THE USE OF A LEARNING MANAGEMENT SYSTEM TO ENHANCE THE PERFORMANCE AND ENGAGEMENT OF STUDENTS IN SOUTH AFRICA

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Submitted in fulfilment of the requirements for the degree

Master of Higher Education Studies
Publishable Manuscripts/Published Articles

University of the Free State
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Declaration

I hereby declare that this work, submitted for the degree Master of Higher Education Studies Publishable Manuscripts/Published Articles, at the University of the Free State, is my own original work and has not previously been submitted, for degree purposes or otherwise, to any other institution of higher learning. I further declare that all sources cited or quoted are indicated and acknowledged by means of a comprehensive list of references. Copyright hereby cedes to the University of the Free State.

Christa Faber

14/06/2021

Date

Dedication

This thesis is dedicated to my wonderful parents, Bertus and Connie de Wet, my dear partner Paul, and my beloved children, Connie and Jani.

Acknowledgements

To my heavenly Father – Soli Deo Gloria!

I would like to express my sincerest appreciation to the following people who contributed to the completion of the study in various ways:

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APPLICATION FOR TITLE REGISTRATION

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Dear Ms Faber

Your registered title is as follows:

"The use of a learning management system to enhance the performance and engagement of students in rural South Africa"

All of the best with your study.

Yours sincerely,

Prof Jan Nieuwenhuis
Chair: CTR committee

Ms CS Duvenhage
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Ethics Approval

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We are pleased to inform you that your application for ethical clearance has been approved. Your ethical clearance is valid for twelve (12) months from the date of issue. We request that any changes that may take place during the course of your study/research project be submitted to the ethics office to ensure ethical transparency. furthermore, you are requested to submit the final report of your study/research project to the ethics office. Should you require more time to complete this research, please apply for an extension. Thank you for submitting your proposal for ethical clearance; we wish you the best of luck and success with your research.

Yours sincerely

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Letter from Language Editor

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I confirm that I edited this thesis, checked the references and recommended changes to the text.

MA Language Practice

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List of Acronyms and Abbreviations

AP score	Admission Point score
CLASSE	Classroom Survey of Student Engagement
ERT	Emergency remote teaching
LMS	Learning management system
OAT	Online assessment tool
PHGA	PH Grade Assist
UFS	University of the Free State

Abstract

This study focused on a higher education environment that has changed rapidly over the last 20 years. These days, during the fourth industrial revolution, almost all higher education institutions use some sort of learning management system to keep track of the digital environment. Online assessment tools, which help students to stay engaged and to improve their performance, are important in the current digital age. In this study, the researcher created a platform for teaching and learning by using online technology, to enhance student engagement and performance.

This study followed the article option route and, thus, resulted in two publishable articles. The first article examines a blended learning environment by using an online assessment tool to achieve improved performance and engagement in a first-year statistics class. The second article focuses on a second-year biostatistics course during the worldwide COVID-19 pandemic, and which, consequently, used emergency remote teaching. This article discusses how a learning management system, in this case, Blackboard, was incorporated to create a learning and teaching environment that engaged students and promoted satisfactory academic performance.

The empirical investigation reported on in the first article focused on an online assessment tool in a blended teaching environment. A pragmatic parallel mixed method design was applied. Qualitative and quantitative results were drawn from two groups, the experimental group (37 students) and the control group (64 students). Tutorials, assignments and semester tests were used to collect quantitative data, including from the Classroom Survey of Student Engagement (CLASSE).[1] Open-ended questions incorporated in the survey, as well as interviews with students, provided the qualitative data. Data analysis involved two-sample t-tests and regression analysis. The researcher developed an online assessment tool (the intervention) with the help of the online learning assessment platform Questionmark. The online assessment tool was created in such a way that it provided immediate feedback after each question. After the students received the feedback, they could answer the same question again, until they were successful. Only when a question had been answered correctly did the program allow the students to continue with the next question, until the assessment had been completed. Once students had completed the assessment, the program allowed them to do the tutorial assessment without any intervention; the tutorial contributed to students' final marks.

The empirical investigation reported on by the second article used the learning management system Blackboard to enhance student engagement and performance. During the COVID-19 pandemic, and the resulting lockdown, the researcher was forced to use emergency remote teaching as a teaching and the learning platform. A quasi-experimental design without a control group was used with a group of biostatistics students (n=24). A pre-post-test, tutorials, practicals and semester tests, together with a post-course questionnaire, provided quantitative data for analysis. Pre-post-test marks were compared by using paired t-tests. Time spent on tasks and student activity (number of hits) were also recorded. Regression analysis analysed the correlation between student activity, time spent on tasks via Blackboard, and students' resulting grades. Qualitative data were collected by means of the CLASSE survey of student engagement. This questionnaire had seven open-

[1] https://www.ufs.ac.za/sasse/classe-home

ended questions, and the qualitative data it yielded was only used to enrich the quantitative data.
The performance and engagement of students at higher education institutions are constantly under a magnifying glass, and continuous research in this area is relevant across the world. This research is even more relevant when emergency remote teaching is expected of educators during a pandemic. The significance of the study relates to improving a teaching and learning platform for online learning. The innovations proposed by this study could create positive conditions for student learning.

Key concepts: blended learning, online assessment tool, student learning, e-learning, student engagement, enhanced learning, adaptive release tool, online learning, emergency remote teaching, Blackboard, learning management system

CHAPTER 1: ORIENTATION TO THE STUDY

1.1 INTRODUCTION

This study investigated the interdisciplinary area of statistics education and technology. The researcher has lectured undergraduate students for more than 20 years at the Qwaqwa campus of the University of the Free State (UFS), part of the eastern Free State province. Investigating the effect of online interventions on the engagement and the performance of students in South Africa was the driving force behind this research.

Online learning methods can be an important factor in enhancing university education. Expertise in this field is limited. Even though studies into online learning systems to enhance student engagement has been the focus of many research projects over the last 20 years, there is still a need to develop knowledge in this field. The researcher conducted empirical studies to investigate, first, the engagement and performance of statistics students with and without interventions using an online assessment tool (OAT) and, second, the engagement and performance of biostatistics students using Blackboard, the learning management system (LMS) used by the UFS, which served as an emergency teaching platform during the lockdown that was enforced during the COVID-19 pandemic in 2020.

All the participants in the study were registered at the Qwaqwa campus of the UFS. The throughput rate of students at this campus is not always satisfactory. Many of the students' basic mathematics skills are below the average standard expected, and students find the content of the subject challenging. Investigating methods by which student engagement and performance can be developed is, therefore, of crucial importance. The focus of the study was on student engagement in the field of statistics, and how an OAT and an LMS, in this case, Blackboard, can be incorporated to enhance student engagement and, consequently, student performance in statistics.

An all-embracing literature review on student engagement and blended learning and the use and effectiveness of OATs and LMSs for teaching and learning preceded the empirical studies. The empirical investigations aimed to verify whether the utilisation of these tools can enhance students' engagement and performance in statistics.

The thought process behind the first study related to the need for students to spend more time practising certain concepts during the particular course in statistics. It was expected that, the more time they spent practising the content, the better their performance would be. An OAT could be used to encourage students to engage with the content, by delivering assignments online and providing easier access for students. The adaptive release tool (of which the program settings allows the student to open the next question only after the correct answer of the current question has been successfully submitted) used in this study challenged students to continue attempting to answer questions correctly until they succeeded. Providing immediate feedback motivated students to continue, and promoted higher-order thinking.

Results show that there was a significant positive difference between the performance of students in the experimental group and the control group. Although the average tutorial and test marks of students in the experimental group were not significantly higher than that of students in the control group, the average assignment marks, which were awarded for questions relating to all the topics covered during all the tutorials, did show a significant difference. The experimental group's performance was much better than that of the control group. In addition, the quantitative and qualitative results of a survey/interview design,

used to gather information regarding the experience of students exposed to these online teaching tools, indicates that learning with the OAT as intervention was accepted well, and was successful.

The second study focused on the use of a LMS in a second-year biostatistics module during a worldwide pandemic, and investigated whether there was a positive association between using a LMS for teaching and learning and student engagement. Results show a significant relationship between the number of hits on teaching and learning content on the LMS and their resulting grades. Number of hits, which indicates student activity on the LMS, could be seen as a measurement of engagement. A probable reason for the effectiveness of the LMS is that it is available anywhere and at any time, using any digital device, like a smart phone, tablet or laptop. This feature was particularly important during the COVID-19 pandemic, during which emergency remote teaching (ERT) took place throughout the course. The questionnaire results enabled the researcher to gather information (quantitatively and qualitatively) on the experiences, attitudes and concerns of students who had been exposed to ERT via Blackboard. Feedback from students indicate that learning through an LMS was not only popular, but also successful. The researcher firmly believes that a LMS facilitates student learning, motivation, performance and, ultimately, student engagement. As a whole, the results reveal that using an OAT and an LMS for teaching and learning statistics modules enhances academic achievement and engagement.

The literature review is significant because it aimed to provide lecturers in higher education with information on how to use an OAT most effectively in a blended environment. Choosing the appropriate assessment tool, and using it effectively to enhance students' engagement and performance is of great importance. According to Beer, Clark and David (2010:75–86),

> *Student engagement data from the LMS can be presented to students for informational and motivational reasons. If students can be shown the degree of effort required to pass a particular course matched with an indication of their degree of effort to date, it may lead to enhanced effort by the student.*

The significance of the empirical study is based on the belief that an LMS can enhance student engagement and student performance. The study could be applied to most learning programmes in South Africa, as well as at international universities. Finally, the study is of significance for the discipline of higher education studies in statistics. Groundwork for the development of future scholars has been done in the educational environment.

In light of the current transition from contact teaching to blended learning that involved an interaction between students, their lecturers and their learning material, the outcomes of this study heightened awareness of the impact of online engagement on the performance of students in South Africa.

1.2 PROBLEM STATEMENT

Student groups are, generally, diverse, and pass rates are, in many ways, unsatisfactory. Studies into online interventions for improving student engagement and performance are, thus, important.

There is a need for research in higher education on the effect of using an LMS on students' performance and engagement during a worldwide pandemic.

1.3 RESEARCH QUESTIONS

Taking the problems stated in Section 1.2 into account, the following research questions were applicable to this study:

1. Can student performance be enhanced by the interactive use of an OAT in a blended environment?
2. Is there a correlation between students' interactive use of an LMS and their participation and engagement?

1.4 AIM AND OBJECTIVES OF THE STUDY

Bearing in mind the overarching goal of improving the teaching and learning in statistics education, the aim of the study was to research the effectiveness of using an OAT and an LMS on students' performance and engagement. The following objectives served to achieve this aim:

1. To undertake a literature review to gain insight into ongoing perspectives on the effective use of an OAT and an LMS to enhance student engagement and performance (see Chapter 2, Article 1, and Chapter 3, Article 2);
2. To statistically compare, on the basis of an experimental study, the engagement and performance of students who had been exposed to an intervention, to another group of students, who had not been exposed to the intervention, during the first six weeks of lessons (see Chapter 2, Article 1);
3. To gather quantitative information on the correlation between students' interactive use of an LMS during a worldwide pandemic (as indicated by number of hits) and students' active participation and achievement, or student engagement (see Chapter 3, Article 2); and
4. To collect quantitative and qualitative information on the experiences, attitudes and concerns of students exposed to an OAT and an LMS, namely Blackboard, during a worldwide pandemic (see Chapter 3, Article 2).

1.5 RESEARCH HYPOTHESES

The research questions were transformed into the following hypotheses:

H_0: There is no difference between the mean performance of students who had been exposed to interventions with an OAT, and that of students who had not been exposed to interventions.

H_1: There is a difference between the mean performance of students who had been exposed to interventions with an OAT and that of students who had not been exposed to interventions.

H_0: There is no correlation between students' interactive use of an LMS during a worldwide pandemic, and students' engagement.

H_1: There is a correlation between students' interactive use of an LMS during a worldwide pandemic, and students' engagement.

1.6 RESEARCH DESIGN AND METHODOLOGY OF THE EMPIRICAL STUDIES

This section will offer an outline of the research design and methodology used for the studies reported on by the two articles. More detail regarding these methods and procedures will be provided in Chapters 2 and 3 (Articles 1 and 2).
The empirical studies focused on achieving Objectives 2, 3 and 4, and involved a quasi-experimental study, a pragmatic parallel mixed method design, and the gathering of quantitative and qualitative information by means of questionnaire surveys and interviews.

1.6.1 Research design and methodology

The first empirical study used a pragmatic parallel mixed method design. This design was chosen because it includes qualitative and quantitative features to answer the research questions. A randomised treatment-group-control-group design was applied (see Chapter 2, Article 1).
The interventions that were implemented were as follows (see Chapter 2, Article 1): While all practicals were done on Questionmark, an e-learning assessment platform used by the UFS, only the experimental group (Group A) was subject to the intervention with the practicals. Group B, the control group, also did the practicals on Questionmark, but without the intervention. These students from Group B were exposed to the 'live' presence of the lecturer and tutors during the practical session, to ensure constant live feedback whenever it was needed or requested during the execution of the practicals.
The intervention empowered students to complete and submit Question 1 successfully, before the adaptive release tool allowed them to move on to Question 2. This process was repeated until the practical had been completed successfully. If a question was answered incorrectly, immediate written feedback was automatically provided, which referred the student to the corresponding content in their study material or textbook. The student then had to attempt the same question with different data. This process repeated itself until the student gave the correct answer to the question. Only after submission of the practical, the program allowed students to submit a tutorial that contributed to their semester marks. Thus, if the practical was not submitted, the student forfeited the chance to do the tutorial that counted towards the semester mark.
The second study was situated within a quantitative paradigm, with some qualitative observations added (see Chapter 3, Article 2). The researcher used a quasi-experimental design in the experimental category, and a survey design in the non-experimental category. The quasi-experimental design was used because the participants in the study were not randomly assigned. The researcher focused on the pre-post-test design as a form of the quasi-experimental study, without the use of a control group, through which she compared the quantitative data. The qualitative data were used in addition to the quantitative data, and did not resemble a complete qualitative data set.

1.6.2 Population and sampling

The participants in the first study (see Chapter 2, Article 1) represented students from two academic programmes that were combined into one class, for which the researcher was the only lecturer. All students were registered for an elementary statistics course. The two academic programmes included mainstream students (registered for EBCS1524: Economic and business calculations in statistics) and extended programme students (registered for

EFBC2524: Economic for business calculations in statistics). The mainstream students were in their first of a three-year study programme, and the extended programme students were in the second year of a four-year study programme.
All registered students (n=101) engaged in the study. They were divided into two groups by choosing the random enrol option for creating groups on Blackboard. Simple random sampling was applicable as the sampling strategy, because each sample has an equal probability of being chosen. The two groups attended classes at different times. Some students had clashes on their timetables and were given the option to self-enrol in the other group. Thus, there were two groups, namely the treatment group (Group A, 37 students) and the control group (Group B, 64 students).
In the second study (see Chapter 3, Article 2), the participants who were selected represented students in one class, with the researcher as the only lecturer. Participants were all registered for one module, BIOL2674, which is a biological statistics course that serves as foundation for the basic statistics studied in BSc Natural Sciences. All students enrolled for the module (n=23) participated in the study. Convenience sampling was applicable as the sampling strategy, because all the students in the class participated in the study.

1.6.3 Identifying the variables

For discussion purposes of the research design and methodology, the researcher focussed on the following variables:

- The OAT as intervention and the use of the LMS Blackboard in an ERT environment, as the independent variables.
- Student engagement and performance of students in statistics courses, as the dependent variables.

1.6.4 Data collection

Quantitative data, consisting of a variety of assessment marks, were collected for the first study (see Chapter 2, Article 1). Data was collected by means of weekly tutorials, an assignment and the semester test. A quantitative questionnaire comprising of quantitative as well as qualitative open-ended questions was applied to enhance the quantitative data. Demographic data collection was also included in the questionnaire. The questionnaire was supplemented by qualitative interviews, which gathered data on students' experiences and perspectives, and helped to create an overview on issues of concern.
For the second study (see Chapter 3, Article 2), there was no random assignment of participants, therefore data were collected by using a quasi-experimental design. The data consisted of the following:

- Marks from 14 practicals, 12 tutorials. and two assignment tests that were completed during the semester. Results from the pre-post-test compared the basic mathematical skills before and after the intervention.
- Participants' final Grade 12 mathematics scores, as well as South African universities' Admission Point score (AP score), were considered as the pre-test marks, and the post-test marks consisted of students' final scores on the practicals (10% of the final score), tutorials (20% of final score) and two assignment tests (70% of final score).

- Overall evaluation of number of hits (user activity) inside content areas of Blackboard.
- A questionnaire survey that was completed on students' experiences of using Blackboard as an ERT platform. For the qualitative mode of the study, the questionnaire included seven open-ended questions.

1.6.5 Measuring instruments

To determine the influence of interventions that took place via an online assessment platform and Blackboard on students' performance and engagement, quantitative data were collected by applying instruments developed by the researcher. In the first study (see Chapter 2, Article 1), quantitative data was collected using tutorials, assignments and a test. In addition, the Classroom Survey of Student Engagement (CLASSE) was administered, and interviews were conducted with students to gain information on their experiences of online learning.
For the second study (see Chapter 3, Article 2), quantitative data was collected by instruments designed by the researcher (practicals, tutorials, tests and the pre-post-tests). The time spent on Blackboard (in hours by every user) was obtained from Blackboard's database, as was user activity inside content areas. The CLASSE was also used to gain information on the students' experiences of ERT during the pandemic.

1.6.6 Data analysis

The quantitative data for the first study was analysed with Excel (see Chapter 2, Article 1). The two-tailed p-value for a two-sample t-test for mean differences was used to compare the data collected from the experimental group with interventions, and the control group without the interventions. Demographic data of participants, collected by means of the survey questionnaire, to compare demographic characteristics of both groups regarding gender and academic programme, were also analysed. Descriptive statistics were used to describe the groups with and without interventions, in terms of the dependent variables (tutorial scores, assignment scores and test scores).
Additionally, regression analyses were performed to compare the experimental group and then control group on their AP scores. The AP score is based on students' Grade 12 marks, and can be used to determine whether there is a correlation between students' performance and students' AP scores. In order to analyse the responses from in-depth interviews and open-ended questions, the researcher employed content analysis. The interviews and open-ended questions enabled students to give their perspectives and opinions. The researcher identified themes in the text in order to interpret and understand the raw data.
For the second study, the quantitative data was analysed using Excel. The two-tailed p-value for a paired t-test for mean differences was used to compare the data collected from the pre-test and post-test of the same group. Descriptive statistics were used to describe the group's performance in terms of the dependent variables. Furthermore, regression analyses were implemented to determine whether students' performance in practicals and tutorials, and the difference between pre-post-test marks and semester tests were related to time spent on the course content on Blackboard. Regression analyses were also implemented to conclude the correlation between students' performance and the overall user activity (hits) inside content areas by each student.

1.6.7 Reliability, validity and objectivity

The reliability of the study is based on using valid software for data analysis, which contributed to the Internal validity of the first study by offering the intervention to all research participants. The researcher tested and compared the engagement and performance of students in Group A during the first six weeks (with the OAT intervention) to that of students in Group B, covering the same course work (without the OAT intervention). During the last six weeks, the two groups changed around: Group A did not have access to the OAT intervention, while Group B had access to the OAT intervention.
Internal validity was established in the second study, as only one group participated in the study.
Regarding external validity, each study's research was performed at one specific academic institution, namely the Qwaqwa campus of the UFS. Quantitative data in the second study was not collected by using any randomisation methods, because all the students in the class participated in the study.

1.6.8 Ethical considerations

The first study was an experimental/control-group study that offered the intervention successively to both Group A and Group B. Practicals did not count towards students' final marks – only the tutorials did, and the tutorials did not involve any intervention. In the second study, all students executed the same practicals, tutorials and tests, on the same LMS, at the same time.
The principle of informed consent was followed in all data collection activities. It was compulsory for students to have a letter of consent (see Appendices B and C), signed by students in both studies, prior to commencement of participation. The research ethics committee of the UFS provided ethical clearance for the studies (Appendix A). Participant anonymity and confidentiality were ensured in all reporting. Data summaries ensured that no participant could be identified. In all phases of the study, the no-harm principle was followed.

1.7 DEMARCATION OF THE STUDY

The field of higher education studies encompasses the research; teaching and learning was established to be the most relevant subcategory for these studies. The empirical studies focused on an introductory statistics module and a biostatistics module at the Qwaqwa campus of the UFS. All participants were South African students.
The empirical studies were twofold. The first study focussed solely on the effect of using an OAT on student engagement and performance. The time was limited to July 2019 to October 2019. The second study focused on how a LMS, such as Blackboard, can be incorporated to enhance student engagement and, consequently, students' performance during a pandemic. The time of this empirical study was the period between March 2020 and August 2020.

1.8 CHAPTER LAYOUT

The compilation of the study applied the following structure:

Chapter 1 provided a brief introduction and an overall view of the research. It included the background to the studies and perspectives indicative of the research design and methodology.
Chapter 2 will present the article, entitled *The impact of an Online Assessment Tool on the performance and engagement of students in South Africa*.
Chapter 3 will present the article, entitled, *The effect of a Learning Management System on the engagement and performance of students in South Africa.*
In conclusion, Chapter 4 will provide a final reflection on the empirical investigations, together with proposals for further research.

1.9 CONCLUSION

In short, the conclusion reached by this study is that the use of an OAT and an LMS revealed a positive correlation between online technology and student engagement. Evaluation of the first study shows that the more time students spend on learning content, the better their academic performance. The immediate feedback provided by the OAT motivated the students and assisted them to engage in higher-order thinking.
The second study indicated a positive relation between the number of hits (student activity) on the LMS and their resulting grades. This proved to be indicative of student engagement by drawing on "click count tracking data and student performance" (Maltby and Mackie, 2009, p. 49). One of the reasons for the effectiveness of the use of the LMS might be the availability of this powerful tool, anywhere, at any given time. The results indicate that using an LMS during ERT, where students connected to the LMS via Global protect Application which is a zero data usage platform, facilitates student learning, motivation, performance and, ultimately, student engagement.
The conclusions of this study provide interesting perspectives on the impact of online engagement on the performance of students in South Africa. The recent change, from one-way contact teaching to hybrid learning, enhanced interaction amongst students, their lecturer, and their course content. These benefits are of great importance for teaching and learning.

CHAPTER 2: ARTICLE 1: THE IMPACT OF AN ONLINE ASSESSMENT TOOL ON THE PERFORMANCE AND ENGAGEMENT OF STUDENTS IN SOUTH AFRICA

This article was written for submission to the journal, *SOTL in the South*, of which the instructions for authors can be found here:
https://sotl-south-journal.net/?journal=sotls&page=instructionsForAuthors
The formatting of the article will be adjusted to meet journal requirements before submission.

THE IMPACT OF AN ONLINE ASSESSMENT TOOL ON THE PERFORMANCE AND ENGAGEMENT OF STUDENTS IN SOUTH AFRICA

Abstract

This study concentrated on student engagement in the area of statistics, and how an online assessment tool (OAT) can be incorporated to enhance student engagement and, consequently, performance in statistics of students. The data was analysed by performing two-sample t-tests and regression analysis. In addition, the coefficient of determination and adjusted means were examined. The results reveal that using an OAT in an introductory statistics module had a statistically significant positive effect on academic engagement, and on performance. The performance of students who were exposed to the OAT indicated that learning by means of the intervention had been well accepted and successful, and that students' attitudes towards statistics had changed from being mainly negative to mainly positive. This study provided important insights on the impact of online learning on engagement and achievements of students. Over the last two decades, the transition from face-to-face teaching to blended learning has been a "much discussed" topic. Research on students' interaction with the teaching and learning content on a blended platform was and still is of great importance.

Key concepts: blended learning, online assessment tool, student learning, e-learning, student engagement, enhanced learning, virtual learning environment, adaptive release tool

INTRODUCTION

Since 1997, the predictions of researchers have been that "(t)hirty years from now big university campuses will be relics. Universities won't survive. It's as large a change as when we first got the printed book" (Massyn, 2009:7). This forecast is an indication of radical amendments in the teaching and learning environment over the last 24 years. Technology is rapidly becoming indispensable for all higher education institutions. Online learning is expected by learners and, according to Chen, Lambert and Guidry (2010), the integration of internet technologies into traditional face-to-face teaching could enhance students' performance and engagement. This study investigated the use of an online assessment tool (OAT), to determine whether it can be used to improve students' engagement with, performance in and understanding of statistics concepts in an entry-level statistics course. In the rural parts of South Africa, many students originate from poor backgrounds, and schools are not always equipped with the latest technology. Nevertheless, most first-year students have access to some sort of digital device – either a smartphone, laptop, tablet or digital music player. Thus, introducing online learning seems to be a logical extension of students' current lifestyles.

An advantage of using an OAT is that it improves the quality of interaction between teachers and learners, and between learning material and learners. Most importantly, however, it can enhance student engagement and their performance (Mijatovic, Cudanov, Jednak & Kadijevich, 2013). The aim of the article is to discuss the impact of an OAT on students' performance and engagement in the field of statistics.

LITERATURE REVIEW

Blended learning

Blended learning refers to the combination of face-to-face and online teaching. This could result in an elevated teaching and learning experience. One idea behind the blended approach is "to allow teachers and learners to shift from classroom-based learning to online learning in small stages" (Baharun & Porter, 2009:40). The research of Bergtrom (2009) found that blended learning improves students' learning outcomes. According to Ituma (in Zanjani, 2017), online learning improves students' knowledge of a subject, contributes to active learning, assists in the participation in teamwork and provides an opportunity for more introverted students to engage more spontaneously with each other and their teachers. The use of technology in a course refer to all the resources we choose to enrich the curriculum and to be better equipped to communicate information which supports the curriculum (Mpungose, 2020:4).

By integrating online learning with traditional face-to-face teaching, we create an unique environment for both teachers and learners – an environment that can enhance student satisfaction and learning. This integration has lately received the attention of researchers all over the world, and has garnered more attention than any other learning platform (Zanjani, 2017). Consequently, student engagement can be greatly enhanced when a university uses the benefits of online learning to its maximum potential (Chawdhry, Paullet & Benjamin, 2011).

According to Young and Duncan (2014), seven items contribute to a good definition of effective online teaching and learning: Accommodating students' needs; supplying significant examples; motivating learners to their ultimate performance; assisting the

progress of the course successfully; providing a course of considerable use; good communication; and a concerned and effective instructor who provides encouragement and immediate feedback. This definition strives to describe a motivated student who spends considerable time on task and who strives to be an active learner – ultimately this mindset leads to enhanced student engagement (Ambrose, Bridges, DiPietro, Lovett & Norman, 2010; Barkley, 2010) via effective online learning. In addition, Gazioglu and Branzila (2019) found that students appreciate it if prompt feedback is given on assignments or tutorials they submit. This finding is confirmed by one of the *Seven Principles for Good Practice in Undergraduate Education* of Chickering and Gamson (1987), namely to enhance engagement through prompt feedback and active learning, whether it is in a face-to-face environment, or via an online platform.
Consistent with the abovementioned research, Heizer, Render and Watson (2009) promote using Web-based commercial software, namely PH Grade Assist (PHGA), which supplies unique quizzes with immediate grading and instantaneous feedback. Heizer et al. (2009) evaluated this tool by comparing two classes at the University of New Orleans: the first class did assignments using PGHA, and the second class (the control group) did not. Results found that the first group performed much better than the second.

Using technology and online learning to teach first-year statistics students

According to Neumann (2011), technology can be used in a course such as statistics to teach difficult concepts more successfully. Interaction between lecturer and student, the use of animations, and the availability of online statistical software are only some of the applications of technology, in the classroom or online, that could be used to improve higher-order thinking. Neumann (2011) interviewed 38 first-year statistics students, and concluded that using technology improved their comprehension of statistical applications. This contributed to a better understanding of difficult concepts, served as motivation, and promoted a positive attitudes regarding statistics. The audio-visual nature of the media used, the lecture notes and recording clips available online, easy communication with the lecturer and the immediate feedback of online activities, all contributed to a positive interest in the subject. Moreover, Gazioglu and Branzila (2019) argue that, because statistics, like mathematics, is viewed with psychological fear by many students, the above-mentioned learning benefits help to achieve a higher success rate in modules.
In 2008, Hawkins and Rudy (in Chen et al., 2010) found that a large percentage of all students in the United States own personal computers, cell phones, digital music players, tablets or other digital devices. Subsequently, there are expectations by current students that traditional contact learning should be integrated with modern technologies, such as learning management systems (LMS). They believe that these tools can advance students' learning opportunities, and that it leads to a more effective education, obtained more conveniently. Last, but not at all the least, the research of Mijatovic, et al. (2013), included the effect of learning management systems on student achievement. This study aimed to determine how the interactive usage of a LMS could influence active learning and achievements of students in a blended learning environment. Hundred and sixty nine students from a university of Serbia formed part of this study, and one of the research questions explored was whether the results of students can be affected by either their active participation in class or by the synergistic usage of an LMS combined with face-to-face learning, thus a blended learning environment.

The findings of this study indicated that LMS's influence on the performance of students in a blended learning environment was not as positive as students' active participation in the face-to-face learning environment. Although both had a positive correlation, the students still had to warm up to the idea of an online learning environment, combined with the classical face-to-face environment. This can be a relative indication for universities in a rural environment where students' technological background is constrained to the use of mobile equipment such as cell phones.
These findings correspond to the current study where students from a rural environment have many challenges finding and affording compatible digital devices. Thus the current study treat the devices as a confounding variable, by offering the OAT to all students by using iPads provided by the Centre of Teaching and Learning, in the class environment.

PURPOSE OF THE STUDY

In this study, the independent variable was an intervention, which involved an adaptive release tool and written feedback. The dependent variable was performance and engagement of students in the statistics module. The purpose of the study was to compare, statistically by means of an experimental study, the engagement and performance of Group A (with the intervention) and Group B (without a intervention), during the first six weeks of classes. While all practicals were done on Questionmark, an e-learning assessment platform for both groups, only the treatment group (Group A) received the intervention with the practicals. Group B, the control group, also did the practicals on Questionmark, but without the intervention – these students were subject to the 'live' presence of the lecturer and tutors during the practical session, to ensure constant live feedback whenever it was needed or requested while students were busy with the practicals.

THEORETICAL FRAMEWORK

According to the framework developed by Fink (2003), truly significant learning is expected to take place where these six learning categories are promoted. It is important to know that the feature of this taxonomy is that it is not ranked. It is rather relational and even interactive. Each kind of learning is related to the other kind of learning and that achieving any one kind of learning simultaneously enhances the possibility of other kinds of learning being achieved. Fink's focus is that for significant learning to take place, you need to take in all the different aspects of a student. Students from QwaQwa campus are very diverse, coming from different backgrounds and cultures. Human relationships are extremely important and valuable. it is therefore important for the lecturer to move beyond the content. Not to stop at the knowledge phase, but to look at the human dimension and the caring aspects.

Learning how to learn (L) involves the development of the learning process and this interact with human dimension and caring. If I encourage the "learning how to learn" the students saw an aspect of caring and they saw the human dimension in that. When a course or a

learning experience is able to promote all six kinds of learning we have a learning experience what could be deemed significant.

RESEARCH DESIGN AND METHODOLOGY

The researcher applied the pragmatic parallel mixed method design for this study. The concept of incorporating online assessment tools in teaching statistics students has always been of great importance to the researcher. The pragmatic researcher is described by Teddlie and Tashakkori (2009:90–91) as follows:

> *Pragmatists decide what they want to study based on what is important within their personal value systems. They then study the topic in a way that is congruent with their value system, including units of analysis and variables that they feel are most likely to yield interesting response.*

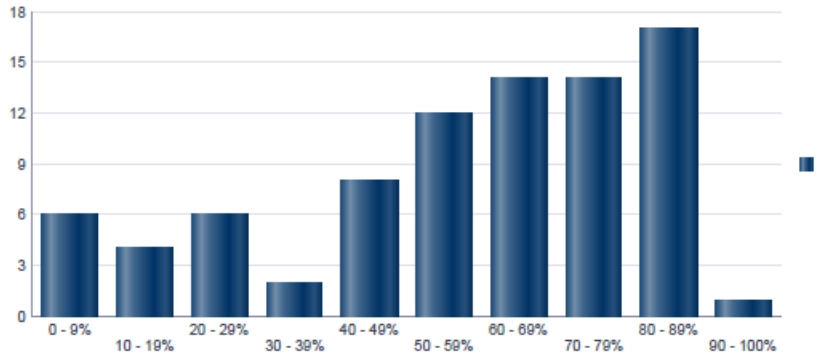
Research questions can be answered by using quantitative as well as qualitative data in a single study. (Teddlie & Tashakkori, 2009).

Participants

This study was conducted at the Qwaqwa campus, University of the Free State (UFS), South Africa. The Qwaqwa campus attracts students from across the continent, and is one of the fastest-growing rural campuses in South Africa. The campus offers a variety of programmes in all the major fields, and postgraduate teaching by various centres of excellence. The students are very diverse, and pass rates are, in many respects, unsatisfactory.
The following figures indicate students' participation in tutorials on Elementary Statistics in Business Calculations (EBCS1524) held at the Qwa-Qwa campus during the second semester in 2018. This is a typical example of the 15 tutorials attended by the students throughout the semester.

EBCS1524 - QWAQWA - 2182
Tutorial 10

Grade Interval	Students
0 - 9%	6
10 - 19%	4
20 - 29%	6
30 - 39%	2
40 - 49%	8
50 - 59%	12
60 - 69%	14
70 - 79%	14
80 - 89%	17
90 - 100%	1



Students Participated	84		Average	55 %
Pass	58	69.05 %	Minimum	0
Pass with Distinction	24	28.57 %	Maximum	90
Fail	26	30.95 %	Standard Deviation	25.07 %
Students not Participated	30		Incomplete	0
			Deregistered	2

Figure 1: Student attendance

The participants of this study represented students from two academic programmes that had been combined into one class, with the researcher as the only lecturer. All students were registered for an elementary statistics course. Students of the two academic programmes were mainstream students (registered for EBCS1524: Economic and business calculations in statistics) and extended programme students (registered for EFBC2524: Economics for business calculations in statistics). The mainstream students were in their first of a three-year study programme, and the extended programme students are in the second year of a four-year study programme.

Identification of experimental and control groups

All registered students (101) contributed to the study and were randomly allocated to two groups. The researcher chose the random enrol option for the students when creating the groups on Blackboard. The two groups attended classes at different times. Some students had clashes on their timetables and were given the option to self-enrol in the other group. Students could switch once they knew what the differences between the two groups entailed. Although no student choose that option. Therefore, there were two groups,

namely the treatment group (Group A, 37 students) and the control group (Group B, 64 students).

Ethics considerations

The researcher received ethical clearance from the UFS to do the study. Randomisation ensured non-biased treatment and experimental groups. This, together with the fact that students were assessed at the same institution using the same e-assessment platform (McMillan & Schumacher, 2006), ensured the validity and reliability of the data. Furthermore, both groups had the same lecturer, thus, other lecturers could not influence the outcomes of the study. Data analysis was done by validated software.
For the purpose of this study, the focus was on the first six weeks of the course, during which time Group A participated as experimental group and B as control group. All the discussions will be based on this time interval. The two groups attended lessons at different times. Strict attendance control was done to ensure that students from one group did not attend the sessions of the other group.
It was explained very clearly to all students that the control group has absolutely no disadvantage over the treatment group. Group B students understood that they would experience the same method of written feedback and adaptive release when they did their practicals during the last six weeks, when it was their turn to be the experimental group. The students also understood that marks obtained for the practicals did not count towards their final marks; only the tutorial marks did, and the tutorials were without any intervention.
Consent was restricted to the experimental group. Data collection was coincidental, as the lecturer collected the data anyway. The principle of informed consent was followed for all data collection activities. Participant anonymity and confidentiality were ensured in all reporting. All participation in the surveys and interviews was voluntary. No data summaries allowed any participant to be identified. In all phases of the study, the no-harm principle was adhered to. Therefore, the researcher believes that, in this study, it was possible to keep within ethical boundaries at all times.

Data collection

A randomised treatment-group-control-group design was applied. Quantitative data consisting of a variety of assessment marks were collected. The Classroom Survey of Student Engagement (CLASSE)[1] included quantitative questions as well open-ended qualitative questions. The open-ended questions contributed to expansion and validation of the data.
A questionnaire with quantitative items and a few qualitative open-ended questions, to expand and validate some of the information, was also used to enhance the quantitative data. The questionnaire was combined with qualitative interviews to collect data on students' perspectives and experiences and to generate broad overviews on issues of concern.
Data were collected by means of marks students obtained on weekly tutorials, an assignment and the semester test. As the tutorials, assignments and tests were compulsory for all students, it was possible to obtain marks for all of them.

[1] https://www.ufs.ac.za/sasse/classe-home

Class facilitation

The intervention empowered students to complete and submit Question 1 successfully before the adaptive release tool allowed them to move on to Question 2. This process was repeated until the practical had been completed successfully. If a question was answered incorrectly, immediate written feedback appeared, which referred the student to the corresponding work in the study material or textbook. The student then had to provide an answer to the same question with different data. This process repeated itself until the student had provided the right answer to the question. In this way, the student was still responsible for figuring out the correct answers. Only after a student had completed all the questions, the program allowed him/her to submit a tutorial that contributed towards the semester mark. Thus, if the practical was not submitted, the student forfeited the chance to do the tutorial, which counted towards the semester mark.

Measuring instruments

To determine the impact of the interventions on student performance and participation during the first six weeks, the quantitative data was collected by means of self-developed instruments (tutorials, assignment and a test). The CLASSE, constructed with the help of the Centre of Teaching and Learning at the UFS, and interviews with students, were also used at the end of the semester to gather information with regard to the students' experiences of online learning.

RESULTS AND DATA ANALYSIS

The. researcher used Excel to analyse the quantitative data. The two-sided p-value for a two-sample t-test for mean differences was used to compare the data collected from the experimental group (with intervention) and the control group (without the intervention).

Demographic data of participants

Table 1 provides a comparison of demographic characteristics between the experimental group and the control group regarding gender and academic programme.

Table 1: Distribution of respondents according to gender and academic programme

	Experimental group (n=37)		**Control group (n=64)**		**p-value (Fisher's exact test)**
	n	**%**	**n**	**%**	
Gender					
Male	20	54.1	29	45.3	0.417
Female	17	45.9	35	54.7	
Academic programme					

Extended	16	43.2	51	79.7	0.0004**
Mainstream	21	56.8	13	20.3	

Significant p-value: *** 0.001; ** 0.01; * 0.05

The Fisher's exact test was performed to examine whether gender and academic programme for students in the experimental group were different than for students in the control group. The Fisher's exact test can be used when you have two nominal variables and you want to see whether the proportions of one variable are different depending on the value of the other variable. Use it when the sample size is small. The p-value for Fisher's exact test indicates no significant difference in gender distribution. However, the proportion of students in the extended programme was greater in the control group than in the experimental group. The p-value indicates a significant difference for academic programme between the two groups.

Descriptive statistics

Table 2 provides information on the comparison between the assessment results of the mainstream programme students and the extended programme students.

Table 2: Tutorials, assignment and test scores (%) of mainstream programme students and extended programme students

Programme	Assessment opportunity	N	Mean	SD	Min.	Median	Max.	p-value
Mainstream programme	Tutorials	34	58.4	15.2	4	61.1	90.0	0.1391
	Assignment	34	66.6	13.1	22	68	98	0.8933
	Test	34	33.4	16.4	11	32	72	0.9216
Extended programme	Tutorials	67	64.1	16.6	16.4	67.9	92.9	
	Assignment	67	67.1	17.1	26	68	96	
	Test	67	33.8	17.0	7	31	86	

Significant p-value: *** 0.001; ** 0.01; * 0.05

The p-values, as indicated in Table 2, suggest that there is no significant difference between the assessment results of the mainstream programme students and the extended programme students. The median scores for both groups are basically identical. Thus, we can conclude that that the mathematically competencies of students from Groups A and B were not statistically different and that randomisation was successfully applied.

Table 3 provides information on the comparison between the assessment results of the experimental and control groups.

Table 3: Tutorials, assignment and test scores (%) of students in the experimental and control groups

Group	Assessment opportunity	N	Mean	SD	Min.	Median	Max.	p-value
Experimental group	Tutorials	37	62.2	18.4	22.1	65	90.0	0.9872
	Assignment	37	71.6	13.1	34	72	98	0.0275*
	Test	37	35.9	16.9	11	31	73	0.2953
Control group	Tutorials	64	62.1	18.5	13.6	63.9	92.9	
	Assignment	64	64.3	17.1	22	67	96	
	Test	64	32.3	16.6	4	31	86	

Significant p-value: *** 0.001; ** 0.01; * 0.05

Table 3 indicates that the average tutorial mark of the experimental group is marginally better than that of the control group, but with no significant difference (p=0.9872). Comparing the assignment scores, the experimental group's performance exceeds the control group's performance significantly. The student two-sample t-test was applied, assuming equal variances ($p<0.05$). The average test mark of the experimental group's students was better than that of the control group's students, although not significantly. According to these results, it can be concluded that the performance of the students exposed to the intervention with the practicals was slightly better than their performance would have been without this intervention.

One criterion for admitting students to South African universities is their Admission Point (AP) score, which is is based on students' Grade 12 marks.

In Table 4, the AP scores of the experimental and control groups are compared.

Table 4: Comparison of AP scores of experimental and control groups

Descriptive statistics	Experimental group	Control group	p-value
Average score ($\underline{x}$)	30.1	28.1	0.0028*
Sample size (n)	37	64	
Standard deviation	3.2	3.3	
Minimum	24	23	
Maximum	39	38	

Significant p-value: *** 0.001; ** 0.01; * 0.05

The p-value in Table 4 (p=0,0028) indicates a significant difference between the AP scores of the experimental group and the control group.

Statistics of association: Regression analysis

Regression analysis was performed to determine whether performance was related to students' AP scores. Regression results are summarised in Table 5.

Table 5: Regression results of the average tutorial marks, assignment marks and test marks

Dependent variable	N	Standard error	Coefficients	p-value
Tutorials	101	0.5405	-0.0105	0.9845
Assignment	101	0.4730	0.5199	0.2743
Test	101	0.4859	0.9411	0.0556

Significant p-value: *** 0.001; ** 0.01; * 0.05

According to the results indicated in Table 5, students' performance in this module cannot be predicted by students' AP scores. Although there is an indication here that the groups are unbalanced in terms of AP and that there is a possible relationship between AP and Test results, all three p-values >0.05, which statistically implies no significant difference between the AP scores of the students from both groups. The researcher can, thus, confirm that, even though there was a significant difference in the mean AP scores of students when comparing Groups A and B (see Table 4), it is not the absolute reason for the difference in performance between the experimental group and the control group.

Questionnaire results: Quantitative data analysis

In this section , we will consider the data collected on the items of the CLASSE survey. These items were categorised and summarised using percentages. The aim of analysing this questionnaire was to explore students' engagement in the module presented. The analysis of the questionnaire was conducted under six sections, as displayed in Table 6. Only the questions of Section I and Section II are relevant to the research topic, and will be discussed.

Table 6: Distribution of questions grouped together under each of the six sections of the CLASSE questionnaire

Section	Section description	Question numbers
I	Engagement Activities	1 – 22
II	Cognitive Skills	23 – 27
III	Other Educational Practices	28 – 37
IV	Class Atmosphere	38 – 41
V	Supplementary Learning Activities	42 – 46
VI	Demographics	47 – 56

Tables 7 and 8 summarise the students' responses on a Likert-scale to questions relating to Sections I and II of the questionnaire. The tables contain the question/statement, and the distribution of responses in counts and percentages, and the lecturer rating of the score for each item.

Table 7: Responses concerning Section I: Engagement Activities

Engagement Activities		Response options	n	%	Lecturer rating
2	Asked questions in class	Never	10	16%	Very important
		1 or 2 times	36	57%	
		3 to 5 times	7	11%	
		More than 5 times	10	16%	
		Total	**63**	**100%**	
3	Contributed to discussions in class	Never	13	20%	Very important
		1 or 2 times	32	50%	
		3 to 5 times	11	17%	
		More than 5 times	8	13%	
		Total	**64**	**100%**	
5	Worked on a paper or a project that requires combining ideas or information from various sources (e.g., books, internet, class notes, or other)	Never	18	28%	Very important
		1 or 2 times	15	23%	
		3 to 5 times	11	17%	
		More than 5 times	20	31%	
		Total	**64**	**100%**	
7	Attended class without having completed readings or assignments	Never	27	42%	Important
		1 or 2 times	22	34%	
		3 to 5 times	8	13%	
		More than 5 times	7	11%	
		Total	**64**	**100%**	
8	Worked with classmates on projects or assignments during class	Never	6	9%	Important
		1 or 2 times	13	20%	
		3 to 5 times	15	23%	
		More than 5 times	30	47%	
		Total	**64**	**100%**	
9	Worked with classmates outside of class to prepare assignments	Never	4	6%	Important
		1 or 2 times	14	22%	
		3 to 5 times	17	27%	
		More than 5 times	29	45%	
		Total	**64**	**100%**	

Engagement Activities		Response options	n	%	Lecturer rating
11	Explained subject content of this module to other students	Never	9	14%	Important
		1 or 2 times	27	42%	
		3 to 5 times	17	27%	
		More than 5 times	11	17%	
		Total	**64**	**100%**	
12	Used an electronic medium to discuss or complete an assignment	Never	4	6%	Very important
		1 or 2 times	14	22%	
		3 to 5 times	15	23%	
		More than 5 times	31	48%	
		Total	**64**	**100%**	
19	Received prompt written or oral feedback from the lecturer (e.g., marks from assignments, tests, and exams)	Never	24	38%	Very important
		Sometimes	11	17%	
		Often	17	27%	
		Very Often	12	19%	
		Total	**64**	**100%**	
20	Worked harder than you thought you could to meet the standards or expectations of the lecturer	Never	8	13%	Very important
		Sometimes	17	27%	
		Often	25	39%	
		Very Often	14	22%	
		Total	**64**	**100%**	
22	Received motivating and engaging interaction in this module/subject	Never	9	14%	Very important
		Sometimes	18	28%	
		Often	17	27%	
		Very Often	20	31%	
		Total	**64**	**100%**	

Table 7 indicates that the intervention had a strong influence on students' active interaction with the learning content, as well as their engagement with the content. On average, more than 80% of the students reported contributing to discussions in class and asking questions. Furthermore, 85% of the students regarded working together when doing online assessments and discussing difficult topics during the practical sessions with each other and with the lecturer to be part of active learning. Seventy percent of the students found that they were required to utilise information from several sources (e.g., books, internet, class notes) while doing the online practical assessments, and only 6% of the students claimed

that they had never conferred with classmates out of the class environment to prepare for online assignments.

We thus, conclude that more than 91% of the students found the intervention motivating and engaging, while 92% reported that their work rate improved significantly. Seventy five percent of the students regarded the prompt feedback on the practicals during the intervention positively, and 96% claimed that the use of a digital device to complete their assessments, coupled with the immediate feedback provided, contributed to their improved performance.

Table 8 summarises the responses to the Likert-scale questions regarding the influence of the intervention on cognitive skills in this module.

Table 8: Responses concerning Section II: Cognitive Skills

Cognitive Skills		Response options	n	%	Lecturer rating
23	Memorise module/subject content (facts, ideas, etc.)	Very Little	3	5%	Very important
		Some	12	19%	
		Quite a Bit	21	33%	
		Very Much	27	43%	
		Total	**63**	**100%**	
24	Identify the different parts of an idea, experience, or argument in detail (analyse)	Very Little	7	11%	Very important
		Some	14	22%	
		Quite a Bit	24	38%	
		Very Much	19	30%	
		Total	**64**	**100%**	
25	Form a new idea or understanding by putting together various pieces of information	Very Little	5	8%	Very important
		Some	16	25%	
		Quite a Bit	23	36%	
		Very Much	20	31%	
		Total	**64**	**100%**	
26	Evaluate a point of view, decision, or information source	Very Little	5	8%	Important
		Some	20	31%	
		Quite a Bit	24	38%	
		Very Much	15	23%	
		Total	**64**	**100%**	

Cognitive Skills		Response options	n	%	Lecturer rating
27	Apply facts, theories, or methods to practical problems or new situations	Very Little	7	11%	Important
		Some	16	25%	
		Quite a Bit	14	22%	
		Very Much	26	41%	
		Total	63	**100%**	

Statements 23 to 27 indicate that the majority of students believed that the use of technology in this module had a strong influence on students' learning of statistics. More than 90% regarded the intervention as a teaching strategy that assisted them to memorise subject content and to identify different parts of an idea in detail. The immediate feedback with reference to the relevant sources helped them to to come to a new understanding by helping them to compile various pieces of information. Statement 27 indicates that the vast majority of students believed that the intervention helped them to apply facts and methods to practical problems.

Questionnaire results of five additional and three open ended questions.

Additional, self-developed questions were administered to explore students' opinions on the use of technology in the module. Table 9 summarises the responses to these additional questions, which students answered by selecting an option on a Likert scale. With Questions 1, 2 and 4, the students were given the opportunity to explain their answers with a follow-up open-ended question.

Table 9: Additional questions related to use of technology in the module

	Use of technology in the module	Response Options	n	%
1	To what extent did the use of technology in this module enhance your learning (e.g., video clips on Blackboard, assessments on the online platform Questionmark and Blackboard)?	Very Little	1	2%
		Some	5	8%
		Quite a Bit	9	15%
		Very Much	47	76%
		Total	**62**	**100%**
2	To what extent was adequate support provided for you to be successful in this module (e.g., practical exercises, tutorials, additional reading material)?	Very Little	0	0%
		Some	3	5%
		Quite a Bit	18	28%
		Very Much	43	67%
		Total	**64**	**100%**
3	To what extent were you satisfied with the availability of digital resources (iPads) for	Very Little	3	5%

	Use of technology in the module	Response Options	n	%
	this module?	Some	10	16%
		Quite a Bit	16	25%
		Very Much	35	55%
		Total	**64**	**100%**
4	To what extent did the immediate feedback provided by either the lecturer or the feedback function within the practical tasks help you to improve your performance?	Very Little	4	6%
		Some	7	11%
		Quite a Bit	24	38%
		Very Much	29	45%
		Total	**64**	**100%**
5	Which communication channels do you prefer to communicate with your lecturer about the module?	Face to face	36	56%
		Email	22	34%
		Discussion Board	5	8%
		Other	1	2%
		Total	**64**	**100%**

The usefulness of technology for enhancing their learning was acknowledged by the vast majority (98%) of the students. The only concerns that were mentioned in the follow-up answers were that the practicals were more time-consuming than the typical traditional assignments. Fifty six percent of the students prefer face-to-face communication with the lecturer. This implied a definite need of some human interaction between the lecturer and the students. Ninety five percent of the students appreciated the availability of digital resources (iPads) for this module. Many of the respondents (94%) claimed that the immediate feedback assisted them to improve their performance. These opinions are reflected in the following quotes:

> *It helped me in such a sense that I was able to tell where I made mistakes and how I go about rectifying it.*
> *If I made a mistake automatically the system shows me my mistake and refers me to the book. It gave me an idea of where to look for the content and examples in the book.*
> *It helped me very much because I was able to navigate my error areas immediately after submitting my answer and seeking for help if I could not get it right by myself.*
> *The Feedback allowed me to check my mistakes and attempt a different question but with the same concept to check if I understand the work.*

One of the three open-ended questions gave the respondents the chance to provide an overall opinion on the course. Some of the respondents expressed that the module was challenging, but also interesting, and that it is likely to help them when they have to do their

own research. A minority of students said that they found it time-consuming, because it required so much work.
The following quote demonstrates another opinion from a student who had struggled with the module:

> *I really found it hard to adapt to the second semester system (primarily the intervention). Not only did the system affect my academic performance in Statistics, it also affected my performance in other modules. THE LECTURER IS AMAZING THOUGH!*

One possible reason for this response could be that the students were forced to do and submit a practical before the relevant tutorial would open. In addition, they had to complete the practical with the re-try function right up to the last question. If a student did not bother to do the practical, they did not have the opportunity to do the tutorial, which counted towards their semester marks. The researcher found that some students really did not like that aspect of the intervention at all.

Perceptions and experiences of the participants

During an interview session with the experimental students in Group A, their opinions about whether the intervention with the practicals made their learning of statistics more effective was tested. The aim of the interviews was to acquire detailed information concerning their feelings, attitudes, beliefs and experiences regarding the intervention.
Several students indicated that the intervention helped them to learn through the process of answering questions. Another reason indicated by many respondents why technology made their learning more effective was that it helped them to study more effectively. The following statements reflect this opinion:

> *Maybe you do not have some time to study, but through the practicals you are doing the studying.*
> *It encouraged me to study and practice [practise] and be ready for the tutorial.*

Some students also remarked that, by doing the practicals, they had a chance to ask for help. Furthermore, they could ask for further explanation of the topic, so that, when they did the tutorial for marks, they understood the work and had a chance of getting good marks.

> *It was helpful because in the practical session you learn more about that chapter that you're going to write within tutorials and if you have questions, you can go and ask about that and read about it before you open the tutorial so it was easy to write the tutorial if you have done the practicals before.*
> *For me the practicals were good because we were using the practical as a pre-practise section so that you are able to prepare for the tutorial.*
> *The practicals helped me with the idea of what is the question that I will get doing the tutorial or the semester test.*
> *It supported on a very high level because it's a rule that for the practicals help you to practise it. I don't remember a tutorial where I got less than 70 because I was practicing [practising], I got to practice through the practical.*

Several students described the re-try function of the intervention, which meant that they could not move to the next question without answering the first correctly, as one of the highlights of the intervention. The following comments in this regard confirm this opinion:

> *It enhances your skills, it gives you the ability to know and learn from your mistakes, and it just helps you to do the best you can.*
>
> *We have to retry it because you know, like you get better next time, you get motivated to do better.*

On the other hand, some of the students found the re-try function challenging. They found it time-consuming and also experienced that, sometimes, they were stuck and couldn't move on to the next question, as illustrated by the following comments:

> *The re-try part was very challenging, because if you don't understand the question like you totally you don't understand anything and it's keep on giving you the feedback how to do it you keep trying but you don't get it.*
>
> *If I don't understand the question, it will keep on saying I should finish it first before I move on even though I don't understand the concept of the question.*

The intervention also provided immediate feedback and, thus, students knew immediately if they were wrong, and where to find the explanation about that part of the chapter needed to answer the question. Many respondents mentioned that the immediate feedback was good hands-on learning experience. Their opinions are illustrated by the following quotes:

> *If we got the question wrong, they gave us feedback where to refer to and then try it again. So, it was very helpful.*
>
> *It shows you where your mistakes are. It helps you to see things that I didn't pick up in the textbooks.*
>
> *I was able to know immediately if I was wrong, I could study effectively and getting rid of fear and mistakes on exams.*
>
> *It enhances your skills; it gives you the ability to know and learn from your mistakes.*
>
> *I think doing the practicals with feedbacks help us with the success of this module.*

Many students indicated that the intervention helped them to "reduce procrastination". The fact that the practicals needed to be finished before they could start with the tutorials (which counted towards their semester marks), forced them to finish the practical before it closed, otherwise they forfeited the chance to do the tutorial. This procedure taught them to be responsible. This opinion is illustrated by the following comments:

> *I needed something that will push me to do the practicals a every week.*
>
> *The practicals were very helpful because we were forced to do them, and in that way, we were learning.*
>
> *It helped me so that I can manage to work faster 'cause I knew I had to do my practical then after practical I'll do my tutorial.*

Furthermore, students were asked what their biggest challenge or negative experience was in relation to this intervention. The majority indicated that time allocation was a problem. A practical session was only available for a maximum of three hours. They expressed that they needed more time, and, in addition, to be able to log out and back in after a certain time to continue. The following remark confirms this finding:

> *Sometimes you've got off between two periods and then you can quickly sit around and then you think oh you've got time you can do two more*

problems. Then when you come back you find out that the 3 hours have passed and it auto submitted. So now you have to email them again.

Technical issues, like the slow response time of Questionmark on queries, also featured as a negative experience for some students. Another issue was that, sometimes, students received a couple of practicals and tutorials in one week, because the Questionmark team had fallen behind with the workload and were unable to keep up with the demand of the practicals that had to be set with the feedback intervention.

The fact that it overlapped some of us were already busy with the next chapter and in a practical it's still about the work of the previous chapter. The time period like one time, maybe we have three per week and you know, sometimes you might have other things to do and then you only realise when there's an hour left.

LIMITATIONS

The students' results indicate whether they met the assessment criteria, but do not necessarily confirm that effective learning took place. More research is required to study the significance of these patterns. One of the most obvious limitations of an OAT is its dependence on multiple-choice and short-response tests. There is an obvious place for multiple-choice questions, which can be designed to test rather complex concepts, but it would be insufficient if this form of testing and feedback became dominant in higher education. Therefore, there could be a need to incorporate more active-learning components such as simulations and games to provoke the interest of students further, in order to promote active learning and, ultimately, performance.

RECOMMENDATIONS

The results of this study indicate a necessity for further research. An extension of this study should include data on topics such as diversified demographics including educational background, teacher participation, course design, and number of students per class, as well as the age and gender of the students. These are factors that could affect student engagement via an OAT. Further research is necessary to determine which OAT should be utilised and the frequency with which online technology should be applied. Despite claims of the effectiveness of using an OAT in an introductory statistics course, more in-depth research, addressing additional OATs, is needed.

CONCLUSION

The thought process that underpinned this study related to the need for students to spend more time practising certain concepts during a statistics course. The more time they spent, the better their performance became. An OAT was used to support this idea, by delivering assignments online. The adaptive release function of the OAT used in this study challenged the students to continue attempting a question until the correct answer was submitted. The fact that immediate feedback was provided by the OAT motivated students, and stimulated higher-order thinking. Self-reported feedback by students indicated that practising through a OAT was not only popular, but also successful. It is important though to keep in mind that the majority of students still have a need for face-to-face communication with the lecturer, as seen by the questionnaire results mentioned before.

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CHAPTER 3: ARTICLE 2: THE EFFECT OF A LEARNING MANAGEMENT SYSTEM ON THE ENGAGEMENT AND PERFORMANCE OF STUDENTS IN SOUTH AFRICA

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THE EFFECT OF A LEARNING MANAGEMENT SYSTEM ON THE ENGAGEMENT AND PERFORMANCE OF STUDENTS IN SOUTH AFRICA

ABSTRACT

Background: The thought process that underlies this study is to determine whether there is a positive relationship between the use of a learning management system (LMS) and student engagement in a second year biostatistics module. Research with regard to emergency remote teaching (ERT) is limited, despite the extensive adjustment to online learning during the current worldwide COVID-19 pandemic.

Purpose: In response to recent developments in the field of online learning systems, the researcher conducted an empirical investigation to determine whether students' learning experiences and enjoyment of statistics can be enhanced by means of an LMS.

Sample: A group (n=24) of biostatistics students at the University of the Free State participated in the study. Convenience sampling was applicable as sampling strategy.

Design and methods: A quasi-experimental design was used to elicit results. The group of students was assessed by means of a pre-post-test, tutorials and practicals, semester tests and the CLASSE survey, which is designed to assess students' engagement. The data was analysed by conducting paired t-tests and doing regression analysis. In addition, correlation coefficients were examined.

Results: Results indicate a positive relation between student activity on the LMS and the outcome of their performance. Student activity can indicate student engagement, which is particularly pertinent for a course using ERT during the COVID-19 pandemic. The questionnaire results enabled the researcher to gather quantitative and qualitative information on the experiences, attitudes and concerns of students exposed to ERT via Blackboard. Feedback by students indicated that learning through an LMS was not only popular, but also successful.

Conclusion: The researcher founded that a LMS facilitates student learning, motivation, performance and, ultimately, student engagement. The study supports the promotion of student engagement in biostatistics education, in particular, as well as in the general educational field.

Key concepts: emergency remote teaching, Blackboard, e-learning, student engagement, learning management system

INTRODUCTION

Due to the risks posed by COVID-19, education institutions worldwide were compelled to adapt to engage academically on a relatively unexplored platform. While a virus created havoc and faculties and staff were expected to move courses online within a matter of weeks, questions arose regarding how to cope with a relatively new teaching and learning mode, emergency remote teaching (ERT), while ensuring engaged students.
The aim of this study was on student engagement in the field of biostatistics, and how a learning management system (LMS), in this case Blackboard, can be incorporated to enhance student engagement and, consequently, improve students' performance during a worldwide pandemic. The study concentrated on students' engagement and performance. A thorough knowledge and understanding of online learning platforms during the COVID-19 pandemic is pivotal for monitoring future blended university education. It would be useful to note that the experience of educational institutions under ERT highlighted the differences between (i) ERT, (ii) fully online (without lockdown restrictions) teaching and (iii) blended learning. This is of great importance, not only currently, where lockdown regulations due to the COVID-19 pandemic still apply, but also "to highlight strengths and identify weaknesses to be better prepared for future needs to implement ERT" (Hodges et al. 2020).

LITERATURE REVIEW

The effects of using a learning management system to enhance student engagement

Student engagement has been a source of research since the mid-1990s – the actual investigation of student engagement began in 1984, with the work of Alexander Austin, who studied student involvement (Trowler 2017). Since then, the interaction between student engagement and online learning has become a popular platform in higher education.
A single definition for engagement does not exist, but it is possible to illustrate its meaning in the context of a university classroom (Barkley 2010). First, engagement implies the extent of energy and time students invest in their learning activities in order to work towards success in their study career. Second, it refers to the way an institution supports advantageous circumstances for teaching and learning. Furthermore, Trowler (2017) argues that engagement requires beliefs and opinions, in addition to activity; therefore, the engaged student will be a motivated student. Barkley (2010) indicates that motivation is the gateway to engagement. The conclusion is, therefore, that there is a deep connection between motivation and active learning, and this forms the basis of student engagement.

Ambrose et al. (2010) specify three principles that are important for student engagement. These principles relate to students' prior knowledge, the factors that motivate them to learn, and the effective application of practice and feedback. The first principle, namely that "(s)tudents' prior knowledge can help or hinder learning" (Ambrose et al. 2010, p. 13), especially in environments where their rural upbringing causes their educational foundation and basic skills to be below the expected average standard is applicable to this study. Regarding the second principle, namely "Students' motivation generates, directs, and sustains what they do to learn." (Ambrose et al. 2010, p. 69), Holmes (2018) claims that an LMS could influence the way students observe their studies. The impact of certain interventions at an early stage of their education could help to build students' confidence regarding their abilities, which may increase their motivation.

Ambrose et al. (2010) found that a purposeful goal and specific feedback are indispensable for learning to take place. This claim underpins the third principle, namely “Goal-directed practice coupled with targeted feedback are critical to learning.” (p. 125). Feedback shortly after the learning activity took place can assist students to understand the content of the subject, and promotes higher-order thinking and meaningful learning.

According to Maltby and Mackie (2009), an LMS can enhance or discourage student engagement and student performance. They state that an LMS must be suitable for different types of learners. Their study investigated whether an LMS can help students who are not engaged, by drawing on “click count tracking data and student performance” (p. 49). They found that students who registered only 0–32 clicks were unsuccessful, with an average mark of 34%, and that students who registered between 358 and 1 432 clicks (high usage) achieved an average of 55%. Maltby and Mackie (2009) conclude that using an LMS promotes a positive learning environment and, consequently, enhances student engagement. A key aspect of the current research was to determine if there is a relationship between students’ assessment performance and the use of an LMS.

A number of recent studies concentrated on the importance of understanding online student engagement. Chung and Coates (2019) considered six reasons why online student engagement is important, of which the researcher will discuss two. First, being able to assess students’ engagement via certain processes provides a good idea of the extent of students’ involvement in their studies. Second, the data provided by certain online LMSs provides a direct measure of how active a student was, i.e. how engaged the student was. LMSs are prominent in the technology-focused era we live in. Virtual online environments, such as those provided by Blackboard and WebCT, are currently in use by up to 80% of universities all over the world (Chung and Coates 2019). The Student Engagement Questionnaire was developed to measure online engagement of students based on campuses (Chung and Coates 2019), and uses seven scales to measure students’ online engagement. Findings of the questionnaire include that students who are highly engaged in their studies have an intense online engagement through using an LMS. These students see themselves as active, motivated learners. These results lead to a conclusion that online engagement can serve as a good measurement scale of a student’s degree of activity regarding subject material, and of how motivated a student is regarding studies. There is a need though for a separate instrument to show that online activity is highly correlated with engagement.

“(S)tudent engagement can be characterized as either intense, collaborative, independent or passive” (Coates, 2007, p. 132). The intense style reflects online engagement in all its facets, including collaboration opportunities and communication with other students and lecturers. The independent style reflects a more academically oriented approach. With this approach, students use the LMS mainly for academic work, to enrich their knowledge of the subject and to enhance success in their study career. Passive and collaborative engagement styles are, in many ways, the opposite of intense and independent styles. According to Coates (2007, p. 134), "a collaborative style of engagement tend to favour the social aspects of university life and work". Passive engagement indicates that students with this approach seldom part take in general online activities. From these findings, we can conclude that assessments of students’ engagement in certain processes provides a good idea of what the involvement of students is in their studies.

The second reason why it is important to understand online student engagement is that LMSs can provide a direct measure of how active a student is, by measuring the

engagement of the student. LMSs provide a great deal of data that can be used as indicators of student participation. Beer, Clark and Jones (2010) provide an interesting summary of how data captured by a LMS can provide information about the degree of student engagement. Their study found that, although not all universities use data captured by the LMS effectively, this information has the potential to be one of the major indicators of student engagement.

It remains a challenge to measure student engagement and its link to successful, active learning. According to Beer et al. (2010), research done to measure student engagement has concentrated mainly on class attendance. While class attendance is an indicator of student participation, it does not necessarily take into account the quality of participation, even though attendance could be an important factor in determining students' degree of active learning. We need to acknowledge that the same is also possibly true of online activity, students are able to download work and work offline (often need to as a result of data restrictions) and so don't appear as engaged as other students who can stream videos live; conversely students can click through an exercises to get it done but actually not be particularly engaged with the material.

Prince (as quoted by Beer et al. 2010, p. 80), "[t]he core components of active learning are student activity and engagement in the learning process". The researcher presumes the existence of a distinct positive relation between students' performance, how often students engage with the LMS-hosted courses, and the time they spend on activities provided by the LMS. There is a chance that highly engaged students would perform better than students who are less engaged. Therefore, an important finding of Beer et al.'s study is that the performance outcome of students correlated with the number of clicks within the LMS. "Organizations need to emphasize on creating learning opportunities, knowledge sharing, and tapping knowledge at both individual and corporate levels developing an e-learning culture in the process" (Choudhury & Pattnaik, 2020: 9). Therefore, we have to ensure that online learning platforms are used to its full advantage. This brings to the foreground some important questions regarding currcilum designs. It is important to ensure that online learning platforms are used effectively to enhance active learning (Ituma 2011).

Learning management system tools applied in teaching and learning

To enhance the understanding of the role and potential impact of LMS tools in teaching and learning to enhance student engagement, a summary of some of the available LMS tools is provided in Table 1.

Table 10: Outline of learning management tool functions

No.	Name	Description
1	Announcements	To announce upcoming tests or the availability of new PowerPoint slides, posting of new practicals or tutorials, updates on previous tests or exam papers, posting of memoranda, scheduling of extra tutorial sessions, timetable changes, updated grade book
2	Course Calendar	Work schedule with tutorial, practical and test dates, as well as a completed schedule with work division according to calendar
3	Course documents	Course guide as well as course material, PowerPoint slides, links to relevant websites, question bank, extra reading material
4	Grade book	Mark lists updated weekly
5	Assessment/quizzes	Practicals and tutorials posted weekly to be done online
6	Blackboard Collaborate	Synchronous communication via chat and whiteboard (in real time) as well as lecture/screen capturing
7	Discussion board	Place for students to conduct conversations in the form of posted messages
8	Talk to the lecturer	Instead of using email, students can use this function to communicate with the lecturer

Research by Chawdhry, Paullet and Benjamin (2011) at a relatively small, rural university provided a quantitative assessment of Blackboard. The most useful tools in this study included Announcements, Syllabus, Discussion Board, Digital Dropbox and Quizzes. The students rated their ability to check their marks, the continuous availability of course materials and the overall accessibility of Blackboard as the best advantages of Blackboard.

Easy access to a variety of resources, as well as an ‘anywhere, anytime, anyplace’ approach, leads to students spending more time on the task, thus, enhancing student engagement (Chickering and Gamson 1987; Ambrose et al. 2010; Barkley 2010). On the negative side, for the ‘disengaged’ student, the ease of procrastination under the umbrella of ‘working online’, may hinder active learning.

Last, but not least, the research of Mijatovic et al. (2013) investigated the effect of LMSs on student achievement. This study aimed to determine how the interactive usage of an LMS influenced active learning and performance of students in an educational environment where blended learning is actively pursued. The sample of this study was 169 students at a university in Serbia, and one of the research questions related to comparing the effect on student achievement of using an LMS in synergy with contact learning in a blended learning environment, and by active participation in class. The outcome of the study indicates that the effect of the LMS on the students' performance in a blended learning environment was not as great as students’ active participation in the contact learning environment was. Although both activities had a positive correlation with achievement, the students still had to warm up to the idea of an online learning environment supplementing the classical

teacher-student contact environment. This finding can be useful for universities in a rural environment, where students' technology background may be limited to the use of mobile equipment, such as cell phones.
Nevertheless, the study of Mijatovic et al. (2013) shows that active participation in class, combined with using an LMS, could be used to make predictions regarding student performance. The advantages of active face-to-face teaching for improving student engagement should definitely not be underestimated. However, the online learning environment can be an esteemed extension of the classical approach. These findings correspond with the research of Ho and Kuo (in Mijatovic et al. 2013), who found that online learning systems have a positive influence on active learning and, therefore, also on the enhancement of student engagement. Ho and Kuo's study magnified the importance of developing new teaching techniques that combine the face-to-face aspect with an online teaching environment.

METHODOLOGY

Research design

The quasi-experimental design was incorporated in this empirical study, and was situated within a quantitative paradigm. This design was used because randomisation was not used to select participants for the study. Quantitative information was collected by means of a questionnaire survey, and supplemented by qualitative observations. The researcher used a survey design in the non-experimental category.
The aim of the survey was to collect information on students' experiences of being subjected to using the LMS, namely Blackboard, during a worldwide pandemic. This information was collected by requesting students to complete a post-course questionnaire. We focused on the pre-post-test design as a form of the quasi-experimental study, without the use of a control group.
The Classroom Survey of Student Engagement (CLASSE), which had been compiled with the help of the Centre of Teaching and Learning at the University of the Free State (UFS), South Africa, has seven open-ended questions. In this study, the qualitative data was only used to enhance the quantitative data.

Population and sampling

This study was conducted with students from the Qwaqwa campus, one of the campuses of the UFS. The participants who were selected were students in one class, of which the researcher was the only lecturer. These students had registered for a biological statistics course that served to provide a foundation in the basic statistics used in the BSc Botany and Life Sciences, BSc Zoology and Life Sciences and BSc Life Sciences degrees. All the students enrolled for the module (n=23) participated in the study. Convenience sampling was applicable as sampling strategy, because the researcher had easy access to all the participants in the class.

Identifying the variables

For the purposes of this study, the use of Blackboard in an ERT environment was the independent variable, while the dependent variable was student engagement, combined with the performance of students in the biostatistics course.

Data collection

Data comprised marks achieved on weekly practicals, tutorials, two assignments, final marks and two tests, namely the pre- and post-tests, the time spent, in hours, on Blackboard, and an overall summary of user activity (hits) inside content areas. As the practicals, tutorials and tests were required from all students, we were able to obtain marks for all of them. Fourteen practicals, 12 tutorials and two assignment tests were completed during the semester. Participants' final Grade 12 mathematics scores and Admission Point (AP) scores were used as the pre-test marks; the post-test marks were students' final scores on the practicals (10% of their final score), tutorials (20% of final score) and two assignment tests (70% of final score).
Furthermore, a questionnaire survey provided information on students' experiences of using Blackboard as an ERT platform.
The intention of the study was to survey, on the basis of a quasi-experimental study, the engagement and performance of students who received all their video lectures via the LMS Blackboard. During the COVID-19 pandemic, all students were required to continue their studies via low-tech online/distance teaching. The institution decided to cancel all face-to-face lessons, thus, the researcher had to move the course from a blended learning environment to an emergency remote online platform, as part of measures to limit the spread of COVID-19 infection.
In addition, video recordings made with the Blackboard Collaborate tool were posted on Blackboard. For each online lecture, a Blackboard Collaborate recording of the PowerPoint presentation was posted, as well as a Blackboard Collaborate recording of Excel-based practical demonstrations that explain all the steps the students have to take to do the various statistical steps in Excel.

Measuring instruments

To establish the effect of ERT via Blackboard on students' learning and performance, quantitative data was collected with instruments created by the researcher (practicals, tutorials, tests and the pre-post-test). A survey (CLASSE) was used to gather information on students' experiences of online learning. The time spent on Blackboard, in hours, by every user was obtained from Blackboard's database, as was user activity inside content areas.

Reliability, validity and objectivity

Valid software was utilised for data analysis, which supported the reliability of the study. Internal validity was established, as only one group engaged in the study. All students did the same practicals, tutorials and tests, on the same online platform, at the same time. Regarding external validity, this research was conducted at only one higher education institution, namely the Qwaqwa campus of the UFS. Quantitative data was not collected at random; therefore, the findings cannot be generalised. Face and content validity were checked by sending practicals, tutorials and assignments to the researcher's colleagues in the department for review.

Ethical considerations

A letter of consent was signed by all the students prior to commencement of the research. All the data was collected upon receiving informed consent. The research ethics committee of the UFS granted ethical clearance before any data was collected. Participant anonymity and confidentiality were ensured in all reporting. Data summaries ensured that no participant could be identified. In all phases of the study, the no-harm principle was followed.

Data analysis

The quantitative data was analysed using Excel. The two-tailed p-value for a paired t-test for the mean differences was used to compare the data collected from the pre-test and post-test for the same group. Descriptive statistics was applied to describe the group's performance in terms of the dependent variables (practical scores, tutorial scores, test scores, pre-post-test scores and hours spent on course content).
Regression analyses were performed to determine whether students' performance on practicals, tutorials, pre-post-test and semester tests was, in any way, related to the amount of time students spent on the course content on Blackboard. Regression analyses were also performed to establish if there was a correlation between students' performance and the overall user activity (hits) inside content areas by each student.
The items of the post-course CLASSE survey were categorised and summarised, using percentages and scoring the Likert scale responses, from 1 to 4. The analysis of the questionnaire was conducted under five sections, namely

- engagement activities
- cognitive skills
- other educational practices
- class atmosphere and
- demographics.

In order to determine if students participated to the degree required by the lecturer, lecturer ratings were compared to the frequency of student response options. Quadrant analysis was used to display the CLASSE data.
The researcher made use of content analysis in order to analyse the open-ended questions' responses, i.e. the researcher identified key concepts in the responses to interpret and understand the raw data.

RESULTS AND DISCUSSION OF THE INVESTIGATION INTO THE APPLICATION OF A LEARNING MANAGEMENT SYSTEM IN HIGHER EDUCATION

Descriptive statistics

Tables 2 and 3 provide information on the comparison between the pre- and post-test scores. In Table 2, the researcher utilised the Grade 12 Mathematics results as the pre-test scores. For the post-test scores the final marks for the module were utilised. In Table 3 the final Grade 12 Mathematics results as pre-test scores were replaced with the students' AP scores as pre-test scores. Paired t-tests were performed to analyse the results.
Table 2: Paired t-test results between pre-test and post-test scores

Significant p-value *** 0.001; ** 0.01; * 0.05

Score	N	Mean	SD	Min	Median	Max	p-value (paired t-test)
Pre-test (AP score)	23	61.9	8.2	44.8	63.3	77.6	0.0245*
Post-test	23	67.7	10.7	43.0	71.0	86.0	

Table 3: Paired t-test results between pre-test and post-test scores

Significant p – value *** 0.001; ** 0.01; * 0.05

Scores	N	Mean	SD	Min	Median	Max	p-value (paired t-test)
Pre-test (Grade 12 marks)	23	55.6	9.58	35	56	77	<0.001***
Post-test	23	67.7	10.7	43.0	71.0	86.0	

A significant difference was exposed by the paired t-tests (Tables 2 and 3). Having taken both the average Grade 12 mathematics results and the standardised AP scores into account, the results indicate that students' final module marks in biostatistics, after they had been taught by ERT interventions on Blackboard, improved significantly. The assumption was that the same mathematics abilities were measured with pre-test Grade 12 mathematics scores and post-test final marks. We also assumed that the students' dedication to academic performance can be measured by the standardised AP score as pre-test, and final marks, as post-test scores.

Statistics of association: Regression analysis

Multiple regression analysis was conducted to determine whether performance was related to students' time spent, in hours, on the content on Blackboard, and to user activity (hits) inside content areas. This analysis could also be seen as an investigation into the relationship between the LMS (interventions on Blackboard) and student engagement (time on task). Thus, the data obtained from the online LMS provided a direct measure of how active, i.e. how engaged, a student was. The multiple regression analysis results are presented in Tables 4 and 5.

Table 4: Multiple regression analysis results of the differences between the pre-post test marks, the average practical marks, the average tutorial marks, the average test marks and the average final marks on time spent, in hours, on the content areas

Dependent variable	Coefficients	Standard error	Multiple R	R Square	p-value
Difference between pre-(Grade 12 marks) and post-test marks	0.1066	0.1207	0.1891	0.0358	0.3874
Difference between pre-(AP score) and post-test marks	-0.0703	0.1439	0.1060	0.0112	0.6304
Average practical marks	0.2553	0.1953	0.2743	0.0753	0.2053
Average tutorial marks	0.1249	0.1588	0.1691	0.0286	0.4404
Average test marks	0.1263	0.1412	0.1915	0.0367	0.3814
Average final marks	0.1385	0.1412	0.2242	0.0502	0.3038

Significant p- value *** 0.001; ** 0.01; * 0.05

Table5: Multiple regression analysis results of the difference between the pre-post-test marks, the average practical marks, the average tutorial marks, the average test marks and the average final marks on overall summary of user activity

Dependent variable	Coefficients	Standard error	Multiple R	R Square	p-value
Difference between pre-(Grade 12 marks) and post-test marks	0.0024	0.0077	0.0673	0.0045	0.7602
Difference between pre-(AP score) and post-test marks	0.0109	0.0088	0.2602	0.0677	0.2305
Average practical marks	0.0157	0.0123	0.2683	0.0720	0.2159
Average tutorial marks	0.0172	0.0094	0.3687	0.1360	0.0834
Average test marks	0.0223	0.0077	0.5359	0.2872	0.0084**
Average final marks	0.0199	0.0073	0.5130	0.2632	0.0123*

Significant p-value *** 0.001; ** 0.01; * 0.05

According to the results indicated in Table 4, time spent, in hours, on the content areas was not a significant indicator of improvement between the pre- and post-test marks and all the assessment marks. Thus, the researcher concludes that time spent, in hours, on the content areas did not have an influence on the students' performance. It can be noted that the

coefficients for all the dependent variables are positive, which indicates positive correlation between course activity in hours and the students' performance, although it cannot be said that it is a significant predictor of student performance.
Regression results of the difference between averages provided in Table 5 indicate that the number of hits (student activity) inside content areas were, once again, not a statistically significant predictor of differences between the pre-post-test marks, practical marks and tutorial marks. However, the number of hits (student activity) relating to the area of content was a statistically significant predictor of the test marks and students' final marks.
According to all these results, the conclusion can be made that, for this study, time spent, in hours, on the content areas did not have an influence on performance and engagement in the biostatistics course. The reason for this finding could be that some students downloaded the content during once-off sessions when they had access to data and a mobile network or when load shedding did not affect the access to material. Thus, they spent time on the content while they are not logged on to Blackboard. Nevertheless, overall summary of user activity (hits) inside content areas of Blackboard did have an influence on performance and engagement of the respondents. Therefore, it is safe to say that students' engagement could be measured and that it is a significant predictor of students' performance.
In Figure 1, a quadrant analysis summarises the CLASSE data. The vertical axis represents the the CLASSELecturer results. Areas valued by the lecturer as either important or very important are reflected by the two upper quadrants. The two lower quadrants reflect areas valued as either somewhat or not important.
The CLASSEStudent average frequency results are displayed on the horizontal axis. Areas that students participated in at above average frequency are presented by the two right-hand quadrants reflect an above-average frequency of participation by students. The two left-hand quadrants reflect a below-average frequency of participation by students.

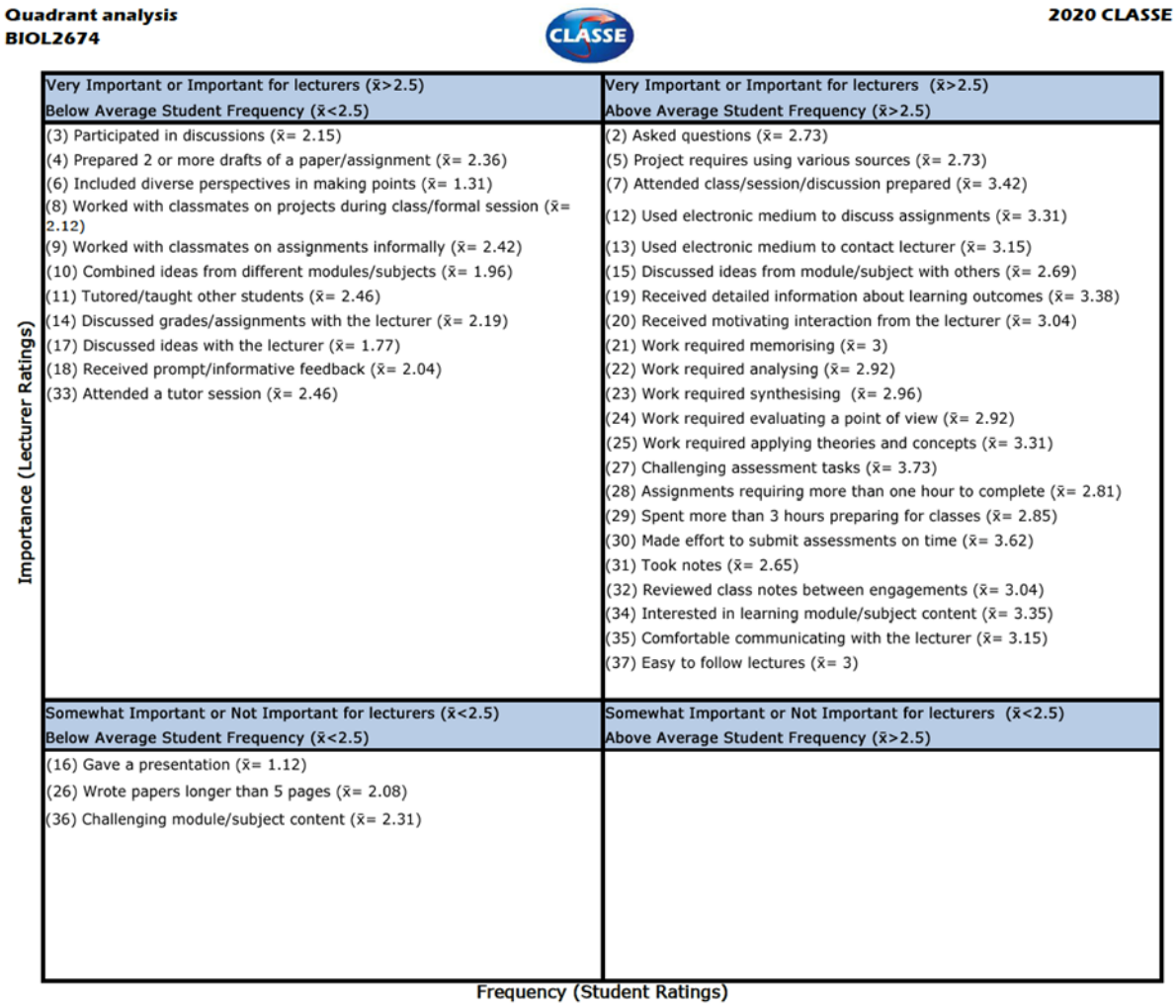

Figure 2: Quadrant analysis

Quadrant 1 of Figure 1 displays items that were rated as important or very important by the lecturer, and that the students rated as occurring with above average frequency. It is evident that cognitive skills were successfully implemented in this ERT course in biostatistics. A large number of students (93%) reported spending time on memorising content and analysing theories or methods, while 95% of students reported spending time on assignment questions and applying methods to practical problems.

Furthermore, 88% of students reported that they perform educational practices often or very often. These activities incorporate assessment tasks, homework assignments, preparation for class sessions and being on time with assessment submissions. Regarding general impressions of the online class atmosphere, 92% of the students were comfortable or very comfortable. Communicating with the lecturer and following the lecturer's instructions were rated as easy or very easy by 69% of the students. To conclude, it is safe to say that ERT was successfully implemented to enhance students' active learning, thus, student performance.

Students reported some engagement activities they were engaged in with above average frequency, as indicated by the responses three to five times, or more than five times. These activities include the asking of questions and the integration of information from various resources. On statements 12, 13 and 15, the majority of students indicated that the use of technology (i.e. Blackboard, WhatsApp, Telegram) in this module enhanced their learning,

and that it motivated them to learn. Seventy-three percent of the students reported that active positive interaction was experienced amongst themselves, the lecturer and classmates.
Although the online learning experiences were experienced positively by most of the students, there were some reports of uneasiness about engagement activities. Quadrant 2 of Figure 1 indicates the learning activities that the lecturer regarded as either important or very important, but that the students participated in at a rate below average. The results indicate that only 18% of the students contributed to class discussions – discussions of assignments, subject content, grades and ideas in this module – with each other or with the lecturer. Only 39% of the students indicated prompt oral or written response from the lecturer on their academic submissions. It is important to note that specific improvements/initiatives need to be incorporated on the Blackboard grading centre, to encourage participation by students, and to improve oral and written feedback, to ensure student engagement in an ERT environment.
The researcher will use the Talk to my Lecturer tool on Blackboard more effectively in the future. The students responded positively to this idea during a follow-up discussion, and it can be recommended as a solution to online communication in a blended learning environment.
Quadrant 3 reports on items that were rated as not important by the lecturer, while students reported that it occurred at below average frequency. Sixty-four percent of the students find the subject content not at all or somewhat challenging, which can be seen as a positive reflection of the degree of understanding of the module content. The items that fall in Quadrant 4 are items that the students reported participating in at above average frequency, while the lecturer valued these activities as only somewhat important, or not important. No items are listed in this quadrant, which confirms a beneficial teaching and learning environment.

QUESTIONNAIRE RESULTS OF THE OPEN-ENDED QUESTIONS

The seven open-ended questions included in the questionnaire are: 1) What challenges, if any, did you experience accessing the online material? 2) Please advise on ways we can improve on the availability of 'low-tech-low-data' online learning material. 3) Please advise on ways we can improve prompt written or oral feedback. 4) What could be done to improve how your lecturer/tutor involves students in this module? 5) What aspects of this module, besides technology, helped you to be a motivated student? 6) What aspects of this module, besides technology, hindered your motivation and learning? 7) Any additional comments about this module?
Results from the first open-ended question indicated that the majority of the students initially experienced technical difficulties accessing the online material. Many of the students were situated at home when they had to interact with the ERT material. Limitations regarding resources, such as the availability of a mobile data network in their area, load shedding, and data costs, hindered many students in their efforts to do active online learning. Although efforts were made to zero-rate Blackboard to limit data costs for students, the researcher had to keep the challenge of access to a network at students' homes, and data costs, in mind while developing the course material.
The students' responses to the second question indicated that some of them were of the opinion that more cost-effective applications, like Telegram and WhatsApp, could be used,

in addition to Blackboard, for sharing materials. The following comments confirm this opinion:

Use fewer paying apps for sharing of materials.
Use different apps applicable for online materials sharing.
Use a cheap network for data supply.
Share smaller files.
Convert files to less holding MBs sizes.
Create apps that charge less data.

The following quotes demonstrate a positive attitude regarding the use of 'low-tech-low-data' online learning material, via Blackboard, in the course:

Nothing has to be changed.
Currently everything is been well, I'm not complaining.

Furthermore, students were asked about ways to improve oral and written feedback. Assessments were graded with the grading tool of Blackboard. Students could see the comments of the lecturer on their assignments, as well as their marks when they logged on to Blackboard Gradebook. Some suggestions given by the respondents are the following:

Make use of Telegram, its ideal for connection.
By writing everything on blackboard.
By writing emails to the students.

Other students responded that they were "satisfied", "Not much improvement is needed I think everything is fine", "No need to change" and "Everything is perfect nothing need to be improved". One of the shortcomings mentioned by the respondents is that the feedback was sometimes not well defined and, when a mark was deducted for an error, no feedback was given at all.

Informative responses were given in response to the fourth open-ended question regarding ways to improve how the lecturer involves students in this module. Some positive comments are listed below:

Nothing much. I think the involvement during the lockdown was okay because all students participated.
I think everything is fine the way it is.
Nothing the lecturer is the best. The tutors were very quiet.
Nothing can be improved so far everything is going well.
Lecturer is good.

On the other hand, suggestions were made on how the lecturer could improve the involvement of students. Many students expressed a need for more communication platforms, like Microsoft Teams, Zoom, or even correspondence by email. One respondent suggested, "make the Q&A periods longer and allowing us as students to ask questions whenever because we didn't always have data on the assigned discussion days". Another respondent suggested, "occasional pop-up tests to ensure everyone understands". The researcher is of the opinion that the discussion board tool on Blackboard can be utilised more effectively to improve communication with students. Because Blackboard is zero-rated, it is data free, which ensures low costs for students. Another improvement could be to have the class sessions live, instead of posting video recordings of all the presentations. Even though many students could not always attend the live session times, due to electricity problems or network outages, it is still an alternative.

The following comments indicate which aspects helped the students to be more motivated students:

The manner in which the lecturer was interacting with us, and making sure that we all understood the content and can be able to apply it in different scenarios.

The effort that the lecturer has on preparing for the lesson using videos, audios and pictures. It really makes me to appreciate the module and work hard also.

One student reported that "the step-by-step analysis of biological data helped me in decision making," and another student said that the module improved "self-time management, to cope with work load, to read and understand without the presence of a lecturer or facilitator".

The main aspects identified as hindering motivation and learning were the lack of networking with fellow students on a face-to-face platform, which was the result of pandemic-related restrictions. The researcher found that most students had a real need for interaction with each other and with the lecturer.

The last qualitative question gave the respondents the opportunity to provide an overall opinion on the module. Some of the respondents expressed that the assignments were challenging, but enjoyable. The following quotes demonstrate positive attitudes regarding the module:

This module is great and I would encourage every student in the Science and Technology faculty to enrol for it, as it enhances your knowledge of analysing different situations, work with statistics.

This is one of the best modules I ever had since I was a student.

LIMITATIONS

The most apparent limitation of the study was that the sample group was small (23 students). The small number of students could affect the outcomes of the statistical analyses. Instead of random sampling, non-probability sampling methods were used, therefore, the results cannot be used to make inferences about the population. Nevertheless, the conclusions drawn should provide a scholarly contribution.

Measuring student engagement according to the number of hits within an LMS does not necessarily measure the quality of engagement, or active learning. However, it can be said that counting hits over a certain time period would be a more reliable indicator than monitoring class attendance.

The downloading of the content during once-off sessions when students had access to data and a mobile network or when load shedding did not affect the access to material and consequently, spending time on the content while they are not logged on to Blackboard can be seen as a limitation factor and could potentially confound the results. The researcher should address the issue of multiple statistical testing (and the potential need to adjust reported p-values) during future in-depth research in order to establish the significance of these patterns.

CONCLUSION

The present study indicates that using an LMS during the COVID-19 pandemic lead to a significant positive correlation between the interactive use of a LMS and the level of engagement with an anticipated outcome. Results indicated a definite positive correlation between number of hits (student activity) on the LMS and students' academic results.

Number of hits could be seen as a measurement of student engagement. A probable reason for the effectiveness of the use of the LMS might be its accessibility – it can be accessed anywhere, anytime. This feature carried a great deal of weight, especially during a national lockdown, where students were expected to continue learning while staying safe during a public health emergency. The results indicate that using an LMS during ERT facilitates student learning, and improves motivation, performance and, ultimately, student engagement. Feedback from students helped to identify strengths and weaknesses, and this information can be used in the future to meet students' needs via ERT.

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CHAPTER 4: CONCLUSION AND RECOMMENDATIONS

4.1 INTRODUCTION

These research studies focussed on student engagement in the field of statistics, and how an OAT and an LMS, such as Blackboard, could be incorporated to enhance student engagement, and consequently, students' performance in statistics.
The purpose of Chapter 1 was to provide a general summary and introduction to the study. Chapter 2 presented the first research article, and Chapter 3 the second research article. This chapter aims to summarise conclusions derived from findings of these studies. Recommendations for future research will also be made.

4.2 CONCLUSIONS OF THE LITERATURE REVIEW

The literature review of both articles is based on the research questions (see Section 1.3):

1. Can student performance be enhanced by the interactive use of an OAT in a blended environment?
2. Is there a correlation between students' interactive use of an LMS and their participation and engagement?

Objective 1, namely, to undertake a literature review to gain insight into ongoing perspectives on the effective use of an OAT and an LMS to enhance student engagement and performance, was achieved by this study (see Chapter 2, Article 1, and Chapter 3, Article 2). The researcher considered it important to determine whether student engagement and performance can be enhanced by an OAT and an LMS, like Blackboard. According to the literature study, we can conclude that online technologies, on their own, do not ensure improvement in student learning; instead, it must be seen as a scaffold to enhance student engagement. A detailed discussion of the potential advantages of using an OAT in a blended environment and an LMS in teaching and learning of statistics were presented in the two articles presented in Chapters 2 and 3 respectively.
According to the literature, the impact of certain interventions at an early stage of students' education can help them to build confidence in their abilities, which, in turn, may improve the motivation of the student. One way to apply these interventions is through online learning in a blended environment (see Chapter 2, Article 1). Consequently, the effectiveness of learning and teaching can be improved by technology. This relation can be due to an increased focus on students and student activity. The online environment can certainly address some of the restrictions faced by traditional contact teaching. Sometimes, the use of technology can increase the workload of both student and teacher, though using technology, nevertheless, still holds many teaching and learning advantages in a blended, online era.
The second application made use of certain LMS tools. The literature suggested many tools that can serve as supportive aids to active teaching and learning, whilst also enhancing student engagement. Chapter 3, Article 2 presented a discussion on LMS tools used in teaching and learning. LMS tools, such as announcements, blogs, course calendar, Blackboard Collaborate, discussion boards, assessment and instructional video clips were but a few of the most popular tools discussed (see Chapter 3, Article 2). The literature review aimed to provide educators with information on the uses of the LMS that proved to be most effective and appropriate for enhancing student engagement.

The results of the empirical investigations will be discussed in Section 4.3.

4.3 CONCLUSIONS OF THE EMPIRICAL INVESTIGATION

The empirical investigation continued to explore the research questions (see Section 1.3). These aims were realised by pursuing Objectives 2 to 4, as stated in Chapter 1 (see Section 1.4).

4.3.1 First objective of the empirical investigation (Objective 2)

The first objective of the empirical investigation involved the overall effect of using an OAT to enhance students' performance and engagement in a statistics course. To accomplish Objective 2, the following procedure was followed and results achieved.
Demographics of the participants were investigated to compare the characteristics of the experimental group and the control group regarding gender and academic programme. The conclusion drawn regarding this study is that gender distribution did not differ significantly between the two groups.
Descriptive statistics were used to compare the academic performance of the mainstream programme students with the extended programme students (see Chapter 2, Article 1), as well as the AP scores of experimental group and control group participants. The results indicate that academic performance of the mainstream programme students and the extended programme students were not significantly different. Therefore, we can assume that participants of both groups had the same level of mathematics ability. Although there was a significant difference between the AP scores of the experimental and control groups, regression analysis was performed to establish whether a relationship between performance and students' AP scores existed. The researcher concludes that the AP scores did not have an influence on the performance of students in the first-year statistics course. Furthermore, descriptive statistics describe the dependent variables (tutorial marks, assignment marks and test marks) (Chapter 2, Article 1). The analysis indicates that the performance on relevant assignment questions of students who had been exposed to certain interventions with an OAT, was better than the performance of students who had not been subjected to these interventions.

4.3.2 Second objective of the empirical investigation (Objective 3)

The second objective relates to quantitative information on the relationship between pre-test scores and post-test scores of students in a biostatistics class. Additionally, the relationship between the amount of time spent by the students on the course content on Blackboard, and students' interactive use of the LMS (number of hits) (see Chapter 3, Article 2) were investigated. During a worldwide pandemic, students' active participation in online teaching material could result in student engagement and achievement.
The researcher used descriptive statistics to provide information on the relationship between pre-test scores and post-test scores. Participants' final Grade 12 mathematics scores and participants' AP scores were considered as the pre-test marks, with the final module marks serving as post-test marks. The average final module marks of students taught by ERT interventions on Blackboard improved significantly from their average final Grade 12 mathematics scores, as well as from their standardised AP scores. The assumption is that the same mathematical abilities are measured by the pre-test Grade 12 mathematics

scores and post-test final marks. We also assume that the students' dedication to academic performance can be measured by the standardised AP scores, which served as pre-test scores, and final marks, as post-test scores.
Furthermore, statistics of association through regression analysis was performed to determine whether performance was related to students' time spent, in hours, on the content on Blackboard, and the user activity (hits) inside content areas of this specific module. The conclusion is that, for this study, time spent, in hours, on the content areas did not have an influence on performance and engagement in the biostatistics course. Nevertheless, overall summary of user activity (hits) inside content areas of Blackboard did find an influence on performance and engagement of the respondents (Chapter 3, Article 2).

4.3.3 Third objective of the empirical investigation (Objective 4)

The third objective was to obtain information regarding students' experiences, attitudes and concerns after they had been exposed to an OAT and Blackboard. To gain information in order to achieve this objective, a post-course questionnaire and interviews, which concentrated on student engagement and on teaching and learning, were completed.
The questionnaire about the OAT intervention consisted of questions that had to be answered with a Likert scale, as well as three open-ended questions (see Chapter 2, Article 1). The open-ended questions provided the students with the opportunity to elaborate on aspects of the module that helped or hindered them in being active, thus, engaged learners. Evaluation of the questionnaire, open-ended questions and interviews lead to the following conclusions:

- Interventions using the OAT resulted in positive and motivated reactions in the respondents.
- The respondents experienced the practical assignments with the adaptive release tool, which included written feedback, as advantageous for active learning.
- The adaptive release tool forced students to increase the time they spent with course material, offered prompt feedback that enhanced active learning, and kept them motivated.
- It became clear that the OAT was effective in improving students' understanding of statistics in the first-semester module.

Although the results indicate that the interventions were assessed positively by most of the students, there were some students who found it time consuming.
In the second study, the analysis of the questionnaire and seven open-ended questions regarding the use of the LMS during the international pandemic (Chapter 3, Article 2) indicates that ERT via Blackboard was successfully implemented to enhance students' active learning, thus, students' performance. Although the online learning experiences were acknowledged to be supportive by most of the students, there were also concerns about engagement activities. There is a need to increase the participation of students and to make oral and written feedback more prominent, to ensure student engagement in an ERT environment.

4.3.4 Final conclusion of the empirical investigations

By exploring Objectives 2, 3 and 4, the researcher concludes that the use of an OAT and an LMS for statistics modules identified a positive relationship between online learning and student engagement; hence, a desirable outcome.

The thought process that underpinned the first study (see Chapter 2, Article 1), focused on the need for students to spend more time practising certain concepts during the course. The more time they spent, the better their performance would be. An OAT could be used to support the students, by delivering assignments online, and thereby providing easier access to the course content. The adaptive release tool used in this study challenged the students to attempt to redo the questions until they submitted the correct answer. The fact that immediate feedback was provided by the tool, motivated students and assisted with higher-order thinking. The researcher concludes that the first null hypothesis (see Section 1.5) can be rejected. There is a difference between the mean performance of students who had been exposed to interventions with an OAT and that of students who had not been exposed to interventions.

Results of the second study (see Chapter 3, Article 2) indicated a significant correlation between number of hits (student activity) on the LMS and their resulting grades. Student activity could be viewed as a measurement of engagement. A probable explanation for the effectiveness of the use of the LMS might be its accessibility, and the way it makes engagement possible anywhere, anytime. This feature meant using an LMS had considerable benefits, especially during the worldwide pandemic.

Following Objective 4, the questionnaire results enabled the researcher to gather information (quantitative and qualitative) on the experiences, attitudes and concerns of students exposed to an OAT in a statistics course and the LMS Blackboard in a biostatistics course. Feedback by students indicated that practising with the OAT was not only popular, but also successful. Using Blackboard to do ERT proved to be a successful platform during the COVID-19 pandemic, which rendered remote learning essential throughout the world in 2020. Therefore, the researcher rejects the second null hypothesis (see Section 5). There is a correlation between students' interactive use of an LMS during a worldwide pandemic, and students' active participation and achievement, or student engagement. These results agreed with the findings of prior research which investigated the influence of LMS on students' performance (Coates 2005; Coates 2007; Martin 2008; Maltby and Mackie 2009; Chen 2010; Chawdhry 2011).

The researcher firmly believes that a LMS facilitates student learning, motivation, performance and, ultimately, student engagement.

4.4 RECOMMENDATIONS

The results of this study indicate a necessity for further research which is indicated by the researcher in the next paragraphs.

An expansion of the first study should diversify demographic information to include course design, number of students per class, student age and student gender. These factors could play a major role on student engagement via an OAT.

Further research is necessary to determine which OAT should be used, and the frequency with which online technology should be applied. More in-depth research that addresses additional OATs, is needed.

ERT is a relative new concept, and further research is needed to investigate the different platforms available to perform this kind of teaching in tertiary education.

4.5 SIGNIFICANCE OF THE STUDY

First, because most universities currently use an LMS of some sort, the significance of the literature review lies in it providing lecturers in higher education with information on how to use an OAT effectively in a blended environment. Choosing the appropriate platform to aid online assessment is important, as is effective utilisation to enhance students' engagement and performance.

Secondly, data regarding student engagement provided by the LMS can be availed to students for motivational and informational purposes. The availability and perusal of this data could be used by students as an inspirational element to frequent technological engagement, ultimately creating better performance. The significance of the empirical study is grounded in the belief that a LMS contributes to the enhancement of student engagement and performance in an ERT environment.

These studies could be functional to other learning programmes on the international education platform. Finally, these studies should have an impact in the field of higher education studies, and serve as a foundation for improving the effectiveness of future scholars in the higher education environment.

4.6 CONCLUSION

In light of the current transition from teaching in a traditional contact environment to an environment where blended online education is prevalent, the current study depicts interesting and important insights on the use of online engagement, as well as the consequential performance profile of students in South Africa.

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Appendix A: Ethical Clearance

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS UV

GENERAL/HUMAN RESEARCH ETHICS COMMITTEE (GHREC)

15-Aug-2019

Dear Mrs Faber, Hendrika HC

Application Approved

Research Project Title:
THE IMPACT OF ONLINE ENGAGEMENT ON THE PERFORMANCE OF STUDENTS IN RURAL SOUTH AFRICA.

Ethical Clearance number:
UFS-HSD2016/1571/1508

We are pleased to inform you that your application for ethical clearance has been approved. Your ethical clearance is valid for twelve (12) months from the date of issue. We request that any changes that may take place during the course of your study/research project be submitted to the ethics office to ensure ethical transparency. furthermore, you are requested to submit the final report of your study/research project to the ethics office. Should you require more time to complete this research, please apply for an extension. Thank you for submitting your proposal for ethical clearance; we wish you the best of luck and success with your research.

Yours sincerely

Digitally signed by Derek Litthauer
Date: 2019.09.06 15:58:01 +02'00'

Prof Derek Litthauer
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Appendix B: Research Study Information Leaflet and Participant Consent Form: Article 1

RESEARCH STUDY INFORMATION LEAFLET AND CONSENT FORM

DATE

15/08/2019

TITLE OF THE RESEARCH PROJECT

THE IMPACT OF AN ONLINE ASSESSMENT TOOL ON THE PERFORMANCE AND ENGAGEMENT OF STUDENTS IN SOUTH AFRICA

PRINCIPLE INVESTIGATOR / RESEARCHER(S) NAME(S) AND CONTACT NUMBER(S):

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FACULTY AND DEPARTMENT:

Faculty of Education
Department of Higher Education studies

STUDYLEADER(S) NAME AND CONTACT NUMBER:

Dr Linda van der Merwe
0514012933
Co-study leader: Johan Coetzee; 0514012395

WHAT IS THE AIM / PURPOSE OF THE STUDY?

Bearing in mind the ultimate goal of the advancement of scholarship of teaching and learning in statistics education, the aim of the study is to investigate the effectiveness of a learning management system on students' performance and engagement.

WHO IS DOING THE RESEARCH?

My name is Christa Faber. I am a Junior Lecturer at Qwa Qwa campus. I am doing this research project as part of my Masters Degree in Higher Education.

HAS THE STUDY RECEIVED ETHICAL APPROVAL?

This study has received approval from the Research Ethics Committee of UFS. A copy of the approval letter can be obtained from the researcher.

Approval number: *UFS-HSD2016/1571/1508*

WHY ARE YOU INVITED TO TAKE PART IN THIS RESEARCH PROJECT?

You are being asked to participate in this study because you are a student on the Qwaqwa campus and your input is important to us..

WHAT IS THE NATURE OF PARTICIPATION IN THIS STUDY?

If you agree to partake in this project one or more of the following procedures will occur: •Lecturers might use your marks and class averages and report on it anonymously. •Lecturers might introduce new teaching or assessment methods in your class and report on it anonymously.

•Lecturers might ask you questions related to teaching and learning, individually or in a group in a written or oral format and report on it anonymously.

CAN THE PARTICIPANT WITHDRAW FROM THE STUDY?

All participation is voluntary and there will be no penalty or loss of benefit for non-participation. Being in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason. The practicals which are forming part of the intervention are not counting towards your final marks. Only the tutorials will, and the tutorials are without any intervention. Consent is restricted to the experimental group. If you choose not to participate in this research, you can choose whether you want to be part of the group with interventions or without interventions.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

The results of this research can be used to improve student support, student life and the quality of teaching and learning within this module. You might also benefit directly from applied teaching and learning interventions.

WHAT IS THE ANTICIPATED INCONVENIENCE OF TAKING PART IN THIS STUDY?

It is not expected that you experience any risks or discomforts. However, participation is completely voluntary and you are allowed to withdraw at any stage during the research process.

WILL WHAT I SAY BE KEPT CONFIDENTIAL?

Your name will not be recorded, anywhere and no one will be able to connect you to the answers you give. Your answers will be given a fictitious code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings. Transcriber/external coder will have access to the data and they will be signing a confidentiality agreement. Your answers may be reviewed by people responsible for making sure that research is done properly, including the transcriber, external coder, and members of the Research Ethics Committee. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records. Your anonymous data may be used for other purposes, e.g. research report, journal articles, conference presentation, etc. Your privacy will be protected in any publication of the information. A report of the study may be submitted for publication, but individual participants will not be identifiable in such a report. While every effort will be made by the researcher to ensure that you will not be connected to the information that you share during the focus group, I cannot guarantee that other participants in the focus group will treat information confidentially. I shall, however, encourage all participants to do so. For this reason, I advise you not to disclose personally sensitive information in the focus group. You can stop being in the study at any time without getting in trouble.

HOW WILL THE INFORMATION BE STORED AND ULTIMATELY DESTROYED?

Electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. It is not expected that you experience any risks or discomforts. However, participation is completely voluntary and you are allowed to withdraw at any stage during the research process.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICPATING IN THIS STUDY?

There will be no costs involved and you will receive no payment as a result of your participation in this study.

HOW WILL THE PARTICIPANT BE INFORMED OF THE FINDINGS / RESULTS OF THE STUDY?

If you would like to be informed of the final research findings, please contact Mrs Christa Faber on 0587185205 or email faberhc@ufs.ac.za. Should you require any further information or want to

contact the researcher about any aspect of this study, please contact Department Mathematics and Applied Mathematics. Email: FaberHC@ufs.ac.za Telephone: 058 718 5205 Office Natural & Agricultural Science Building, 0007. Should you have concerns about the way in which the research has been conducted, you may contact Dr Linda Van Der Merwe, Senior Lecturer: Mathematical Statistics and Actuarial Science on 051 4012933 or email vdMerweL@ufs.ac.za.

Thank you for taking time to read this information sheet and for participating in this study.

CONSENT TO PARTICIPATE IN THIS STUDY

I, _____ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study. I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable). I am aware that the findings of this study will be anonymously processed into a research report, journal publications and/or conference proceedings.

I agree to the recording of the *insert specific data collection method*.

I have received a signed copy of the informed consent agreement.

Full Name of Participant: _____

Student number of Participant: _____

Signature of Participant: _____ Date: _____

Full Name(s) of Researcher(s) _____

Signature of Researcher: _____

Date:_____

Appendix C: Research Study Information Leaflet and Participant Consent Form: Article 2

RESEARCH STUDY INFORMATION LEAFLET AND CONSENT FORM

DATE

01/02/2020

TITLE OF THE RESEARCH PROJECT

THE USE OF A LEARNING MANAGEMENT SYSTEM TO ENHANCE THE PERFORMANCE AND ENGAGEMENT OF STUDENTS IN SOUTH AFRICA.

PRINCIPLE INVESTIGATOR / RESEARCHER(S) NAME(S) AND CONTACT NUMBER(S):

HC Faber *1989247679* *0794909805*

FACULTY AND DEPARTMENT:

Faculty of Education
Department of Higher Education studies

STUDYLEADER(S) NAME AND CONTACT NUMBER:

Dr Linda van der Merwe
0514012933
Co-study leader: Johan Coetzee; 0514012395

WHAT IS THE AIM / PURPOSE OF THE STUDY?

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I have read (or had explained to me) and understood the study as explained in the information sheet. I have had sufficient opportunity to ask questions and am prepared to participate in the study. I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable). I am aware that the findings of this study will be anonymously processed into a research report, journal publications and/or conference proceedings.

I agree to the recording of the *insert specific data collection method*.

I have received a signed copy of the informed consent agreement.

Full Name of Participant: _____

Signature of Participant: _____ Date: _____

Full Name(s) of Researcher(s): _____

Signature of Researcher: _____ Date: _____

Appendix D: CLASSE Survey: Article 1

https://documentcloud.adobe.com/link/review?uri=urn:aaid:scds:US:1a16e71a-4189-462a-8ced-aa91bbc01c74

Appendix E: CLASSE Survey: Article 2

https://documentcloud.adobe.com/link/review?uri=urn:aaid:scds:US:0e7666c6-1774-450e-b362-038986eb3782

Appendix F: Test Questions: Article 1

UNIVERSITY OF THE FREE STATE
Qwa Qwa Campus

EBCS 1524

DEPARTMENT: MATHEMATICAL STATISTICS AND ACTUARIAL SCIENCE

Assessor: Mrs. HC Faber **Moderator: Dr. L. Van der Merwe**

Test 1 **6 September 2019**
Time: 3 hours **Total: 100**

INSTRUCTIONS:

- Show all your steps to find the solution.
- Show all calculations.

1. A market research firm conducted an experiment in an attempt to determine what types of food and drink advertisements on television best hold the attention of students. They observed 15 students:
    - Five during showing of an advertisement featuring breakfast cereal.
    - Five during showing of an advertisement featuring a student meal at a food outlet.
    - Five during showing of an advertisement featuring a well – known fizzy drink.

   All three advertisements were exactly 90 seconds long. The following table gives the duration in time (in seconds) that the students paid attention to the advertisement viewed:

Advertisement	Duration of attention (sec)					$\bar{x}$	S
Cereal	75	37	83	68	75		
Student meal	68	60	45	38	67	55.6	13.4648
Fizzy drink	45	68	60	75	52	60	12.0208

   Assume that the population of duration of attention is normally distributed for all advertisements.

1.1 Briefly explain the difference between a point estimate and an interval estimate.
[2]

1.2 What is the purpose of the confidence level in a confidence interval?
[2]

1.3 What happens to the margin of error of a confidence interval for a population mean if the sample size increased? [2]

1.4 What happens to the margin of error of a confidence interval for a population mean if we lower the confidence level of the interval? [2]

1.5 Name three shape characteristics of the t – distribution. [3]

1.6 Calculate the sample mean of Cereal. [2]

1.7 Calculate the sample variance of Cereals. [3]

1.8 Construct an 80% confidence interval for the average duration of attention of cereals and answer the following questions:

1.8.1 What is the t - critical value of the interval?

1.8.2 What is the standard error of the interval?

1.8.3 What is the marginal error of the interval?

1.8.4 What is the lower limit of the interval?

1.8.5 What is the upper limit of the interval?

1.8.6 Interpret your results. [6]

1.9 Construct a 90% confidence interval for the difference between the two population means of the duration of attention of cereals and student meals and answer the following questions:

1.9.1 What is the critical value of the interval?

1.9.2 What is the pooled sample standard deviation of the interval?

1.9.3 What is the marginal error of the interval?

1.9.4 What is the lower limit of the interval?

1.9.5 What is the upper limit of the interval?

1.9.6 In your opinion, is it possible that there is a difference between the mean duration of attention of cereals and the duration of attention of student meals? Motivate your answer.
[6]

1.10 What do we call the hypothesis test when the alternative hypothesis (H_1) involves the unequal sign$(\neq)$? [2]

1.11 What do we call the value that divides the rejection and non – rejection regions?
[2]

1.12 The research firm claims that the population average of duration of attention of cereals is more than 80 seconds. Is there sufficient evidence to contradict the claim? Test at a 5% level of significance and answer the following questions:

1.12.1 State the null and alternative hypothesis.

1.12.2 Calculate the test statistic.

1.12.2 Make your decision.

1.12.3 Draw a conclusion. [5]

1.13 The market research firm wants to determine if there is a difference between the mean time of an advertisement featuring a student meal at a food outlet and the mean time of an advertisement featuring a well – known fizzy drink. Test at a 1% level of significance whether there is a difference in the population means between student meals and fizzy drinks.

1.13.1 State the null and alternative hypotheses.

1.13.2 Calculate the pooled standard deviation.

1.13.3 Calculate the test statistic.

1.13.4 Make the decision by using a graph.

1.13.5 Draw a conclusion. [5]

1.14

1.14.1 Does the experiment provide sufficient evidence to indicate a difference in the average duration of attention students pay to the three types of advertisements? $\left(H_0: \mu_{cereals} = \mu_{meals} = \mu_{fizzy\ drink}\right)$. Use the 5% significance level to perform the appropriate hypothesis test. [8]

1.14.2 Is it necessary to perform a multiple comparison procedure? Motivate your answer. [2]

1.14.3 We have to compare three treatments using confidence intervals constructed by means of the Roy – Scheffé method as a multiple comparison procedure. How many confidence intervals would we have to construct? [2]

1.14.4 Find $Conf_{1-\alpha}(\mu_{cereals} - \mu_{meals})$. Conclusion. [4]

2. A transport company wants to compare four makes of 3-ton trucks before ordering an entire fleet of one of the makes. Because the purchase price for each of the makes is basically the same, the company is interested in comparing the running cost per kilometer for the makes.
It is known that the way a truck is driven affects the running cost per kilometer. To make provision for this, the company decides to use six drivers to conduct the experiment and randomly assigns trucks to drivers in such a way that each driver has the opportunity to drive each of the trucks. Once the data had been obtained, the following partially completed ANOVA table was constructed:

Source	SS	df	MS	F	F_{tab}
Treatments	271				
Blocks			149		
Error	334				
Total					

Use the 5% significance level where required.

2.1 Complete the ANOVA table. [10]

2.2 Perform the appropriate hypothesis test to determine whether there is a difference in the mean running cost per kilometer for the four makes of trucks. [2]

2.3 Perform the appropriate hypothesis test to determine whether randomly assigning the trucks to the drivers in such a way that each driver drives all the trucks was effective in eliminating variation that might occur as a result of the different driving styles of the drivers. [2]

2.4 Is it necessary to use the multiple comparison procedure to determine where differences occur among the four makes of trucks with respect to their mean running cost per kilometre? Motivate your answer. [2]

3. An auto manufacturing plant plans to institute a new employee incentive plan. To evaluate the new outputs before and after implementation of the new plan the outputs are as follows:

	Employee				
	1	2	3	4	5
Output before	20	17	23	20	21
Output after	23	19	24	23	23

Test at the 5% level of significance whether the new incentive plan results in greater average output. [6]

4. A lecturer conducted a survey in her classes. Out of 100 male students, 20 had at least one pierced ear and out of 90 female students, 47 had at least one pierced ear.

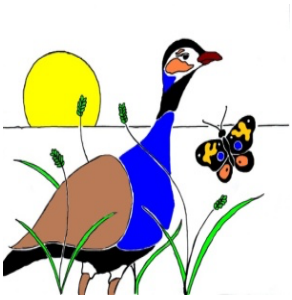
4.1 Construct a 99% confidence interval for the proportion of male students with at least one pierced ear. [4]

4.2 Construct a 90% confidence interval for the difference between the proportion of male and female students with at least one pierced ear. [5]

4.3 She claims that the proportion of male students with at least one pierced ear is 25%. Test the lecturer's claim at a 10% level of significance. [5]

4.4 She claims that the proportion of male students with at least one pierced ear is not as high as the proportion of female students. Test the lecturer's claim at a 5% level of significance. [6]

Appendix G: Test Questions Article 2



UNIVERSITEIT VAN DIE VRYSTAAT

UNIVERSITY OF THE FREE STATE

YUNIVESITHI YA FREISTATA

(Qwa Qwa campus)

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

BIOL 2674: TEST 1 **Total: 90**

JUNE 2020 **Time: 3 hour**

Name: **Student No.:** **Date:**

Question 1 [10]

You want to know whether running 4 times a week causes the resting heart rate to decline. You measure the heart rate of 100 people, and then make them run 20 minutes a day, 4 days a week, for three months. Then you measure their heart rate again.

1.1 State the biological null hypothesis and alternate hypothesis.

1.2 State a statistical null hypothesis and alternate hypothesis.

1.3 Determine which variables are relevant to the question:

1.4 Determine what kind of variable each one is:

_____

_____

1.5 Design an experiment that controls or randomizes the confounding variables.

_____

1.6 State the best statistical test to use._____

1.7 How would you do your data collection?

_____

_____

1.8 What is the statistical population?_____

1.9 Identify the dependent and independent variable.

_____

_____

1.10 What sample size will be sufficient?_____

Question 2 [3]

You do a pilot study on 9 people on range-of-motion of the knee, and the average value for knee flexion is 138 degrees, with a standard deviation of 15.6 degrees and a standard error of the mean of 5.2 degrees. You plan to do a larger study of knee flexion in 900 people. How do you think the standard deviation and standard error of your larger sample will compare to that from your pilot study?

_____

_____

_____

_____

_____

Question 3 [10+4]

More and more households in South Africa are using energy-saving light bulbs. As part of a study to determine the amount of energy that can be saved, 270 bulbs were tested and the number of hours the bulbs lasted was recorded.

3.1 Calculate

a) the range

_____

b) the arithmetic me_____

c) the variance_____

d) the standard deviati_____

e) the median_____

f) the mode_____

g) Standard error_____

h) Geometric mean_____

i) Construct a Histogram of the distribution. [8+4]

3.2 Construct a 95% confidence interval for the population mean number of hours the bulbs will last.

_____ [2]

Question 4 [13+11]

You are planning to study the effect of salt on blood pressure by surveying the amount of salt in people's diets and measuring their blood pressure. Before you start you study, you're worried that high-salt foods may also tend to be high in fat, and that could make the results of your planned study rather ambiguous. To test this, you buy a variety of 42 different foods and measure the salt and fat content of each kind of food.

4.1 Give the sample regression equation and interpret the value of the slope of the regression line. [2+2]

_____

_____

_____

4.2 Use Excel® to develop a graphical summary of the data by constructing a scatter plot and by plotting the regression line on the scatter diagram. [4]

4.3 Do you think that the estimated regression equation developed for these data could be used to determine the percentage of the variation in amount of fat due to change in the amount of salt?
Answer the question by finding and interpreting the value of the coefficient of determination. [2+1]

_____

_____

4.4 Comment on the strength of the relationship between amount of salt and the amount of fat in food. [2+1]

4.5 Test at a 5% level of significance whether there is a significant correlation between amount of salt and the amount of fat in food. Show all the steps. [5+1]

4.6 Predict the amount of fat in food, which have a salt content of 5 grams. [2+2]

4.7 Give the 95% confidence interval for the population slope. [2]

Question 5 [11+8]

You want to know whether taking the supplement resveratrol, a natural substance found in red wine, can increase HDL levels (the "good cholesterol") in the blood. You measure the HDL levels in a group of 34 people, give them all the supplement for twelve weeks, then measure their HDL again.

5.1 Specify the biological question for the above set of data. [2]

5.2 Put question in the form of a statistical null hypothesis and alternate hypothesis. [2]

5.3 Identify the measurement variable(s) and the nominal variable(s). What test will you use? [3]

5.4 Calculate the test statistic and determine whether you would decide to accept or reject the null hypothesis. Explain. [2+**2**]

5.5 Calculate the p-value and determine whether you would decide to accept or reject the null hypothesis. Explain. [2+**2**]

5.6 Show this data in the form of a bar graph. [**4**]

Question 6 [6+8]

The following data is gathered on the body weight of reed warblers that were caught in two different habitats. There are twenty samples of weights in grams gathered from reed swamps and twenty gathered in papyrus swamps.

6.1 We want to know whether reed warblers in papyrus swamps **tend to be heavier** than reed warblers in reed swamps. State the null hypothesis and the alternative hypothesis explicitly. (One-tail test) [2]

_____

_____

_____

6.2 Give the test statistic value and determine whether you would decide to accept or reject the null hypothesis. Give a reason for your answer. [2+2]

_____

_____

6.3 Calculate the p-value and determine whether you would decide to accept or reject the null hypothesis. Give a reason for your answer. [2+2]

_____

_____

_____

6.4 Show this data in the form of a bar graph. [4]

_____

_____

_____

_____

Question 7 [6]

7.1 Explain the concept of standard error of the mean. [2]

_____

_____

_____

7.2 Explain the concept of standard deviation. [2]

_____

_____

_____

7.3 Explain the concept of confidence intervals. [2]

_____

_____

Appendix H: Practical Questions Article 1

BLOCK A

1. Flowers were cultivated by a researcher and yielded the following results: / Blomme word gekweek deur 'n navorser en het die volgende resultate gekry:

120 red flowers with green stamens / 120 rooi blomme met groen meeldrade

48 red flowers with red stamens / 48 rooi blomme met rooi meeldrade

36 yellow flowers with green stamens / 36 geel blomme met groen meeldrade

12 yellow flowers with red stamens / 12 geel blomme met rooi meeldrade

According to a certain theory, the flowers should appear in the proportion 9:3:3:1. Test at a 5% significance level if they did appear in that proportion. / Volgens 'n sekere teorie, moet die blomme verskyn in die verhouding 9:3:3:1. Toets op 'n 5% betekenispeil of hulle wel in daardie verhouding verskyn.

What is the expected frequency of the red flowers with red stamens?

A) 40.5

*B) 50.5

C) 60.5

D) 30.5

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

Mendel crossed peas that were heterozygotes for Smooth/wrinkled, where Smooth is dominant.

The expected ratio in the offspring is 3 Smooth: 1 wrinkled. He observed 423 Smooth and 133 wrinkled.

The expected frequency of Smooth is calculated by multiplying the sample size (556) by the expected proportion (0.75) to yield 417.

The same is done for green to yield 139.

Thus $e_i = np_i$

See Textbook, Chapter 10, pg 352.

2. Flowers were cultivated by a researcher and yielded the following results: / Blomme word gekweek deur 'n navorser en het die volgende resultate gekry:

120 red flowers with green stamens / 120 rooi blomme met groen meeldrade

48 red flowers with red stamens / 48 rooi blomme met rooi meeldrade

36 yellow flowers with green stamens / 36 geel blomme met groen meeldrade

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What is the expected frequency of the red flowers with green stamens?

*A) 121.5

B) 118.5

C) 128.5

D) 132.5

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

Mendel crossed peas that were heterozygotes for Smooth/wrinkled, where Smooth is dominant.

The expected ratio in the offspring is 3 Smooth: 1 wrinkled. He observed 423 Smooth and 133 wrinkled.

The expected frequency of Smooth is calculated by multiplying the sample size (556) by the

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See Textbook, Chapter 10, pg 352.

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48 red flowers with red stamens / 48 rooi blomme met rooi meeldrade

36 yellow flowers with green stamens / 36 geel blomme met groen meeldrade

12 yellow flowers with red stamens / 12 geel blomme met rooi meeldrade

According to a certain theory, the flowers should appear in the proportion 9:3:3:1. Test at a 5% significance level if they did appear in that proportion. / Volgens 'n sekere teorie, moet die blomme verskyn in die verhouding 9:3:3:1. Toets op 'n 5% betekenispeil of hulle wel in daardie verhouding verskyn.

What is the hypothesis?

*A) $H_0 : p_1 = \frac{9}{16}; p_2 = \frac{3}{16}; p_3 = \frac{3}{16}; p_4 = \frac{1}{16}$

B) $H_0 : p_1 = \frac{4}{16}; p_2 = \frac{4}{16}; p_3 = \frac{4}{16}; p_4 = \frac{4}{16}$

C) $H_0 : p_1 = \frac{5}{16}; p_2 = \frac{3}{16}; p_3 = \frac{3}{16}; p_4 = \frac{5}{16}$

D) $H_0 : p_1 = \frac{7}{16}; p_2 = \frac{3}{16}; p_3 = \frac{3}{16}; p_4 = \frac{3}{16}$

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

The statistical null hypothesis is that the number of observations in each category is equal to that predicted by a biological theory, and the alternative hypothesis is that the observed

numbers are different from the expected.

The null hypothesis is usually an extrinsic hypothesis, one for which the expected proportions are determined before doing the experiment.

See Textbook, Chapter 10, pg 352.

BLOCK B

4. Flowers were cultivated by a researcher and yielded the following results: / Blomme word gekweek deur 'n navorser en het die volgende resultate gekry:

120 red flowers with green stamens / 120 rooi blomme met groen meeldrade

48 red flowers with red stamens / 48 rooi blomme met rooi meeldrade

36 yellow flowers with green stamens / 36 geel blomme met groen meeldrade

12 yellow flowers with red stamens / 12 geel blomme met rooi meeldrade

According to a certain theory, the flowers should appear in the proportion 9:3:3:1. Test at a 5% significance level if they did appear in that proportion. / Volgens 'n sekere teorie, moet die blomme verskyn in die verhouding 9:3:3:1. Toets op 'n 5% betekenispeil of hulle wel in daardie verhouding verskyn.

What is the expected frequency of the yellow flowers with green?

A) 36.5

B) 44.5

*C) 40.5

D) 48.5

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

Mendel crossed peas that were heterozygotes for Smooth/wrinkled, where Smooth is dominant.

The expected ratio in the offspring is 3 Smooth: 1 wrinkled. He observed 423 Smooth and 133 wrinkled.

The expected frequency of Smooth is calculated by multiplying the sample size (556) by the expected proportion (0.75) to yield 417.

The same is done for green to yield 139.

Thus $e_i = np_i$

See Textbook, Chapter 10, pg 352.

5. Flowers were cultivated by a researcher and yielded the following results: / Blomme word gekweek deur 'n navorser en het die volgende resultate gekry:

120 red flowers with green stamens / 120 rooi blomme met groen meeldrade

48 red flowers with red stamens / 48 rooi blomme met rooi meeldrade

36 yellow flowers with green stamens / 36 geel blomme met groen meeldrade

12 yellow flowers with red stamens / 12 geel blomme met rooi meeldrade

According to a certain theory, the flowers should appear in the proportion 9:3:3:1. Test at a 5% significance level if they did appear in that proportion. / Volgens 'n sekere teorie, moet die blomme verskyn in die verhouding 9:3:3:1. Toets op 'n 5% betekenispeil of hulle wel in daardie verhouding verskyn.

What is the expected frequency of the yellow flowers with red stamens?

A) 23.5

B) 8.5

C) 18.5

*D) 13.5

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

Mendel crossed peas that were heterozygotes for Smooth/wrinkled, where Smooth is dominant.

The expected ratio in the offspring is 3 Smooth: 1 wrinkled. He observed 423 Smooth and 133 wrinkled.

The expected frequency of Smooth is calculated by multiplying the sample size (556) by the expected proportion (0.75) to yield 417.

The same is done for green to yield 139.

Thus $e_i = np_i$

See Textbook, Chapter 10, pg 352.

BLOCK C

6. Flowers were cultivated by a researcher and yielded the following results: / Blomme word gekweek deur 'n navorser en het die volgende resultate gekry:

120 red flowers with green stamens / 120 rooi blomme met groen meeldrade

48 red flowers with red stamens / 48 rooi blomme met rooi meeldrade

36 yellow flowers with green stamens / 36 geel blomme met groen meeldrade

12 yellow flowers with red stamens / 12 geel blomme met rooi meeldrade

According to a certain theory, the flowers should appear in the proportion 9:3:3:1. Test at a 5% significance level if they did appear in that proportion. / Volgens 'n sekere teorie, moet die blomme verskyn in die verhouding 9:3:3:1. Toets op 'n 5% betekenispeil of hulle wel in daardie verhouding verskyn.

What is the test statistic value?

*A) 2.0741

B) 5.6482

C) 8.2654

D) 12.6534

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

If an experiment with k possible outcomes is repeated n times, then the test statistic for the null hypothesis $H_0 : p_i = p_i^{'}$, $i = 1,2,\ldots,k$ against H_a : not H_0, for significance level α, is

$$\chi^2 = \sum_{i=1}^{k} \frac{(O_i - E_i)^2}{E_i} = \sum_{i=1}^{k} \frac{O_i^2}{E_i} - n, \qquad n = \sum_{i=1}^{k} O_i$$

where O_i is the observed frequency in cell i
E_i is the expected frequency in cell i
k is the number of cells
n is the sum of the frequencies.

We reject H_0 if $\chi^2 > \chi^2_{v;1-\alpha}$, where v = degrees of freedom = $k-1$.

See Textbook, Chapter 10, pg 352.

7. Flowers were cultivated by a researcher and yielded the following results: / Blomme word gekweek deur 'n navorser en het die volgende resultate gekry:

120 red flowers with green stamens / 120 rooi blomme met groen meeldrade

48 red flowers with red stamens / 48 rooi blomme met rooi meeldrade

36 yellow flowers with green stamens / 36 geel blomme met groen meeldrade

12 yellow flowers with red stamens / 12 geel blomme met rooi meeldrade

According to a certain theory, the flowers should appear in the proportion 9:3:3:1. Test at a 5% significance level if they did appear in that proportion. / Volgens 'n sekere teorie, moet die blomme verskyn in die verhouding 9:3:3:1. Toets op 'n 5% betekenispeil of hulle wel in daardie verhouding verskyn.

What is the critical value?

A) 4.65

*B) 7.82

C) 9.56

D) 11.2

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

If an experiment with k possible outcomes is repeated n times, then the test statistic for the null hypothesis $H_0 : p_i = p_i', \quad i = 1,2,\ldots,k$ against H_a : not H_0, for significance level α, is

$$\chi^2 = \sum_{i=1}^{k} \frac{(O_i - E_i)^2}{E_i} = \sum_{i=1}^{k} \frac{O_i^2}{E_i} - n, \qquad n = \sum_{i=1}^{k} O_i$$

where O_i is the observed frequency in cell i
E_i is the expected frequency in cell i
k is the number of cells
n is the sum of the frequencies.

We reject H_0 if $\chi^2 > \chi^2_{\nu;1-\alpha}$, where ν = degrees of freedom = $k-1$.

See Textbook, Chapter 10, pg 352.

BLOCK D

8. Conduct a goodness of fit test at a 1% level of significance to see whether the following sample appears to have been selected from a normal distribution. The sample mean and sample standard deviation are 69 and 17.8237 respectively. / Doen 'n passingsgehalte toets met 'n 1% betekenispeil om te bepaal of die volgende steekproef gekies is uit 'n normaalverdeling. Die steekproefgemiddeld en steekproef standaardafwyking is 69 en 17.8237 respektiewelik:

50	80	90	50	55	90	55	50	70	95
90	60	85	58	60	98	62	80	62	40

Determine the number of intervals.

A) 6

B) 8

C) 5

*D) 4

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

$$\text{Number of intervals} = \frac{n}{5}$$

See Textbook, Chapter 10, pg 363.

9. Conduct a goodness of fit test at a 1% level of significance to see whether the following sample appears to have been selected from a normal distribution. The sample mean and sample standard deviation are 69 and 17.8237 respectively. / Doen 'n passingsgehalte toets met 'n 1% betekenispeil om te bepaal of die volgende steekproef gekies is uit 'n normaalverdeling. Die steekproefgemiddeld en steekproef standaardafwyking is 69 en 17.8237 respektiewelik:

50	80	90	50	55	90	55	50	70	95
90	60	85	58	60	98	62	80	62	40

What is the upper value for the third interval?

A) 84.5689

B) 86.2587

*C) 80.9419

D) 78.5698

Feedback:

If correct:

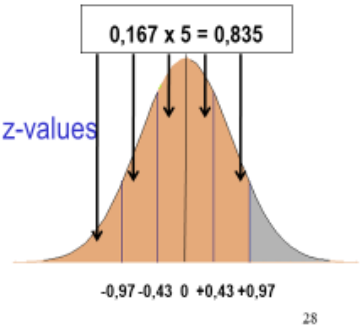
Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

Chi-squared tests

- **Example**
  - Find the z-values:
    - $Z_{0,50} = 0$
    - $Z_{0,668} = 0,43$
    - $Z_{0,835} = 0,97$
    - Because of symmetry the z-values on left side is negative



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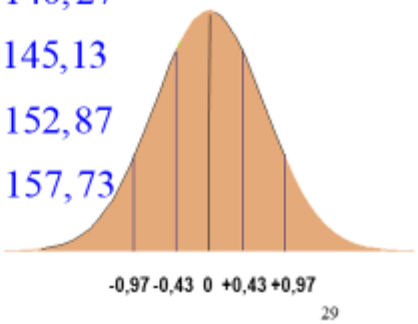
Chi-squared tests

- **Example**
  - Calculate the category boundaries:
  - $\bar{x} = 149$ and $s = 9$
  - $\bar{x} - 0,97s = 149 - 0,97(9) = 140,27$
  - $\bar{x} - 0,43s = 149 - 0,43(9) = 145,13$
  - $\bar{x} + 0,43s = 149 + 0,43(9) = 152,87$
  - $\bar{x} + 0,97s = 149 + 0,97(9) = 157,73$



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See Textbook, Chapter 10, pg 364.

BLOCK E

10. Conduct a goodness of fit test at a 1% level of significance to see whether the following sample appears to have been selected from a normal distribution. The sample mean and sample standard deviation are 69 and 17.8237 respectively. / Doen ‘n passingsgehalte toets met ‘n 1% betekenispeil om te bepaal of die volgende steekproef gekies is uit ‘n normaalverdeling. Die steekproefgemiddeld en steekproef standaardafwyking is 69 en 17.8237 respektiewelik:

50	80	90	50	55	90	55	50	70	95
90	60	85	58	60	98	62	80	62	40

What is the probability for each interval?

*A) 0.25

B) 0.17

C) 0.125

D) 0.1

Feedback:

If correct:

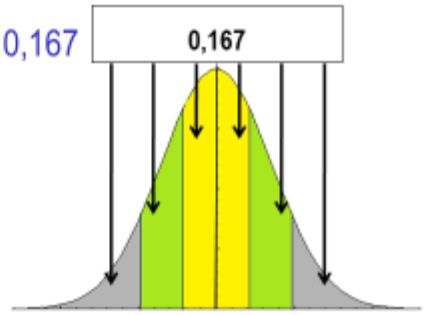
Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

Chi-squared tests

- **Example**
  - Total area under normal curve = 1
  - n/5 = 30/5 = 6 categories
  - Area in each category : 1/6 = 0,167



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See Textbook, Chapter 10, pg 364.

BLOCK F

11. Conduct a goodness of fit test at a 1% level of significance to see whether the following sample appears to have been selected from a normal distribution. The sample mean and sample standard deviation are 69 and 17.8237 respectively. / Doen 'n passingsgehalte toets met 'n 1% betekenispeil om te bepaal of die volgende steekproef gekies is uit 'n normaalverdeling. Die steekproefgemiddeld en steekproef standaardafwyking is 69 en 17.8237 respektiewelik:

50	80	90	50	55	90	55	50	70	95
90	60	85	58	60	98	62	80	62	40

What is the observed frequency of the second interval?

*A) 5

B) 6

C) 7

D) 8

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

The observed frequencies are the number of observations in the sample data that falls into a specific interval.

See Textbook, Chapter 10, pg 365.

12. Conduct a goodness of fit test at a 1% level of significance to see whether the following sample appears to have been selected from a normal distribution. The sample mean and sample standard deviation are 69 and 17.8237 respectively. / Doen 'n passingsgehalte toets met 'n 1% betekenispeil om te bepaal of die volgende steekproef gekies is uit 'n normaalverdeling. Die steekproefgemiddeld en steekproef standaardafwyking is 69 en 17.8237 respektiewelik:

50	80	90	50	55	90	55	50	70	95
90	60	85	58	60	98	62	80	62	40

What is the expected frequency of the third interval?

A) 4.17

*B) 5

C) 2.5

D) 4

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

The expected frequency is always equal to the minimum value that it is allowed to be (5).

See Textbook, Chapter 10, pg 365

BLOCK G

13. Conduct a goodness of fit test at a 1% level of significance to see whether the following sample appears to have been selected from a normal distribution. The sample mean and sample standard deviation are 69 and 17.8237 respectively. / Doen 'n passingsgehalte toets met 'n 1% betekenispeil om te bepaal of die volgende steekproef gekies is uit 'n normaalverdeling. Die steekproefgemiddeld en steekproef standaardafwyking is 69 en 17.8237 respektiewelik:

50	80	90	50	55	90	55	50	70	95
90	60	85	58	60	98	62	80	62	40

What is the degrees of freedom for the critical value of this test?

A) 4

B) 3

C) 2

*D) 1

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

See Textbook, Chapter 10, pg 321.

14. Conduct a goodness of fit test at a 1% level of significance to see whether the following sample appears to have been selected from a normal distribution. The sample mean and sample standard deviation are 69 and 17.8237 respectively. / Doen ‘n passingsgehalte toets met ‘n 1% betekenispeil om te bepaal of die volgende steekproef gekies is uit ‘n normaalverdeling. Die steekproefgemiddeld en steekproef standaardafwyking is 69 en 17.8237 respektiewelik:

50	80	90	50	55	90	55	50	70	95
90	60	85	58	60	98	62	80	62	40

What is the critical value for this test?

A) 9.21

B) 11.34

*C) 6.64

D) 7.78

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

$\chi^2_{k-m-1;1-a}$

k = the number of intervals and m = the number of parameters estimated from the sample data.

See Textbook, Chapter 10, pg 365.

BLOCK H

15. The following table shows the results from a survey to compare the principal water source in three villages in North Africa. The numbers of households using a river, a pond, or a spring are given.

	Village		
Water Source	Avillage	Bevillage	Cevillage
River	30	32	18
Pond	18	20	20
Spring	12	18	10

Test the hypothesis that there is no association between the villages and the number of households using different water sources. $(\alpha = 0.05)$

What is the test statistic value?

*A) 3.11

B) 3.56

C) 2.28

D) 2.66

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

$$\chi^2 = \sum \frac{(f-e)^2}{e}$$

See Textbook, Chapter 10, pg 367.

BLOCK I

16. The following table shows the results from a survey to compare the principal water source in three villages in North Africa. The numbers of households using a river, a pond, or a spring are given.

	Village		
Water Source	Avillage	Bevillage	Cevillage
River	30	32	18
Pond	18	20	20
Spring	12	18	10

Test the hypothesis that there is no association between the villages and the number of households using different water sources. $(\alpha = 0.05)$

What is the expected frequency of the Pond and Bevillage?

*A) 22.8

B) 18.8

C) 28.8

D) 32.8

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

A	B		Total
	B_1	B_2	
A_1	f_{11}	f_{12}	r_1
A_2	f_{21}	f_{22}	r_2
Total	c_1	c_2	n

$$e = \frac{\text{row total} \times \text{column total}}{n}$$

$$e_{11} = (r_1 \times c_1)/n \;;\; e_{12} = (r_1 \times c_2)/n$$

$$e_{21} = (r_2 \times c_1)/n \;;\; e_{22} = (r_2 \times c_2)/n$$

See Textbook, Chapter 10, pg 359.

17. The following table shows the results from a survey to compare the principal water source in three villages in North Africa. The numbers of households using a river, a pond, or a spring are given.

	Village		
Water Source	Avillage	Bevillage	Cevillage
River	30	32	18
Pond	18	20	20
Spring	12	18	10

Test the hypothesis that there is no association between the villages and the number of households using different water sources. $(\alpha = 0.05)$

What is the expected frequency of the River and Avillage?

A) 33

*B) 27

C) 23

D) 20

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

A	B		Total
	B_1	B_2	
A_1	f_{11}	f_{12}	r_1
A_2	f_{21}	f_{22}	r_2
Total	c_1	c_2	n

$$e = \frac{\text{row total} \times \text{column total}}{n}$$

$$e_{11} = (r_1 \times c_1)/n \;;\; e_{12} = (r_1 \times c_2)/n$$

$$e_{21} = (r_2 \times c_1)/n \;;\; e_{22} = (r_2 \times c_2)/n$$

See Textbook, Chapter 10, pg 359.

18. The following table shows the results from a survey to compare the principal water source in three villages in North Africa. The numbers of households using a river, a pond, or a spring are given.

	Village		
Water Source	Avillage	Bevillage	Cevillage
River	30	32	18
Pond	18	20	20
Spring	12	18	10

Test the hypothesis that there is no association between the villages and the number of households using different water sources. $(\alpha = 0.05)$

What is the expected frequency of the Spring and Cevillage?

A) 16.8

B) 14.8

*C) 10.8

D) 8.8

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

A	B		Total
	B_1	B_2	
A_1	f_{11}	f_{12}	r_1
A_2	f_{21}	f_{22}	r_2
Total	c_1	c_2	n

$$e = \frac{\text{row total} \times \text{column total}}{n}$$

$$e_{11} = (r_1 \times c_1)/n \;;\; e_{12} = (r_1 \times c_2)/n$$

$$e_{21} = (r_2 \times c_1)/n \;;\; e_{22} = (r_2 \times c_2)/n$$

See Textbook, Chapter 10, pg 359.

BLOCK J

19. The following table shows the results from a survey to compare the principal water source in three villages in North Africa. The numbers of households using a river, a pond, or a spring are given.

	Village		
Water Source	Avillage	Bevillage	Cevillage
River	30	32	18
Pond	18	20	20
Spring	12	18	10

Test the hypothesis that there is no association between the villages and the number of households using different water sources. $(\alpha = 0.05)$

What is the total of the expected frequencies?

A) 160

B) 190

C) 168

*D) 178

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

A	B		Total
	B_1	B_2	
A_1	f_{11}	f_{12}	r_1
A_2	f_{21}	f_{22}	r_2
Total	c_1	c_2	n

$$e = \frac{\text{row total} \times \text{column total}}{n}$$

$$e_{11} = (r_1 \times c_1)/n \;;\; e_{12} = (r_1 \times c_2)/n$$

$$e_{21} = (r_2 \times c_1)/n \;;\; e_{22} = (r_2 \times c_2)/n$$

See Textbook, Chapter 10, pg 359.

20. The following table shows the results from a survey to compare the principal water source in three villages in North Africa. The numbers of households using a river, a pond, or a spring are given.

	Village		
Water Source	Avillage	Bevillage	Cevillage
River	30	32	18
Pond	18	20	20
Spring	12	18	10

Test the hypothesis that there is no association between the villages and the number of households using different water sources. $(\alpha = 0.05)$

What is the critical value?

A) 3.65

*B) 7.49

C) 7.82

D) 11.92

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

$$X^2 > X^2_{(r-1)(c-1);1-\alpha}$$

See Textbook, Chapter 10, pg 360.

21. The following table shows the results from a survey to compare the principal water source in three villages in North Africa. The numbers of households using a river, a pond, or a spring are given.

	Village		
Water Source	Avillage	Bevillage	Cevillage
River	30	32	18
Pond	18	20	20
Spring	12	18	10

Test the hypothesis that there is no association between the villages and the number of households using different water sources. $(\alpha = 0.05)$

What is the hypothesis?

*A) H_0 : No association between villages and the number of households using different water sources. (indep)

B) H_0 : There is association between villages and the number of households using different water sources. (dep)

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

No association means no relationship, Thus the two variables are independent.

Association means there is a relationship, Thus the two variables are dependent.

See Textbook, Chapter 10, pg 359.

BLOCK K

22. Two different sites near a certain city are being considered as possible locations for natural gas terminal. To get information on public opinion regarding the natural gas project, a separate random sample of individuals in each region is obtained. Each individual is then asked whether he/she favours the building of a natural gas terminal at the proposed location in the region in which the individual resides. The observed cell counts are given in the table: / Twee verskillende streke naby 'n stad word oorweeg as moontlike liggings vir aardgasaanlegte. Om die publiek se mening aangaande hierdie aardgasprojek te toets, is 'n steekproef van individue uit elke omliggende streek geneem en is elke individu gevra of hy/sy die oprig van 'n aardgasaanleg by die voorgestelde ligging in die streek, waar die individu woonagtig is, steun. Die waargenome seltellings word in die tabel gegee:

	REGION / STREEK	
	1	**2**
Favour / Steen	190	140
Oppose/Gekant	200	210

Test at 1% level of significance if the opinion of a natural gas terminal in that region is independent of the two regions. / Toets by 1% betekenispeil of die mening van die oprigting van 'n aardgasaanleg in die streek is onafhanklik van die twee streke.

What is the test statistic value?

*A) 5.394

B) 8.648

C) 10.654

D) 12.654

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

$$\chi^2 = \sum \frac{(f-e)^2}{e}$$

See Textbook, Chapter 10, pg 360.

BLOCK L

23. Two different sites near a certain city are being considered as possible locations for natural gas terminal. To get information on public opinion regarding the natural gas project, a separate random sample of individuals in each region is obtained. Each individual is then asked whether he/she favours the building of a natural gas terminal at the proposed location in the region in which the individual resides. The observed cell counts are given in the table: / Twee verskillende streke naby 'n stad word oorweeg as moontlike liggings vir aardgasaanlegte. Om die publiek se mening aangaande hierdie aardgasprojek te toets, is 'n steekproef van individue uit elke omliggende streek geneem en is elke individu gevra of hy/sy die oprig van 'n aardgasaanleg by die voorgestelde ligging in die streek, waar die individu woonagtig is, steun. Die waargenome seltellings word in die tabel gegee:

	REGION / STREEK	
	1	**2**
Favour / Steen	190	140
Oppose / Gekant	200	210

Test at 1% level of significance if the opinion of a natural gas terminal in that region is independent of the two regions. / Toets by 1% betekenispeil of die mening van die oprigting van 'n aardgasaanleg in die streek is onafhanklik van die twee streke.

What is the value of f_{11} ?

*A) 121.5

B) 118.5

C) 128.5

D) 132.5

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

See Textbook, Chapter 10, pg 358.

24. Two different sites near a certain city are being considered as possible locations for natural gas terminal. To get information on public opinion regarding the natural gas project, a separate random sample of individuals in each region is obtained. Each individual is then asked whether he/she favours the building of a natural gas terminal at the proposed location in the region in which the individual resides. The observed cell counts are given in the table: / Twee verskillende streke naby 'n stad word oorweeg as moontlike liggings vir aardgasaanlegte. Om die publiek se mening aangaande hierdie aardgasprojek te toets, is 'n steekproef van individue uit elke omliggende streek geneem en is elke individu gevra of hy/sy die oprig van 'n aardgasaanleg by die voorgestelde ligging in die streek, waar die individu woonagtig is, steun. Die waargenome seltellings word in die tabel gegee:

	REGION / STREEK	
	1	**2**
Favour / Steen	190	140
Oppose / Gekant	200	210

Test at 1% level of significance if the opinion of a natural gas terminal in that region is independent of the two regions. / Toets by 1% betekenispeil of die mening van die oprigting van 'n aardgasaanleg in die streek is onafhanklik van die twee streke.

What is the value of f_{12}?

A) 40.5

*B) 50.5

C) 60.5

D) 30.5

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

A			Total
	B_1	B_2	
A_1	f_{11}	f_{12}	r_1
A_2	f_{21}	f_{22}	r_2
Total	c_1	c_2	n

See Textbook, Chapter 10, pg 358.

BLOCK M

25. Two different sites near a certain city are being considered as possible locations for natural gas terminal. To get information on public opinion regarding the natural gas project, a separate random sample of individuals in each region is obtained. Each individual is then asked whether he/she favours the building of a natural gas terminal at the proposed location in the region in which the individual resides. The observed cell counts are given in the table: / Twee verskillende streke naby ‘n stad word oorweeg as moontlike liggings vir aardgasaanlegte. Om die publiek se mening aangaande hierdie aardgasprojek te toets, is ‘n steekproef van individue uit elke omliggende streek geneem en is elke individu gevra of

hy/sy die oprig van ‘n aardgasaanleg by die voorgestelde ligging in die streek, waar die individu woonagtig is, steun. Die waargenome seltellings word in die tabel gegee:

	REGION / STREEK	
	1	**2**
Favour / Steen	190	140
Oppose / Gekant	200	210

Test at 1% level of significance if the opinion of a natural gas terminal in that region is independent of the two regions. / Toets by 1% betekenispeil of die mening van die oprigting van ‘n aardgasaanleg in die streek is onafhanklik van die twee streke.

What is the value of r_2 ?

A) 36.5

B) 44.5

*C) 40.5

D) 48.5

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

A	B_1	B_2	Total
A_1	f_{11}	f_{12}	r_1
A_2	f_{21}	f_{22}	r_2
Total	c_1	c_2	n

See Textbook, Chapter 10, pg 358.

26. Two different sites near a certain city are being considered as possible locations for natural gas terminal. To get information on public opinion regarding the natural gas project, a separate random sample of individuals in each region is obtained. Each individual is then asked whether he/she favours the building of a natural gas terminal at the proposed location in the region in which the individual resides. The observed cell counts are given in the table: / Twee verskillende streke naby ‘n stad word oorweeg as moontlike liggings vir aardgasaanlegte. Om die publiek se mening aangaande hierdie aardgasprojek te toets, is ‘n steekproef van individue uit elke omliggende streek geneem en is elke individu gevra of hy/sy die oprig van ‘n aardgasaanleg by die voorgestelde ligging in die streek, waar die individu woonagtig is, steun. Die waargenome seltellings word in die tabel gegee:

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	1	**2**
Favour / Steen	190	140
Oppose / Gekant	200	210

Test at 1% level of significance if the opinion of a natural gas terminal in that region is independent of the two regions. / Toets by 1% betekenispeil of die mening van die oprigting van ‘n aardgasaanleg in die streek is onafhanklik van die twee streke.

What is the value of c_1?

A) 23.5

B) 8.5

C) 18.5

*D) 13.5

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

A	B_1	B_2	Total
A_1	f_{11}	f_{12}	r_1
A_2	f_{21}	f_{22}	r_2
Total	c_1	c_2	n

See Textbook, Chapter 10, pg 358.

BLOCK N

27. Two different sites near a certain city are being considered as possible locations for natural gas terminal. To get information on public opinion regarding the natural gas project, a separate random sample of individuals in each region is obtained. Each individual is then asked whether he/she favours the building of a natural gas terminal at the proposed location in the region in which the individual resides. The observed cell counts are given in the table: / Twee verskillende streke naby 'n stad word oorweeg as moontlike liggings vir aardgasaanlegte. Om die publiek se mening aangaande hierdie aardgasprojek te toets, is 'n steekproef van individue uit elke omliggende streek geneem en is elke individu gevra of hy/sy die oprig van 'n aardgasaanleg by die voorgestelde ligging in die streek, waar die individu woonagtig is, steun. Die waargenome seltellings word in die tabel gegee:

	REGION / STREEK	
	1	**2**
Favour / Steen	190	140
Oppose / Gekant	200	210

Test at 1% level of significance if the opinion of a natural gas terminal in that region is independent of the two regions. / Toets by 1% betekenispeil of die mening van die oprigting van 'n aardgasaanleg in die streek is onafhanklik van die twee streke.

What is the hypothesis?

*A) H_0: Opinion is independent of region.

B) H_0: Opinion is dependent on region.

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

χ^2 test as a *test of independence* for two categorical variables.

For a test of independence, the null and alternative hypotheses follow:

H_0: The two categorical variables are independent (i.e., there is no relationship between them).

H_1: The two categorical variables are dependent (i.e., there is a relationship between them).

Once again, you use Equation (12.1) on page 469 to compute the test statistic:

$$\chi^2_{STAT} = \sum_{\text{all cells}} \frac{(f_o - f_e)^2}{f_e}$$

You reject the null hypothesis at the α level of significance if the computed value of the χ^2_{STAT} test statistic is greater than χ^2_α, the upper-tail critical value from a chi-square distribution with $(r - 1)(c - 1)$ degrees of freedom (see Figure 12.8 on page 482). Thus, the decision rule is

$$\text{Reject } H_0 \text{ if } \chi^2_{STAT} > \chi^2_\alpha;$$

$$\text{otherwise, do not reject } H_0.$$

See Textbook, Chapter 10, pg 360.

BLOCK O

28. Two different sites near a certain city are being considered as possible locations for natural gas terminal. To get information on public opinion regarding the natural gas project, a separate random sample of individuals in each region is obtained. Each individual is then asked whether he/she favours the building of a natural gas terminal at the proposed location in the region in which the individual resides. The observed cell counts are given in the table: / Twee verskillende streke naby 'n stad word oorweeg as moontlike liggings vir aardgasaanlegte. Om die publiek se mening aangaande hierdie aardgasprojek te toets, is 'n steekproef van individue uit elke omliggende streek geneem en is elke individu gevra of hy/sy die oprig van 'n aardgasaanleg by die voorgestelde ligging in die streek, waar die individu woonagtig is, steun. Die waargenome seltellings word in die tabel gegee:

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Test at 1% level of significance if the opinion of a natural gas terminal in that region is independent of the two regions. / Toets by 1% betekenispeil of die mening van die oprigting van 'n aardgasaanleg in die streek is onafhanklik van die twee streke.

What is the critical value?

A) 4.65

*B) 6.64

C) 9.56

D) 11.2

Feedback:

If correct:

Well done! Continue with the next question.

If incorrect:

Your answer is incorrect. Please use the feedback and try again.

$$X^2 > X^2_{(r-1)(c-1);1-\alpha}$$

See Textbook, Chapter 10, pg 360.