical on accuracy of content found on the Internet and depicts dependence on teachers as books provided are valid and accurate. The learner argues, recommended textbooks might offer simplified and clear information than the Internet.

> "Sometimes like the information that you get on the Internet, you are not sure if it's accurate. So, like the best thing will be like in terms of comparing. Because I will search for certain thing when I am doing my assignment. Search on my phone where as if I would search on a certain book that your teacher told to search on, may be the information is better than what you were going to get on the Internet. Sometimes on

the book the explanation is simplified or quoted in better terms than what you were going to get on the Internet". S7M

Searching on mobile devices offers learners access to content on Internet, which supplements their learning material. Learners favour use of mobile device for learning as a supplementary source of material.

**Complexity**. Use of mobile devices for learning is a complex process. Table 1 illustrates that 55 learners' view using mobile devices for learning as a complex process largely because learners compare mobile devices to books. Complexity is brought by need for accuracy of information on the Internet, information overload and not understanding operating a mobile device.

"Sometimes like your book gives a lot of information and the phone sometimes just simplifies everything". S9M

Striving for credibility enforces learners to use recommended textbooks as explained earlier by S7M. The learner depicts information overload from accessing content on the Internet. Ironically, textbooks contain information overload as argued by S9M. Teachers assist with reducing credibility by explaining to learners. To reduce information overload, teachers guide learners on websites to access and books to read.

"It's not easy to use an iPhone as you have to be patient, but you learn a lot of things". S15F

Respondent S15F describes experience of an iPhone owner. Owning an iPhone requires patience in learning how to operate. Thereafter, to use the mobile device for learning. Learners explained of applications used to share files between iPhone and Android mobile devices and among Android users. These include Share It and WhatsApp, which allow transfer of social and academic content on either operating systems.

### 4.2 Social Systems

Society argues learners are not using mobile devices for learning but communication. To identify and provide explanations, learners were asked on communication to peers and academic relationship. As Table 2 illustrates, learners use mobile devices to communicate to peers and friends through social and knowledge networks on academic issues. The two networks for learners are not separated. At least 70 learners use phone calls, 58 use SMS and 77 use instant messaging to communicate to peers and friends on academic issues.

**Network Interconnectedness**. Learners work in collaboration with peers to complete projects, assignments, homework and prepare for examination. Working in group's aid learners understanding of content. Peers offer solutions using social networks and instant messaging applications. Learners take pictures and audio records in classroom and share in groups. Groups are created on instant messaging applications and social networks.

> "Like in class we normally, when we are lazy to write the breakdown or the work on the board, then we take pictures and send to each other. When we are to do a team work, group session and we take pictures and just work through pictures on WhatsApp or Facebook". S9M

Learners take pictures of notes and share in groups. Notes shared assist absent peers, slow learners and lazy group members to understand content covered. S9M explains. The learner depicts use of WhatsApp and Facebook to complete tasks as a group.

Learners record voice notes and share with peers. Voice notes recorded explains to peers how to approach a question from assignment. Peers record response and share.

**Table 2.** Learners' use of networks for learning.

| Concept | Characteristics and aspects | Frequency | | |
|---|---|---|---|---|
| | | Yes | No | Total |
| Social system | | | | |
| | Network interconnectedness | | | |
| | **Using calls** | | | |
| | Call a peer to ask for solution | 70 | 22 | 92 |
| | Received a call requesting for solution | 74 | 18 | 92 |
| | **Using SMS** | | | |
| | Sent text to a peer requesting for a solution | 58 | 34 | 92 |
| | Received text asking for a solution | 62 | 30 | 92 |
| | **Using instant messaging** | | | |
| | Sent instant message asking for a solution | 77 | 15 | 92 |
| | Received instant text requesting for a solution | 85 | 7 | 92 |

**Norm**. Learners are affected by norms in the society. The society has created an image of learners misusing mobile devices. Parents and teachers hold perceptions on learner's use of mobile devices both, at home and within school compounds. Academic use of mobile devices is considered by few parents.

Parents ensure learners are not misusing mobile devices while at home. Parents confiscate children mobile device. Parents begin by threating to confiscate mobile devices followed by confiscating. Parents use harsh words to children like "if you fail your exams, it is because of the mobile device". Learners are forced to abandon mobile devices despite using for learning.

Learners spending considerable hours on mobile devices is perceived misuse. Parents assume learners are chatting for socialization. S7M illustrates parents' perceptions.

> "Sometimes my parents have a problem because they say I am always on my phone instead of being on my books. Why don't I use the time that I am always on my phone, on social media, use that time for doing my studies?" S7M

When learners have intention to learn using mobile devices, hours on mobile devices are used for learning. Few parents inform their children the onus of learning is upon them.

> "Teachers discourage us because they know we are not really using it on our school work. It distracts us in classes as that is all we concentrate on. We don't learn much from what they are teaching us. Instead, we are busy on our phones and concentrating on them. Our business teacher discourages a lot". S5F

Teachers discourage use of mobile devices within school compounds due to fear of learners failing. S5F explains views from a teacher. Learners go to school with mobile devices despite prohibition. In classrooms, learners do not use mobile devices unless asked by a teacher. Teachers support learners using mobile devices outside the class.

The culture in the society has labelled constant use of mobile devices as misuse. S15F provides explanation on the phenomenon. The learner insists, peers should monitor use of mobile devices to considerable hours.

> "It's not a bad thing if you don't constantly do it. But currently we don't understand a number of things, especially in learning. So, I think it's quite an advantage. But it can also be a disadvantage as we try and rely mostly on the Internet without doing our own research first". S15F

However, the learner highlights the current generation will always use mobile devices to search for information. This is the 21st century with promises of science and technology and mobile devices are the technology learners have adopted.

**Consequences**. Learners have suffered for having mobile devices. Learners incur costs in buying Internet bundle on mobile devices. Respondent S7M depicts impact on mobile data usage. The learner migrated from a Blackberry where Blackberry Internet Service (BIS) provide fixed Internet rate per month to a Samsung S4 mini. Now the learner buys internet bundle that is capped. Finishing a bundle before allocated date means learner must use pocket money for data.

> "Previously before we wrote our mock exams. I lost my phone. It was stolen. I suffered a lot because I used it for BIS and I didn't have to buy data all the time. But like now, its data, data, data, all the time". S7M

Mobile devices are confiscated from learners. Confiscation happens both, at home and at school. At home parents and siblings deny learners access to mobile devices. Parents also threaten children of confiscating mobile devices. Learner's mobile devices are confiscated at schools. Teachers insist on learners not going to school with mobile devices. Learners are either fined or mobile devices are confiscated if found at school.

> "Parents have never stopped me from using my device. I have just got to the point of stopping myself from using my device and I give it to them". S4F

Some parents have taken a different approach to confiscation. Parents have allowed children to use mobile devices and teach self-control. S4F depicts controlling use by giving parents her devices when she wants to study.

## 5 Discussion

The research began by posing the question *how are high school learners adopting and using mobile devices for learning outside the classroom in South Africa*? Findings depict mobile devices afford learner's access to mobile internet, and act as a platform to access educational multimedia content, and instant messaging applications, which can be used for educational discussions. Affordances are argued in previous studies by [3] and [33]. Affordances put learners at risk of mobile devices confiscation and damage.

Learners depict receiving a relative advantage using mobile devices by communicating with peers and teachers for communication and learning as related by [20] and [35] findings. Learners download and use social networks and instant messaging applications as [26] supports. Learners use blogging which allows access to social networks and sharing content to peers. Peers contribute through comments as argued by [25].

Learners observe peers as they use mobile devices before adopting. Observing peers is supported in research by [15]. While observing, Learners become interested. In the process, learners receive advice from peers and shop attendants on mobile devices to acquire. Learners receive technical support from peers and relatives on affordances of interest. Technical support includes details on operating system and storage capacity of a mobile device. Regardless of advice and support, learners make emotional decisions during adoption. Emotional decisions relate to a mobile device being within budget, durable and of quality.

Much as [8] and [16] found, we also identified learners enquire and try mobile devices observed from peers. Learners prefer a blend of multimedia and text in both cases as supported by previous research by [27]. Learners use Google, YouTube, camera and video and maps on mobile devices for learning outside the classroom. These affordances enhance and enrich learning.

Learners explain using a mobile device for learning outside the classroom compatible with traditional education which is supported by findings from [27] maintaining impact is on lifelong learning. Learners argue mobile devices are convenient due to affordance of reading while travelling. Learners use mobile devices in cafeteria, taxi's and trains as found by [24].

Learners argue, mobile devices are not as complex as the researchers assumed. Learners are sceptical of information overload. Learners need to be vigilant of content beyond their level. Device incompatibility may influence learners to abandon mobile device as it will be viewed complex. [13] claims, learners want mobile devices that will simplify academic work.

It was found that learners use social and knowledge networks to acquire academic content. Research by [39] support our findings that learners call, send SMS and use instant messaging to communicate to peers and teachers. The norm in the society has labelled use of mobile device as misuse leading to consequences of mobile device confiscation and punishment as [39] findings have also shown.

## 6 Conclusion

Mobile devices are adopted at the high school and learners use them for learning. The mobile devices used afford access to Internet that offers multitude of information to learners. While learners are sceptical of information accuracy and data bundles, they continuously access the Internet to acquire information that aids with learning outside the classroom. This practice assists learners to employ technology at reach and reduce shortage of teaching and learning material. Teachers play a critical role in advancing and enhancing learners learning. Using technology in education assists with not only quick access to information but overcoming poverty that is rampant in developing countries.

This research contributes to theory by providing empirical evidence on application of the diffusion of innovation theory as lens in using mobile devices for learning outside the classroom by using quantitative and qualitative data from a high school in Cape Town, South Africa. The research also contributes to practice by explaining how and why learners use mobile devices for learning outside the classroom which expands discussion on adoption of technology for learning. The explanation is extended to afford replication in different setting of developing countries therefore affording learners' Independent learning leading to lifelong learning. Future research may focus on providing qualitative information from teachers on tools and techniques learners can adopt for learning outside the classroom with support.

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# Mobile Usage at Universities for Academic Purposes: Should Lecturers Change Teaching Approaches?

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**Abstract.** Information and Communications Technologies (ICTs) continue to expand the borders of higher education into an anytime and anywhere experience. Mobile technology presents new means for students to access classroom information and communicate with peers and lecturers. Today, mobile phones have become popular devices for accessing and sharing information. Such mobile devices include personal smart phones, tablets, Personal Digital Assistants (PDA), iPod touches, iPad, and numerous other devices. There is no doubt that the usage of mobile devices for academic purposes is becoming increasingly popular. Universities now consists students who are easily connected to technology and smart mobile devices. Despite the growth of mobile usage, some lecturers do not allow mobile usage during lectures. A mixed method was applied to determine mobile ownership and usage during lectures. Quantitative and qualitative approaches were incorporated in data analysis. Results show that students are increasingly utilising their mobile phones during lectures. The results helped in formulating the recommendations discussed in the paper.

**Keywords:** Mobile technology, Mobile usage, Mobile learning, Innovative teaching approach.

## 1 Introduction

As technologies emerge within the academic sector, mobile technology usage is increasingly being witnessed. This is influencing the way in which learning takes place. Mobile technology has become an important part in learning and is transiting to more affordable and compact devices with more reliability and connectivity [5]. The use of mobile devices such as mobile phones, laptops, iPad, PDA and various types of tablets has grown across the world and is now used in higher institutions. Use of mobile devices has grown to such an extent, over years, that they now overtake the proliferation of personal computers in modern professional and social contexts [6]. Mobile learning enables students and lecturers to have a variety of innovative ways to access information [17]. With mobile technologies, learning can now happen anywhere anytime. Literature has shown that the commonly used mobile device among students is the



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smart phone [21]. In general, mobile learning can be regarded as any form of learning that happens when arbitrated through a mobile device [14].

While it has been described as a growing model research indicates that few universities have implemented widespread mobile technologies learning, and in those that have, it is not clear that they are being used in educationally appropriate ways [21]. There is also dearth of research into the use of mobile devices for academic learning in institutions of higher learning, despite their popularity. Most of the research in this topic has been done on high schools. Considering that most university students own or have access to mobile phones, this paper focused on university students. We understand that there are a variety of mobile devices available to students, however for this paper, the smart phone is the commonly used device that was considered. We argue that there is sufficient evidence in literature that mobile phone usage has become common in lecture rooms. The paper is based on the observations by the two authors who are university lecturers and a pilot study that was carried out at Namibia University of Science and Technology on mobile usage by students. The challenge at hand is that despite the growth in mobile phone usage in lectures, there are many lecturers who prohibit and discourage students to use mobile phones during lecture times. Our opinion is that, rather than discouraging students to use mobile phones during lectures, there is need to incorporate them in teaching and learning by restructuring the teaching approaches and course content. The following research question was used to write this paper: *How can the mobile technology usage be considered to enhance teaching and learning at universities?*

The research question was achieved by formulating the following objective for the paper: *To analyse mobile technology usage among university students and formulate innovative teaching recommendations to lecturers.* We considered one university for the pilot study and used current literature to support the growth of mobile usage among the students. At the end of the paper we propose recommendations on how lecturers could incorporate mobile phone technologies within their lecture rooms. Despite the data collected from one university, we are confident that the paper recommendations could be applied by other university lecturers across the continent. The paper is structured as follows: literature on technologies in teaching and learning, common teaching approaches, the methodology which was applied, key findings and the proposed recommendations.

## 2 Related Literature

Mobile phones are now an integral part of everyday life, only found strange when it is absent [22]. Many students at universities embrace mobile technology establishment and utilise it consistently in their own lives. Mobile phones are becoming smarter and their usage in universities by students is becoming more popular each and every day [18]. Students are spending an increasing amount of time on their phones with the passage of time. This is made possible by the affordability of smart phones whose prices are continuously dropping [1]. It is important for interested parties at universities to come together and encourage university students to own mobile devices that can be adopted for learning. It is high time stakeholders should start thinking about buying, subsidizing and providing mobile devices to all university students [1]. Mobile learning provides significant learning prospects for students who regularly use mobile devices like personal digital assistance, android, smart phones, and so on [3].

[7] argued that the use of mobile devices for learning can enlarge the scope of tertiary education and allow it to better reach students. The use of these technologies for learning is equally capable of providing a more interactive and effective type of learning to meet individuals‟ student needs. Mobile technology can be beneficial for higher education due to its ubiquitous nature and ability to shape information processes [10]. It offers the ability to engage in learning activities such as communication and content material sharing between students and lecturers, students and subject experts, and among students and their environments.

Other researchers also argue that the mobile phone is ever-present at universities and is frequently used in settings where learning occurs [16]. The usage of mobile phones by students is very frequent [4] to the extent that some students become addicted to their phones checking their phones regularly for any messages [19].

Mobile phones are being used to wake people up in the morning, organize appointments and personal contacts, store personal images, store and play music, and take pictures [22,23]. They are quickly becoming devices of personal expression where users can customize ring tones, skins, photos, and songs and to interact via voice and text. Whilst most lecturers may see mobile phones as distractions that lead to disturbances or disruptions, most students cannot do without them [23]. The current generation possesses a keen ability to quickly understand, use, exploit, and integrate new and emerging technologies. Involving technologies such as mobile phones that are held with high value to students into teaching and learning cannot help but motivate students. Utilising the mobile phone as a teaching and learning tool should increase the desire of students to become fully involved in their education [20].

According to [25], 79 percent of institutions of higher learning students own newly innovated smartphones. Despite most students having smart phones, not much has been published regarding incorporation of mobile phones into teaching and learning for enhancements of student learning. As a result, there is dearth of literature available in South Africa on this subject. Whilst mobile phones are not part of the traditional university culture, they can be a fundamental tool for enhancing teaching and learning. It is becoming increasingly difficult to ignore the importance of mobile learning to enhance education in higher education [15]. As mobile phone technology continues its rapid development, the device is capable of contributing to student learning and improved academic performance [13]. Mobile phones play a huge part in how the student lives are shaped and have become an indispensable part of their lives [4]. The use of mobile phones by students leads to a change in their attitudes, values, beliefs and behaviors. Such an influence needs to be tapped into as understanding how students use their phones and their attachment to them can be used to find ways in which mobile phones can be integrated into the teaching and learning. Since social networking is the main use of mobile phones [19], lecturers should attempt to go social with their teaching and assessment methods.

Most e-learning platforms within the universities are not mobile phone friendly compared to other products such as Facebook, Twitter and YouTube which have apps specifically meant for smart phones. Most students do not use their mobile phones for academic purposes but for socialization, safety and privacy purposes [19].

Other studies on mobile devices in classroom found that if appropriately used the mobile device may have a positive impact on the students [20,9]. The arguments cited by most in academia as reasons for not fully integrating mobile phones in their teaching and learning include:

- Multi-tasking: Use of phones while studying or listening to the teacher is a common behavior for university students [8,11]. During class sessions, students use their phones to send and read text messages, visit social networks, chat and visit the internet sites. Some go to the extent of calling and receiving calls.
- Addiction or over reliance: Students get addicted to mobile phones to the extent that it causes anxiety when they take long without their phones [19]. Over dependency on the mobile phones leads to emotional stress, damaged relationships, and falling literacy [2]. Integrating mobile phones into the syllabus would exacerbate over-reliance on mobile phones.

The capability of mobile phones to entertain, connect, and inform will continue its rapid development. As such, mobile phones and related devices will only increase in popularity and use. There is, therefore, a need to better understand how this technology can be harnessed to make a genuine contribution to student learning [13].

It is important to point out that as mobile technology continues to grow and develop; universities need to ensure that the wireless infrastructure is effective to support the information flow [24]. Critically, stakeholders should ensure that lecture venues have strong Wi-Fi signals or could avoid activities relying on heavy Internet access during lecture times. The success of mobile technology at universities requires a complete change of mindset among lecturers. It requires committed individuals who are willing to use devices effectively in lectures and to working through the learning curve associated with new technology [9].

In summary, there is sufficient evidence that mobile usage is growing. There is no argument on the fact that the mobile phones have become part of the daily life and classroom. It is therefore ideal to incorporate them into teaching and learning so that student learning is enhanced. Mobile technologies used for sharing and communicating vary from one community to the other. However, for university students, smart phone ownership is higher than other devices. It was also noticed during literature study that there is less research undertaken on mobile technologies at universities. Majority of the studies on mobile technology usage are done at high schools. This made it difficult for us to get latest information and statistics on mobile usage for academic purposes at universities. We appreciate current literature on general mobile usage growth and common uses and we were able to relate this to this paper. The summary of mobile technology usage from literature will be summarised in the findings section.

**Findings from Desktop Survey.** This section presents the current literature on mobile usage. We have considered the current literature on the popularity of mobile phones and usage. From a study by Erickson supported by United Nations, the growth of mobile subscriptions is summarised as follows.

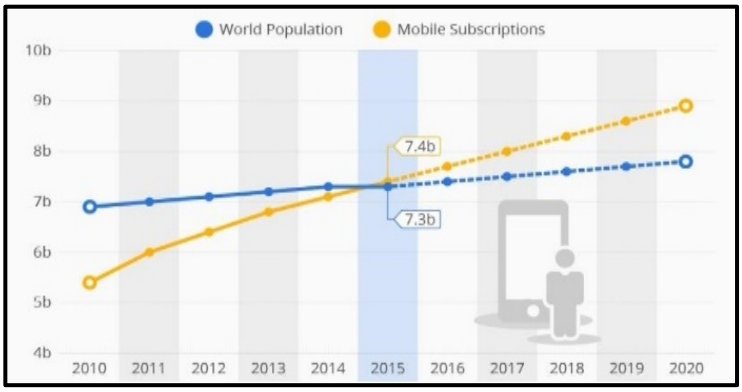


**Fig. 1.** Mobile subscribers versus world population.
https://www.weforum.org/agenda/2015/11/mobile-subscriptions-outnumber-people-world

Fig 1 shows that the number of mobile subscribers has exceeded the world population. This explains how the mobile phone is continuously becoming popular and its growth is expected to continue for years to come.

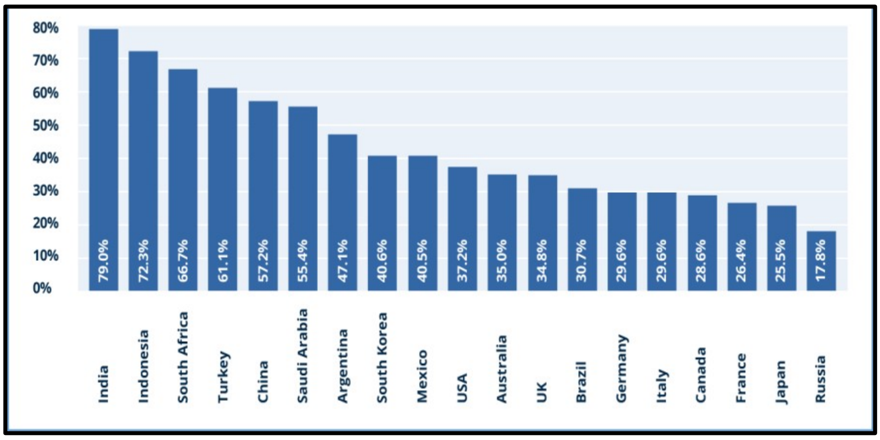


**Fig. 2.** Mobile usage among the youth from selected countries extracted from Global statistics (2017).

The graph (fig. 2) shows the mobile usage by the youth in respective countries. Interestingly South Africa is one of the countries with a high rate of youths (68%) utilising mobile devices.

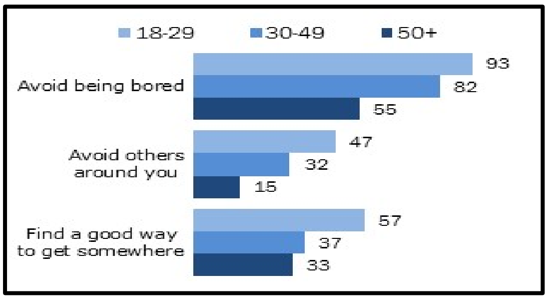


**Fig. 3.** Reasons for mobile use.

In another study by Pew Research Centre in 2014, one of the common reasons for using mobile phones among the youth is to avoid boredom (fig. 3). This could be a lesson to those teaching so called boring courses or those who are boring lectures to note that, students between 18-29 are likely to be bored even during the lectures and turn to their mobile phones. This argument is corroborated by [20] who argue that students use mobile phones in the classroom when they perceive the education to be boring, not demanding enough, uninteresting, or when they got stuck and had to await the educator's assistance. Students argue that the gap filled by the mobile phones in the classroom would have been filled by other disruptive behaviors such as yawning and talking in class were the mobile phones not available [20].

Pew Research Centre also carried a similar study on mobile usage in 2014. The graph (fig. 4) shows that messages are one of the common mobile use among the youth.

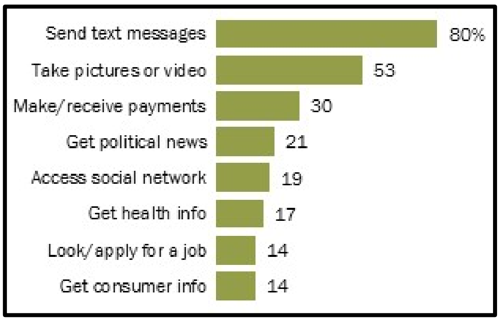


**Fig. 4.** General mobile use by youth.

The uses of mobile phones as noticed by Per Research Centre are important as they may assist those who are willing to incorporate mobile technologies in teaching and learning.

In a separate study still on mobile in usage, the following results came out (fig. 5):

| | 18-29 (n=321) | 30-49 (n=535) | 50-64 (n=572) | 65+ (n=430) |
|---|---|---|---|---|
| Send or receive text messages | 95%*** | 85%** | 58%* | 24% |
| Take a picture | 91*** | 81** | 60* | 37 |
| Access the internet | 64*** | 54** | 26* | 10 |
| Send a photo or video to someone | 72** | 65** | 40* | 16 |
| Send or receive email | 51** | 46** | 26* | 10 |
| Download an app | 49*** | 37** | 17* | 7 |
| Play a game | 53*** | 44** | 18* | 7 |
| Play music | 58*** | 39** | 16* | 4 |
| Record a video | 53*** | 42** | 19* | 3 |
| Access a social networking site | 50*** | 36** | 13* | 2 |
| Watch a video | 44*** | 32** | 10* | 3 |
| Post a photo or video online | 37*** | 26** | 9* | 5 |
| Check your bank balance or do any online banking | 29** | 22** | 10 | 6 |
| Participate in a video call or video chat | 14*** | 5** | 2 | 2 |

**Fig. 5.** Other common mobile use.

The results show that the age group between 18-29 years, like sending messages and taking pictures, sending pictures and videos to others. This imply that, if incorporated into teaching and learning, students would enjoy using the pictures and video options of the mobile phones which may reduce their boredom in classrooms. This in turn may arouse the interest of students in learning as they will be utilising one of their favorite dives, the mobile phone, into their learning.

Finally, there is evidence that parents are also in support of having or buying their children mobile phones (fig. 6). For example, parents would like their child to have connectivity and mobile device before the age of 13 years.

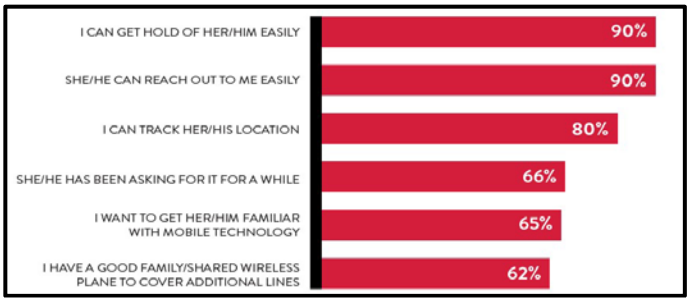


**Fig. 6.** Parents support children connectivity.

These are the children who will later join the university. This implies that lecturers should be prepared to work and teach technologically prepared students.

**The Findings from Current Literature are Summarised as Follows:**

- According to [20] students mainly use mobile devices to: access e-learning management systems, browsing information on the internet, calculations, translation of words, note taking, organisation of the school day through calendar or social media groups, download music, videos, podcasts, send and receive emails, take and share pictures for academic purposes.
- Students who use mobile devices are more motivated and self-driven and they enjoy their studies [9]. This is corroborated by [26] who argue that use of cell phones in a class can act as a motivator for students.
- Mobile technology requires a proper plan and alignment to the curriculum to get positive results. From the results by [11], despite incorporating and allowing students to access the internet, the overall performance was not so good.
- According to some students in a study by [20,2], using mobile devices in class foster productive collaborative learning and improve interactions with peers and instructors.
- Learning using mobile devices those students own improves their participation as they already understand how the device works. As [15] suggests, students instead of waiting to be assisted by the educator, they can use mobile phones to access additional information. When students do this, they develop their own personal infrastructures for learning, in which the ubiquity of the mobile phone enables new learning practices. These practices challenge the teacher's role as a source of knowledge in the infrastructure for learning.
- One way to capitalize on information access for learning is to maximize the collaborative potential of mobile phones. Smart phones allow for easy sharing information and encourage interaction between group members [9].

## 3 Methodological Approach

This study adopts a mixed approach where both qualitative and quantitative techniques were employed. The specific methods for data collection and analysis were desktop survey and online questionnaires. The study relies on qualitative methods for data analysis. The assumed qualitative strategy is grounded on the paper's objectives and the research strategy employed to achieve each objective. Given that the research took an interpretivist philosophical approach to formulate the recommendations, the research question was: How can the mobile technology usage be considered to enhance teaching and learning? The final outcome of the paper is a list of recommendations on how lecturers could incorporate mobile technology usage during lectures.

An interpretive approach was applied in making sense of the collected data and formulating the recommendations. In this study, an inductive approach is considered to understanding the collected data and subsequently formulates constructive recommendations on how lecturers could incorporate mobile phones within the classroom environment. The study considered qualitative data in reviewing documents and literature on mobile learning and innovative teaching approaches.

Quantitative data was collected through the desktop survey. A variety of documents were considered for the study. Additionally, the online questionnaire consists of both quantitative and qualitative questions related to mobile technology, mobile devices, student behavior towards mobile devices and performance with the use of mobile devices such as how do students study, their concentration etc. The study also required a comprehensive understanding of the students‟ views on mobile technologies for academic purposes. The online questionnaire was developed to gather information on how exactly mobile technologies influence teaching and learning in university lectures. For the purpose of this paper, simple random sampling technique was used. Only one university was considered as this is where the main author and second were based. We also considered available literature on mobile usage at universities. We gained a lot of experience from the involvement of the third author on observations on what happens during lecture times.

### 3.1 Data Collection Instruments

An online survey was carried out using Google form. The link was randomly distributed to 100 students from Namibia university of Science and Technology. Of the invitations, 67 respondents successfully completed the survey. For convenience purposes, only students from the Faculty of Computing and Informatics were engaged. A number of emails were collected from the Faculty students by going physically to classes and ask for emails. Some students‟ emails were collected by engaging the class representatives who announced on their WhatsApp groups. Reminders to complete the questionnaire were sent through emails and class representatives.

Data was also collected by sending links via mobile phones to student one by one asking them to make time and answer the survey questions. These were students who indicated that they will not get access to their emails easily. Several reminders were sent via WhatsApp, reminding students to complete the survey. Two lecturers were also contacted and asked, to inform their class representatives to send out the survey link to other students in their class and invite them to make time and answer the survey. The link was sent to the lecturers who forwarded the link to their class representative. The online questionnaire had thirteen (13) questions which consisted of two sections, A and B. The respondent had to evaluate the statements by clicking the answers they have in the column, which also consisted of questions answered with Yes or No and evaluation block where they tick accordingly.

For this paper, only that provided data on mobile technology usage for academic purposes were considered. We understand that engaging more students and lecturers would have improved the reliability of the findings, however, the obtained findings from the pilot study supported by current literature were sufficient to produce this paper.

### 3.2 Ethical Considerations

As a part of this research all participants were informed about all the aspects of the study including those that could affect their willingness or ability to be part of the study.

Since we consider this research as a pilot study, we did not engage all the faculties and students at the university. However, the data collection ethical procedure was adhered to and permission from Namibia University of Science and Technology and the students engaged was obtained.

## 4 Findings

The findings for this study are classified based on the methods that were used. The first set of findings is from the online questionnaire. The second is from the desktop survey which included secondary data from current literature on mobile usage. Data is presented in percentages and from a total of sixty-seven (67) participants who were engaged.

### 4.1 Findings from Online Questionnaire

Section A of the questionnaire comprised basic questions on mobile devices ownership and how students used mobile devices to assist with their studies. The results are presented in percentages using pie charts and graphs.

**Mobile Technology Ownership.** Figure 7 shows the results of mobile technology ownership amongst students. The participants had to indicate if they own each of the indicated mobile devices. The y-axis shows the type of mobile devices that are owned by respondents. The x-axis represents the evaluated percentage of the number of respondents.

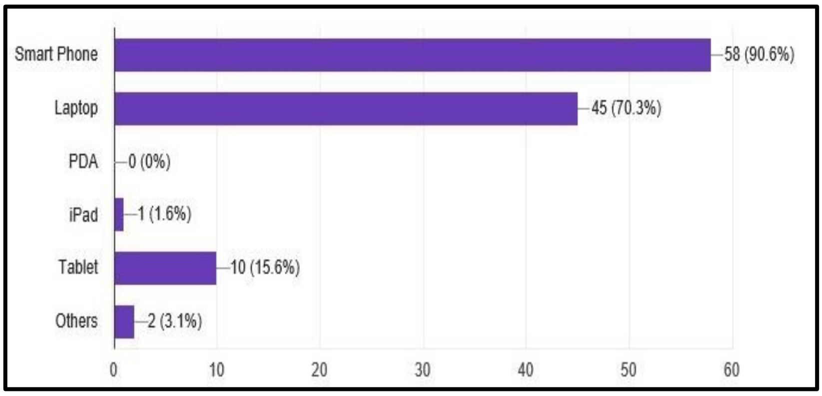


**Fig. 7.** Mobile ownership.

Results show that 90.6% of participants own smart phones, 70.3% owns laptop and 15.6 % own tablets.

**Mobile Devices Mostly Used for Study Purposes.** It was also necessary to consider the specific devices used for study purposes. Figure 8 shows the results of the type of mobile devices that are mostly used for study purposes. The y-axis represents the type of mobile devices used while the x-axis represents the percentage of the number of the respondents. The results show that 92.2% of the respondents use laptops and 31.3% make use of smart phones for study purposes. Only 4.7% uses tablets for studies.

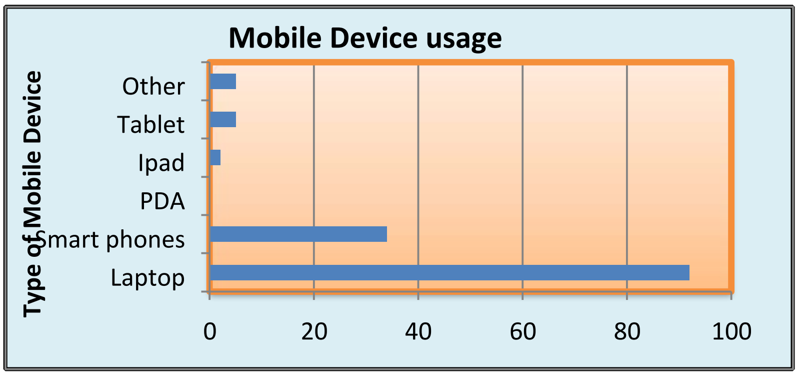


**Fig. 8.** Which device do you use for study purposes?

**Usage of Mobile Devices.** The participants were asked to choose the usage per each of the provided tasks. Results show that the participants are using mobile devices to enhance their studies.

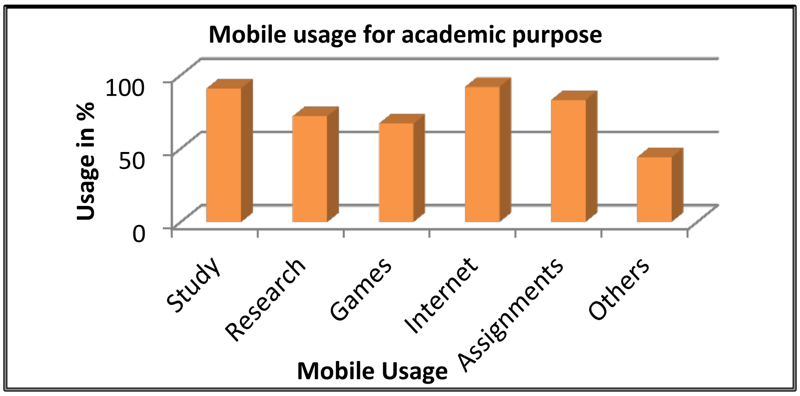


**Fig. 9.** Usage of Mobile Devices.

Figure 9 shows the results of what students use mobile devices for. The y-axis represents the specific usage of devices whilst the x-axis represents the percentage of the number of the respondents. The results show that 92.2% participants use devices for internet, 90.6% uses them for study purposes, 82.8% use their device to do home works and assignments, 71.9% do research, 68.2% play games and 43.8% use devices for other tasks. Each of the participants was allowed to select any of the uses indicated.

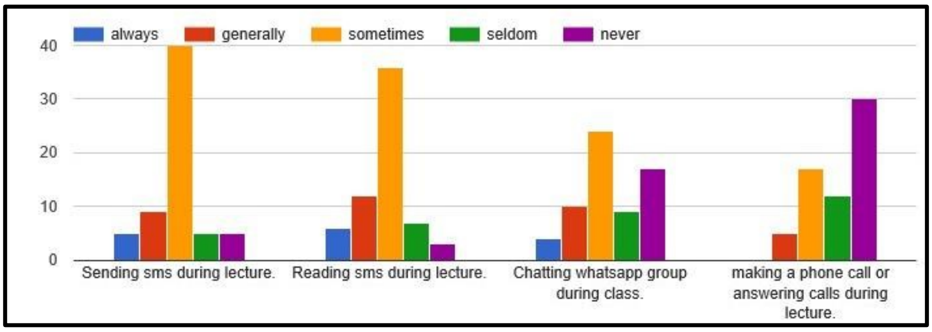


**Fig. 10.** Usage of Mobile Device During Lectures.

Figure 10 shows the results of how students use their mobile devices during lectures. In response to the questions about the purpose for using mobile devices during class, the respondents revealed that they sometimes send SMSs and read SMSs during lectures in the top order of priority. A higher percentage tends to indicate that they do not answer calls during lecture and sometimes students tend to chat in WhatsApp group during class time. Results were not convincing that the participants are always on their mobile phones during the lectures. However, in some cases they do. Possibly this is attributed to the nature of the courses done by students as some lectures are practical, as a result, students will be utilising their computers.

The results in Table 1, however, show that students are affected by mobile usage during the lectures.

**Table 1.** Impact of mobile devices use on learning.

| Variables | Never | Rarely | Some-times | Often | Very often | Total |
|---|---|---|---|---|---|---|
| How often does making use of your mobile device during lecture interfere with your learning | 9 | 23 | 21 | 12 | 2 | 67 |
| How often does receiving calls/messages during class affect your ability to concentrate | 10 | 19 | 19 | 13 | 6 | 67 |
| How often does using your mobile device during lecture assist your learning? | 6 | 13 | 20 | 20 | 8 | 67 |
| How often does the use of mobile device during study time distract you | 5 | 17 | 16 | 20 | 9 | 67 |
| How often does being in a course WhatsApp group help you in learning? | 2 | 5 | 23 | 19 | 18 | 67 |
| **Does owning a mobile phone help you communicate with other students** | **6** | **11** | **12** | **18** | **20** | **67** |

**Impact of Mobile Devices Use on Learning.** Results show that in one way or the other the participants are distracted by their phones during the lecture times.

The effect of mobile device on student learning is analysed on a 5-point Likert scale. This was reported based on the specific numbers of respondents. Majority (21) of the respondents revealed that the common use of mobile devices sometimes interferes their learning whereas (23) are of agreement that it also assist them in learning sometimes. (19) Of the respondents are of the opinion that the call/messages received during class impact on their ability to concentrate sometimes and (13) said it happens to them often. (16) Mentioned that the use of mobile devices during their study time distracts them sometimes and (20) confirmed that it also assists them in learning.

This is summarised in Table 2.

**Table 2.** Positive effects of mobile devices on academic performance.

| Indicate the extent you strongly agree to disagree with each of the following statements. | Strongly disagree | Disagree | Not really | Agree | Strongly agree |
|---|---|---|---|---|---|
| I use my mobile device to contact lecturers for study purposes | 9 | 9 | 18 | 17 | 11 |
| I use my mobile device to contact my classmates for study purposes | 9 | 6 | 7 | 20 | 27 |
| I use my mobile device to enhance my academic performance | 4 | 1 | 26 | 29 | 9 |
| Usage of mobile devices by lecturers during Lectures | 13 | 20 | 22 | 7 | 2 |
| I use the dictionary, thesaurus and calculator on my mobile device during | 5 | 1 | 25 | 22 | 11 |

Mobile phone is useful for the students for trading of helpful data with their classmates about their studies. They utilise this interesting enchantment gadget in a superior manner and some studies demonstrated that this technology has improved the academic performance. In this section the study attempted to discover the constructive outcomes on learning accomplishments of students. A majority (18) agreed that they do not really text their lectures for study purposes.

(17) agreed that they contact the lecturers for this purpose whilst (11) respondents agreed that they contact their lecturers for study purposes. (27) of the respondents strongly agreed that they can easily contact their classmates for study purpose. (29) Students indicated that their academic performances as a result of using mobile technology whereas 26 are not completely convinced. 23 agreed that mobile devices have not really helped them to increase their performance whereas 24 respondents concurred.

### 4.2 Discussions of Results

There were notable similarities and differences between the findings from the respondents and the current literature. The common feature is the popularity of mobile usage during the lecture rooms. Though the results from respondents did not clearly show that students are addicted to their mobile phones, this is a common feature from literature. For instance, there is evidence of mobile addiction among the youth. Both literature and results from the survey indicate frequent use of mobile phones during lectures. The use of phones during lectures is considered to be disruptive and is associated with poor academic performance. Another similarity is in the type of mobile devices owned by students. Both literature and the survey show that the most common device owned is the smart phone. The only difference identified in the two sources of information was the laptops being commonly used device for academic purposes. This is in contrary to literature which indicates the smart phone as the commonly used device by university students for academic purposes.

The most common uses of the mobile devices included videos, social media and sharing of files. These uses are categorised as “other” in the online questionnaire used. However, there were few students who indicated this as their common use. The majority of the students in the survey use their mobile devices primarily for studying, research and internet browsing. No major emphasis was given on sharing of videos and sharing of files. Literature indicates potential of mobile phones in enhancing student learning within the classroom. It identifies the experiences of students regarding mobile technologies and investigates how mobile phones can be used to advance teaching and learning of students.

No matter what the research regarding mobile phones in school suggests, the mobile phone has become an important resource in the universal service infrastructure. Despite some lecturers discouraging and prohibiting use of phones, evidence shows that many students still use their mobile devices during class sessions [12]. Students view mobile phones as part and parcel of their being, thus it is futile to attempt and ban use of mobile phones. We believe that there is value in incorporating mobile phones in the teaching methods and curriculum. Uncontrolled use of mobile phones in the classroom is disruptive but we believe if controlled, it can achieve positive outcomes. Use of the mobile phone in the classroom can be a means for lecturers to make teaching and learning more authentic and personalized thus, making it more relevant to students [23]. Such a strategy would motivate students and stimulate knowledge acquisition [12].

Integrating mobile phones into teaching and learning in universities is only possible if all university stakeholders come together. We understand that mobile technology could succeed at universities as it enables the following teaching approaches:

**Learning Types Behaviorism** – By incorporating mobile technologies, there is room for instant feedback.

**Constructivism** – Mobile technologies enables the use of media, simulations and immersive environments. Simulations, visualization and gaming environments are possible through mobile devices and more convenient for students.

**Collaborative learning** – This includes recording and sharing instantly. Mobile devices are good for this approach and it allows many possibilities of creating and sharing student and lecturer content.

If the above teaching approaches are followed, mobile technology could transform the current learning environment and improve the learning experiences of students.

## 5 Recommendations

The findings of this study lead to the following recommendations being made. Firstly, there is need for university lecturers to understand and accept that mobile technologies are influencing the teaching and learning and are here to stay. Based on the literature findings and our own interpretation the following recommendations are provided:

- The appreciation and permission by university lecturers to use mobile devices in lecture rooms;
- Internet access to the lecture rooms and ways of how lectures should enable students to use internet during lectures;
- Redesign the course content and online learning platforms to be user-friendly and accessible on mobile devices;
- Encourage lectures to form social media groups for their courses and promote information sharing;
- Stakeholders and universities to formulate mobile technology polices that promote mobile phone usage within lecture rooms;
- Introduce innovative platforms like online questioning systems during lectures;
- Borrow social media features such as ability to upload videos, files, audio and recording of lectures.
- Lecturers to permit students to record some lectures for students to playback at their own time.
- Allow students to interact and access their mobile devices during lectures and create collaborative environment within the lecture rooms.
- There is need to provide with cheap android alternatives to students from poor backgrounds. Alternatively, such assistance can be indicated at registration if the student would need an android phone and the cost added to the student fees. Assistance can be in the form of a mini-introduction and provision of a mobile device.

## 6 Conclusion

As mobile technologies and usage grow, there is need for universities to appreciate and plan for a paradigm shift. This involves redefining the way information and academic content is delivered and disseminated. There is clear evidence that mobile technology is playing a huge role within the academic sector. There is need for lecturers to re-think about the best practices that could accommodate the mobile technologies. In this context, the study focused on finding the usage of mobile technology among university students and proposes some recommendations on how lecturers could accommodate mobile usage. There is a significant connection between teaching and studying skills of respondents over the usage of mobile technology. Accordingly, we conclude that mobile technology usage significantly influences class activities. Mobile phones are helpful to students for exchanging of useful information with their classmates about their studies. Students are able to share information and easily communicate with one another.

The paper has provided a summary of findings from only one Faculty and one institution. However, there are positive results to indicate that there are different views on what students feel about using mobile technologies. Further studies involving many students from different universities are recommended. There is also need to practically implement mobile technologies in specific courses and monitor the success and areas to be improved. The study has provided some insights that lecturers should be aware of as mobile addiction is becoming a common issue among university lectures. It is concluded that lecturers must find innovative ways of incorporating mobile technologies and incorporate this within the lecture rooms. We argue that with proper plan and commitment among all the stakeholder mobile technology success could be witnessed in African universities and this will transform university teaching and learning.

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