Comparison of Lecturers' Epistemological Beliefs in Teaching Electromagnetic Theory

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Abstract
This research was conducted to compare the epistemological beliefs of two lecturers in teaching Electromagnetic Theory course. The two lecturers were selected based on their experiences in teaching the course at a University in Malaysia. A series of interviews were conducted, audio recorded and transcribed. The data were analysed using thematic analysis approach. The research found that based on the Yu and Strobel framework of the epistemological beliefs, only a few items within the constructs were undefined and most of the items meet the learning environments.

*Keywords:*Epistemological beliefs;Experience; Framework

1. Introduction
Educators need to be aware and identify the crucial factors that learners need to acquire a certain knowledge and skill.According to Greene et al.'s [1] it is not adequate for learners to know what but also know why. This is more important in the twenty-first century [1] and within the education research concerns how people acquire and use the knowledge, which includes personal epistemology. The adjective of epistemology, epistemic, is an Ancient Greek word meaning knowledge, what is known, or the way of knowing [2]. Additionally,

the terminology of engineering-related beliefs was made popular by Yu and Strobel in 2012 to develop an instrument for learner's belief in the domain of epistemic beliefs, epistemological beliefs and ontological beliefs [3]. The definition from this study presented that epistemic belifes is "what we believe what the discipline and practice of engineering is", epistemological beliefs is "how we know what we know in engineering" and ontological beliefs is "what we belive is reality that engineering deal with". On the other hand, Hofer &Pintrich stated that epistemological beliefs able to stimulus on the people thinking, reasoning and motivational [4]. Other researchers defined that epistemological beliefs as a belief about nature and the acquisition of knowledge [5]. All the definitions include the cognitive difficulties while learning the subject matter domains such as electromagnetic theory (EMT) course.

Based on the engineering programme accreditation manual for Engineering Accreditation Council of Malaysia (EAC)[6], one area that must be covered under the programme for electrical engineering is electromagnetic fields and waves. Most of the undergraduate programme for this area is related to the EMT course. In the study of EMT, most of the learners believe it's essential to have an intensive mathematical reasoning on the invisible phenomena [7], one of the most problematic courses in the electrical engineering (EE) curriculum[8], an extremely abstract and mathematically rigorous[9][10]. All the process of these complications in learning EMT had been identified as the conceptual and procedural knowledge. Thus far, no research can be found on the epistemological beliefs from the lecturer's perspective for EMT course.

Hence, this research aims to study the comparison of epistemological belifes of lecturers in teaching the EMT course. This comparsion adopted the research determined by Yu and Strobel which recognized three constructs for instance certainty of engineering knowledge, simplicity of engineering knowledge and source of engineering knowledge [3] that can be mapped to a lecturer's belief in EMT.

2. Theoretical Perspectives

A deep review and analysis by Hofer and Pintrich found that epistemological beliefs have different construct from various theories and models [4]. It can be summarized that epistemological beliefs can be divided into two dimensions known as nature of knowledge and nature of knowing. Nature of knowledge [4] can be concluded into two parts: 1) certainty of knowledge and 2) simplicity of knowledge. The nature of knowing can be divided into two sections : 1) source of knowledge and 2) justification of knowing.

However, Yu and Strobel [3] emphasized that the epistemological beliefs for engineering is defined as how individuals believe the nature of knowledge and the process of knowledge development. It determines certainty of knowledge, simplicity of knowledge and source of knowledge. The certainty of knowledge defines three stages, beginning with the absolute to the contextual and finally the relativism. The simplicity of knowledge defines two stages from the simple issues to the complex issues. The source of knowledge defines two stages from reliance on the expert to self-construction. Our research, adopted these constructs for the EMT course and aims to map with the lecturers' perspective as an expert in the subject matter.

3. Methodology

To achieve the aims of this research, qualitative data was collected for identifying epistemological beliefs at a university in Malaysia. Based on the qualitative characteristics inLeydens et al.'s[11] two lecturers were interviewed and recorderd. The first lecturer has thirty years experience in teaching EMT and the second lecturer has fifteen years in experience in teaching EMT. Both have their own style of teaching and perspectives on delivering the EMT material.

Next, the recorded data were transcribed. Later, the transcription were analysed using thematic analysis. The step-by-step process is based on the six thematic phases [12][13] such as : 1) familiarizing the data via reading and listening the audio recorderd, 2) generate or labelling the codes (in this research we label the construct based on Yu and Strobel framework, 3) searching for themes and mapping with the construct and items, 4) reviewing the themes, 5) continually defining and naming the themes and 6) summarized the data and produced the report.

4. ResultsAndDiscussion

The results are discussed based on the adopted frame-work from Yu and Strobel [3]. Three constructs which concerns the epistemological beliefs of the lecturers practices. The constructs are certainty of engineering knowledge (covers ten items), simplicity of engineering knowledge (covers two items) and source of engineering knowledge (covers nine items).

The results obtained from the interviews for construct certainty of engineering knowledge showed not all the items were mapped. Lecturer 1 have more idea in implementing this construct compared to Lecturer 2. Table 1 shows the summary of the items that mapped with the extracts of the interview transcripts.

Table 1. Summary of the certainty of engineering knowledge construct

Items	Lecturer 1 Transcriptions	Lecturer 2 Transcriptions
Principles in EMT cannot be argued or changed.	undefined	undefined
All EMT experts understand engineering problems in the same way.	I do not continue to exercise and copy. each step has to question why and so he thinks and he has an idea for me to solve.	undefined
Most EMT problems have only one right answer.		undefined
Most words in EMT knowledge have one clear meaning.		undefined
In EMT, knowledge should be accepted as an unquestionable	because we don't want him to use this method,	undefined

Items	Lecturer 1 Transcriptions	Lecturer 2 Transcriptions
truth.	no, he's based on that problem with the criteria that he sees that he decides to choose A.	
There is one universal in EMT method.		let say, for example, we want to find out, what is the value of electric field applied from one point to another?
If you read something in a book for EMT, you can be sure it is true.	Significant. He looks at the book, he goes on, when we go into why he did this, why that person made him find something interesting	Well, he's note we use as a reference, and then we have a book, and then we use / combine it two, for sure to have to practice it, from the book, thanrefer to the past year paper.
If your personal experience conflicts with 'big ideas' in a book, the book is probably right.		
EMT knowledge cannot be subject to change with new observations by individual engineering students.	Instead of studying math just like engineering math, he had to change his mindset, he had to relate to engineering.	
EMT textbooks written by experts presents the best way to learn engineering	undefined	

Table 2 shows the summary of the construct for simplicity of engineering knowledge. Both lecturer make an effort in their teaching to deliver the material as simple as possible in order to obtain better understanding from the learner. It also presents that both lecturers consistent to articulate the EMT facts and procedural knowledge is implemented.

Table 2. Summary of the simplicity of engineering knowledge construct

Items	Lecturer 1 Transcriptions	Lecturer 2 Transcriptions
EMT knowledge is an accumulation of facts.	Why you chose that law is not this law. He has an argument to answer. That would train him to think.	Two things, the first most basic of mathematics to be good, the mathematical person says there is a basis of vector, calculus, it must exist
Engineers can solve EMT problems by just following a step-by-step procedure.	That's not my way, derive from basic, how the formula works, from there we tell the whole process so he can see what's going on and we just show	let say, for example, we want to find out, what is the value of electric field applied from one point to another?

Table 3 depicts the findings from the selected transcription from Lecturer 1 and Lecturer 2. This construct determines reasoning process to the learner. Questiones that the lecturer poses with indirect reasoning to the learner will facilitate learning and thinking [14] that helps to focus student attention. Both lecturers are expert in the subject matter since both involves the reviewed on the syllabus content. Lecturer 1 prefer to use inductive approach begins with elaborate the real application and finally link with the theoretical aspect. Alternatively, Lecturer 1 favor to apply deductive method whereby his material begins with teaching the theoretical aspect and finally associatie with the real application.

Table 3. Summary of the source of engineering knowledge construct

Items	Lecturer 1 Transcriptions	Lecturer 2 Transcriptions
Traditional EMT ideas should be considered over new ideas.	First, when I talk about equations, I'm going to tell the history of that person.	undefined
Correct solutions in the EMT are more a matter of opinion than fact.	When we ask the questions below what he or she can conclude with the answer, the student cannot. For those numbers, the numerical value alone cannot relate to what is the engineering issue that problem	Because in this EMT we need to have that. Because EMT is a concept. This concept sometimes wants to explain to a person, who thinks his logic is not acceptable ..... right, people think this logic is not acceptable, where is it?
EMT knowledge is created only from an expert's logical thinking.	Second, I always use simple models. At first, before I wanted to understand it, I didn't point out the difficult structure, the simple fact that he saw the idea	
A theory in EMT is accepted as correct if engineering experts reach consensus.	Instead of studying math just like engineering math, he had to change his mindset, he had to relate to engineering.	Mathematical and physics, So physics has to exist, for example how he wants to know how electrons, electrons have movement, So, that's the thing we should use again here. Two things la, maths and physics.

EMT knowledge should rely on experts' observation, experimental evidence, and rational arguments.	I always take the analysis or analogy of their most valuable thing, a mobile phone. The handphone is, for example, easy to use around us with many uses, one way communication, other examples, if you want to tell us about battery charge, the various EMTs around us, so first I believe that, because they have their phones.	
First-hand experience is the best way of knowing something in EMT.	I think our experience is, when it comes to memorizing, bad habits, for EMT. For general medical I know	But depending on the kind of lecturers who are helpful, teaching and understanding, thank God it's a bonus. But if the lecturer kind of understands that yes, if the kind of lecturer that we teach doesn't understand, we admit it does, but if it does, we accept, thank you, that is the condition. Let's do it. That's it.
We can develop EMT knowledge, whenever an EMT expert transmits his or her knowledge to us.		
Understanding EMT principles written by experts is equivalent to getting the right solution for EMT problems.	I think the fundamental knowledge is they should be curious. He must be curious	in the classroom, it's difficult because we just base on, assessment, word, written assessment.
EMT students learn when a teacher or expert transmits his or her knowledge to them.	For example, I said that day to calculate capacitance, to determine the adhesive strength of the wig, to experiment. Student create how to calculate the capacitance	Usually, this student, how to learn Add Maths, learn to add Maths level 4 5, we learn how to teach, understand, but want to solve dumb problems, how to solve problems

5. Conclusion

This research has revealed several interesting findings with regard tothe epistemological beliefs for Lecturer 1 and Lecturer 2. Firstly, the comparative research showed that most of the construct met the activities on teaching environment for both lecturers. The undefined items within the constructs need to be pondered and require postmortem. Secondly, the conceptual and procedural knowledge were implemented in the EMT course very well.

However, the epistemological belief awareness need to be enhanced since there are some undefined issues were obtained during the series of interview for example in item EMT textbooks written by experts presents the best way to learn engineering since the resources of the learning not limited only at the texbooks. Hence, it is a important towards the impact in engineering education to know the epistemology so that, the lecturer have big picture on the overall courses and also determine know why during the delivery process. Finally, this kick-start on determining on the comparative of epistemological belief on the EMT course will guide a young lecturer to have a prior knowledge of the suitable practise on teaching.

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