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A Case Study Engineering Mathematics I

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Abstract
The subject of mathematics is important as a prerequisite and requirement as most topics in engineering courses widely employ these fundamentals. The paper will describe an analysis based on Engineering Mathematics I course results for first year student of Semester I 2009/2010 academic year at the Faculty of Engineering, University of Malaysia Sarawak (UNIMAS). The aim is to identify the topics within Engineering Mathematics I, which may cause some difficulties for new students to understand. The performance that directly related to the students' weaknesses is obtained from the continuous assessments of the course, end of semester report analysis based on course outcomes and item analysis. The results will be used as the basis for improving the teaching and learning process for this course.

Keywords: Engineering mathematics; Students ; Course Outcome; Item Analysis; Assessments

Introduction

Engineering Mathematics has always been the fundamental and essential components for engineering courses. This is because mathematical skills are required and necessary for the understanding of almost every conventional engineering subject (Chirwa, 2006). At the Faculty of Engineering UNIMAS, students have to undertake four engineering mathematics courses during their under graduate study. The four courses are Engineering Mathematics I, Engineering Mathematics II, Engineering Mathematics III and Numerical Methods and Statistics. All the courses are three credits hour course and itis core courses.

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The course syllabus covers topics of Function, Limit, Differentiation, Integration, Application of Differentiation, Application of Differentiation, Application of Integration, Sequence and Series, Complex Number. The course syllabus and course plan was designed as such to achieve four course outcomes (COs) syllabus and course plan was designed as such to achieve four course outcomes (COs).The course outcomes are:

- CO1 Ability to apply the fundamental concepts of calculus
- CO2 Ability to solve trigonometric, functions and limits
- CO3 Ability to formulate and apply differentiation and integration equations
- CO4 Ability to solve series and complex number.

The course outcome is designed to reflect the course content. It is then important to evaluate the outcome as to see whether the students achieve the course outcomes. This paper is to discover topics in Engineering Mathematics I where the first year students perform well or otherwise. The course assessment includes mid-semester test, course works and final examination. The sub-components of course works mostly based on assignment, project or case study. The mark distribution is 30% for mid-semester test, 20% for course work and 50% for final examination.

The discussed results here will be solely based on assessments of final examination result. The finding will lead to suggestions of how to overcome the weaknesses. The objectives of this paper are:

i. To identify achievements of course outcomes of Engineering Mathematics I.
ii. To determine index of difficulty and discrimination from item analysis of Engineering Mathematics If in all examination questions
iii. To suggest areas of improvement of teaching and learning process for Engineering Mathematics

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Methodology

In this study, two analyses was carried out, which are course outcomes achievement analysis and item analysis. The data of students score used in this analysis is based only on the final examination results.

Data Collection

This study is based on a first year group of students enrolled in a degree program in engineering. The group constituted of 298 registered students from four different engineering programs, which are Electronics, Mechanical, Civil and Chemical Engineering.

Data collected for this analysis is only from the final examination marks which contribute 50% of the final result. The examinations for Engineering Mathematics are 3 hours where the students have to answer 5 questions. Each of the questions will assessed different course outcomes or different topics. The questions have gone through qualitative analysis during examination vetting process carried out by a group of experts in this area.

Table 1 shows the questions of which course outcomes is assessed. Notice that two questions were posed in order to assessed CO3. This question is to test on integration and differentiation topic.

Table1.Mapping of Question No with Cos

Question No.	Course Outcomes Assessed
1	CO1
2	CO2
3,4	CO3
5	CO4

Course Outcomes

Course outcomes achievement is identify through end semester report analysis of final examination Engineering

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Mathematics I. It is measured based on percentage of marks of each question of final examination which is tabulated in Table 2. Table 2 is adopted in Faculty of Engineering in order to check the achievement of course outcomes. CO is achieved if>50%ofstudents scored on the questions.

Table2.Level and range of Course Outcomes Achievement

Strongly Not Achieved	< 25% Not Achieved	25% - 49%
Achieved	50% - 74%	
Strongly Achieved	≤75%	

Method in Item Analysis

The question posed in the final examinations will be analysed to check the appropriateness. This is accomplished by means of performing Difficulty Index (*p*) and Discrimination Index (*D*) analysis. The Difficulty Index is defined as the proportion (%) of students who get a question right where *p* ranged from 0 to 1. When *p* is multiplied by 100, it ranges from 0% (for a very difficult item) to 100% (for a very easy one) (Evaluation and Examination Service, The University of Iow a).Difficulty Index(*p*) equation is defined as in equation(1):$P=(\sum_U+\sum_L)/(2N(Score_{max}))(1)$

where,

$\sum U$=sum of scores for upper 25%-35%

$\sum_L$= sum of scores for upper 25% - 35%

N=25% - 35% of number tested

$Score_{max}$=highest possible score on the question

The Discrimination Index is defined as the difference in proportions of students who get an item right in two selected criterion group of examinees. Normally, when items are being develop, the aim is to have the items to be sensitive to

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differences among individuals on the attribute range. *D* values ranges from-1.0 to + 1.0. Generally, a positive discrimination suggest that the item is discriminating between the criterion groups in the direction as desired by the item developer. The equation for Discrimination index, *D* is defined in equation (2):

$$D=(\sum_U-\sum_L)/(N(Score_{max}))(2)$$

The analysis was performed by taking 30% of high score and 30% of lower score group. Each of the questions is analyzed using Difficulty Index (*p*) and Discrimination Index (*D*).

The results will follow the classification based on Score pak (Score pak: Item Analysis, University of Washington, Seattle). It classifies item difficulty as" easy" if the index is .85 or above;" moderate" if it is between .51 and .84; and "hard" if it is .50 or below. It classifies item discriminationas" good" if the index is above .30; "fair" if it is between .10 and .30; and "poor" if it is below .10.

Results and Discussion

This section will elaborate results of the analysis of course outcomes and item analysis.

Course Outcomes Achievement

Figure 1 illustrates the course outcomes achievement based on final examination only. Overall, CO4 is the *strongly achieved* outcomes with 132 students out of 298 achieved it. This is followed by CO3 with 164 *achieved* the CO.

The strongly not achieved and not achieved outcome is both from CO2 with 67 and 111 students' respectively.

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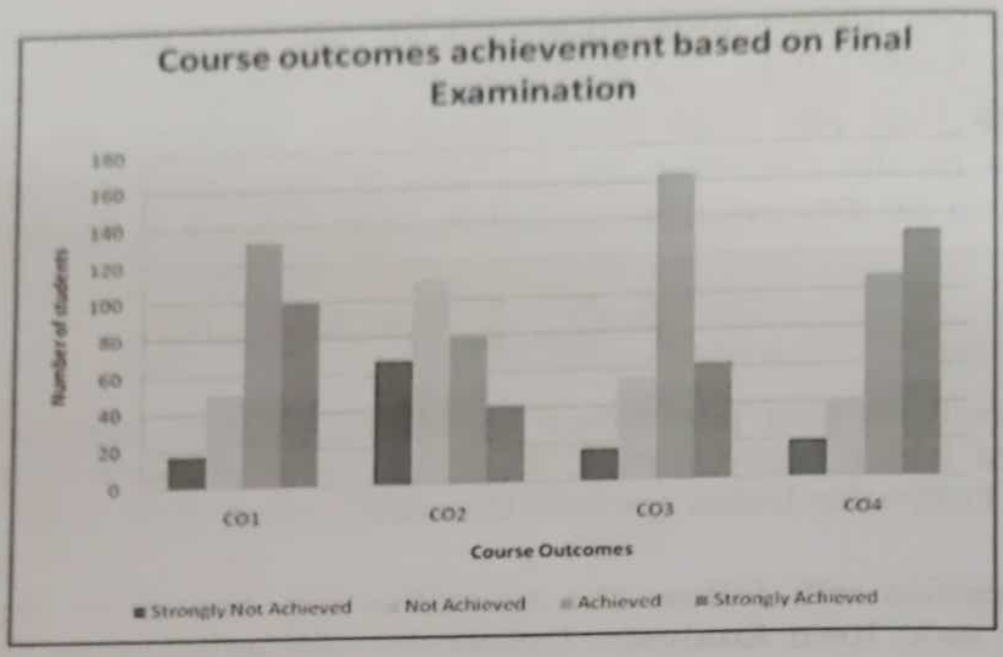

Fig.1.Course Outcomes achievement based on final examination

To further illustrate the findings, the course outcomes achievements are grouped into just 2 categories, which is achieved and not achieved. See Table 3. It showsthatCO2 significantly is not achieved compared to other COs. More than 60% of the students did not manage to achieve CO2.The analysis revealed that CO2 is not achieved due to poor student performance inansweringquestionNo.2(as mapped inTable1).

	CO1	CO2	CO3	CO4
Not Achieved	28.3	60.0	28.3	24.9
Achieved	71.7	40.0	71.7	75.1

Item Analysis

Item analysis is done to determine the index of difficulty and discrimination of the final examination questions of Engineering Mathematics I. Item difficulty will provide an idea of the level of difficulty of the final examination questions. The item discrimination also measure how well the questions are able to separate and distinguished between high score and low score students.

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Table 4 shows the item difficulty and item discrimination for all of the questions posed to students during the final examination. The results indicated that there are balance and moderate set of questions given for the final examination.

Table 4. Item analysis for questions

Index / Question No	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
Discrimination, *D*	0.29	0.39	0.23	0.36	0.31
Difficulty, *P*	0.66	0.47	0.79	0.46	0.68

To obtain a better view of the situation, questions with non-achieved CO and strongly achieved will be further scrutinised. Focusing on question No.2, the discrimination index of 0.39 revealed that the question has good discrimination. Thus, CO2 is not achievable is unrelated with the question design being too difficult, but because there are high number of students who are weak in the assessed topic. Question No.2 is assessing student's ability to solve limits problem.

Focusing on question No.5 (CO4), results in Table 4 showed that the question is moderate with good discrimination similar to question No.2. Question No.5 deals with series and complex number. This gives an indication that most of the students are actually competent or have no problem in these topics.

As mentioned earlier, this study is based on the final examination only. If the course work and mid-semester test are taken into consideration in the analysis, all course outcomes are probably accomplished.

Conclusion

Based on the final examination results analysis, it shows that three out of four COs were achieved. CO2 is the only strongly not achieved CO. The index of difficulty and discrimination showed that the questions posed in Engineering Mathematics I final examination are balance with difficulty ranging from 0.47 to 0.79 and discriminate well between high score and low score students.

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It is found that the topic on limits is the most difficult topic for students of Engineering Mathematics I. Where as the topics on series and complex number are the easiest, that is most students demonstrate they are competent. Hence, the topic on limits should be given more emphasis during lecture. More tutorial or assignments in this area is suggested to build up better understanding on solving problems on limits. Further more, it is also recommended that more time is allocated on the topic. Further study to investigate the effectiveness of the action taken will be carried out. It would be of interest to extend the study to investigate the course outcomes achievement and item analysis based on mid-semester test as well to further confirm the findings reported in this paper.

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References

Chirwa, L.(2006).*Use of E-Learning in Engineering Mathematics*, University of Ulster, United Kingdom.

University of Iowa. Preparing and Evaluating Essay Test Questions. *Technical Bulletin#36*, Evaluation and Examination Service. Retrieved from The University of Iowa website.www.uiowa.edu/~examserv/Level_2/.../Tech%20Bulletin%2036.pdf

Scorepak: *Item Analysis*, University of Washington, Seattle. Office of Educational Assessment, e-mail: scorepak@u.washington.edu.University of Washington Seattle, WA. Retrieved from the website.http://www.washington.edu/oea/services/scanning_scoring/scoring/item_analysis.html

Zurawski,RaymondM.andJanssens,Steven(1998).*MakingtheMostofExams:ProceduresforItemAnalysis*.Retrieved16March2010from OryxPress:http://www.ntlf.com/html/pi/9811/exams_1.htm