Students' Viewpoints on Mathematics Courses in Engineering: A Basis for Improvement

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Abstract - *This research is about the Adamson University's third year regular engineering students' viewpoints on mathematics courses in engineering as basis for improvement. The objective of the study are as follows: (1) to identify the engineering students' views on the content of the mathematics courses taught in engineering education; (2) to identify the engineering students' views on the teaching style used in the mathematics courses; (3) to identify the engineering students' views concerning the faculty teaching the mathematics courses for the engineering departments; (4) to determine how do students' viewpoints on mathematics courses in engineering serve as basis for improvements. The researcher used qualitative research method. The respondents consisted of 12 regular third year engineering students of Adamson University. To improve the interview questions, a pilot study has been conducted with 5 sophomore engineering students of Adamson University to make sure that the words used in the interview questions can be grasped by students; and can provide answers and explanations to the problem posed in the present study with the aid of 2 experts. Based on data obtained from the research findings, students' viewpoints on mathematics courses to engineering are categorized under five (5) main themes and thirty (30) subthemes including one hundred forty two (142) codes. The main themes are as follows: the content of the mathematics courses, perception on relevance, lecturer's focus, teaching styles, and the assessment process.*

Keywords: *students, viewpoints, mathematics, engineering*

INTRODUCTION

Education plays a considerable part in man's life. To most Filipino educators the educational process and the school process are one. Educators like professors and curriculum developers have realized that for students to be successful in school nowadays they have to be responsible. A teacher can be effective if he has mastery of the subject matter but in reality it is not the only condition in helping the students to develop the necessary skills to become efficient in learning. It also requires different approaches to teaching and learning system. As a result, how the education runs inside and outside classrooms must be over and over again reviewed and assessed by both educationalists and students mainly in mathematics classes [1]. Moreover, the connections of mathematics to various areas most especially in the field of engineering must be considered for it is defined as the application of mathematics and sciences to the building and design of projects for the use of society [2], then as a consequence, future engineering students are subject to view engineering degrees through mathematics. According to Zeidmane and Sergejeva [3] the relevance and the number of subjects included in the study programs particularly in engineering are evaluated according to the contribution of the subjects in the achievement of the overall aim of the entire study program; and mathematics is involved in this process; as a result it is important to study how mathematics classes run in the present education, especially in engineering education. Mathematics has long been a fundamental part of engineering course. Some see mathematics as the first step to engineering, paving the way to sound plan, but denying the entrance to not so mathematically inclined individuals [4]. Most of the time, mathematics departments often have responsibility for teaching mathematics to engineering students. This may lead to the situation where engineering departments have little idea of what mathematical content is presented to their students in the standard prerequisite mathematics units for according to Guner [5], students think that mathematicians, meaning the faculty from mathematics department but non engineering degree holder, cannot hold the attention of the engineering students in mathematics classes as they do not know which aspects of mathematics are more important for engineering purposes. Furthermore, there seems to be no consistent, research-informed, view of how, what, when and by whom mathematics should be taught to engineering students as emphasized by Flegg, Mallet and Lupton [6]. On the other hand, if the mathematics syllabus for engineering is presented by identifying the full list of topics in mathematics then engineering students are anticipated to discover the value of mathematics in the near future [7].

In recent years, many modifications have been made to engineering education corresponding to the advancements in the fields of technology and education; and new applications have been put in place [8]. Much research has been conducted on the teaching and learning of mathematics for engineering undergraduates. Various engineering and mathematics organizations conducted studies and prepared reports on the kind of reforms needed in the mathematics education given to engineering candidates [9]. In the study of Binogbali, Monaghan and Roper [10] engineering students see mathematics primarily as 'a tool'; they want to learn mathematics that they can apply in engineering applications. Further to this, students' views on mathematics show that they regard mathematics as a 'tool' for their profession and want to learn its 'application' aspects. In the study of Pomales-Garcia and Liu [11] on the undergraduate engineering students' perspective on engineering education indicated that students preferred spending more time on real world applications, examples and less time on lectures. This research also showed that students favored smaller classes with increased interaction in lectures, and use of visual aids. Meanwhile, in the study of Firouzian, Ismael, Rahman and Yusof [12] some of the sub-topics in engineering mathematics that need to be reviewed during engineering courses by the curriculum designers, are as follows: complex numbers, matrix algebra, sequences and series, limits, differentiation of functions, techniques of integration, application of integration, and improper integrals. It is found that the topic on limits is the most difficult topic for students with basic engineering mathematics whereas the topics on series and complex number are the easiest where most students demonstrate competency. Hence, the topic on limits should be given more emphasis during lecture. In the study of Kipli, Bateni, Osman, Sutan, Joseph and Selaman [13] more tutorials and assignments in the most difficult topics are suggested to build up better understanding on solving problems specifically on limits. Furthermore, it is also recommended that more time is allocated on difficult topics. Battacharya [14] found that among the most important criteria cited as good teaching in engineering and effective mathematics education are the lecturer's knowledge of the subject area, clarity of presentation, and ability to stimulate student's interest. In the study of Cardella [15] indicated that while engineers demand a focus on mathematics subjects that are necessary for the engineering curriculum, mathematicians argue that omitting some topics from mathematics courses damage the integrity of the subject and later may lead to students not acquiring the required mathematics knowledge. The engineering students in the study of Flegg, Mallet and Lupton [6] were learning mathematics from mathematicians in a module or lesson alongside undergraduate mathematics students. In the study of Tully and Jacobs [16] classrooms that were interactive, relaxed, and friendly, and where 50% of class time was regularly devoted to problem-solving activities, positively impacted students' perceived academic self-concept and self-efficacy. According to Gallaher and Pearson [17] students mainly women agreed it is important for faculty to be supportive and approachable and they wanted faculty to let them know how they are doing professionally. The importance they placed on was significantly greater than the amount of support they perceived in the environment, which suggests that engineering faculty needs to pay attention to developing supportive relationships with their students. In the study of Perkin and Bamforth [18] mathematics requires ongoing practice and that it is not possible to cover a year-long module just before the examination period. By not accessing help during the first year of their course students are not only at risk of failing their first-year mathematics module but also many other modules that require mathematical competence. Lastly, according to Othman, Asshaari, Bahaludin, Tawil and Ismail [19] students' perception agrees that the cooperative learning give them certain benefits.

To further understand the mathematics scenario in the Philippine engineering education context, the present researcher, who is a committed mathematics teacher, believe in the idea that the mathematics education in Adamson University in the engineering departments can be explained by students' viewpoints on mathematics in engineering. The students' viewpoints on mathematics courses in engineering will be the center of the study.

OBJECTIVES OF THE STUDY

This study attempted to determine the views of Adamson University's third year regular engineering students on mathematics courses in engineering. Specifically, this paper aimed to answer the following: what are the engineering students' views in terms of content of the mathematics courses taught in engineering education, teaching style used in the mathematics courses, faculty teaching the mathematics courses for engineering departments; and how do students' viewpoints on mathematics courses in engineering serve as basis for improvements.

MATERIALS AND METHODS

This research is a qualitative study. Qualitative research according to Creswell [20] is a type of educational research in which the researcher relies on the views of participants, asks broad and general questions, collects data consisting largely of spoken words or written text from participants, describes and analyzes these words thematically and conducts the inquiry in a subjective and biased manner. The participants of this study were selected using the typical multistage sampling method. First, the researcher divides the third year regular students of engineering into departments. Using stratified sampling, 6 out of 8 departments were selected. Second, from each of the 6 engineering departments, 2 samples were selected using convenience sampling method for a total of 12 samples. For ethical considerations, the researcher asked for approval to conduct research through a letter of request to the Chairperson of Mathematics Department noted by the Dean of College of Science and CRECE Director, all from the same university. After the letter of request has been approved, the researcher started data gathering. Data used in this research were collected in the second semester of the academic year 2014 – 2015. Interviews were conducted on students' vacant hours. In every interview, the researcher briefly explained to students the purpose and content of the research. Prior to data collection, participants were ensured that the data will only be used for research and educational purposes. Data were gathered through individual interviews, each lasting for about 15 – 30 minutes. Each participant was individually interviewed inside Adamson University campus. The interviews were recorded through an iPod with recording application, which is allowed by each students involved, for the purpose of this study; and then transcribed. Transcripts of the interviews were read and reread several times by the researcher, together with the recorded voice interview; to identify the themes and subthemes. Responses obtained which are classified into themes and sub-themes, were described and analyzed using qualitative analysis methods. And to improve the interview questions, pilot study has been conducted with 5 sophomore engineering students of Adamson University. The participants of the pilot study were selected using convenience sampling. Sophomores were selected as participants of the pilot study for the reason that they have the minimum experience required, which is one year or equivalent to two semesters, to do practical comparative analysis on mathematics setting in engineering. The instrument is divided into two parts. Part 1 is about short school profile of the student and Part 2 is the interview questions. These interview questions are consists of four open-ended guide questions. These interview questions were developed with the assistance of 2 experts, one from College of Education and Liberal Arts and the other from College of Science.

RESULTS AND DISCUSSIONS

Based on data obtained from the research findings, students' viewpoints on mathematics courses in engineering are categorized under five (5) main themes and thirty (30) subthemes including one hundred forty two (142) codes from twelve (12) respondents. The main themes are as follows: the content of the mathematics courses, perception on relevance, lecturer's focus, teaching styles, and the assessment process.

17.61% of the findings obtained were categorized under the content of the mathematics course, 13.38% of the findings were categorized under perception on relevance, 7.04% of the findings were categorized under lecturer's focus, 53.52% of the findings were categorized under teaching styles; and 8.45% of the findings were categorized under assessment process.

Table 1.Frequency and Percentage Distributions of Main Themes

Themes	**# Codes**	**%**
Content of the Mathematics Courses	25	17.61
Perception on Relevance	19	13.38
Lecturer's Focus	10	7.04
Teaching Styles	76	53.52
Assessment Process	12	8.45
Total	**142**	**100**

Table 2. Percentage Distribution of the Subtheme The Content of Mathematics Courses

Subtheme	**%**
Unfinished Syllabus	3.52
Time Allocation in Syllabus	0.70
Following Syllabus	2.82
Putting Applications	2.82
Focus of Subjects	5.63
Alignment of Syllabus	2.11
Total	**17.6**

There are six (6) subthemes under the content of the mathematics courses: unfinished syllabus (3.52%), time allocation in syllabus (.70%), following syllabus (2.82%), putting applications (2.82%), focus of subjects (5.63%), and alignment of syllabus to engineering program (2.11%).

Table 3. Percentage Distribution of the Subtheme Perception on Relevance

Subtheme	%
Tools for Major Subjects	7.04
Tools in Solving Problems	1.41
Way of Thinking	2.82
Its Impact	2.11
Total	13.38

There are four (4) subthemes under perception on relevance: tools for major subjects (7.04%), tools in solving problems (1.41%), ways of thinking (2.82%), and its impact (2.11%).

Table 4. Percentage Distribution of the Subtheme Lecturer's Focus

Subtheme	**%**
Current Structures	4.23
Theoretical	1.41
Lack Application	0.70
Its Product	0.70
Total	**7.04**

There are four (4) subthemes under lecturer's focus: current structures (4.23%), theoretical (1.41%), lack application (.70%), and its product (.70%).

Table 5. Percentage Distribution of the Subtheme Teaching Styles

Subtheme	**%**
Presentation of Lessons	9.15
Concerns on Behaviors	10.56
Concerns on Environment	1.41
Concerns on Examples	7.75
Concerns on Explanations	4.93
Concerns on Solutions	1.41
Concerns on Flow of Discussion	7.04
The Need for Supplementary Materials	2.82
Teachers' Mastery of Lessons	2.11
Encouraging Students	2.11
Ways of Supervising Students	4.23
Total	**53.52**

There are eleven (11) subthemes under teaching styles. presentation of lessons (9.15%), concerns on behavior (10.56%), concerns on environment (1.41%), concerns on examples (7.75%), concerns on explanations (4.93%), concerns on solutions (1.41%), concerns on flow of discussion (7.04%), the need for supplementary materials (2.82%), teacher's mastery of lessons (2.11%), encouraging students (2.11%), and ways of supervising students (4.23%).

Table 6. Percentage Distribution of the Subtheme Assessment Process

Subtheme	**%**
Examination	2.82
Quiz	2.11
Seatwork and Assignments	3.52
Total	**8.45**

There are three (3) subthemes under assessment process: examination (2.82%), quiz (2.11%), and seatwork and assignments (3.52%).

Evidently, numerous concerns are addressed to teachings styles; and very minimal concerns are addressed to lecturer's focus. This is because students are more concerned on the styles than the focus; likewise, students are more interested on how to gain knowledge than what knowledge to gain.

CONCLUSION

Based on the results acquired in the study through qualitative analysis, the researcher concluded the following:

(1) Engineering students are expected to discover the relevance of mathematics in engineering through

the mathematics syllabus presented by identifying the full list of topics in mathematics [7]; evident through their demand of having an aligned syllabus, as early as first year, by fitting necessary and appropriate mathematics principles and laws, with regard to the applications of mathematics courses to their respective engineering program [10]; in a way that difficult topics found on syllabus should be given more emphasis on lectures by allocating more time to it [13], that has to be reviewed [12].

(2) It is found in this study that among the three most important criteria cited as good teaching in engineering and effective mathematics education are the clarity of presentation, lecturer's knowledge of the subject area and ability to stimulate students' interest [14].

(a) First among the three most important criteria cited as good teaching in engineering and effective mathematics education is the clarity of presentations. Concepts, procedures, illustrations and long definitions may be placed on PowerPoint presentations through the use of projectors [11], to fasten and organize lessons, but with regards to the problem proper that requires students to compute or to solve, it is an advantage to go back to the conventional manual writing of solutions placed on board, for the reason that the students subjectively consider the manner of presenting solutions, meaning the whole thing is presented through projector, as a provider of an incomplete or undetailed origins. In fairness, it is not solitarily the use of projector itself, but the removal of the full display of details and origins in the solution process, which coincidentally exists in the use of projector, that pushes students to form a subjective reaction that it is a teaching style that takes away the fairness and integrity of the solution.

(b) Second among the three most important criteria cited as good teaching in engineering and effective mathematics education is the lecturer's knowledge of the subject area. Teachers' mastery alone does not teach but the impartation of one's mastery that teaches, and helps students in their learning process. Meaning, if teachers are both reachable through approachability and have mastery, it produces good learning environment; otherwise, even teachers have mastery but they are not approachable, it just makes students hesitant to ask questions that serves as students' additional clarifier and confirmer of knowledge [17][11]. Alternatively, having no mastery drives lecturers to hide confusing parts of the lessons, by means of becoming procedure oriented and not process oriented; that leads to unapproachability due to lack of supposed confidence in dealing with details contributing to unclear explanations. Clear explanations, relating to teachers' mastery, happen when there are: first, explanations on the origin of concept; second, explanations on how to solve and not just by giving formulas; third, explanations which are not procedure-driven but process-driven; fourth, explanations that are simple and thorough; and lastly, explanations that enlighten things. In addition, lecturers' mastery on the subject area produces confidence to deal with a number of issues on examples; more specifically the order of difficulty levels; the quantity of examples; its purpose; and lastly conceptual teaching through case to case examples.

(c) Third among the three most important criteria cited as good teaching in engineering and effective mathematics education is the ability to stimulate students' interest. Evidently, a perception on the relevance of mathematics courses, through the demonstration of mathematics courses' application and its relationship in engineering, motivates and encourages students, resulting to an increase in interest. Meaning, without the knowledge on the area that is used for its engineering applications, students are pressed to study only stress-free ones, contributing to an increase in students' laziness, contradicting the spirit of interest. And to maintain a healthy yet with a spirit of excitement and interest among students on mathematics courses which is perceived as serious matter; a ready, available and serious professor, yet funny and with a loud voice is a prerequisite. To be specific, a ready, available and serious professor does not mean not capable of cracking jokes that serves as a stopper of lecturers' repeated acts and quick brief attacks; but rather, a professor, who is ready and available for such mathematical attention to deal out mathematical information, and when necessary, knows how to crack jokes; resulting to a reduction on their distresses that increases interest. Likewise, a teaching style that invites one way communication just does not stimulate students' interest, caused by negligence and lack of interaction producing an unpleasant, not relaxed and unfriendly environment [16][17]. In addition, calling students by their surnames or names, and giving reference materials boosts their confidence, denying a decrease on interest. Lastly, to give them interest in taking notes that contributes to a favorable learning process and denying a decrease in students' interest in mathematics, seating arrangements with the ability of providing each student with lecturer's receipts of lectures in the form notes; and an external motivator like giving incentives is suggested to those students who faithfully write lectures as notes.

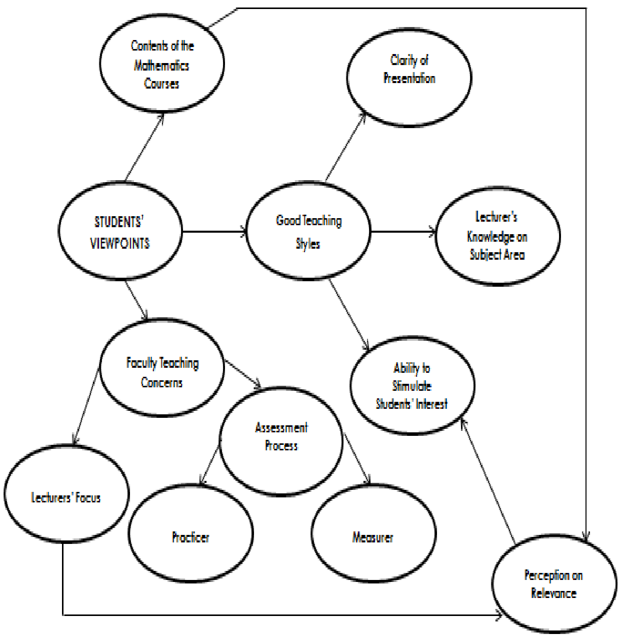

Figure 1. Outcome Framework

(3) Engineering students are possible not 'natural mathematicians' so it is important to keep the formal mathematics aspects to a reasonable level [6]. Students indicate that mathematics lecturers are generally conducting theoretical lectures. Also, students think that these theoretical mathematics lecturers are not much familiar on which aspects of mathematics are more important for their respective engineering program. [5]. Although engineering students demand a focus on mathematics courses that are necessary for their engineering program, driven by their perception on relevance, if lecturers turns out not to be theoretical in the way they discusses lessons, this would lead to students not acquiring the required mathematics knowledge; damaging the integrity and fairness of the mathematics courses [15].

Mathematics requires ongoing practice, and that, it is not justifiable for lecturers to cover very extensive lessons for engineering students, just before the quiz or examination without much practice [18]. A quantity of tutorials, seatwork and assignments functions as their ongoing practice provider before examination period [13]. By not having ample number of practices during the first year of their mathematics course, students are not only at risk of failing their first-year mathematics courses, but they are also putting at risk, their development through the higher years on their respective engineering program, most specially, those engineering subjects that require mathematical competence.

(4) The results obtained from students' viewpoints may serve as reliable basis for recommendations for improvement, on some issues on mathematics education in the engineering departments; more specifically, how to build a perception on relevance of mathematics courses, how to stimulate students' interest on mathematics courses, what teaching styles contributes to clarity of discussions and presentations; and what energies an assessment process.

RECOMMENDATION

To build a perception on relevance of mathematics courses means to require an analysis for both the contents of the mathematics courses through the syllabus and the lecturer's focus. The results of the analysis for both contents of each mathematics course through the syllabus and the lecturers' focus, determines the place of concentration stressed on each mathematics course. Applications of mathematics courses that are matched and aligned to students' respective engineering program, stressed out by mathematics lecturers, must be placed into spot light and climax, to strengthen and intensify the perception on relevance of mathematics courses to engineering program.

To stimulate students' interest on mathematics courses means the manifestation of a perception on the relevance of mathematics courses, through the demonstration of mathematics courses' application and its relationship in engineering. To maintain a healthy yet with a spirit of excitement and interest among students on mathematics courses which is perceived as serious matter; a serious professor who is ready and available to deal out detailed mathematics information, yet funny who knows how to crack jokes, knows students' names with a loud voice that provides reference materials, is a prerequisite. Teachers' negligence and lack of interaction that produces unpleasant, unrelaxed and unfriendly environment does not stimulate students' interest. And to stimulate students' interest in taking down notes, seating arrangement that considers students' ability to gather notes and giving some incentives is recommended.

Teachers who are approachable that entertains queries fired by mastery; who are process oriented with a heart to show and to derive origins from solution process gradually; who systematizes different examples for and from conceptual teaching to critical thinking; who links missing and obscured connections through the use of an introduction, a recall and clarifying definitions; determines good teaching styles that contributes to the clarity of discussions and presentations. The use of technology like projectors is an advantage if things above are considered and exercised.

Assessment process indicates two functions: as a measurer and as a practice provider. While quizzes and major examinations are used for measuring students' progress; seatwork and assignments functions not just as measurer but also as a practice provider. As an assessment process, seatwork and assignments requires students to put necessary attention into it, but as a practice provider it requires the faculty teaching mathematics to give more, to help students master their lessons. As a consequence, it is recommended to give a
lot of seatwork and assignments after certain lessons for the purpose of practice before quiz and examination period.

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