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Exploring student's in-depth learning difficulties in Mathematics through teachers' perspective

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Abstract

This study reports on a qualitative study of teachers teaching mathematics in a secondary school in Malaysia. The literature focuses on the role of teachers adopting in-depth approaches which lead to in-depth learning by students. Findings provide descriptions of factors that hinder in-depth learning of mathematics including student discipline, time constraints, and less exposure to the latest pedagogical techniques. Findings also provide teacher perspectives of pedagogical remedies that can help their students overcome the difficulties that hinder in-depth learning in secondary Mathematics classrooms such as fun learning, effective communication, problem based instruction, constructivism approach, real life application, technology integrated learning and student centred learning. Implications of the results of the study include describing a need for effort by teachers, schools, and the Ministry of Education to create and promote an environment conducive to in-depth learning in mathematics.

Keywords: In-depth learning in mathematics, teachers's perspective and qualitative study.

Introduction

The Mathematics curriculum for secondary schools in Malaysia aims to develop individuals who are able to think mathematically, apply mathematical knowledge effectively in solving problems and making decisions, and face the challenges of everyday life brought about by the advancement of science and technology [2]. There is a gap between what is intended in the Malaysian National Curriculum and what actually happens in the classroom. In traditional teaching system in Malaysia, students learn through rote-learning and being 'spoon-fed' [6]. Students need teachers to guide them in organising information or being analytical towards problem solving, so is important for teachers to guide students towards adopting an in-depth learning approach. In-depth learning helps to meet the demands towards self-satisfaction, accelerates the process of mastering the new materials and allows flexible use of knowledge in other contexts or situations [1].

The literature describes a variety of multidimensional factors which bear upon in-depth learning difficulties concerning Mathematics education. It involves an appreciation of the structure of mathematics, the availability or otherwise of learning resources, teacher quality, the curriculum, the learners themselves, and the value placed on the subject by society.

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These factors, however, are rooted in two main sources: external forces or environment such as parent, career aspiration, employment's need, and so on, as well as the intrinsic motivation learners bring to the classroom. Students with intrinsic motivation and interest may be more inclined to seek understanding while others may simply want to pass the examination [3]. The prior knowledge students bring to the learning situation is considered to be a vital factor in facilitating in-depth learning [7]. Prior knowledge of primary concepts provides a foundation upon which learning of subsequent concepts is based.

The teacher's central role in promoting in-depth learning requires understanding and practicing some of the basic principles of conceptual learning in mathematics. These principles include teaching general knowledge or generic concepts in the subject and helping students overcome the in-depth learning difficulties they face with mathematical concepts. Teachers can use a wide variety of activities and techniques such as discussion, stories, songs, role plays, visual illustrations, patterns seeking, using examples from real life, and use of analogy and explanations to help in building prerequisite knowledge and strengthen connections between what students already know about a concept and what they need to know [12].

The evolution of mathematical thinking and mathematical reasoning thus becomes a process which can be stimulated or influenced by external factors or conditions, which, in many researchers' view, may be controlled to some extent by teachers [5]. Researchers have described a teacher's interaction with learners as the axis on which education quality of learning turns [14]. As Stoll [14] argues that a teacher's perception, behaviour, teaching strategies, and subject knowledge are likely to determine the degree to which students make sense of the material presented to them.

1.1. In-depth Learning

The definitions of in-depth learning in Mathematics are as follows: 1) In-depth learning occurs when a student acquires detailed knowledge in a specific subject area and investigates a topic to a great depth, whereupon completion students are able to able to apply skills and knowledge gained through their programme of study for modelling, solving and appraising appraisal a solution for unknown or unseen problems in the particular area. 2) In-depth learning occurs when a student is able to use his or her knowledge and skills in a wider, not necessarily topic specific context in addition the student has the ability to apply their skills and knowledge, gained through the course of study, into the wider modelling, solution and evaluation of problems, therefore the student will have the ability to apply knowledge and skills into new areas [10].

The advantages of in-depth learning are many. First, in-depth learning can satisfy a number of personal needs of the learner. One of the important needs is the desire to achieve a certain level of satisfaction, which arises from the curiosity to know reasons and facts, explanation and causes behind events or principles. So in-depth learning helps to meet these demands towards self-satisfaction. Second, in-depth learning accelerates the processes of mastering new materials and flexible use of knowledge in other contexts or situations [13]. Prior knowledge that students bring to the learning situation is considered to be an important factor in facilitating in-depth learning [11].

1.2. Teachers Perspective

Teachers' knowledge about how students think and reason about mathematics is a key component of pedagogical content knowledge for the teacher of Mathematics. It informs instructional practices and guides instructional decision-making by providing an important lens through which to view and interpret how students respond to lesson activities generally and to assigned mathematics tasks in particular. Accordingly, it drives instructional modifications and interventions that are responsive to students' needs and result in improved student performance relative to quality mathematics standards [9]. The in-depth learning approach, the intention to extract meaning produces active learning processes that involve relating ideas and looking for patterns and principles on the one hand (a *holistic* strategy), and using evidence and examining the logic of the argument on the other (*serialist)*. The approach also involves monitoring the development of one's own understanding [4].

1.3 Teaching and Learning Mathematics

A report on Trends in International and Mathematics and Science Study (TIMSS) 2007 found that Malaysian average score for Mathematics was 474, well below the TIMSS scale score average of 500. It indicates that students could only apply basic mathematical knowledge in straightforward situations such as addition and multiplication and solve one-step word problems. This clearly indicates that students did not reach in-depth understanding of mathematics as defined by Jenkins [9], who stated that in-depth learning manifests itself in mathematical thinking characterized in terms of how students make of sense of mathematics, the strategies they apply to solve problem, the conceptual representation they create, the arguments they make, and the conceptual understanding they demonstrate.

Mathematical concepts at the secondary level are mainly rooted in the knowledge gap that students bring with them. Insufficient knowledge of generic concepts seems to hinder students to make conceptual connections. Ali [1] suggested that to improve teaching and learning processes in Mathematics classrooms requires a better understanding of real nature of the common difficulties that hinder conceptual learning, particularly at secondary level, as well as the pedagogical remedies by the teachers to help students to overcome these difficulties.

The views that mentioned and discussed as above, suggests that the way students learn is essentially influenced by the way teachers teach. Mediocre teaching techniques may result in poor learning of subject matter knowledge. Encouraging students to think logically and learn more relationally are always challenging for both teachers and the students because the investment (in terms of time, efforts, cognitive engagement) required to fostering in-depth learning is greater than instrumental learning which depends merely on rote memorization. In this context, it is important to examine the various roles that teachers can play and the pedagogical tactics that can be applied in the efforts to promote in-depth learning in the Mathematics classroom.

Recognizing the teachers' critical role in in-depth student learning in the Mathematics classroom thus gives rise to such intriguing questions as how teachers recognize the worth of and how to apply appropriate instructional strategies to promote in-depth learning in mathematics?

2. Methodology

An initial qualitative study method was used to investigate the topic of the teachers' perception of in-depth learning in mathematics, the context and nature of common difficulties students face every day in the mathematics classroom, and the instantaneous pedagogical remedies the teachers used to help students overcome these difficulties.

2.1. Sample

The respondents in this study were four secondary school Mathematics teachers in Klang Valley, Malaysia, characterized by their relatively good reputation for imparting quality Mathematics education at the secondary level. The four participants drawn from these schools were selected as representatives of those interviews in purposive sampling process and all displayed a high level of commitment towards teaching Mathematics. Moreover, the selection criteria considered to include mathematics teachers in the sample who had at least five years of experience in teaching Mathematics with characteristics or achievements such as reputation as being hardworking (consistent high grading of their performance in appraisal). The academic qualifications of the respondents were as follows: one respondent had a Bachelor degree in Engineering, with diploma of education majoring in Mathematics; the other three respondents had a Bachelor degree in Science, with a diploma of education majoring in Mathematics. In addition, all of the respondents had been teaching mathematics for more than five years at secondary school.

2.2. Data source

A qualitative study method was employed, which used structured interviews and document analysis as tools for data collection. The face-to-face interviews sought to examine the participants' experiences of promoting in-depth learning in Mathematics classroom and their views about the context and nature of students' difficulties. The interview questions were open ended, to facilitate in-depth answers and allow the participants to raise issues and

reflect on experience in dealing with these issues. Interviews that were spoken in Malay language were translated as closely as possible so that the original meanings were not lost.

2.3. Data analysis

Teachers' views about conceptual learning of subject matter and 4 underlying issues were analyzed, with particular focus on mathematical concepts prescribed in the curriculum at secondary level, as well as the ways in which teachers recognize conceptual difficulties facing students for in-depth learning of these concepts and how they go about helping students overcome those difficulties.

3. Finding

3.1. What do the teachers know about the notion of in-depth learning in mathematics?

Analysis of the teachers' perspectives about in-depth learning and their reflections clarify the meaning the teachers bring to the notion of 'in-depth learning' in mathematics. The teachers seem have broad understanding to the notion of in-depth learning, and this understanding in turn seems to influence the way they facilitate between students and subject matter knowledge. They consider mathematical learning as a cognitive process rather than memorization of rules. They proposed the need for exposing students to an exciting learning environment in the early stages helps to improve mathematical knowledge of the student.

3.2. What common difficulties do teachers face in using in-depth learning in their mathematics classroom?

Student discipline is the major common problem that hinders teachers in imposing in-depth learning in mathematics lesson. The following comments were noted:

Respondent 1: *Students with discipline problem tends to disturb the smoothness of teaching and learning.*
Respondent 2: This type of student does not have the exercise book and other mathematics tools. They easily lost focus.
School organized extra program such as canteen day and charity program that involve teachers and students result in a less time teaching and learning process.
Settings district and state equivalent tests cause teachers not to give greater emphasis to in-depth learning of Mathematics.
Workload other than teaching and learning such as clerical work and tide time table reduce the teaching focus and creativity of the teachers.
Teachers are less exposed to the latest pedagogical techniques which cause the difficulty for teachers to diversify their teaching methods.

3.3. What pedagogical remedies and tactics do teachers use to help students overcome these difficulties?

3.3.1. Fun Learning

The teachers interviewed agreed that the most important things in learning is fun learning, so teachers have to create a teaching and learning environment which is conducive and fun to the students, so that the students will feel happy and avoid stress.

Respondent 2: Fun learning through contextual learning, games and outdoor activities
Respondent 3: Make sure the teaching and learning is fun like inducing games in teaching and learning
Respondent 4: Fun learning through contextual learning or simulation.

3.3.2. Communication

Communication between student and teacher is very important in teaching and learning. Teachers have to be caring, concerned, and befriend the students:

Respondent 1: Teacher must create conducive teaching and learning environment that make the student happy. Teachers have to befriend with the student and show their concern to the student.
Respondent 2: Make sure there are two-way communication between student and teacher and make sure that the teacher befriend with the student ("Cikgu kena mesra dengan pelajar")
Respondent 3: The teacher should be in good relation with the student, if the student asked questions do not scold the student.
Respondent 4: The teacher should be friendly with the student.

3.3.3. Problem Based Instruction

The questions posed to students should be problem based, this prevents the students from memorizing the steps and teaches the student to do backward steps:

Respondent 2: From early learning, our teacher in Malaysia tend to teach mathematics through drill and practise, the student will memorized the step when solving mathematics problem. If the questions twist a bit or the problem was in long sentences, the student failed to solve the problem. I suggest teach the student problem based instruction and backward step or reverse engineer.

The students like to be challenged by being given problem-solving questions. The teacher should guide the student to diagnose the problem before going to solution of the problem:

Respondent 4: Don't give the student too easy questions to bore the students because the question does not challenge their minds.

3.3.4. Constructivism approach

Some students have *mathematics phobia*. These types of students are weak in basic mathematics concepts, so they hesitate to ask questions of the teacher. Teachers should act as facilitators and befriend the student:

Respondent 1: The students are not very good at mathematics, their prior knowledge is very poor, they are very shy, they wound ask you question, you have to be concerned.

Teacher should also show their concern to the student, guide the student based on the student prior knowledge, give the student simple questions, guide the student to solve their own problem with a little hint, As this will enhance student confident in solving mathematics problems.

Teacher should start teaching with the existing knowledge, basic concepts, the development of concept and real life applications:

Respondent 3: If the student asked you a question, don't just give them the answer, posted a question to know their prior knowledge, let the student answer the question with teachers guidance.

3.3.5. Real Life Application

All the four teachers interviewed agreed that relating teaching and learning with real life applications can enhance in-depth learning. Moreover, teachers should use real life applications based on the students' demographic background to attract student attention:

Respondent 3: When I teach "negative number", I used the daily life example like direct purchasing system (debt and pay) but the student was not interested and I can't attract student attention but when I used the credit card system for the student to show "negative sign" they are more interested.

The teacher should relate each topic in Mathematics based on students' future interests:

Respondent 2: When I teach certain topic in Mathematics for example Algebra, my student asked me why they should learn algebra and are they going to used it in the future when they are working.

The teachers have to relate each mathematics topics to the student career interest:

Respondent 3: The student also asked me if they want to be an aeroplane pilot, which topics in mathematics they should be expert with.

The teacher is unable to relate each mathematics topics to the students' future interest as they have less experience in other field of knowledge:

Respondent 2: As I'm an engineering graduate, the example I gave to the student more towards engineering discipline and seldom connect the use of mathematics in other field. I would suggest that the teacher should guide the student to relate the mathematics to the field based on their own interest through self-access learning.

3.3.6. Technology Integrated Learning

Self-access learning using ICT or internet can be used by the student to find more information with the guidance of the teacher:

Respondent 2: Students now a day are generation Y. They like to do thing and explore on their own. Teacher should benefit the use of facebook in teaching and learning. Teachers just have to guide the student, asked the student to explore and the result student got the information better than the teacher can offer.
Respondent 3: Students prefer using facebook for mathematics quiz. Using CD-ROM provided by the ministry of education also attract student attention in teaching and learning of mathematics. Students love to explore and the student have all the facilities at home which is more advanced than at school.
Respondent 4: Students like to explore and want more than the teacher can provide.

3.3.7. Student centred learning

Students in the 21st century prefer student-centered learning approach to express their ideas:

Respondent 4: Most of the subject taught are student centred learning where the students are doing the presentation and express their thought and feeling.

4. Conclusion and Discussion

This study identified the context specifics teaching and learning strategies the teachers encountered in developing in-depth understanding of students lessons. Behaviour such as being friendly and concerned about the student provides the positive emotional and motivational conditions necessary for in-depth learning. This study is in line with the finding by Goh [6] that in-depth learning is impeded by teaching approaches and behaviour.

The teaching and learning process proposed by the teachers are fun learning, problem based instruction, constructivism approach, real life application, technology integrated learning and student centred learning. Such encouraging approaches were found to be instrumental in students developing active and positive attitudes and adopting in-depth learning [8]. We live in a changing world. Facilitating active and in-depth learning is extremely

valuable. It is the learner who should be responsible for the learning. However, the teacher should become a good facilitator or instructor. The obstacles or barriers that hinder in-depth learning can be successfully overcome through careful, thoughtful planning by the teacher and adequate preparation by students [1].

The study has implications for teachers in Malaysia. The teachers should open the eye that student in the 21st century need paradigm shift of the teacher to move from rote learning and spoon feed pedagogical to student centred learning to impose in-depth learning of student. The Ministry of Education should organize more staff training programs to provide teachers with the latest pedagogical techniques in order to induced in-depth learning of mathematics aspired by the Mathematics education national curriculum.

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