The Application of Teaching Interventions in a First-year Fundamental IT Course in Improving Throughput Using the PAC Framework: 2013 to 2018

Full Paper

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Abstract. South African students come to university with vastly different background and skills and are grouped together in general first year courses. All first-year students at university are introduced to an information technology and information literacy subject, called Academic Information Management (AIM), where they have to be able to pass the course as a prerequisite for their future courses and assessments. From 2013 to 2018, new teaching interventions were introduced annually and the success rates of the students were measured in terms of comparing the intervention with the pass rate. The Providers, Activities and Contexts (PAC) Framework is used as a structure to place the teaching interventions in context. It is concluded that technology as a teaching tool can assist universities to manage large groups of students, but also ensure an upward trend in throughput. A short comparison is drawn between other large university groups, mostly locally, but also internationally. Future research will expand the comparison of other courses with large numbers to AIM, both nationally and internationally.

Keywords: Teaching Interventions, Technology, PAC Framework, Blackboard, Learning Management System, Student Throughput.

1 Introduction

First-year university students in South Africa have vastly different information technology and information literacy skills, ranging from highly proficient to completely novice [1]. It is the university's responsibility to provide the necessary fundamental training to all their first-years, as the skills are required to successfully complete assignments and activities. Also, multilingualism, varying academic readiness and large class sizes [2] lead to a need for contextualized teaching approaches focusing on a variety of teaching methods and interventions. This paper illustrates by means of an example drawn from a large, residential university how student needs are met in

applying different interventions in an Academic Information Management (AIM) course and how it affects student throughput over a period of six years, using the Providers, Activities and Contexts (PAC) Framework.

2 Background

In South Africa, the diverse demographical composition is evident, with eleven different official languages and a myriad of cultures [3]. The majority of the population is poor [4], with minimum exposure to technology in their secondary schooling. This means that many first-year students are only exposed to technology after enrolling at a university [5]. It is pivotal that first-year students are introduced to technology in an environment that caters for all students and provide them with enough opportunities to learn and excel using technology.

A major challenge remains multilingualism, where only a half percent of the African population speak English as their home language [6]. English by itself is difficult and is often only a student's third- or fourth language, but all subjects are presented in English. One also cannot move away from English as the language used in IT. It is therefore important to keep in mind that students might struggle with the IT jargon in order to master the AIM courses.

Another challenge is the fact that student numbers increase annually. In 2013, the number of students enrolled for AIM was 2 968 and in 2018 the number was 5013, an increase of 69%. From 2000 to 2012, the state subsidies universities received declined from 49% to 40% [7]. The universities often lacks the financial resources to build bigger IT laboratories to cater for the growing student numbers, leading to larger numbers of students in classes, with less personal help and guidance, if needed to follow the lecture. Also, in 2015/2016, the #FeesMustFall movement led to a fee-freeze in 2017 and the subsequent promise of free higher education for all by the governing party [8], placing further financial constraints on universities, as well as even larger class numbers. It is within this university context that the universities have to cater for all the students, but also ensure annual pass rates improve [8].

Students require more help to pass their subjects and universities have to cater for their needs by making available additional resources.

3 Technology as a Teaching Resource

Technology is known as one of the greatest resources used at educational institutes and provides a platform to enhance teaching, learning and assessment [9]. There are many learning styles, but one of the most used in today's tertiary environment is the blended learning approach [10], where technology is used together with traditional methods to assist students to perform better in their courses. Blended learning is also referred to as hybrid learning, with benefits such as improved large-group efficiency and acquisition of skills [11]. Blended learning assists students to gain more independence in their studies, have other tools than merely face-to-face learning, while also enforcing individual accountability [12]. A study in Malaysia explains why large groups of

students have become the norm and highlights the usefulness of the blended learning classrooms [13].

In the AIM course, technology has proven to be very successful. The cloud based Learning Management System (LMS): Blackboard, provides the AIM courses with the advantage of increased availability to students and great communication, feedback and tracking. A study at the University of Limpopo, where 42% of students stated that Blackboard Learn has improved their computer skills performance, with a further 62% of students stating that Blackboard Learn had a positive influence on learning [14].

In the AIM courses these features are used extensively to communicate at any point in time on the students' progress. Assessments are set up as to provide immediate feedback on objectives not met and the course of action to take. The Grade Center in Blackboard Learn is also an invaluable tool used, the different technologies integrate with Blackboard to sync marks automatically for large numbers of students, thereby cutting out the administration of manually entering the marks. Technology assists to eliminate human error and saves hours of data capturing.

Textbooks used in the AIM course have moved from carrying big bulky textbooks to being available as an e-Book. The e-Book is always available to students when they require it. All the students' e-Books can exist on the same platform. It is described as carrying around your own library on you iPad, phone or digital device. E-Books are easily portably and because of how the e-Book is set up, it caters for many different learning styles [15]. In a white paper by Renner [16], the advantage of e-Books are outlined. Enhanced user access and book functionality is among the advantages that benefit the students at AIM. Cost saving and immediate availability is an extra benefit that students enjoy. In an article by Waller [17], it is explained that the customization of e-Books can enhance a student's learning experience and since this is the age where technology is driving education, e-Books should be implemented earlier rather than later. At AIM a custom e-Book is prescribed in the first semester of the first year. The custom e-Book is put together using the most popular series and titles that meet the objectives of the course.

Two major challenges with using technology are privacy and ethics. It is important to take cognizance of these issues and how it affects students in a blended learning environment [18], however, it is not the main aim of this paper.

4 The PAC Framework

The PAC Framework was introduced by Blosser and Kratcoski [19] as a useful tool in describing interventions with students suffering from hearing impairments. In this paper, the study is adapted to describe the different teaching interventions in the AIM course over a period of six years. The framework relies on the following three premises:

Premise one: Characteristics of good student performance [20]:

- Good teachers: For any intervention to ensure a positive outcome, one needs good teachers. By good teachers, it is implied that the teacher can engage with a group of students in such a way that the students are able to learn and apply new skills. In

terms of the AIM course, the "teachers", or "Assistant Lecturers", as they are called, are graduate students.

- Efficacy: The AIM course, and how it is structured and presented, enable the efficient and effective every-day running.
- Continuity: The course must have a logical flow, also in how the course is presented.
- Student Participation: Students need to participate in class, but also participate in assignments and own study via the tools made available.

Premise two: A variety of teaching and learning methods [21]:

- The teaching and learning methods need to be flexible and up to date.
- Students should be able to link skills, apply it to the real world and be offered different perspectives.
- Not all learning is linear. Students do not have to start engaging in learning strategies at the beginning and end at the end of the course.

Premise three: The provider, activity and context must be clear. There are three interactive factors that need to be considered in learning [22]:

1. The task that needs to be completed.
2. The way in which it need to be completed.
3. The learner.

In terms of the PAC Framework, the factors are described as:

1. Providers: Providers have to have a meaningful impact.
2. Activities: Meeting the needs of students. These activities are further broken down:

- Planning
- Assessment
- Implementation Intervention
- Evaluation

3. Contexts: Situations, conditions and environments where interactions take place.

The PAC Framework will provide the structure in which the different teaching interventions will be placed in perspective.

5 Main Research Question

Taking into account the different challenges facing higher education in South Africa, there is an upward trend in the AIM students' pass rates over six years. In order to fully understand this phenomenon, students' marks were analyzed from 2013 to 2018, taking into account the implemented teaching interventions of that specific year, as well as interventions that build on one another. AIM is presented on three campuses over the course of a year, but in order to identify the effectiveness of every intervention, only

the first-semester AIM course marks were analyzed of students studying on the main campus, as well as the marks of the three campuses combined. Subsequently, the two research questions asked in this paper are:

4. How effective was every intervention in terms of annual throughput of first-year students in their first semester on the main campus?
5. How effective was every intervention in terms of annual throughput of first-year students in their first semester on the three campuses combined?

6 Methodology

Table 1 below summarizes all the aspects involved in the AIM teaching interventions as outlined in the PAC Framework:

Table 1. The PAC Framework applied to the AIM teaching interventions. (Framework adopted and adapted from Blosser and Kratcoski [17]).

Providers: Bring about meaningful change.	**Activities: Meeting the needs of students.**	
Assistant lecturer Tutor Management of IT Labs Technical support staff Administrative support staff	Planning Plan specific intervention Develop assessment Create consistency Buy-in from entire team	Assessment Evaluate efficacy Test concept

Activities: Meeting the needs of students (continued)		**Contexts: Situations, conditions and environments where interactions take place.**
Implementation intervention Teach Elicit feedback Modify Accommodate	Evaluating progress Gather data Monitor progress Chart effectiveness of intervention	Class room Tutor / consulting sessions Assignments Feedback Reinforcement of concepts Study environment

7 Research Context

In support of the university's strategic goals, the AIM program offered views its mission as:

6. Creating an educational and intellectually stimulating environment.
7. Generating significant value for students through the quality of its courses, lecturers, and facilities.
8. Assisting students daily to achieve academic excellence, and to equip them with Business and Industry skills.
9. Remaining innovative and professional at all times.

This course history backs up its mission statement; in 1997 the management at the university communicated that all students that attend the university should not only be computer literate but also information literate before they graduate. The school of information technology was then tasked with the job to investigate and present a suitable solution to make sure all students will be digitally and information literate and carry this skill to the world of work. Many different departments and stakeholders were involved to come up with a suitable solution.

A number of constraints existed, infrastructure and resources was the biggest concern. This ultimately led to a three-year contract with an external company to present information and material developed by a department within the university. This introduced the compulsory course for all students at the university – Computer and Information Literacy (CIL). Despite a few technical and administrative difficulties, this worked well until the termination of the third party's contract in 2002. A further committee was introduced to oversee the preparation of a new course that included information and computer literacy. All first year students had to then attend two courses offered at the IT labs of the university. These courses were structured to ensure that they were equipped with the right skills for their studies and future careers. By 2005 these courses were offered by other campuses because of the drastic increase in numbers of first year students.

An exemption exam was introduced for one of the courses, but the university also saw a drastic increase of students with no former experience to digital literacy. Many other challenges existed and the strain on the IT labs infrastructure was becoming a huge concern. One of the major challenges was the concept of a one-approach to service all students with different skills levels. This then led to a phased addition of infrastructure to cater for the growth and needs of students. By 2011 a major shift was implemented, this included a move from CIL towards a more academic approach leading to the new service courses called AIM. These courses were developed to emphasis the skills of information management concepts, in which now computer and software were view as supporting tools.

The AIM courses cover the following topics:

- Navigation Information Literacy
- Windows 10

- MS Word 2016
- MS PowerPoint 2016
- MS Excel 2016
- Browsers
- Office 2016 common features
- Blackboard
- In house Portal training
- Gmail and Google Drive training

7.1 The Learning and Teaching Environment

AIM is conducted in 18 computer laboratories across three campuses. AIM is offered for five session from a Monday to a Thursday. Each session has a two-hour duration. Seventeen computer laboratories are equipped with approximately 50 workstations and one laboratory with 32 workstations. All laboratories have a projector and screens for visibility. All computers are loaded with the software needed to run AIM. Each class comprises of learners from different faculties and different programs. Each learner books his/her own time slot in which to complete the AIM course according to their individualized timetable. Thousands of first-year students take AIM annually, requiring 190 laboratory sessions of 2-hours each.

Consultation sessions also exist from Monday to Friday 9.30 to 3.30 for any students that may require extra help. Apart from offering consultation, most of our classes have tutors to help the lecturers.

Each AIM courses comprises of a fully integrated LMS. The university subscribes to Blackboard. Housed in the Blackboard Classroom, are the e-Books available for students to download, compulsory assessments used for semester marks, integration building block for the digital system used, PowerPoint slides for each chapter as an enhanced resource and a very detailed breakdown of the schedule for the semester with test and exam dates. All marks for assignments and tests are uploaded or automatically synced with Blackboard. The students can determine at any time how they are doing in the course.

7.2 Teaching Interventions

The AIM courses are presented by Assistant Lecturers on all the campuses. All Assistant Lecturers are postgraduate students studying at the university. Novice classes have tutors present for all sessions. An intensive month of training occurs before Assistant Lecturers have to give their first class. Every Monday morning is also training to make sure the AL's understand the content and are fully prepared for the week.

2013 started off with the intervention of using hardcopies of the textbook and a very basic simulated testing environment. The students needed to carry their textbooks to class for every session and this sometimes did not work out to well, as the books were heavy and bulky. A simulated testing environment was used for exams and some assessments. Please refer to Fig. 1 on the next page.

2014 saw the introduction of a Skills Assessment Management (SAM) system. SAM is a web-based application that measures student proficiency in Microsoft Office software and technology-related topics. SAM iterates concepts of Microsoft Word, Excel, PowerPoint, Access, Outlook and Internet Explorer in addition to foundational computer concepts. "SAM uses skill-based assessments, interactive training, real-world projects and just-in-time remediation to help students learn essential computing skills" [23]. When SAM was introduced the full capability of SAM was not used, a subset of the capabilities was introduced. All assignments were based in SAM. The only function of SAM used was the assignment function.

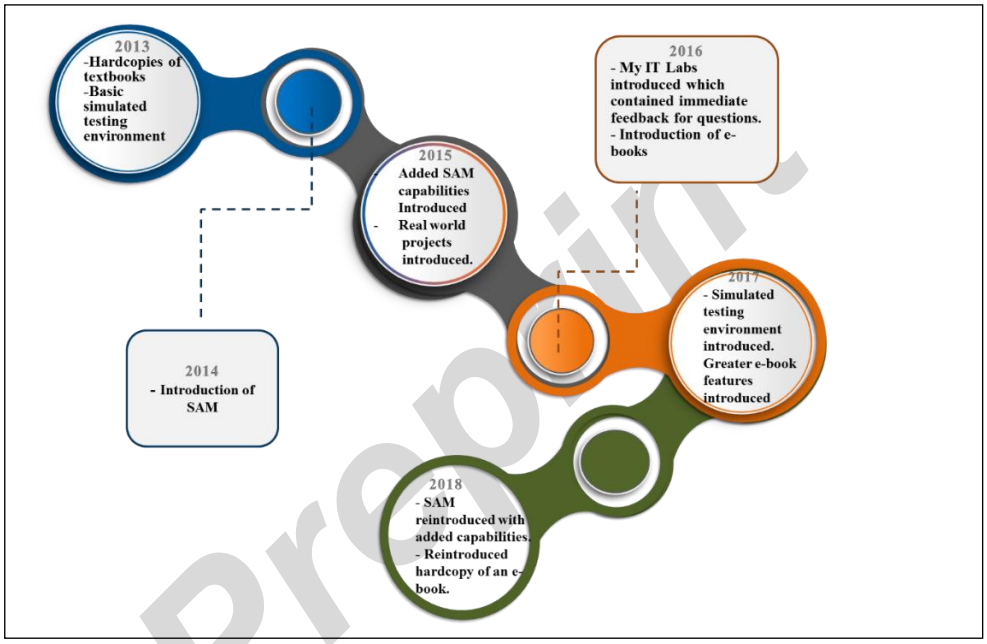

Fig. 1. The different interventions undertaken from 2013 to 2018 summarized.

In 2015, the extra features of SAM were introduced. Assignments and tests were now done using the capabilities of SAM. Real world projects were available on the platform which enhanced the objectives of the course. Students now had more practice in different areas of Microsoft office.

2016 saw a shift of systems due to system capabilities and budget constraints, an introduction of My Lab IT. In My Lab IT Students follow a predesigned path of activities, which can include simulations, Grader projects, and student resources, to support effective learning. Students have to master each activity before moving on to the next one. Customization of My Lab IT can be easy done for this. Students received immediate feedback when an activity is completed and can rectify errors and resubmit assignments. 2016 was also a year that e-Books were introduced and students needed to shift over from the normal tradition textbook system to an e-Book system. E-Books

allowed for access across different devices and students were assured of always having access. The university's free Wi-Fi allowed students to download the e-Books and this would then be available on their devices without data charges being applied. This would allow students to study anywhere and at any given time.

In 2017 a simulated training and testing environment was used for teaching, learning and assessment. Many practice simulated tests were introduced and training was provided based on poorly answered questions or sections. The e-Book features introduced included highlights, summaries and a chance to simplify and customize learning according to one's own learning style. The e-Book platform was also more user-friendly and easy to navigate.

In 2018 the intervention were expanded from 2017 by moving back to SAM now with added capabilities. Students could now observe how a task should be done and then practice these tasks. A simulated environment was extensively used to re-iterate concepts covered in class. Novice students found the added observing capability very helpful. The observing capability also reduced the queries in class. SAM prepares the students for the real world. 2018 also saw the introduction of the hardcopy of the textbook should students prefer to learn via the hardcopy. Students now had a choice of which book to use for learning.

From 2013 to 2018, new interventions were introduced every year, this was to help students get ready for the work place and to understand basic computer concepts and computer software. The course's aim was to help students better understand the digital environment so that it will help them in all their other courses. If AIM became the golden thread that linked all courses, then the course will be considered a success.

All the interventions link to Table 1where the providers involved, the aims and outcomes of the activities are summarized and the specified contexts in order to determine the impact of every intervention. The results of the student performance follow.

8 Results

To determine the effectiveness of every year's teaching interventions, the data obtained from student pass rates are illustrated in Figures 2 to 5 below:

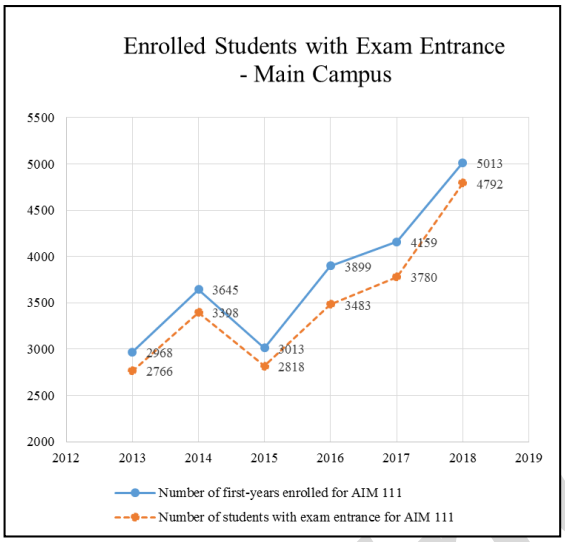

Fig. 2. The number of first year students enrolled for AIM on the main campus compared to the number of students with exam entrance.

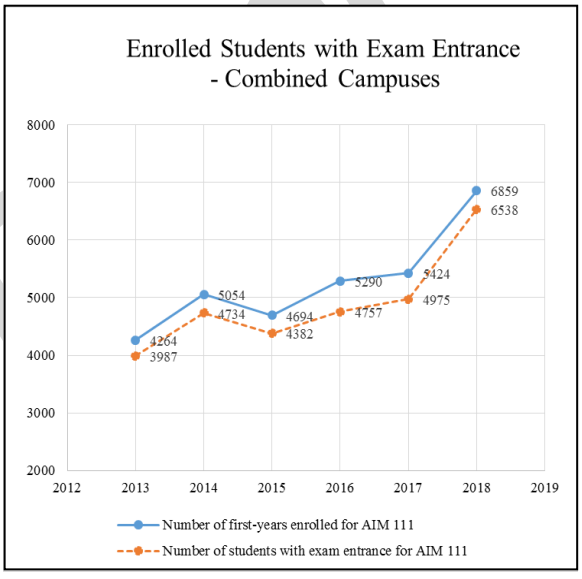

Fig. 3. The number of first year students enrolled for AIM on all three campuses compared to the number of students with exam entrance.

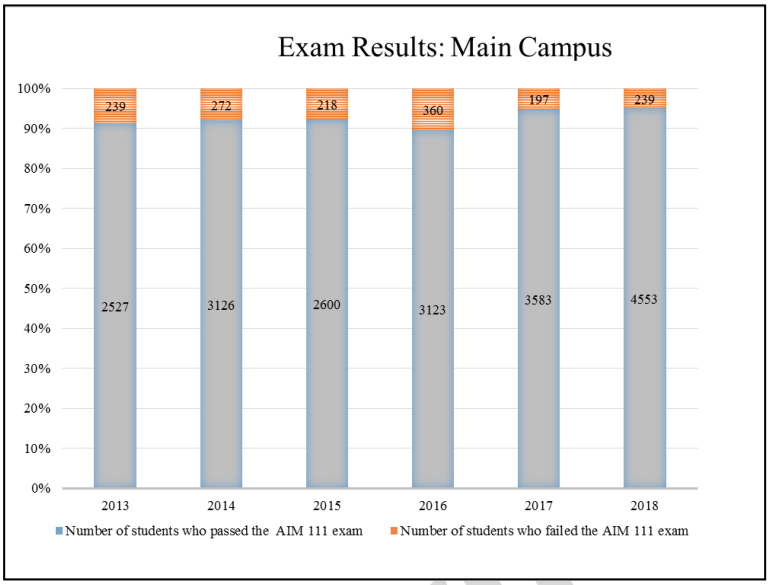

Fig. 4. The number of first year students with exam entrance who passed, or failed, the exam on the main campus.

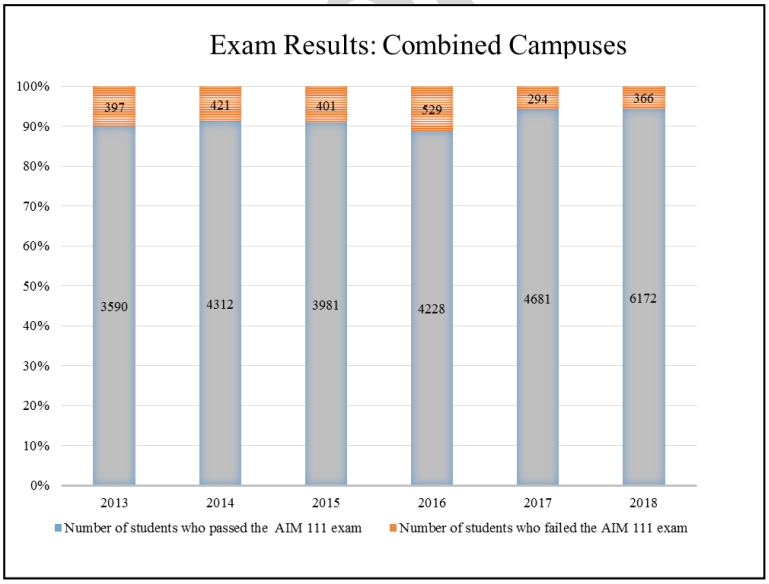

Fig. 5. The number of first year students with exam entrance who passed, or failed, the exam on the three campuses combined.

9 Discussion of Results

In 2013, 93,50% of all first-year students on all three campuses obtained exam entrance, with 93,20% on the main campus. The number of students with exam entrance are high, as it should be, seeing that the course is a pre-requisite for most of their further courses. The exam pass rate for all the students are 90,04% and 91,36% on the main campus. The fact that the main campus' overall pass percentage is slightly higher, can be ascribed to the fact that the other campuses have less sessions and are spread more remotely, thus there might not always be someone available to ask a question to if they struggle. At this stage, the hard copy textbooks were still used, with a simulated testing environment

In 2014, with the introduction of SAM, the number of students with exam entrance were 93,67% on all campuses and 93,22% on the main campus, with the pass rates 91,09% and 92% respectively. SAM made a positive impact, but it was only slightly.

2015 saw the introduction of additional SAM functionalities, leading to the number of students with exam entrance overall of 93,35% and on the main campus 93,53%. The students who passed the exam were 90,85% overall and 93,53% on the main campus. There is a small difference between all the campuses and only the main campus, with the main campus achieving higher pass rates. Again, it might be because of accessibility. The extra SAM functionalities showed an upward trend on the main campus.

In 2016, there was a decline, the most significant change across all years. The main reason being the introduction of the e-Books. Some students struggled to get used to the electronic version, with other students still buying the hard copy additionally. The exam entrance rates dropped to 89,92% overall and 89,33%, with more than 10% of students enrolling failing to obtain exam entrance. The pass rates were 88,88% overall and 89,66% on the main campus. If one is to combine exam entrance and pass rates, almost 20% of all enrolled students failed AIM. During this time, the #FeesMustFall movement gained momentum, with certain contact sessions not taking place, leading to more self-study.

In 2017, the e-Book introduced extra functionality to bridge the gap. Students entering AIM were also more accustomed to e-Books than before and used it much more effectively. The exam entrance rates improved to 91,72% overall and 90,87% on the main campus. There was a sense of relief that the e-Book is a viable option. The exam pass rates were 94,1% overall and 94,79% on the main campus. The data showed that students engaged with the SAM functionalities and the e-Books much more during the exam time than in the previous year.

In 2018, with full SAM functionalities and an option of a hard-copy textbook, saw another increase in both exam entrance and pass rates, with exam entrance at 95, 32% overall and 95,59% on main campus and an exam pass rate of overall 94,4% and 95,01% respectively.

By making use of technology more and more, the positive impact on students are evident, as their engagement with the AIM e-Book can be downloaded from a dashboard and scrutinized. Only a few students opted for the hard-copy textbook, which might also have led to a higher success rate.

10 Lessons Learnt from Other Universities

Other universities, more specifically South African universities, have also encountered issues with large groups and LMSs such as Blackboard, or similar. The Durban University of Technology (DUT) has applied e-learning to nursing [24] and experienced the following challenges:

10. Students were not always psychologically ready and needed assistance in that regards.
11. Students struggled with the technologies themselves.
12. The IT equipment gave problems.

Another study done by Nash [25] looked at the effectiveness of blended learning on different ethnic groups and found that African students struggled more to pass than white students, who struggled the least.

The University of South Africa (UNISA) launched a blended learning course in 1999, with hands-on training on the library website, with an innovative way of tracking the student's performance [26] More courses followed, with varying degrees of success.

Internationally, a study of Ireland [27] found that it is very difficult to differentiate the meaning of a "large group" of students, as the meanings differ in every context. In the findings above, the large groups are split into different lecture groups, not one, very large class for the entire course.

The Northwest Missouri State University first introduced an IT course for first-year students, but it was removed shortly after its introduction, sparking heavy debate in 2001. It was recommended that the course be reintroduced [28].

Higher Education had to adapt to stay current with trends and had to make changes in the way courses are presented currently and in the future, as one simply cannot ignore the 4th Industrial Revolution. Students need the skills to manage life after university, implying that they need to be job-ready. Large groups of students also need to be managed in a cost-effective way to ensure the survival of the South African university system.

11 Conclusion and Future Research

It is concluded that the introduction of technology in how large groups of students are taught and assessed, leads to an increase in student pass rates, as is evident from 2013 to 2018. The role of the teacher remains important to convey knowledge and skills, but technology allows for anytime learning. The university also offers Wi-Fi on campus to download e-Books and to make use of the interactive LMS system. The shrinking number of students without a smart device is countered by the availability of hard-copy textbooks. The high percentage of annual pass rates further strengthens the belief that multiple teaching interventions lead to higher student pass rates.

Future research will include to compare other computer-literacy courses with thousands of students to AIM, whether the course is using any form of technology as a teaching intervention or not. Other universities' data can also be obtained with the

introduction of e-Books and interactive technological capabilities and the trends can be compared to identify further areas of enhancing student throughput.

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