

# Full Paper

## Introduction

Tertiary institutions have always been influenced by two significant factors: the growing number of students; as well as the growing capacity of other competing institutions. For an institution to be financially viable, the student retention plays a substantial role. The degree of student attrition and the decision by students to leave the university before successful completion of a degree program is subject to a wide range of elements, either independent or in combination. Reasons such as personal or academic difficulties, wrong choice of program and loss of interest due to dissatisfaction with the university experience are amongst many that may cause attrition. For each of these reasons, there are well researched remedial strategies (refer to Glesmann (2014) for further references); however the difference between two institutions, or even two cohorts in a particular institution, requires scrutiny of the effectiveness of any remedial action.

This study aims to investigate the academic aspects of students' hardships, by which the success or failure of students in achieving reasonable grades is considered. To perform the research, different cohorts of students were examined with the assumption that the conclusions achieved from the study of previous student cohorts can be used for future ones. The focus, here, is to identify at-risk students by observing the characteristics of the measures used to evaluate the student success. Offering assistance to such at-risk students by the educator or student advisor may result in less attrition as well as better quality skilful graduates.

## Study Background

Students' learning styles are affected by a number of elements, such as their perception of learning and their motives toward performing the studies, as well as their overall emotional feeling (Chan & Bauer, 2014). Bloom (1967; cited in Chan & Bauer, 2014) stated that students' prior experiences and characteristics such as intelligence, self-conception and previous achievements, influence the outcome of their learning. That is, having strong enthusiasm and confidence, achieved from past success, makes new learning less of an obstacle. This eventually results in deeper learning as well as higher grades (Chan & Bauer, 2014). Such a success is strongly bound with personal attitudes. These attitudes are influenced by factors such as age, gender, ethnicity, past GPA, goal setting, personal mindset, parental status, socio-economic status and many others (Duarte, Ramos-Pires, & Gonçalves, 2014; Hale, 1998; Shaeri, Guan, & Howell, 2014; Whannell & Whannell, 2014). Hassanbeigi et al. (2011) also surveyed a large cohort in an attempt to find the common necessary study skills which are essential for the academic success. Their list includes: "time management and procrastination, concentration and memory, study aids and note taking, test strategies and test anxiety, organising and processing information, motivation and attitude, and reading and selecting the main idea". Including all such aspects in a study to find important characteristics is particularly demanding, but necessary. Moreover, the teacher should investigate the interdependency of such characteristics to be able to make a rational decision. However, the research question here examines which of the identified factors is of the most importance in order to recognise if a student is considered "at-risk" (Chan & Bauer, 2014).

From one aspect, the success of an institution in reaching its goal is achieved through identifying at-risk students as early as possible during a semester. This provides enough time to conduct a remediation procedure to help the students (Buckner, Dietrich, Merriman, & Keeley, 2013; Glesmann, 2014). From the other aspect, it is very common for students to dislike to be labelled as "at-risk". Therefore, there is a tendency not to seek assistance and respond to communications with regard to the provision of remedial actions. This is often

due, in many cases, to students feeling uncomfortable or even not considering themselves as being in-need of assistance (Glesmann, 2014). Therefore, all the institutional efforts should be focused on proactively identifying such at-risk students as early as possible and encouraging the students to follow the recommended remedial procedures. To create a trustworthy environment for students to approach the educator, advisor or counsellor, there needs to be a number of factors such as clear demonstration of academic expectations, provision of timely and constructive feedback on assessment tasks, demonstration of unconditional availability of the staff for assistance and the like (Glesmann, 2014). In comparison to other studies (Hale, 1998; Pepe, 2012; Whannell & Whannell, 2014) which consider the final grade as an indicator of the level of student success, this study focuses on the details of students' marks throughout a semester. Chan and Bauer (2014) concluded that unsuccessful, at-risk students possess a set of characteristics (such as negative approach towards learning, weak or absent goal orientation and learning strategy) which are reflected in their intermediate marks (see also Tulbure, 2012). Tait and Entwistle (1996) also believed that these cumulative assessments are the best predictor of end-of-year grades. These details could be the marks for early assignment tasks, mid-semester exam and any other intermediate activities (such as class attendance records or summative assessments). It is believed that such details can be a strong indicator of the progress of the students in their learning journey towards the end of the course. Moreover, Tait and Entwistle (1996) acknowledged that controlling and monitoring the grades is a staff-demanding activity when the size of the class is large. Beside, academics are often of the opinion that students of a tertiary course must personally possess adequate skills in line with their needs. However, from the students' perspective, they often argue that the guidance from academics is inadequate and they demand more in-depth explanation of the required skills or the ways to acquire them (Tait & Entwistle, 1996). For example, report writing or working on assignments are amongst the most essential skills, which are not necessarily easy to digest and implement by all students at the same time. Therefore, appropriate guidance, leadership and academic assistance provided by teachers and advisors could greatly reduce student anxiety and difficulties.

## Method

In order to identify common characteristics of at-risk students through their academic performance at the School of Engineering, Griffith University, six cohorts of students from two similar courses (in regard to their math intensity, conceptual level of complexity, types of assessments, overall teaching and learning techniques, and the like) were selected. A total of 1468 students were investigated, of which approximately 90% were enrolled in a Bachelor of Engineering program, 7% were enrolled in double degree programs which included a Bachelor of Engineering, and the remaining 3% were enrolled in a variety of programs which had no connection with engineering. The latter sub-cohort is deemed important to include and examine possible pitfall for the students in choosing the courses as either compulsory or elective. Three of the cohorts were selected from the first-year Engineering Mechanics (EM) course, offered in the second semesters of 2012, 2013 and 2014 with 263, 310 and 258 students, respectively. The majority of students (about 400) from these three cohorts also attended the second-year Fluid Mechanics and Hydraulic (FM) course, offered in the first semesters of 2013, 2014 and 2015 with 157, 237 and 243 students, respectively. As a convention for this article, for instance, EM-2012 means the students of the Engineering Mechanics (EM) course in 2012. Accordingly, for example, the majority of the students of EM-2012 later attended FM-2013; i.e. two consecutive semesters. Meanwhile, there were 69 students who repeated either of the courses once. By comparing the details of the summative marks, it was clear to the authors how successful or unsuccessful each individual student had been. Nevertheless, for ethical reasons, in preparation of this paper, all the students' names were removed and the database was shuffled to maintain individual student anonymity.

The available data used for this study, included summative marks for a number of elements: assignments, laboratory reports, mid-semester exams and final exams. For simplicity of performing the statistical analyses, as well as comparability of the courses, all the marks of different assignments and laboratory reports were collated and named “assignment mark”. In this way, for each of the courses in each of the nominated years, there were four sets of summative marks to conduct the analyses: an assignment mark; a mid-semester exam mark; a final exam mark; and a total mark (which hereinafter, a grade may interchangeably be used occasionally). All these categories of marks are presented as a percentage of the maximum possible mark within that category. Moreover, the students’ grades are also presented as ‘7’ (for total marks  $\geq 85\%$ ), ‘6’ (75-85%), ‘5’ (65-75%), ‘4’ (50-65%) and less than 4 (<50%). Using SPSS Ver. 22, the inter-relation between the marks for the assignments, mid-semester exams, final exams and total marks for each semester and each course were statistically tested (without reference to an individual student’s performance) to find possible relationships or trends between elements of a course (for instance between final exam mark and total mark for EM-2012). Additionally, similar individual marks (for instance final exam mark for each of the courses) were statistically tested to explore possible relationship or dependency between the two courses.

## Results and Discussion

Simple descriptive statistics of all the total marks for all the six cohorts illustrated that the maximum score was about 93 (out of 100), the minimum slightly less than 22, the average between 57 and 67 and the standard deviation between 13.5 and 18.3. Considering the cross-dependency of marks, on average the students attained better total marks from FM compared to EM. This is evident as the average of FM total marks is 65.7% compared with 60.6% for EM total marks. Figure 1 shows the distribution of the final grades across the courses and years. Almost similar distributions are seen for both courses and all the years (except for EM-2012). Furthermore, the pass rates (successful completion) for all the cohorts were between 70 and 89% with an average of 83%.

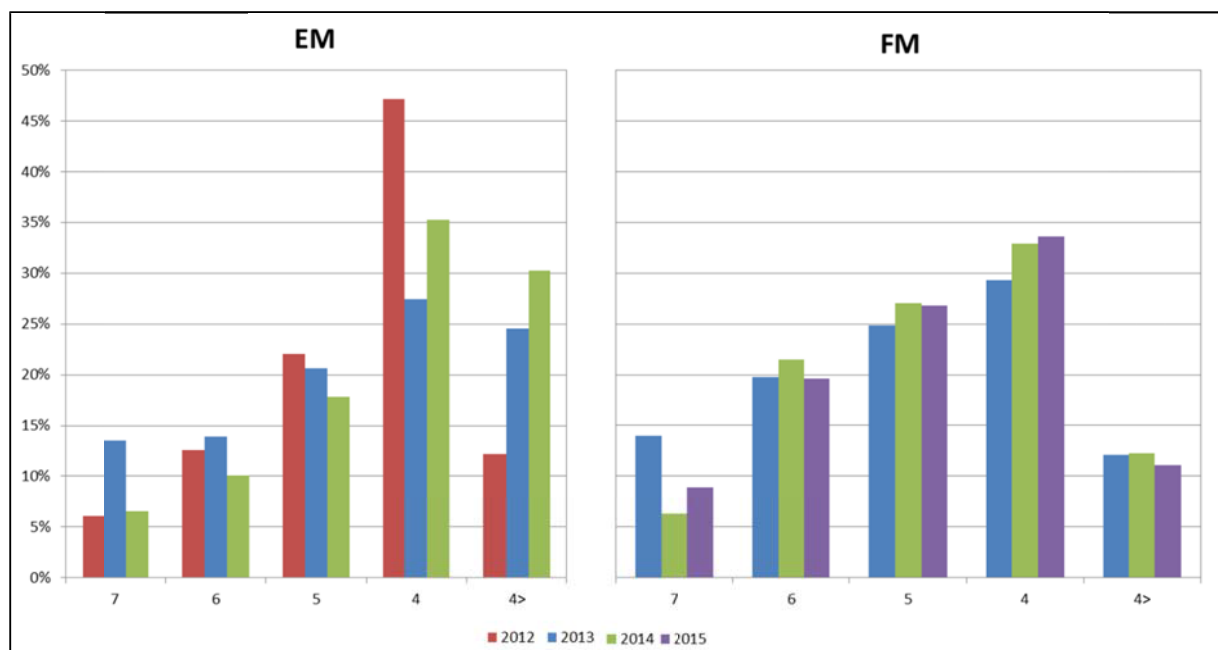


Figure 1: Distribution of the final grades across the courses for different years

Statistical analysis showed that, regardless of the year, overall there is a strong relationship (Pearson correlation=0.874,  $P < 0.0001$ , 99% confidence) between the final exam marks and the total marks (if Pearson correlation equals one, then this considered to be the strongest

correlation). The relationship between the mid-semester exam marks and the total marks (Pearson correlation=0.712,  $P<0.0001$ ) is relatively strong as well. However, there is a medial relationship between the assignment marks and the total marks (Pearson correlation=0.585,  $P<0.0001$ ). Further considering individual courses in each of the studied years, the Pearson correlation factors between the final exam marks and the total marks (compare with 0.874 above) lie between 0.918 and 0.934 or three cohorts of EM, and between 0.905 and 0.913 for three cohorts of FM respectively. These slight gains of correlation could be due to the effect of a higher weighting assigned to the final exams compared to other elements. However, such high correlations still indicate that the majority of the students gained their success (i.e. in passing the courses) from the effort they provided for the final exam and it could be equivocally inferred that overall, they prepared less assiduously for the intermediate assessment tasks.

The correlation coefficient (if equals one, then this considered to be the strongest correlation) between EM-2012 and FM-2013 is approximately 0.52; between EM-2013 and FM-2014 is approximately 0.65; and between EM-2014 and FM-2015 is approximately 0.68 ( $P<0.001$ ). These correlation coefficients between EM and FM marks demonstrate a moderate relationship between two courses while the standard errors for these calculations were around 8 mark units. Furthermore, the Chi square value (the higher, the better) between EM-2012 and FM-2013 is about 56; between EM-2013 and FM-2014 is about 77; and between EM-2014 and FM-2015 is about 66 ( $P<0.001$ ). These Chi square comparisons also show a moderate relationship between the two courses, although each set of comparisons consist of almost a same cohort.

Another useful parameter considered to evaluate the students' performance was the difference between the total marks in both courses for each individual student. Figure 2 is a bar chart showing the difference between the marks for an individual student which was achieved in any of these three pairs: EM-2012 and FM-2013, EM-2013 and FM-2014, or EM-2014 and FM-2015. The students which did not have both consecutive marks (e.g. EM-2012 and FM-2013) are not included in this graph. As can be seen, the differences were most frequently (on average in 30% of the cases) between -10 and zero (as EM has lower marks on average). Put simply, a difference of zero mark units means that an individual student did not exhibit a significant change in his/her approach between different semesters, and a difference of 10 mark units indicates a noticeable increase for the FM total mark compared to the EM total mark for an individual student.

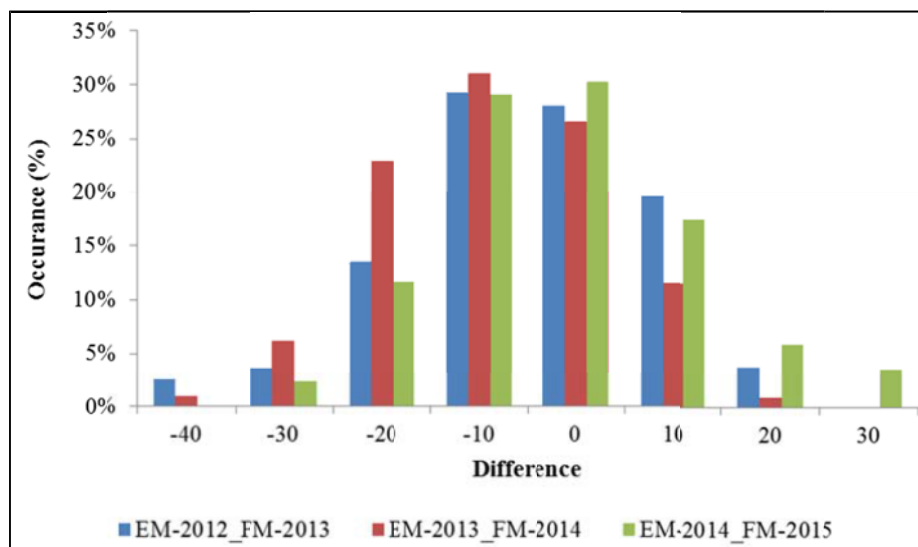


Figure 2: Difference of the individual student's marks between different courses considering different years

Pepe (2012) noted the same pattern and explained that “either the students do not have effective study skills, or they have bad study habits” which shows an approximately unchanged grade throughout their program. On the other hand, apart from the influence of varying number of students, the slight increase of the average of the FM total mark compared to the EM total mark could be the effect of maturity in attending the university and conducting the required tasks. The EM students were generally participating in their second semester (first year), while the FM students were involved in their third semester (second year). Considering the sole effect of students study style in their achievements, it may be inferred that the second year FM students had a stronger reason for success and were more determined in their goal setting in pursuit of their degree, along with already being more mature aged.

Apart from these reasonably strong relationships illustrated by the total marks, in view of the elements of the total mark, there are rather moderate dependencies between the courses offered in different years. The Pearson correlation coefficients (for instance between EM- 2012 and EM-2013, FM-2013 and FM-2014, and the like, and 6 in total, with  $p < 0.001$ ) were between 0.5 and 0.6 for the final exam marks; between 0.4 and 0.6 for the mid- semester exam marks; and between 0.35 and 0.65 for the assignment marks. This could be attributed to the influence of different distribution methods of weighting coefficients for the three elements of the total mark between different years of offering the course. However, performing corresponding paired T-tests (e.g. between mid-semester exam mark for EM- 2012 and FM-2013), all the results for all of the possible tests (nine in total) were found to be statistically significant ( $P < 0.001$ ); with the average of the paired differences lying between the -6.5 and 8.4 mark units, and the standard deviations between 3 and 14 mark units.

As a result, considering an individual student who is not included in the database for this research, these ranges of parameters, statistical relationships and correlational dependencies could be used by instructors or student advisors (within the statistical applicability range) as indicators of the proper or improper study approach of that individual student. They may also be able to identify whether he/she needs assistance in preparation of (for instance) an assignment, taking the mid-semester exam, or even overall preparation for the final exam. However, these conclusions, in no way, can predetermine or predict the marks that students can achieve. This would solely be the start point for the instructor or the student advisor to offer, guide or lead to a particular source or method of one-on-one or institution-wide assistance, before being too late by the end of the semester.

## Conclusion

The purpose of this retrospective study was to find the correlational dependency between the elements of the total mark for an individual student, as well as a comparison between different years of his/her study in two core engineering courses, to be used as indicators of proper or improper selected study approach for future students. The statistical analyses (by comparing the figures weightlessly) showed that there is a stronger relationship (with a high correlation coefficient) between the total mark and final exam mark than the relationship between the total mark and mid-semester exam or the assignment marks. Likewise, quasi-strong relationships were found between the marks across different years, which were an indication that the students' learning style was not changed significantly on average between each of the two consecutive semesters. This was backed by the fact that the difference between comparable elements of summative marks was almost  $\pm 10$  mark units. The elements of the marks were also found to be statistically and significantly paired-wise related in each of the courses and years. This showed that (for instance) an individual student may always have issues regarding the preparation or delivering of one of the assessment tasks, and this was found to be persistent throughout the study period. Thus, this indicates how possibly (based on statistical signposts described in this article) the educators or student advisors can identify and approach at-risk students (during the course of the semester and before it becomes too late) to provide the required assistance; such as tips on time management, note taking, breaking a task to smaller pieces and the like.

The conclusion made out of this study and the statement mentioned here are bounded to the number of students' data which were investigated at Griffith University. There might be possible variation in different contexts, schools and universities. After all, there are also

possible ways to improve this study. As Hale (1998) stated, male students are more likely to be at-risk than females, and they also require more remediation sessions. Therefore, consideration of genders could be an area for further studies. Moreover, as many researchers confirmed (e.g. Duarte et al., 2014), mature students have a different perception of education. They come to university after years of working; and for them, successful completion of the program means finding a better job and position. Therefore, on one hand they tend to study harder and more effectively and on the other hand they are more likely to drop the course or even think about a change of institution (Duarte et al., 2014); if they feel unsatisfied. Hence, another aspect to enhance this study could be solely considering mature or non-mature age students.

## References

- Buckner, M. M., Dietrich, M. S., Merriman, C., & Keeley, J. P. (2013). Identifying At-Risk Nursing Students Using a Midcurricular Examination. *CIN: Computers, Informatics, Nursing*, 31(5), 229-234.
- Chan, J. Y. K., & Bauer, C. F. (2014). Identifying At-Risk Students in General Chemistry via Cluster Analysis of Affective Characteristics. *Journal of chemical education*, 91(9), 1417-1425.
- Duarte, R., Ramos-Pires, A., & Gonçalves, H. (2014). Identifying at-risk students in higher education. *Total quality management & business excellence*, 25(8), 944-952.
- Glesmann, C. (2014). *Identifying Students At-Risk for an Adverse Academic Event* (Doctor of Education thesis). ProQuest, UMI Dissertations Publishing
- Hale, B. (1998). *Identifying students at-risk* (Master of Arts in Education thesis). ProQuest, UMI Dissertations Publishing
- Hassanbeigi, A., Askari, J., Nakhjavani, M., Shirkhoda, S., Barzegar, K., Mozayyan, M. R., & Fallahzadeh, H. (2011). The relationship between study skills and academic performance of university students. *Procedia - Social and Behavioral Sciences*, 30(0), 1416-1424.
- Pepe, K. (2012). A Research of the Relationship Between Study Skills of Students and their GPA. *Procedia - Social and Behavioral Sciences*, 47(0), 1048-1057.
- Shaeri, S., Guan, H., & Howell, S. (2014). *Statistical Analysis of Correlation Between Students' Personal Characteristics and Academic Success in Engineering Mechanics Course*. Paper presented at the the 25th Annual Conference of the Australasian Association for Engineering Education (AAEE2014), Wellington, New Zealand.
- Tait, H., & Entwistle, N. (1996). Identifying Students at Risk through Ineffective Study Strategies. *Higher Education*, 31(1), 97-116. doi:10.1007/BF00129109
- Tulbure, C. (2012). Learning styles, teaching strategies and academic achievement in higher education: A cross-sectional investigation. *Procedia - Social and Behavioral Sciences*, 33(0), 398-402.
- Whannell, R., & Whannell, P. (2014). Identifying tertiary bridging students at risk of failure in the first semester of undergraduate study. *Australian Journal of Adult Learning*, 54(2), 101.

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