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Predicting the Performance of the Diploma Engineering Students Using the Pre-test method

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Abstract

In the Faculty of Engineering & Built Environment (FKAB), UKM, there has been great concern among the academicians over the poor performance of the diploma students in their engineering mathematics course. An early performance indicator is needed to detect students with mathematical problems at an early stage so that relevant actions can be undertaken to mitigate the problem. The objective of this paper is to study the effectiveness of the pre-test mathematics questions in predicting the performance of the students in the subsequent engineering mathematics course. A number of 23 diploma students were selected and their previous institutional details were classified. The pre-test paper consists of 30 objective questions which were constructed based on the compulsory requirements on several mathematical concepts in engineering course. The results of the pre-test were moderated and compared with the results of two subjects, Vector Calculus and Linear Algebra of the same students in the first semester. The correlation analysis was performed between the pre-test results and the results of Vector Calculus and Linear Algebra. The analysis reveals a weak correlation between the pre-test, Vector Calculus and Algebra Linear results. However, a strong correlation was found between Vector Calculus and Linear Algebra results. The study indicates that the pre-test necessitates further refinement and improvement on the contents, for it to be used as indicator to the diploma students' performance in the engineering mathematics course.

Selection and/or peer-review under responsibility of Professor Dr Mohd. Zaidi Omar, Associate Professor Dr Ruhizan Mohammad Yasin, Dr Roszilah Hamid, Dr Norngainy Mohd. Tawil, Associate Professor Dr Wan Kamal Mujani, Associate Professor Dr Effandi Zakaria.

Keywords: Pre-test result; diploma engineering students; Linear Algebra; Vector Calculus; correlation analysis.

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1. Introduction

The students' performance in universities has, of late, become a very important concern not only to the administrators and educators, but also to corporations competing in the labour market. Academic achievement is one of the main factors considered by the employers in recruiting workers, especially fresh graduates [1]. Thus, students need to put their greatest effort in their study, to obtain a good grade in order to fulfil the employers' demands. Students' academic achievements are measured by the Cumulative Grade Point Average (CGPA). The CGPA shows the overall students' academic performance, where it considers the average of all examination grades for all semesters during the term in the university [1].

Mathematics is one of the tools that have been used for a thousand years ago, to assist engineers in inventing and producing things that are considered necessary for the community. It is well-raised as one of the most important subjects to learn since primary school. Over the last ten years, Engineering Institutions in London have been facing a growing challenge of undergraduates being accepted for degree courses with relatively low mathematics qualifications [2]. For instance, the Engineering Council in 1995 published the results of a detailed study, which looked into the nature and extent of the difficulties that the undergraduate engineers faced with mathematics. The engineering students were found to be lacking in mathematical skills [2]. Thus, the problems that are arising to the present day are are in the light of the fact that most of the engineering students still have difficulties in achieving higher grades in mathematics. There are many factors which are related to this problem, and one of them is the transition of mathematical knowledge from the school to pre-university, and later to the university level which is based on the syllabus of the mathematics courses. A study by Yushau [3] has shown that attitude stands as one of the reasons why learning mathematics has proven to be very difficult. Internationally, other researchers have become concerned too, about the knowledge and skill level of engineering mathematics students. A national UK report [4] on mathematics-related issues in engineering points out that `*students are now less well-prepared than 10 years ago . . . evidenced by lack of confidence at understanding algebraic manipulation and reduction of graphing skills*'. Similar concerns have also been shown around the world [5]. Gardner and Broadus [6] who work with US college students also discover that `*mathematics was the basic culprit in undermining students' academic progress*'.

In the Faculty of Engineering & Built Environment (FKAB), UKM, mathematics courses are made compulsory for all undergraduate students, from the first year until the third year of their studies. In order to retain the quality and the standard of the Faculty of Engineering & Built Environment (FKAB), Universiti Kebangsaan Malaysia, students in the Faculty of Engineering & Built Environment (FKAB), UKM are selected and accepted, based on the requirements of admission qualifications that have been implemented. One of the requirements is good mathematics result during the pre-university programme (STPM, Matriculation, or Polytechnic) Panduan Prasiswazah [7]. The main problem faced by the faculty is the decline in the students' achievement towards engineering mathematics subjects. Problems arising in FKAB are equally consistent with the concerns voiced by various other researches worldwide. Numerous efforts have been exerted by the researchers in the engineering faculty to monitor students' achievement level from time to time, but the efforts made were *ad-hoc* solutions. Haliza. O. [8] have conducted a study on the first-year UKM engineering students, revealing that students are lacking the knowledge in certain important topics in mathematics, which is a core subject in engineering studies. The inadequacy in basic mathematical skills has a direct effect to many mathematical skills that are essential for those undergraduate degree courses with a significant mathematical content [9].

This paper investigates the effectiveness of the pre-test mathematics module in predicting the performance of the FKAB, UKM diploma students in the subsequent semester. Several pre-test questions were constructed and given to the diploma students prior to the mathematic courses. The results of the pre-test were then moderated and compared to the Vector Calculus and Linear Algebra subjects taken by the same students in the first year.

2. Methodology

The whole process began with the selection of sample participants. The pretest exam was later administered and the results were compared to the participant's performance in the subsequent mathematics courses.

2.1. Participants

The sample population in this study was 23 engineering diploma students at UKM, where 10 students are registered in the Mechanical and Material Engineering programme, 7 students in the Electrical and Electronic Engineering programme, followed by 4 students in the Civil and Structural Engineering Programme and 2 students in the Chemical and Process Enginering Programme. All of these students had acquired Cumulative Grade Point Average (CGPA) of more than 3.5 from their respective diploma programme.

2.2. Instrument

The pre-test consists of 30 questions related to algebra (10 questions), calculus (17 questions), geometry (1 question), trigonometry (1 question) and numerical method (1 question). These topics were chosen from thefundamental topics required for calculus and algebra courses. The pre-test results were then run through the statistical software SPSS version 16.0. The instrument was validated based on the description analysis of the data, and the Pearson analysis was performed to detect any significant correlation that existed (if any) among the variables under study. The process flow is given in Figure 1.

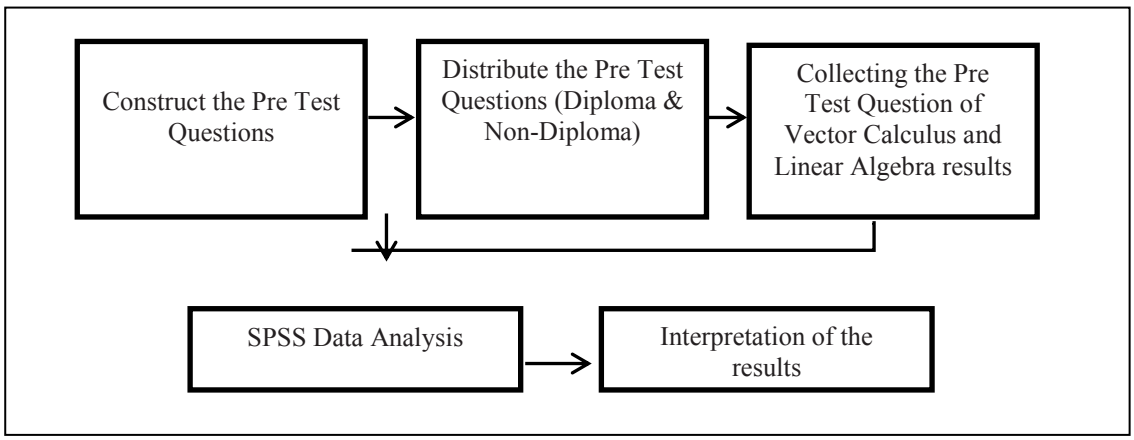

Fig. 1. Process Flow

3. Results and Discussion

Figure 2 shows the results of the pre-test in comparison to the results of Vector Calculus and Linear Algebra courses. Initial observation reveals that on average, the pretest result staggers far below the results of vector calculus and linear algebra. Students who scored lower marks in the pre-test tend to follow the same pattern in their performance in vector calculus and linear algebra. However, on further investigation on the correlation analysis using the Pearson Correlation technique it is revealed that the Pearson correlation results between the pre-test towards Vector Calculus and Linear Algebra show a weak correlation with a negative value of r (a correlation coefficient index), which is -0.160 and-0.095 respectively. The significant value (p) for both sides is 0.465 and 0.668, respectively, which is more than 0.01. A value of $p < 0.01$ would indicate the existence of a significant correlation.

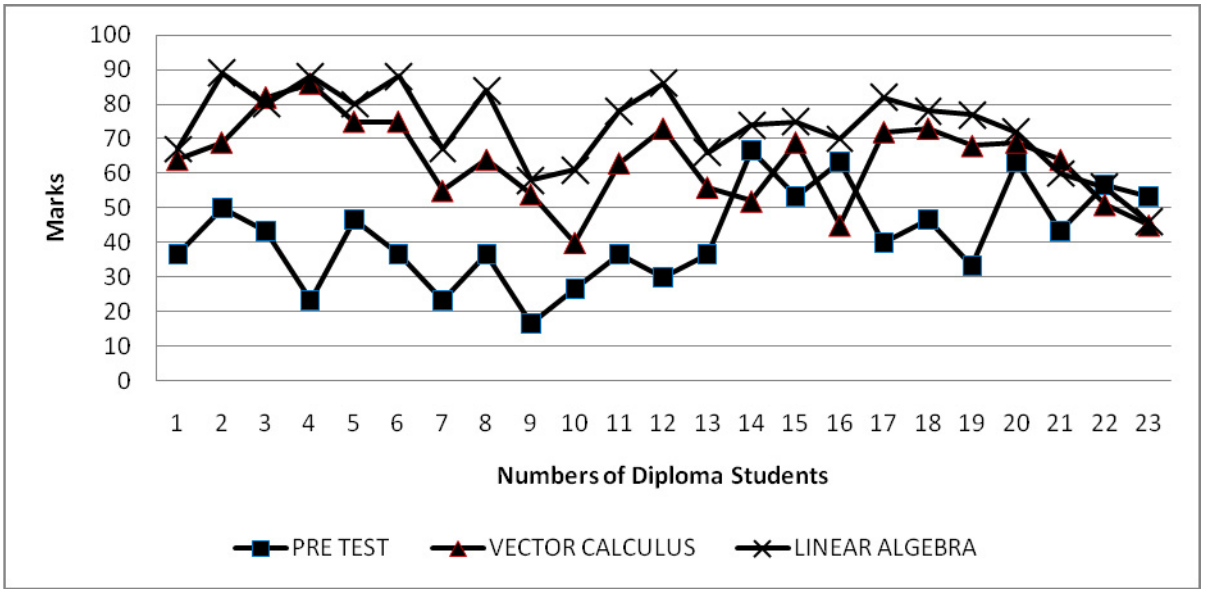

Fig. 2. Pattern of Diploma Students' results in the Pre Test, Vector Calculus & Linear Algebra

However, on further investigation, the Pearson correlation between vector calculus and linear algebra subjects shows a strong correlation with the value of $r = +0.767$, with the significant value $p < 0.01$. This indicates a strong relationship between linear algebra and vector calculus. Students who have scored in Vector Calculus tend to show similar performance in the Linear Algebra course. The summary of the Pearson Correlation values is given in Table 1

Table 1. Pearson Correlation Values for the Pre Test, Vector Calculus and Linear Algebra

		Pre-Test	**Vector Calculus**	**Linear Algebra**
Pre-Test	Pearson Correlation (*r*)	1		
	Sig. (2-tailed)			
Vector Calculus	Pearson Correlation (*r*)	**-.160**	1	
	Sig. (2-tailed)	**.465**		
Linear Algebra	Pearson Correlation (*r*)	**-.095**	**.767****	1
	Sig. (2-tailed)	**.668**	**.000**	

**. Correlation is significant at the 0.01 level (2 tailed).

4. Conclusion

Some significant efforts have been done, to improve the learning and teaching of mathematics in engineering courses worldwide. One of the efforts in this research is to construct an instrument to measure and to predict the performance of diploma engineering students in the subsequent engineering mathematics course using the pre-test method. The weak correlation between the pre-test and the vector calculus and linear algebra results

indicates that further improvement should be aimed in the construction of the pre-test questions. The pre-test questions should reflect the true nature of the mathematical skills that should be developed. On the other hand, a higher correlation established between Vector Calculus and Linear Algebra indicates that the analysis of both mathematics courses should not be treated separately. A second stage of an improvised pre-test module is underway to encapsulate both calculus and linear algebra skills.

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