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Final Pass Rate Fluctuations of Power Engineering Students May Be Related to Load Shedding, and not Load Shifting

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Abstract
Power engineering students need to register for and successfully complete a capstone module within the Baccalaureus Technologiae qualification in Electrical Engineering in South Africa. These students need to submit six different assignments over a period of 10 months, comprising a proposal, a progress report, a poster, a power point presentation, a conference paper and a final report. However, it has been observed that the final grades of working students have fluctuated dramatically over the past three years, leading to the following research question "What may be contributing to these fluctuations?" The purpose of this paper is to discuss the fluctuations and provide possible reasons for them based on literature applicable to this field. An exploratory case study is used to provide quantitative data of the student final grades from 2014 – 2016. Results show that the pass rate varied from 71% to 77% to 56%. Furthermore, some 18 students submitted their proposal in 2016, but never submitted the other five assignments. This concern may be related to load shedding by both students and academics, rather than load shifting. A key recommendation of this research is to share its findings with top management of student employers and the university, thereby hoping to create awareness of the importance of lightening the workloads of employed students and academics during important submission periods of capstone modules.

Keywords: capstone, technology, workloads, working students.

Introduction

"Success is no accident. It is hard work, perseverance, learning, studying, sacrifice and most of all, love of what you are doing or learning to do" (Brainy Quote, 2017). These words, by the well-known Brazilian athlete Pele, well emphasise that success in life does not come automatically. This especially holds true for students in Higher Education, who have to put forth much hard work and perseverance to complete

their studies, often sacrificing time from other endeavours. However, ever-changing personal circumstances of both students and academics may result in the wrong sacrifices being made.

Load shedding may be seen as a sacrifice, where power from one area is turned-off (or sacrificed) to keep the power in another area on. Load shedding is defined as a coordinated sets of controls that decrease the electric load in one part of the system to restore the overall system back to its normal operating condition (Mageshvaran et al., 2015). This instantaneous removal of power from the system therefore helps to keep the remaining section of the system operational (Lim et al., 2011). Applying this same principle to students in higher education means that some students prioritize their responsibilities of working and studying in a way that their studies are turn-off, so as to keep their work on. In other words, their studies are often sacrificed in behalf of other responsibilities. This is in contrast to load shifting, which is defined as the process of shifting loads from peak periods to off-peak periods (Hamidi et al., 2012). Some students are just not afforded the opportunity to shift their responsibilities around, as they are kept engaged by other commitments. For example, when they may need to study at night (off-peak period) they may be called to work to care for an emergency. In such cases, load shedding rather than load shifting occurs. Research has shown that students who study and work at the same time (often called working students) is a phenomenon that entails risks and may be detrimental to the quality of education, as it often prolongs the period of study, preventing students from finishing their qualification in a timely manner (Chavdarova, 2006; Radojković & Milojević, 2016). This usually has a harmful effect on academic performance (Davletov & Bishkek, 2014; Swart, 2016).

These same principles may be applied to academics. Academics may be given such a high workload, that they may sacrifice the quality of their feedback to students in order to just get through the amount of work which they have. They are thus shedding quality, and not shifting their responsibilities around, so as to maintain the standard of education (or the normal operation of the system). Research has shown that, in general, the main problems students report on with regard to academic feedback, is not on the amount they receive, but rather on its timeliness and perceived relevance (Cann, 2014). As academic workloads increase, these issues worsen, and the quality deteriorates.

It was observed, in a power engineering module, termed Industrial Projects IV (IP4), that the final grades of working students have fluctuated dramatically over the past three years, leading to the following research question "What may be contributing to these fluctuations?" The purpose of this paper is to discuss the fluctuations and provide possible reasons for them based on literature applicable to this field. An exploratory study is used to provide quantitative data of the student final grades from 2014 through 2016. Plausible reasons for such fluctuations are firstly presented based on published literature. The context of the study is then presented along with the research methodology. Results and discussions then follow.

Possible reasons for pass rate fluctuations deduced from existing literature

A number of plausible reasons may be deduced from the literature for the abnormal fluctuations in the success rates of working students in the same module over a period of time. These may include unsympathetic employers, demanding work responsibilities, or changing family circumstances. However, it must be noted that students who work and study at the same time demonstrate a desire to take charge of their careers (Supangco, 2014). This is excellent, as a higher degree may lead to promotional opportunities at work and subsequently to a higher quality of life, both for the student and for his or her family. In fact, research shows that individuals who obtain a higher degree have between a 28% and 40% higher chance of becoming managers (Georgellis & Sankae, 2016), as compared to those who do not obtain a higher degree. Furthermore, students who work and study simultaneously are able to relate all their learning assignments to their work, while the employer can develop its business and processes by applying the state-of-the art theoretical knowledge acquired by the student (Mikkelsen et al., 2015).

However, there are challenges that exist for those who work and study at the same time. Students are of the opinion that working and studying at the same time can be difficult (Kori et al., 2016) with many reporting that they feel very tired from doing this (Ahmed et al., 2015). This is especially so when the employer is unsympathetic to the student's academic career. Feelings of frustration with non-performing colleagues, anger about irate customers and interaction with unsympathetic managers are all contributing factors that cause emotion in the workplace (Jonker & Van der Merwe, 2013). These unhealthy emotions may, in turn, lead to higher levels of stress or anxiety, reduced performance and low feelings of self-esteem or efficacy. Dealing with unsympathetic managers or employers who place excessive demands on employee time can cause working students to sacrifice their study time, in order to maintain a reasonable working relationship with their supervisors.

Work responsibilities have also increased over the past decade, which is largely attributed to the advances in technology. Mobile technology has enabled managers and clients to contact staff at all times so that work responsibilities are extended to the home, during holidays and even during sleep time (Rubery, 2015). Working students are therefore not really cut-off from their employers, who may demand more time from them at various times of the week, no matter where they are.

Family circumstances may also change rapidly, affecting both the emotional and physical stability of working students. Relevant changes of family circumstances include marriage, divorce, the death of a love one, the death of relatives and the birth of children (Gill & Allatt, 2011). All these aspects may cause more stress or anxiety to the working student, who then loses focus on his or her academic studies. This is understandable, as family is often perceived to be more important than work (Gill & Allatt, 2011), not to mention academic studies.

These external factors relating to family and work responsibilities have been shown to influence student persistence, especially among at-risk and minority populations

(Kruse, 2013). Furthermore, for non-traditional learners to be successful students they must have the availability of time to engage in academic studies after family and work responsibilities have been satisfied (Campbell, 2015). However, if family and work responsibilities are taking all the time, then nothing is left for the academic studies, which have in effect been sacrificed. Load shedding of academic studies has occurred.

Depending on the number of hours worked, working and studying at the same time has mixed effects on student's achievement at higher educational institutions (Lee et al., 2013). However, this is also applicable to academics in higher education. Massive expansion has resulted in class sizes ballooning, academics being overloaded, resources declining, teaching activities being trimmed and facilities deteriorating—all leading to the perfect storm for a quality crisis (Teferra, 2015). Quality education includes all the processes, procedures, and programmes drafted by institutions to fulfil the demands of the stakeholders (Deshpande, 2015). This includes effective academic feedback to students who have submitted assignments or completed assessments. This may suffer when academic workloads increase due to more student enrolments or due to the resignation of fellow academics from the faculty.

In the last 10–20 years, academic workloads have become increasingly demanding and complex in the UK and North America, with Australia being no exception (Hemer, 2014). This is the case in many countries, where the current "normal" workload is so heavy that academics can only complete all their teaching, research and administration duties by working beyond the contracted number of working hours—at night, during the weekend and even when on holiday (Hemer, 2014). Performing at this level over an extended period of time may prove exhausting and stressful. In this way, academic load shedding may occur, as academics seek to sacrifice various aspects of teaching just to be able to complete the assigned work (keep the rest of the system afloat).

Study context

IP4 is a compulsory capstone module in the Baccalaureus Technologiae: Engineering: Electrical qualification (better known as the BTech). The course structure (highlighting six different submission requirements) used by the Electrical, Electronic and Computer Engineering Department at the Central University of Technology (CUT) for this module is shown in Table 1, which must be completed over a 10-month period (registration is completed in February with the final summative report submitted in October). The Department's objective is to provide quality education to students with regard to both electronic and power engineering, where the principles and application of electricity, electronics, electrostatics and electromagnetism are discussed (Hertzog & Swart, 2015). No formal electrical or electronic based circuits are required from these students who often work on high voltage systems (up to 132 kV). Their final report or dissertation is usually based on a real life case study which was identified in industry.

The purpose of the project proposal is to identify the topic, formulate the problem and present the time frame for completing the study. It must include numerous sketches with two highlighted areas in the sketch which are discussed in the text. Students often struggle to formulate the problem, or to engage with problem-based learning (Swart & Toolo, 2015). The exact phrase "The problem is…" is often missing from the proposal and is very difficult to discern from the text provided by the student. Students also struggle to follow the correct referencing style, and often just copy and paste from the Internet. Here the academic needs to intervene and provide effective feedback to address these concerns.

The purpose of the progress report is to rectify any concerns from the project proposal, requiring students to act on the comments and feedback given by the academic (Swart & Hertzog, 2017). It must also include three possible solutions to the identified problem in the progress report, again presenting numerous highlighted sketches to support their solutions. Students often struggle to explain their solutions in text format, and usually just provide a number of sketches which have not been highlighted or explained in the text. This is to be commented on by the academic when giving written feedback to the students.

Table 1 - Industrial Projects 4 (IP4) structure

Requirement	Assignment	Due period	Weight
Project proposal (formative)	1	End April	10%
Progress report (formative)	2	End July	10%
Conference paper or article (summative)	3	Mid-August	5%
Poster presentation (summative)	4	End August	5%
Oral defense or colloquium (summative)	5	Mid-Sept.	10%
Final written report (summative)	6	End October	60%
		TOTAL	100%

The purpose of the conference article or paper is to create awareness among students about the importance of publishing their research results. The official IEEE template is prescribed where students need to focus on their results and preferred solution (recall they suggested three possible solutions in the progress report) (Swart & Hertzog, 2016). Students often struggle to keep to the page limit, while failing to provide an adequate introduction and conclusion to their paper. These deficiencies must be noted by the academic in the written feedback.

The purpose of the poster is to create awareness among the students of its required structure, which should focus primarily on the preferred solution, having as little text as possible (Swart & Hertzog, 2017). It must include the title of the project, problem statement and student particulars. All sketches in the poster must feature at least three highlighted sections, and have a concise meaningful caption or label attached to it. Students often struggle to get the right balance between text and sketches, with many inserting lengthy paragraphs and many references. Feedback comments from the academic should focus on these concerns.

The purpose of the oral defense is to afford students the opportunity to engage with peer assessment, as their peers form the audience. Students need to compile a power point presentation highlighting their problem statement, three possible solutions and preferred solution, drawing on simulated results to substantiate their preferred solution (Swart & Hertzog, 2016). This furthermore helps to prepare students for conference presentations, which follows the same format and often includes questions from the audience. Students often struggle to effectively articulate the problem and preferred solution, with many students simply reading each slide word for word. This is often commented on by the academic who is present to assess the presentation.

The purpose of the final report is to draw all the previous assignments together, where the student should have acted on a number of written feedback concerns. This final report usually follows the structure of a dissertation or thesis required for postgraduate degrees. Students often struggle to be consistent in the use of fonts, spacing and terms, especially in the front and back matter. 40% of the final report is awarded to these two sections of the report (declaration, expression of thanks, abstract, table of contents, references and annexures) (Swart & Toolo, 2015). This is the only assignment where the students will not view the feedback from the academic, as it is a summative assessment. However, the academic needs to include comments on these reports, as they will be made available for scrutiny to the Engineering Council of South Africa (ECSA), when they do their accreditation visits. ECSA representatives will want to see why a certain grade was awarded, and that the academics actually assessed each section of the final report.

Research methodology

An exploratory case study is used in this study as it describes fluctuating student pass rates over a three-year period, where no clear explanation of the causes may be identified. Yin (2009) describes three types of case studies, being exploratory (examines a situation where an intervention produces no single clear result), descriptive (describes a situation within a real life context) and multiple case studies (discover the differences between and within cases).

Quantitative data is used to highlight the pass rates of power engineering students over a three-year period (2014 - 2016). These results cover the six individual assignments listed in Table 1, as well as the final pass rates of the students in the module, IP4. The target population is restricted to all the students (n = 243) enrolled in this module for the three-year period, thereby negating the use of a sampling technique. More than 95% of the target population are working students.

Quantitative data also includes the number of academics that were involved for the three-year period, so as to indicate any possible academic workload increase during this time period. The number of students who only submitted their proposal is contrasted to the students who submitted all their assignments (see Table 1), so as to

indicate the fluctuating submissions which may have been caused by a change in the circumstances of these students.

Results and discussions

Figure 1 highlights the percentage of students who were assigned to different academics for the three-year period. In 2014, three academics where involved with IP4, with each mentoring around 30 students (equals around 33% of the 98 registered students). In 2015, two academic staff members were involved with IP4, where each mentored around 40 students (approximately 50% of the 81 registered students). Then in 2016, only one academic was assigned to IP4 who had to mentor 64 registered students. This indicates a drastic shift in workload, as that one academic still had the original workload of the previous two years. That one academic in 2016 had to, in effect, do the work of the two academics of 2015 or of the three academics of 2014. It must be noted that this one academic has been involved with IP4 for more than 5 consecutive years, and is thus well-equipped to deal with the module's content. However, to mentor 64 students on your own and then also complete all your other responsibilities may well prove challenging and overwhelming. Effective academic feedback may also have suffered during the 2016 period.

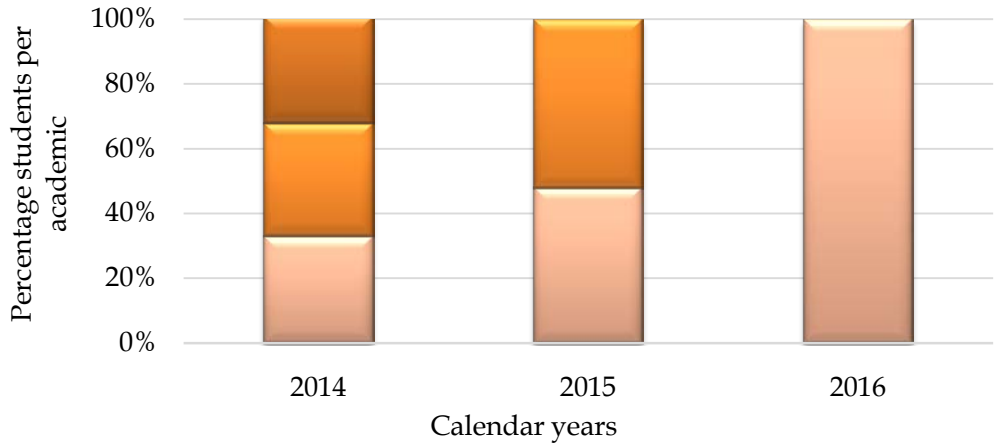

Figure 1 - Percentage of students assigned to different academics over the 3-year period

Figure 2 presents the pass rates of the 243 students for the three-year period, when considering the six assignments outlined in Table 1. It is evident in 2014 and 2015, that the overall pass rate (right-hand side) was relatively high (71% and 77% respectively). The majority of students consistently handed in their six assignments, with an upward trend in 2015 for the final report (highest weighting towards the final mark). However, this trend is not observed for 2016, where a significant decline in the submissions after the progress report is evident (100% submitting the proposal and only 55% the progress report). 2016 had an all-time low pass rate for the three-year period of only 56%.

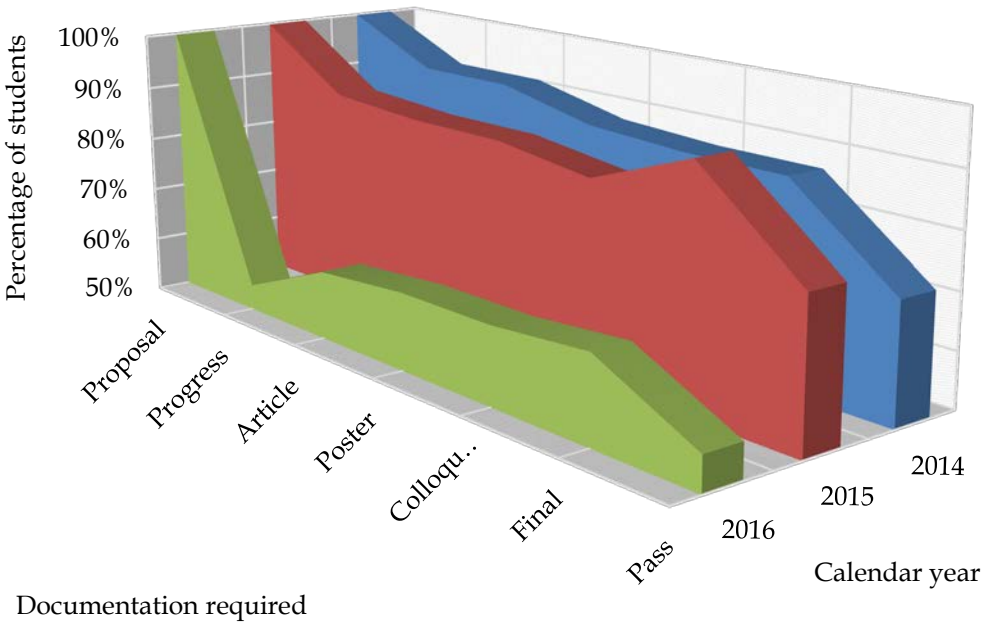

Figure 2 - Percentage of students submitting the required documentation for the three calendar years

Figure 3 portrays the breakdown of the six assignments (see Table 1) according to three criteria. First, students only submitting a proposal was found to be 7% and 6% in 2014 and 2015 respectively. However, in 2016 (outer circle), it jumped to 28%. This means that 18 students registered and submitted their proposal, and then disappeared. A drastic change in the personal circumstances (family or work) of these students may have contributed to this phenomenon. One such drastic change may be an increase in their work responsibilities (as they are studying and working at the same time), thereby preventing them from dedicating time to their studies. In 2016, only 48% of all the registered students submitted all six assignments.

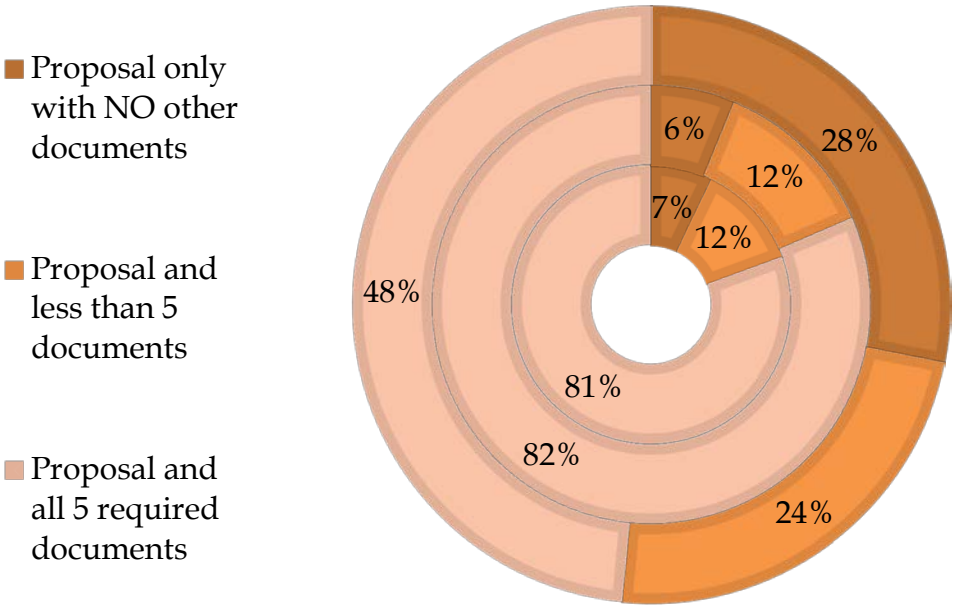

Figure 3 - Percentage of students submitting the proposal for different conditions for 2014 (inner circle), 2015 (middle circle) and 2016 (outer circle)

Conclusion

The purpose of this paper was to discuss the fluctuations of final grades of working students in a compulsory capstone module, termed IP4, and to provide possible reasons for these fluctuations based on literature applicable to this field. Results show that the pass rate for IP4 varied from 71% to 77% to 56% over the three-year period. Three academics mentored 98 students in 2014, while only one academic mentored 64 students in 2016. Furthermore, in 2016, 18 students (28% of all registered students) only submitted their proposal, while never completing the other five assignments.

This concern may be related to the load shedding of both students and academics, rather than load shifting. Load shedding is seen in that other responsibilities of both the students and academic may have taken precedence over the six assignments required in IP4, thereby effectively sacrificing IP4 to keep their other responsibilities intact. These other responsibilities may be linked to changing family circumstances or demanding work responsibilities.

A comparison of student numbers registered for a capstone module at a University of Technology has been given, along with the number of students that completed the module. The numbers are only given for a 3-year period, which does make it difficult to draw inferential conclusions. However, it must be noted that this is an exploratory case study, where no clear explanation of the causes exists. Case studies may also be used to set the stage for future research (Yin, 2013). There are indeed many variables, or contributing factors, to student performance that have not been explored in this paper. However, its purpose was to present plausible reasons from published literature for significant pass rate fluctuations for working students.

Research on additional contributing factors to working student success rates will add to this study. For example, these working students may be interviewed to obtain their perceptions on the study-work relationship. Furthermore, the 18 students who only submitted the proposal could be contacted in an effort to try and understand why they never submitted the other five assignments. Finally, the academics who mentored the students may be interviewed to determine their perceptions of why the abnormal pass rate fluctuation exists. A key recommendation of this research is to make top management of student employers and of universities aware of the importance of lightening the workloads of students and academics during important time periods stipulated in compulsory capstone modules (for this study, it is July through October according to Table 1).

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