

Linking Student Interest and Engagement to Inquiry-Based Teaching in Engineering Classes

Bibi Rawiyah Mulung

BEng Electrical and Electronics Engineering, Faculty of Engineering
Universiti Teknologi Brunei, Brunei Darussalam

Abstract- Although several aspects of teaching have changed over time, traditional teaching is still deeply rooted into many institutions worldwide. Contrary to passive traditional teaching, inquiry-based teaching is a constructive way of teaching and learning which involves some forms of student participation. In this paper, I am presenting an analysis of the results from a study I have conducted on engineering students from three different engineering departments. My main method of data collection was questionnaires. My research was mainly focused on student interest and engagement as measures of the success of inquiry-based teaching in their classes. It was found that inquiry-based teaching can indeed raise student interest and engagement and can go as far as encourage engineering students to attend classes more regularly.

Keywords: inquiry-based teaching; engineering education; student engagement; educational research

Introduction

In many engineering classes, the lecturer uses presentation slides and tools such as a projector and screen to explain conceptual relationships to students. These students merely listen passively and are expected to memorize and reproduce this knowledge during the examinations. In this case, the lecturer and the presentation slides are the source of authority and the students are passive receivers of information. An inquiry-based teaching method works in a very different way from the traditional teaching method. When educators resort to inquiry-based teaching, they are no longer the only source of authority in the classroom. The students are made to participate actively as well. In inquiry-based teaching, students may be made to identify issues to the concepts being taught and asked to provide logical solutions to these. The students' contribution to the teaching-learning process ensures that they are made to develop analytical skills such as researching, questioning and communicating.

The reason for choosing engineering students for this study is that a rapidly expanding knowledge base in the field of engineering makes it difficult for educational curricula to keep up with the changes. The least that engineering institutions can do is to ensure that their graduates have a strong foundation of engineering concepts and skills. Unfortunately, this is often not the case. I believe that inquiry-based teaching could be the solution to eradicate the passiveness in teaching engineering.

In order to successfully reach a conclusion in this research, it was first important to determine the level of student interest and student engagement in a traditional classroom. This acts as a measure. The primary goal of this study was finding out whether engineering students show more interest and become more responsive when inquiry-based teaching is implemented. The changes that can be brought about through inquiry-based teaching have also been discussed. The factors leading to the differences in student response when being taught using the traditional teaching method compared to when they are being taught using an inquiry-based teaching method have been identified through this research.

My target group consists of engineering students. It is further divided into electrical engineering students, civil engineering students and mechanical engineering students. The results I have collected through questionnaires have allowed me to make both a quantitative and a qualitative analysis of student interest and engagement in class when inquiry-based teaching is adopted.

Literature Review

Many studies have previously been published on inquiry-based teaching. Researchers have been trying to investigate its effectiveness and feasibility across many disciplines and across many levels ranging from elementary school to universities. They have also been trying to further break down inquiry-based teaching into different categories such that studies on inquiry-based teaching can be narrowed down to specific types of inquiry-based teaching.

The authors in [1] deduced that inquiry-based teaching can generally be divided into three categories, each of which can be tackled using two types of inquiry-based teaching approaches:

1. Experience-centered lessons; through Free and Illustrated approaches.
2. Problem-centered lessons; through Solution and Method approaches.
3. Question-centered lessons; through Topic and Chaperoned approaches.

It was concluded that the Free Approach is the type of inquiry-based teaching which sustains student interest and causes students to be engaged most in the class. However, the authors of this particular study were elementary school teachers who carried out the experiment using a group consisting of elementary school children only.

In [2], two main research questions regarding inquiry-based teaching are addressed. The first one is about the main factors that determine the inquiry-based methods which the instructors adopt considering the teaching systems in place. The second question is relevant to the main features on which the teachers base their thinking on to adopt these methods. In an attempt to obtain conclusive answers, the authors identified three main types of inquiry-oriented approaches:

1. Problem-Solving Approach; engaging the students in fun activities
2. Research Approach; making the students investigate
3. Dialogic-Discourse Approach; causing the students to reflect

The factors which were found to lead the instructors' thinking were the algebra concept, the task at hand, inquiry and peer interactions. However, the limitation in this study is that it was carried out at a high school level with the principal focus being on the teaching of algebra only.

A previous research that is more closely related to my study is [3]. The authors have tried to provide a definition for inquiry-based teaching while taking into consideration the three main usage of inquiry; scientific inquiry, inquiry learning and inquiry teaching. According to the results obtained, both the means and the ends are essentials to determining the success of inquiry-based teaching. They also remarked that the instructors making use of inquiry-based teaching approaches should concentrate on the student's response and involvement as a measure of success. Another finding that has been teachers should collaborate with each other in order to create the right environment for inquiry-based teaching to be effective, while respecting each other's values and beliefs. However, it is important to note again that this study was conducted based on science teaching, not engineering.

A research that was more focused on undergraduate students is [4]. In this particular study, the challenges faced by instructors applying inquiry-based teaching at college level were explored. It was found that an extensive instructional preparation and support are required for the success of inquiry-based teaching. Students' and instructors' characteristics that may hinder inquiry-based teaching were found to be background, abilities, attitudes, habits, behaviour, beliefs and conceptions of science and nature of inquiry. Contextual barriers included logistics and lack of institutional support and incentives.

In [4] itself, a few reasons have been explained as to why lecturers at universities find it difficult to implement inquiry-based teaching.

1. Lecturers at universities and colleges are more concerned about using their time and resources for conducting research instead of investing that time in learning new teaching approaches.
2. Some lecturers apprehend that they may be less prone to get a promotion if they are categorized as good teachers instead of good researchers.
3. Many lecturers are unaware of inquiry-based teaching approaches and the effects these may have on the learning process for students.
4. Generally, college and university lecturers undergo little teaching training and do not have a well-defined framework for the design and implementation of their subject areas.
5. Instructors also mention a few contextual features for the non-adoption of inquiry-based teaching such as; time consuming, large class sizes, non-conducive class environment, not enough support from peers; not enough recognition from the institutions for their efforts to implement inquiry-based teaching.

My research questions and questionnaire questions are largely based on findings from the studies mentioned in this literature review. Although the chosen groups in these studies are different from the target group in my investigation, the same principles and research methods are applicable.

Methodology

Questionnaires were handed out to a total of 69 students, 23 students from each of the three engineering departments selected, namely electrical engineering, mechanical engineering and civil engineering.

Question 1:

Students were asked whether they are familiar with the term 'inquiry-based teaching' or not.

Question 2: A brief definition of inquiry-based teaching was given as:

"Inquiry-based teaching basically implies that students are made to actively participate in class".

Students were then asked to identify the inquiry-based teaching approaches their lecturers might be implementing in class from three approaches which were provided; they had the choice to select one or more.

- (i) Experienced-centered lessons
- (ii) Problem-centered lessons
- (iii) Question-centered lessons

Question 3:

The following statement was given:

“Engineering is a highly practical field which is often taught in a more theoretical manner.”

The students were then asked if they would be more interested and more engaged in class if their lecturer would carry out group discussions, ask them to investigate the concepts instead of merely reciting it to them and raise points for them to reflect on.

Question 4:

Three approaches to inquiry-based teaching were listed and the students were asked to identify of the approaches would sustain their interest more if implemented in their classes. A brief description of each approach was given as:

- (i) Problem-solving approach: It engages the students in group discussions
- (ii) Research approach: It prompts the students to investigate a concept
- (iii) Dialogic-Discourse approach: It causes the students to reflect on a concept

Question 5:

Students were asked whether they would be more likely to attend a lecture if they knew it will not be the usual “speech being delivered” kind of class, but instead be an interactive and lively class.

Results

Table 1 to Table 5 show the results obtained from each question.

EE represents the number of electrical engineering students.

CE represents the number of civil engineering students.

ME represents the number of mechanical engineering students.

Table 1: Data collected for Question 1.

	EE	CE	ME
Yes	0	0	3
No	20	18	16
Maybe	2	5	4
Total respondents	22	23	23

Table 2: Data collected for Question 2.

	EE	CE	ME
Experienced-centered lessons	8	4	1
Problem-centered lessons	17	23	11
Question-centered lessons	15	10	13
None of the above	0	1	1
Total respondents	23	23	23

Table 3: Data collected for Question 3.

	EE	CE	ME
Yes	19	16	15
No	4	7	8
Total respondents	23	23	23

Table 4: Data collected for Question 4.

	EE	CE	ME
Problem-solving approach	12	14	16
Research approach	6	5	4
Dialogic-discourse approach	5	4	3
Total Respondents	23	23	23

Table 5: Data collected for Question 5.

	EE	CE	ME
Yes	20	16	19
No	3	7	4
Total Respondents	23	23	23

Discussion

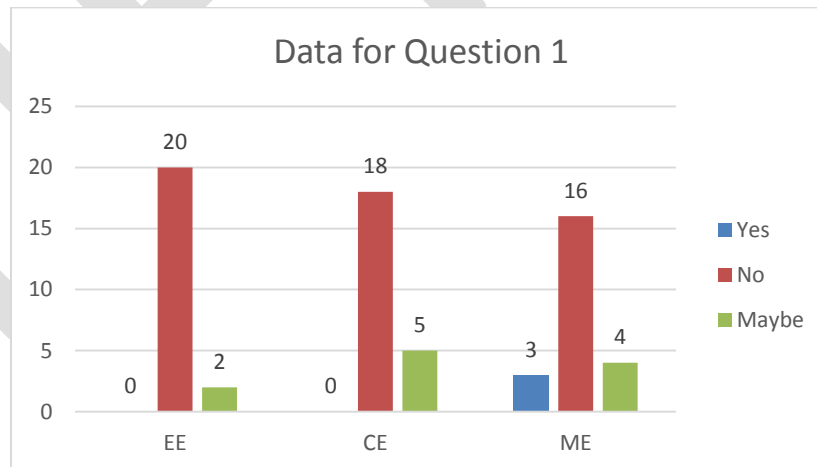


Fig. 1. Graphical representation of data collected for Question 1.

The objective of this question is to have an accurate idea about the extent of familiarity of engineering students with the term ‘inquiry-based teaching’. From the results collected, it can be said that the majority of students, from any of the three groups, is unfamiliar with the term. It is worth noting that the largest proportion of students who is not familiar with the term comes from the electrical

engineering group, accounting for 90.01% from this group. The percentages of students from civil engineering group and mechanical engineering group who are unfamiliar with the term are 78.26% and 69.57% respectively. Interestingly, only 3 students from the mechanical engineering group acknowledged being familiar with the term, compared to none from the other two groups. Finally, the number of students who responded by ‘maybe’ are fairly low for all three groups although a slightly higher number was expected.

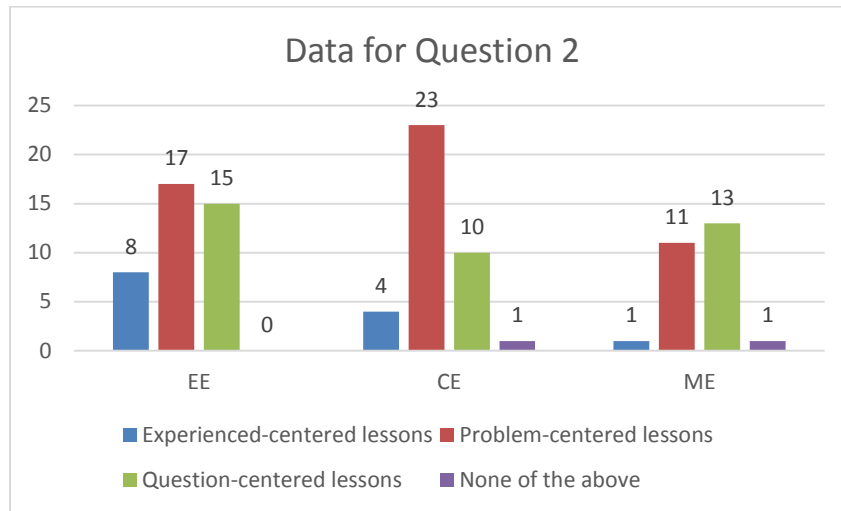


Fig. 2. Graphical representation of data collected for Question 2.

The objective of this question is to learn about the types of inquiry-based teaching approaches students can identify that are being implemented in their current engineering classes. The majority of students in the electrical engineering and civil engineering groups identified ‘problem-centered lessons through solution and method approaches’ as the most common inquiry-based teaching approach and ‘question-centered lessons through topic and chapter-wise inquiries’ as the second most common approach being implemented by their lecturers. However, it is vice-versa when it comes to the mechanical engineering group. Also, the least common inquiry-based teaching approach identified to be implemented in classes by students from all three groups is ‘experienced-centered lessons through free and illustrated approaches’. The number of students who could not identify any of the approaches is almost insignificant.

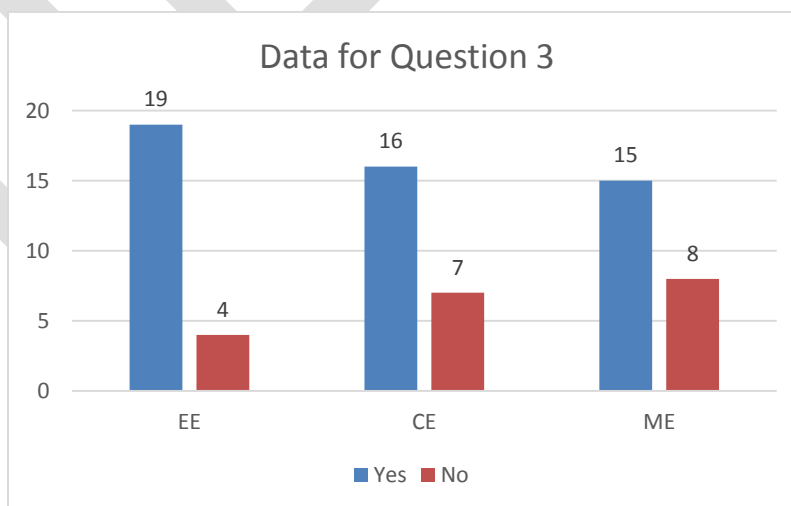


Fig. 3. Graphical representation of data collected for Question 3.

The aim of this question is to determine whether inquiry-based teaching can indeed raise student interest and engagement in class. The results prove that this hypothesis is correct since the vast majority of students; that is 82.61% from electrical engineering group, 69.57% from civil engineering group and 65.22% from mechanical engineering group, agreed that they would indeed be more interested and engaged in class if inquiry-based teaching were implemented. It is interesting to note that only 4 students from the electrical engineering group acknowledged that they would not be interested compared to twice that number for the mechanical engineering group.

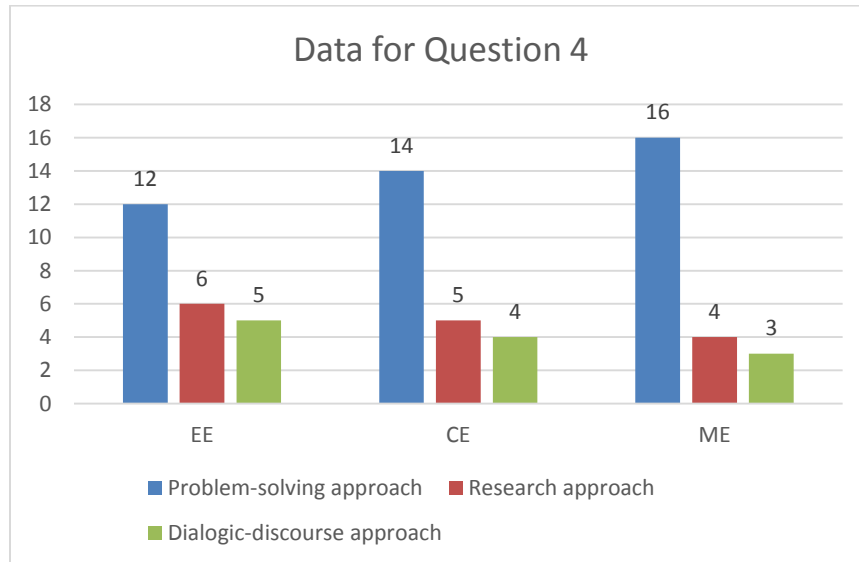


Fig. 4. Graphical representation of data collected for Question 4.

The objective of this question is to identify which inquiry-based approach can be used to make students express more interest and engagement in a class. Surprisingly, the majority of students in all three groups opted for the problem-solving approach. The highest proportion of 69.57% is from the mechanical engineering group, followed by 60.87% from the civil engineering group and 52.17% from the electrical engineering group. The second most popular option, again in all three groups, has been the research approach and the least desirable option has been the dialogic-discourse approach.

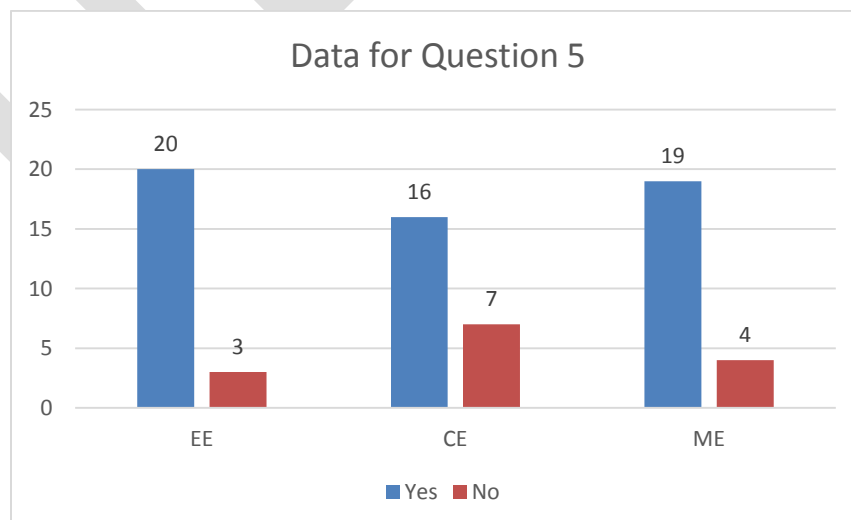


Fig. 5. Graphical representation of data collected for Question 5.

The objective of this question is to mainly determine whether the implementation of inquiry-based teaching in classes can be a factor for the raise in the attendance level of engineering students. At the same, it also allows us to have an idea about their interest and engagement level in classes if inquiry-based teaching were adopted. From the results obtained, it can be seen that over 69.57% of students from the civil engineering group, 82.61% from the mechanical engineering group and 86.96% from the electrical engineering group positively responded to the question, thus accepting that inquiry-based teaching implementation would make them more likely to attend a class. Although 7 students from the civil engineering group stated otherwise, the number is rather insignificant when it comes to the electrical and the mechanical group. It cannot, however, be denied that there is an anomaly due to the 7 students who responded negatively from the civil engineering group.

Conclusion and Recommendations

From the findings of this study, it can be said that inquiry-based teaching approaches, if carefully selected and implemented, can cause student interest and engagement levels to rise significantly. The academic background of the students also proved to be a factor in this study. As far as this particular research is concerned, the main conclusions are:

1. Most engineering students are not familiar with the term 'inquiry-based teaching', although a rather insignificant number express some doubts as to whether they are familiar with the term or not.
2. Among the types of inquiry-based teaching, problem-centered lessons and question-centered lessons have proven to be mostly widespread and recognized by engineering students. The least known approach has been the research-centered lessons.
3. A vast majority of engineering students has stated that the implementation of inquiry-based teaching in their classes would indeed cause them to show more interest and become more engaged in the class.
4. When asked to choose which approach to inquiry-based teaching would sustain their interest more in a class, the problem-solving approach which causes students to engage in discussions, was the most desirable one. The second choice was the research approach which prompts students to investigate a concept. The last choice of approach was the dialogic-discourse approach which causes students to reflect on a concept.
5. Finally, it was found that engineering students are much more likely to attend a lecture when they know that the class will be interactive and lively due to the implementation of inquiry-based teaching methods.

It should, however, be noted that this particular study has been conducted on engineering students from three different engineering departments only. Although the trends suggest that the same results would apply to any other student group, further research would be necessary to confirm this hypothesis fully. Also, the same study, if conducted on students other than those from engineering background, might produce different results.

REFERENCES:

- [1] Approaches to Inquiry Teaching: Elementary teacher's perspectives, Joseph Ireland, James J. Watters, J. Lunn Brownlee and Mandy Lupton, International Journal of Science Education, 2014, Vol. 36, No. 10, 1733–1750.

[2] Instructors' Decisions That Integrate Inquiry Teaching Into Undergraduate Courses: How Do I Make This Fit, Iris Alkahr Hakibbutzim and Erin Dolan Virginia Tech., International Journal for the Scholarship of Teaching and Learning, Volume 5, Number 2, Article 9, 7-11.

[3] Practice-based Perspectives of Inquiry Teaching of High School- Algebra, Olive Chapman, National Council of Teachers of Mathematics Research Conference, Boston, April, 2015.

[4] Reforming Science Teaching: What Research says about Inquiry, Ronald D. Anderson, Journal of Science Teacher Education, 13(1): 1-12, 2002.

IJERGS