
Diploma Students' Conceptions of Mathematics

Roselah OSMAN*

Universiti Teknologi MARA, 40450 Shah Alam, Selangor Darul Ehsan, Malaysia.
roselah@tmsk.uitm.edu.my



Zuraidar BADARUDDIN

Universiti Teknologi MARA, 40450 Shah Alam, Selangor Darul Ehsan, Malaysia.

ABSTRACT

This study aimed to examine how students of Diploma in Actuarial Science conceptualized mathematical aspects such as the meaning of mathematics, mathematics learning, and the use of mathematics in their daily lives. The results showed students interpreted the meaning of mathematics as a form of knowledge that contains specific content, beneficial in human social activities, has elements of beauty in a particular culture, comes from the Creator, but obtained by man from nature and historical background of human. A combination of sensory perception and experience are considered important in the construction and formation of the empirical and mathematical knowledge. Next, the meaning of mathematics learning is interpreted as an important form of activity to receive information from the classroom environment which is well sorted and structured. The most essential elements in mathematics learnings centered on human, while images of mathematics learning are related to cognitive, affective, and physical experiences. In relation to the use of mathematics in their daily lives, students reflect the interrelationship of mathematics to the environment and human. In short, the students of Diploma in Actuarial Science used the universal integrated perspective in interpreting mathematics. However, their understanding of mathematical concepts and the use of correct mathematical ideas are external and on surface, rather than in-depth.

JEL Classification: D83.

Keywords: Diploma Students; Conceptions; Mathematics; Universal Integrated Perspective.

* *Corresponding author.*

1. INTRODUCTION

Previous studies show that mathematics is difficult to learn and students often form a wrong concept about the basic idea of the subject (Gordon & Nicholas, 2013; Ignacio, Blanco & Barona, 2006; Lim et al., 2003; Reid et al., 2003). Many questions have been raised in relation to students' difficulties in mathematics learning which one of them is related to their poor understanding about various math concepts. In the human dimension, the understanding of different conceptions of mathematics is very important and the problem in mathematics learning is seen associated with ideas, descriptions, mental images, meanings, or explanations that are formed in a person about the basic nature of mathematics (Nik Azis, 2016).

Foreign and local studies related to conceptions of mathematics teaching and learning focused on several aspects such as how university students and school children learn and understand mathematics (Atallah, 2003; Petocz et al., 2006), the images of mathematics and mathematics learning held by secondary schools leavers, trainee teachers, and the public (Lim & Ernest, 1997; Nik Azis, 2008), the attitude towards statistics and conceptions about statistics among introductory undergraduate college statistics class; epistemological beliefs and subjective thinking about the practice of mathematics teaching (Nik Azis, 2008), the conceptions of mathematics and students identity in engineering education (Craig, 2013), and the influence of culture in the teaching and learning of mathematics in secondary schools (Lim et al., 2003). Related studies found that conceptions play an important role in providing information about why some students face problems in mathematics learning, while some are not problematic. The use of metaphor and imagery to describe the personal construction is rarely performed in past research.

For example, some researchers use metaphor and image as a tool to examine teachers' conception about teaching and mathematics learning (Nik Azis, 2008), and students' beliefs about mathematics and mathematics learning (Nik Azis, 2008). In teaching and learning, the metaphor often used to describe the conceptions about teaching and learning held by teachers and in which ultimately metaphor is used as a guide in teaching. Koester (2000) explained if the image held by the students and the mathematics educators themselves indicate that they consider mathematics as a subject that is not interesting, hence the process of mathematical education will become more challenging. Merriam (2009) states that mathematics is a discipline that has a strange feature, in which the discipline can be preferable or hated, understood or not understood, but each individual have his own mental pictures or images about it.

So far, most local and foreign studies related to students' conceptions of mathematics and mathematics learning focused on issues related to elements of material or physical, and isolated the elements of metaphysics in their discussions and reviews. Therefore, a contemporary process is needed to interpret the students' conceptions of mathematics, in accordance with the current demands and needs. In this context, the matters that students give priority in their lives will influence their conceptions about the nature of mathematics and the purpose of mathematics learning. In addition, the direction of local and foreign research carried out over recent decades have shown an increased focus on the development of cognitive, affective, and behavioural aspects in teaching and mathematics learning at schools and universities (Picker & Berry, 2000). However, the approach used in the research is mostly based on objective reason viewed from the point of empirical experience that can be experimented and centred on materialistic domain. In other words, this research could help in providing some information related to the difficulties in mathematics learning viewed from the perspective of Diploma in Actuarial Science students and based on domestic mold.

2. LITERATURE REVIEW

The matters discussed above and the need to understand in-depth about Diploma in Actuarial Science students' conceptions of mathematics and their roles during mathematics learning form the background for this study. Its purpose is to identify the conceptions of the Diploma in Actuarial Science students about mathematics, learning of mathematics, and the use of mathematics. Specifically, the research focuses on three questions: (a) what is the Diploma students' conceptions about the meaning of mathematics? (b) what is the Diploma students' conceptions about the meaning of mathematics learning? and (c) what is the Diploma students' conceptions about the use of mathematics in daily life. There are only few in-depth studies carried out on students' conceptions of mathematics among Diploma in Actuarial Science from various semesters. Justification for the selection of these students is aimed to diversify the recent and past research groups. Most literature do not review the conceptions of mathematics among students of a specific programme. In this study, the researcher assumes that the Diploma in Actuarial Science students have different ways of mathematics learning. The researcher believes that the finding of this study can contribute to the improvement of the quality of mathematics education.

The focus of this study is epistemological beliefs and the subjective beliefs held by Diploma Actuarial Science students about the nature of mathematics, how they learn mathematics, and the use of mathematics in daily life. The beliefs and thoughts are represented in the form of a specific image and metaphor. However, the fact that human beliefs and human minds are complex, any reviews of an image or a metaphor of study are not free from deficiency (Atallah, 2003). Next, the term images of mathematics represents the mental or refers to someone's views about mathematics. Generally, this term involves verbal, graphic representation, linguistic representation (metaphor), which relates to beliefs, feelings, emotions, and attitude towards mathematics and mathematics learning. The term metaphor refers to a situation that is compared to a real thing, although the situation is not actually a particular thing. This situation involves implicit comparison. The expression described is known as targets, while the words used to describe the matter known as sources. In addition, the term conception refers to the abstraction of generalizable patterns from perceptions and sequences of mental operations (Nik Aziz, 2016).

Some current learning theories in education such as the behaviourism, the information processing, and the radical constructivism which are all formed in the mold of modern Western secular. Therefore, a logical step is to use a viable alternative, namely the theocentric approach which is free from secularism ideology. A theocentric is also known as universal integrated perspective (Nik Aziz, 2016) which defines the concept of mathematics based on faith and piety to the Creator.

In fact, Reid et al., (2003) consider perspectives that discuss human and education as a whole are more suitable to be used as a theoretical framework for reviewing matters relating to images, metaphors, and personal ideas compared to perspectives that are not holistic. In short, past research had reviewed some questions involving conceptions of adults, school children, and university students about some aspects of the general human experience that can be linked to mathematics and mathematics learning. In this context, human experience is a source of mind or senses. However, questions involving Diploma in Actuarial Science students' conceptions about mathematics has not been examined according to the universal integrated perspective.

3. METHODOLOGY

This study was conducted on a small group of students who were pursuing Diploma in Actuarial Science at one of the public universities in the District of Klang Valley. In particular, the participants consisted of two male students and three female students. Merriam (2009) explained that there is no rule or procedure to determine the size of the participants. The number of participants in this study is small in order to obtain findings that is in depth and focused. The participants ages within 18 to 20 years old and studying in different semesters. The selection of the participants is by maximum variation sampling. The rationale of using this technique is to identify the most difference in terms of variations of experience. The five criteria in selecting participants for this study is based on namely: (a) they have the experience of more than eight years in mathematics education and agree voluntarily to become a participant after the researcher explained the purpose of the interview, (b) they are interested to participate in the study, (c) their involvement in the study does not interfere with their daily lecture schedule, (d) the researcher trusts their mathematics lecturers that the participants can give a detailed explanation about the problems asked during the clinical interview, and (e) the researcher has obtained permission from the faculty to engage the students of Diploma in Actuarial Science as the participants. In addition, the selection of the participants does not reflect overall students of Diploma in Actuarial Science. The results only represent the group of participants selected in the study only.

Data collected in this study is a qualitative descriptive data-source type that involved verbal and non-verbal communication, recording of conversation, and entries at the outset. Data collected through the clinical interview techniques, and the instrument involved four types of clinical interview. Participants were interviewed one-by-one five times within four months. Each session of interviews was recorded in audio and video, which took about 40 minutes to 60 minutes. In addition, analysing data involved four stages, namely transcription recordings of interviews to written form, development of case study, analysis of cross study, and the identification of the participants' conceptions of mathematics.

4. RESULTS AND DISCUSSION

This section discusses some findings in seven major aspects based on the fundamental questions of the study. The aspects are mental pictures of mathematics, mental pictures of mathematics learning, the nature of mathematics, metaphors related to mathematics learning, images of mathematics learning, key matters related to mathematics learning, and matters related to mathematics in daily life. Table 1 displays a summary of the discussion.

Table 1. Elements Underlying the Interpretation of Mathematics

ELEMENTS	KEY ASPECTS
The meaning of mathematics	<ul style="list-style-type: none">• Mental pictures of mathematics• The nature of mathematics
The meaning of mathematics learning	<ul style="list-style-type: none">• Mental pictures of mathematics learning• Images of mathematics learning• Metaphors related mathematics learning• Key matters related to mathematics learning
The importance of mathematics	<ul style="list-style-type: none">• Matters related to mathematics in daily life

Diploma in Actuarial Science students' conceptions of the meaning of mathematics are described below:

Mental Pictures of Mathematics: The dominant mental pictures of mathematics involves specific contents such as figures, numbers, language, and abstract symbols. Mathematics is also described as a form of knowledge that includes three categories, namely the formal definition involving branches of mathematics such as trigonometry, calculus, statistics, and probability; the problem solving tools involving the use of mathematics such as in the field of investment; and the beauty of mathematics such as geometry elements found in the art of carpentry.

The participants' conceptions of basic nature of mathematics involve four key matters, that is the truth, the sources and origins, the significance and the basic structure of mathematics. From the point of truth, the majority of participants regarded mathematics as an absolute truth in which they do not require confirmation and validation. From the point of source and origin on the other hand, some participants explained the matter from the realism point of view, while some explained it from the view of idealism, even though they believe that the origin of mathematics is the Creator. From the point of significance, the majority of participants regarded mathematics as a form of knowledge that is useful in daily life activities, while in terms of basic structure, the majority of participants regarded mathematics as a formal discipline, which is very symbolic and is not based on any range of meaning.

The Meaning of Mathematics Learning: Diploma in Actuarial Science students' conceptions of the meaning of mathematics learning is in line with some aspects pertaining to the theory of mathematics learning.

Mental Pictures of Mathematics Learning: The dominant mental picture about the mathematics learning, on the other hand involves the cognitive process such as thinking, understanding, memorizing as well as receiving, and to use the information when it is needed. Information received is through the senses.

Images of Mathematics Learning: Images specified by the study were in the form of drawings about the participants learning mathematics. The images can be classified into three types, namely the image of students centred learning and skills-oriented, image of teachers centred learning and classroom oriented, and image of technology based and affective learning oriented. However, the dominant learning image is the students-centred learning and skills-oriented. For instance, four out of five participants drew image of mathematics learning based on students-centred learning and involved the mastery of certain skills.

Metaphors Related to Mathematics Learning: Three of the five participants used different metaphors in making analogy on the role of students in mathematics learning, while two out of five participants used similar metaphor. The four identified metaphors were pencil, black holes, empty lantern, and white cloth. All the metaphors focused on the activities of receiving information or knowledge of certain environment and involving experience of the senses.

Key Matters Related to Mathematics Learning: The participants' conceptions on mathematics learning can be classified into elements that are related to the lecturers or teachers of mathematics, students, and schools. However, the most dominant conceptions among the participants involved the elements related to lecturers and students. For instance, four out of five participants assumed that a mathematics lecturer or teacher, and students as two most important elements in mathematics learning.

The Importance of Mathematics: The participants' conceptions of mathematics about the importance of mathematics involved four main contexts, namely matters related to mathematics in the context of daily life, subjects, areas of studies, and career. In this context, all participants considered mathematics as a tool to solve practical as well as abstract problems.

5. CONCLUSIONS

In general, the findings of this study are in line with several previous studies (Attalah, 2003; Koester; 2000; Petoz et al., 2006). Among others, this study found that students consider mathematics as a subject related to calculation, involves the process of thinking, and useful in life. Mathematics was seen close to the human mind and involve human interaction with nature. In other words, mathematics is considered to be a form of human-centred knowledge.

The difference of this the study with past research was the conceptions of the students of Diploma in Actuarial Science towards mathematics tend to feature the perspective of mathematics as relative. While in past research, the students' conceptions of other study programmes tend to feature the perspective of mathematics as absolute. Among others, students of Diploma in Actuarial Science consider mathematics as a form of knowledge through the sources in the physical domain such as intellectual and senses. On the other hand, mathematics is considered to be originated from the Creator and acquired by individuals based on their experience. In addition, knowledge of mathematics is considered objective in nature. In past research, mathematics is considered to be a type of knowledge which is isolated, independent of values and culture but useful because mathematics is universal (Attalah, 2003; Koester, 2000).

The conceptions of Diploma in Actuarial Science students about mathematics learning in terms of cognitive, affective, and behavioural aspects do exist at a certain point. In this regard, the conceptions of the participants about mathematics learning involves the elements of understanding, problem solving, and utilities, which is an approach that is developed by the universal integrated perspective. In addition, in the context of the use of mathematics, this study is parallel to some local studies (Nik Azis, 2008) and also foreign studies (Atallah, 2003; Koester, 2000; Petoz et al., 2006). Among others, local study found mathematics is useful in formal education and human life, while foreign study found mathematics is a useful subject in daily life, career, and high level education. Nevertheless, the study found to vary with the foreign study in terms of theoretical approach used in the review. This study examines the use of mathematics based on universal integrated perspective such as the role of mathematics in helping individuals and students in daily life activities and meet its obligations to the Creator, self, society, and environment. Foreign studies on the other hand, examine the use of mathematics based on rationalism. Rationalism is based on rational thinking or society's preference.

In summary, the conceptions of mathematics among the participants seem to be characterized by two main contexts of their lives, that is, schools and everyday life. Their conceptions also reflect their perspectives and the reality of their lives as teenagers. In addition, the reality of teaching and mathematics learning in the classes which may be focused more on the aspect of skills but less focus on the aspect of construction and acquisition of knowledge. This situation makes participants pay more attention to the use of the mathematical knowledge to help them answer the examination question as the main reason of learning mathematics. These two factors show the lack of understanding and imbalance conceptions of mathematics among Diploma in Actuarial Science students are superficial in nature, rather than in-depth.

Acknowledgements

The research is supported by RMC UiTM, and the Ministry of Higher Education, Malaysia, under the ARAS grant scheme [Project Code: 600-RMI/DANA 5/3/ARAS (0071/2016)].

REFERENCES

- Atallah, F. (2003), *Mathematics through their eyes: Students conceptions of mathematics in everyday life* (unpublished doctoral thesis), Concordia University, Canada.
- Craig, T. S. (2013), *Conceptions of Mathematics and Student Identity: Implications for Engineering Education*, *International Journal of Mathematical Education in Science and Technology*, 44(7), pp. 1020-1029.
- Evan, B. (2007), *Student attitudes, conceptions, and achievement in introductory undergraduate college statistics*, *The Mathematics Educator*, 17(2).
- Lim, C. S., Fatimah, S., & Tan, S. K. (2003), *Impact of culture on the teaching and learning of mathematics in schools*, Paper presented at the International Conference on Science and Mathematics Education, 14-16 October 2003, University Malaya, Kuala Lumpur.
- Koester, M. I. (2000), *Images Of Mathematics Of Working-Class Students of Color in an Alternative Public High School* (unpublished doctoral thesis), New York University, United States.

Merriam, S. B. (2009), *Qualitative research: A guide to design and implementation*. San Francisco, CA: John Wiley.

Nik Azis, N. P. (2016), *Perspektif Bersepadu Sejangat dalam Pendidikan Matematik*, Kuala Lumpur: Universiti Malaya.

Nik Azis, N.P. (2008), *Isu-isu Kritikal dalam Pendidikan Matematik*, Kuala Lumpur: Universiti Malaya.

Petocz, P., Reid, A., Wood, L.A., Smith, G.H., Mather, G., Harding, A., Engelbrecht, J., Houston, K., Hillel, J., & Perrett, G.(2006), Undergraduate students' conceptions of mathematics: An international study. *International Journal of Science and Mathematics Education*, 5(3), pp. 439-495.

Picker, S. H., & Berry, J. S. (2000), Investigating pupils' images of mathematicians, *Educational Studies in Mathematics*, 43(1), pp. 65-94.

Reid, A., Petocz, P., Smith, G.H., Wood, L.N., & Dortins, E. (2003), Mathematics students' conception of mathematics, *New Zealand Journal of Mathematics*, 32(S), pp. 163-172.

Reproduced with permission of copyright owner. Further reproduction prohibited without permission.