Analysing student accesses in a learning management system yields notable insights relating to student success

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ABSTRACT: Student engagement with course content outside of the classroom environment must be encouraged in order to improve student chances of academic success. A learning management system should not be simply viewed as a content dumping site, but rather as a tool to enhance student engagement by means of self-reflection. The purpose of this article is to analyse the accesses of senior engineering students in a learning management system in order to determine any notable insights relating to student success. A time-lag study is used over a five-year period that indicates that self-assessments, practical assignments and the revision accesses could be linked to the academic success of the students. It is recommended that academics make use of all four pillars in their institution's learning management system to encourage self-reflection among their students that may improve their chances of academic success.

INTRODUCTION

Technology is neutral, but it all depends on the way we use it. This statement, by the French musician Jean-Michel Jarre [1], relates to how academics and students use learning management systems (LMS) in higher education. It is true that a LMS can remain neutral if academics and students refrain from accessing and using it on a regular basis.

Many studies have been conducted regarding student access to, and engagement with, a LMS [2]. The majority of these studies indicate a low level of engagement that can be contributed to factors, such as poor course design, lack of attendance and poor information and communication technology (ICT) skills [3]. On the other hand, it is also true that promoting student engagement with the course material outside of the classroom through regular weekly interaction with a LMS can help improve student academic success [4].

Although there are many factors influencing student academic success, the question may be asked: *What notable insights may be discerned from student accesses in a LMS that may relate to their academic success?* The purpose of this article is to analyse the accesses of senior engineering students in a LMS in order to determine any notable insights relating to their academic success as reflected in their final grades.

The importance of self-reflection and student engagement is firstly discussed. Secondly, the study context is presented that focuses on an electronic communication module for senior engineering students. The research methodology is then discussed, whereafter the results and discussion of the results follow. Notable insights are given in the conclusion.

SELF-REFLECTION AND STUDENT ENGAGEMENT

Self-reflection can be defined as a thoughtful and demanding activity that helps learners move from one experience to another, supplemented by a better understanding of each experience, as well as one's attitudes and emotions to affect future actions and thoughts [5]. In the context of this study, reflection is related to the number of times that a student accessed the assessment pillar, where on-line self-assessments and practical assignments had to be completed using the material posted in the content pillar. These assessments were designed to probe student thinking, helping them to either re-inforce or reconstruct their understanding.

The phrase *student engagement* refers to how involved or interested students appear to be in their learning and how connected they are to their classes, their institutions and each other [6]. There are many ways that educational technologies can be used to promote student engagement. For example, a study reported on how students extensively used iPads in a classroom in two foreign language modules at a college in the US [7]. Results of that study showed that students believed that the iPads played an important role in encouraging active learning in the classroom and that it

contributed to their success in the modules [7]. In another study, students used a gamified mobile learning app that received multiple-choice content-based quizzes to help further student learning. The regular use of the app increased both student retention rates and academic performance [8]. A third study found that student engagement with on-line videos and discussion fora that was delivered via a LMS helped to improve student understanding of anatomy, thereby improving their final grades [9]. These three aforementioned studies do suggest that regular access to a technology (such as a LMS) that provides self-assessments or on-line tests can help students to better prepare for their final assessments where they can achieve academic success.

As can be seen in Figure 1, a LMS has four main pillars. The first pillar denotes content and may include electronic documents, e-books, presentations podcasts and videos. All self-assessments or on-line tests along with the practical assignment submissions may be grouped under the assessment pillar. This will also include formative, summative and diagnostic assessments. The third pillar is communication, where all communication-related activities occur, including announcements, blogs, discussion fora, e-mails and Wikis. The administration pillar includes all administration related tools, such as the grade centre, course reports and more. It was from this pillar that the reports were drawn to determine the student accesses to a LMS, called eThuto (built on the Blackboard™ platform), that is used for the module termed, Electronic Communications 4 at the Central University of Technology (CUT) in South Africa.

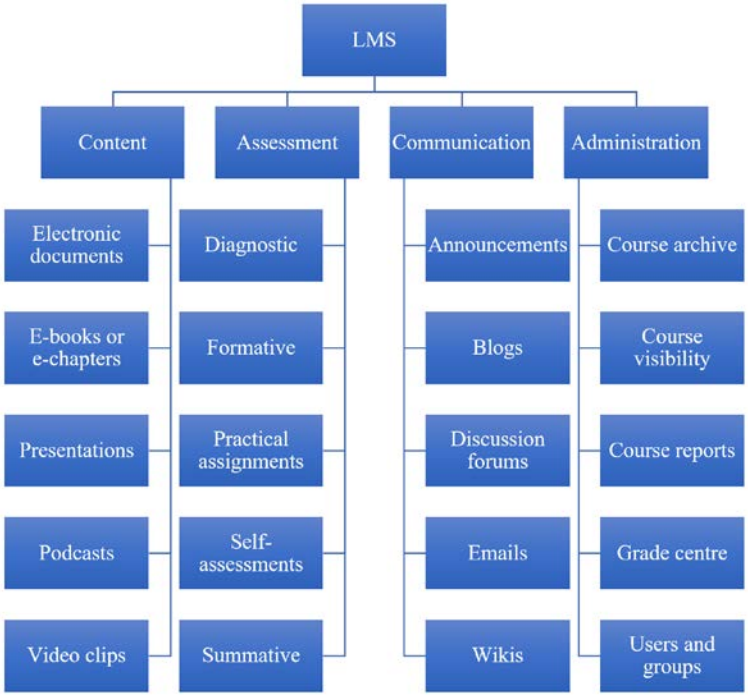


Figure 1: Four pillars of a LMS and its subsequent tools [10].

RESEARCH CONTEXT FOCUSING ON ELECTRONIC COMMUNICATIONS 4

Electronic Communication 4 (EKM4) is an optional offering or module for the Baccalaureus Technologiae (BTech: Engineering: Electrical) qualification in South Africa [11]. Students must obtain a minimum of 120 credits for this qualification (equates to 1,200 notional hours). This is similar to the UK, where the credit system requires 10 hours of learning, being the *universal equivalent* of one credit point. It is different for Europe, where 20 hours of learning is sometimes equated to one credit point [12]. Students must complete seven modules (7 modules x 12 credits = 84 credits) for this qualification (they may choose from a possible 12 available modules) along with a compulsory capstone module (termed Industrial Projects 4 with 36 credits). This qualification can be completed in one year (full-time study), although the majority of students take two years (part-time study).

The CUT operates on a semester basis of roughly 13 weeks (see Table 1), where students attend one classroom session per week (five periods of 45 minutes in duration). Senior engineering students enrolled for this qualification must hold a National Diploma (minimum of three years to complete) in electrical engineering. Many of these senior engineering students have spent a number of years in industry, returning to the university to upgrade their current qualification. Reasons for this include gaining new skills needed for a promotion or new job, to take classes for personal interest or to begin a new career path after the loss of a job [13].

The syllabus of EKM4 is primarily aimed at telecommunication based students, as it focuses mainly on digital communication, where parts of the transmission and reception path are discussed. Mobile antennas, radiation patterns, optic fibre, digital modulation, multiple access and cellular networks form the core syllabus of the module. It is divided into five units, where two main tests are written during the 13-week period. Four on-line self-reflective assessments are also required that involve story telling [14], cloze tests [15] and multiple choice questions. Five practical assignments

linked to the theoretical work must also be submitted on-line via the LMS, where all the practical work is assessed using pre-defined rubrics.

The theory work (see Table 1) contributes 65% to the student's course grade (25% + 40%), while the practical grade contributes 35%. Ten percent of this practical grade is attributed to the on-line self-reflective assessments. This is due to the fact that not all African engineering students are self-directed learners [16], who must therefore be incentivised to complete certain assessments or tasks. Students must obtain a minimum course grade of 40% to be allowed entry into the final summative examination. Fifty percent of the course grade is added to 50% of the examination grade to give the final grade of the student. Senior engineering students must obtain a minimum of 50% for their final grade to successfully complete the module and obtain 12 credits towards the BTech qualification.

Table 1: Course structure for Electronic Communications 4 (EKM4).

Time period	Theory 2 x 90 min/week	Content	Practical 3 x 90 min/week	Weightings
Week 1	Unit 1	Mobile and base station antennas Radiation patterns Specific antenna designs	Assignment 1	5%
Week 2	Unit 1	Friss's Law and the d^{-4} Law Optic fibre design and the power budget	Assignment 2	5%
Week 3	Unit 2	Fourier transforms Fourier series	Assignment 3	5%
Week 4	Unit 2	Filter parameters Channel capacity and S/N		
Week 5	Test 1	Units 1 and 2		25%
Week 6	Unit 3	ASK and FSK digital modulation	Assignment 4	5%
Week 7	Unit 3	PSK and M-ary digital modulation		
Week 8	Unit 4	Switched networks Multiple access (FDMA and TDMA)		
Week 9	University recess			
Week 10	Unit 4 + Unit 5	Cellular network planning Packet radio 2G through 5G systems	Assignment 5	5%
Week 11	Test 2	Units 3 - 5		40%
Week 12	Review	Units 1 - 5 and student support	On-line self-assessments	10%
Week 13	Course grades	Theory and practical weightings add to 100%		50% to final grade
Week 14	Summative final examination	Units 1 - 5	All practical work	50% to final grade

RESEARCH METHODOLOGY

A time-lag study (2014-2018) is used to gather quantitative data for senior engineering students enrolled for a BTech qualification at the Central University of Technology (CUT) in South Africa. This data includes student accesses to the institution's LMS, termed eThuto, built on the Blackboard™ platform, and their final grades awarded at the end of the semester. Time-lag studies usually ask the same questions (or measure the same behaviours) over time [17]. The behaviour relates to student accesses to the four main pillars of the LMS over a five-year period. The number of enrolments is usually lower than 20 per semester, as the CUT only has around 925 post-graduate students [18], being the smallest of all universities of technology in SA.

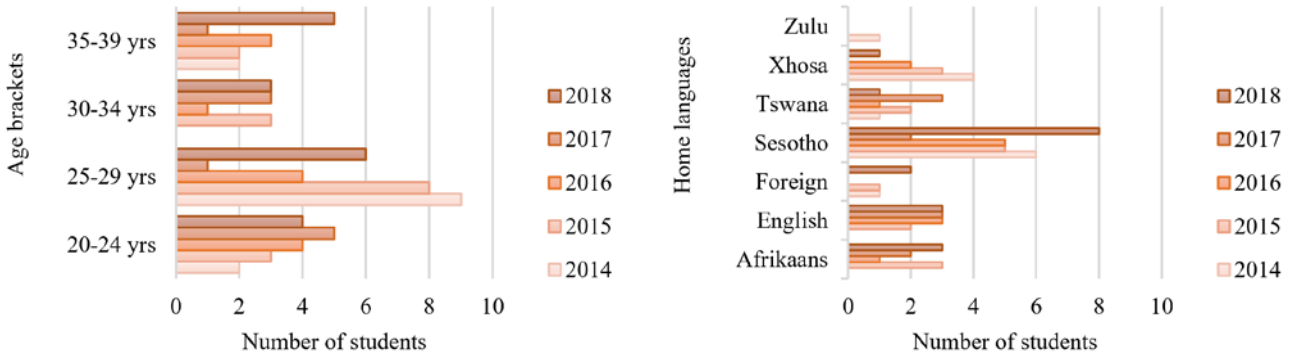
Quantitative data enables identification of patterns of behaviour and factors associated with activity levels of particular groups [19]. The activity levels relate primarily to the final grades of the students in the module, while the patterns of behaviour relate primarily to the number of accesses to the four pillars of the LMS, being content, administration, communication and assessment. These accesses are obtained by running a specific report in the LMS, termed *All User Activity in Content Areas*. This was done at the end of each semester when all students had completed the final summative examination.

The number of student accesses per tool that are embedded into each of the four pillars were correlated to the final grades of the students using the Spearman's rho correlation. If one of the two variables that are considered does not have a normal distribution, then the linear relationship between the order of the variables is evaluated by the Spearman's rho correlation coefficient [20]. In practice, the Spearman's rho correlation uses ordinal variables that do not fit the normal distribution.

Student demography was obtained from one of the on-line self-assessments and is also presented in order to better contextualise the results. Ethical clearance was not required by the University as the data was drawn from the institution's LMS and from the final summative examination papers. No student names or identities are used as the data is anonymous.

RESULTS AND DISCUSSIONS

Figure 2 presents: a) the age brackets; and b) home languages of the senior engineering students enrolled for EKM4 over the five-year period. This forms part of student demography that indicates that the majority of students are older than 25 years of age, being classified as senior engineering students. This view is similar to that of McLennan who defines a mature or senior student as someone older than 25 years of age studying at tertiary level [21]. The dominant home language is Sesotho, which forms part of the 11 official languages of SA [22]. This suggests that the students are from the local communities around the CUT that is located in Bloemfontein, the provincial capital of the Free State Province. Males still dominate this engineering module, which has been noted as a concern in engineering for many years [23]. The total number of males equals 53 while only 16 females. This equates to a gender ratio of 3.3 to 1.



a) b)

Figure 2: Student demography: a) age brackets shown on the left; and b) home languages shown on the right.

Figure 3 highlights the fact that the final grades of the students in the summative examination at the end of the semester does not follow a normal distribution. In fact, a large number of outliers exist between 0 and 30 that can also impact on a Pearson correlation. Screening for outliers should be performed prior to analysis, since outliers can affect the size of the correlation, and thus distort the results [24]. This is an added reason for using a Spearman's rho correlation as it is a nonparametric test, where the data outliers do not affect the results [25].

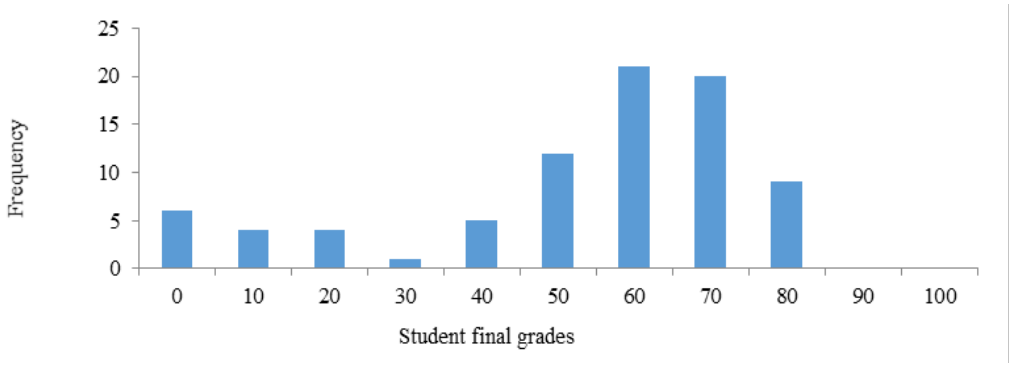


Figure 3. Final grade distributions for the summative examination at the end of the semester.

Table 2 shows the results of the Spearman's rho correlation between the number of student accesses per tool and the final grades that students achieved at the end of the semester. A moderate significant relationship was obtained for revision ($r_s = 0.423$, $n = 80$, $p < 0.001$) and for the self-assessments ($r_s = 0.419$, $n = 80$, $p < 0.001$) that were uploaded to the LMS. Both these tools form part of the Assessment pillar in the LMS that contributed to the course mark of the students (see Table 1). A weak significant relationship was also found between the students accesses for the practical assignments ($r_s = 0.339$, $n = 80$, $p < 0.005$) that were posted on the LMS and the final grades of the students awarded at the end of the semester. No other statistically significant relationships exist.

Senior students would have reflected on the course contents, when completing the four on-line self-reflective assessments. These self-assessments were released every two weeks and were designed to promote student engagement with the course content outside of the classroom environment [4]. These students would also have submitted their practical assignments on-line. This would have required them to download the practical template, complete it by filling in the necessary information, and then upload it again to the LMS. In the process, they would have reflected on the rubric available in the LMS for each assignment in order to determine if they had covered all the requirements.

Table 3 shows the percentage of student's access per tool over the five-year period. These percentages are calculated by dividing the number of accesses per tool to the sum of all the accesses for a given calendar year. Unit 1 (18% average) and Unit 2 (13% average) had the highest number of accesses indicating that the students repeatedly accessed and likely downloaded the content from these units more than that of other units. This may suggest that some students are not downloading the course material to their electronic devices, but are repeatedly returning to the LMS to review it [10].

However, students cannot obtain academic success by solely accessing or logging into, a LMS a number of times. It is rather what students do with the content that they download that will determine their academic success. This includes using the content to complete practical assignments and on-line self-assessments [26] that have a bearing on the final grades of students, as shown in Table 2.

Table 2: Spearman's rho correlations between student final grades and their LMS accesses over a five-year period.

Introduction	Revision	Practical assignments	Self-assessment	Student support	Study guide	Unit 1 - Antenna	Unit 2 - Spectrum	Unit 3 - Mod	Unit 4 - Access	Unit 5 - Cellular	Total
0.046	0.423	0.339	0.419	0.265	0.144	0.080	-0.065	0.001	0.186	0.137	0.204
80	80	80	80	80	80	80	80	80	80	80	80
0.680	0.000	0.002	0.000	0.016	0.198	0.473	0.564	0.995	0.095	0.219	0.065

Table 3. Percentage of student accesses per tool for each calendar year.

Pillar	LMS section	2014	2015	2016	2017	2018	Average	Total
Comms	Introduction	1%	1%	1%	1%	1%	1%	5%
Comms	Annoucements	3%	3%	2%	4%	6%	3%	
Admin	Grade centre	5%	10%	12%	11%	16%	11%	11%
Assess	Practical	2%	10%	13%	8%	9%	8%	25%
Assess	Reflections	4%	8%	8%	7%	10%	8%	
Assess	Revision	11%	9%	12%	6%	6%	9%	
Content	Student support	3%	3%	2%	2%	2%	2%	59%
Content	Study guide	3%	4%	3%	4%	3%	3%	
Content	Unit 1 - Antenna	21%	17%	16%	19%	18%	18%	
Content	Unit 2 - Spectrum	16%	12%	10%	15%	13%	13%	
Content	Unit 3 - Mod	15%	8%	5%	5%	4%	8%	
Content	Unit 4 - Access	11%	10%	12%	11%	10%	11%	
Content	Unit 5 - Cellular	4%	5%	3%	6%	3%	4%	

It is also noteworthy that the total accesses (shown on the right hand side) are divided among the four pillars, with content obtaining 59% and assessments 25%. This equates to a ratio of around 2.3:1, which is also evident between assessments and admin and between admin and communications. This suggests that the academic is not solely using the LMS as a content dumping site, but is actively trying to use all four pillars of the LMS in order to promote student engagement with the course content outside of the classroom environment.

CONCLUSIONS

The purpose of this article was to analyse the accesses of senior engineering students in a LMS in order to determine any notable insights relating to student success. The research question was posed: *What notable insights may be discerned from student accesses in a LMS that may relate to their academic success?*

A moderate significant relationship was found for revision ($r_s = 0.423$, $n = 80$, $p < 0.001$) and for the Self-assessments ($r_s = 0.419$, $n = 80$, $p < 0.001$) that were uploaded to the LMS. Furthermore a weak significant relationship was also found between the students accesses for the practical assignments ($r_s = 0.339$, $n = 80$, $p < 0.005$) and the final grades of the students. No other statistically significant relationships could be found.

These results suggest that the assessment pillar has been well used by the academic to further engage students with the course content ahead of the final summative examination. In fact, for every two accesses to the content pillar, students recorded one access to the assessment pillar (ratio of 2.3:1) that influences their final grades. This notable insight should move more academics to make use of a similar ratio between the content and assessment pillars in their institution's LMS, as it does impact on student success.

A limiting factor to this study was that it was done for only one module in engineering education. Results for other modules using this same pedagogy in using all four pillars in a LMS may result in similar levels of correlation between student access and final grades.

From this study, it can be derived that it is not only the availability or the access to educational technologies that will lead to academic success, but more importantly how students use the technologies to stay engaged. Regularly analysing the reports obtained from a LMS can indeed provide notable insights into the use of the LMS by both the academic and student. These insights can reveal if students are engaging with all four pillars of the LMS that can indeed lead to student success.

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