ASM Sc. J., 13, 2020
https://doi.org/10.32802/asmscj.2020.sm26(2.16)

Metaphors and Images of Mathematics among Secondary School Students

Roselah Osman[1*], Zulkifli Ab Ghani Hilmi[2], Nazirah Ramli[2] and Nur Hidayah Masni Abdullah[2]

[1]*Faculty of Computer and Mathematical Sciences Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia*
[2]*Faculty of Computer and Mathematical Sciences Universiti Teknologi MARA Cawangan Pahang, 26400 Bandar Jengka, Pahang, Malaysia*

This paper discusses the metaphors and images of mathematics held by secondary school students. These elements were obtained through their experiences in mathematics education and they may reflect the attitude and beliefs of students regarding mathematics. The study involved 143 form five students and they were classified as achievers or non-achievers based on their result in the *Pentaksiran Tingkatan Tiga* (PT3) examination. Data were collected through a written question form. Images of mathematics and metaphors between the two groups were compared and discussed. The findings showed that the mathematical images drawn by achievers and non-achievers did not show much difference with majority of the students from both groups drew mathematics learning in a classroom with a teacher (Teacher Centred Learning). There is also no significant difference between the two groups on metaphors that relate to mathematics with respect to activities, instruments, professions and elements.

Keywords: achievers; images; metaphors; mathematics learning

I. INTRODUCTION

Previous researchers used metaphors and images as a tool to study teachers' conception of mathematics and statistics learning (Goodwind, 2007; Roselah, 2012), mathematics and culture in schools (Lim et al., 2003), and students' belief about mathematics and mathematics learning (Attalah, 2003; Latterell & Wilson, 2017;NikAzis, 2009; Picker & Berry,2000). In teaching and learning process, metaphor is used to represent teachers or students' conceptions which eventually will be used as a guideline in teaching (Noyes, 2006).

Rock and Shaw (2000) stated that if students' images of mathematics and mathematician showed that they perceived mathematics as an uninteresting subject, then the learning process would be challenging. According to Furinghetti (1993), mathematics is a discipline that might be favoured or despised, something that is understood or not understood, and everyone has an image or a mental illustration about it. Inan (2015) studied the drawings of middle school students and most of the drawings were in the 'functional in life' and 'numbers and symbols' category.

Much of the earlier researches on metaphors and images of mathematics held by students and academician showed an increase number of studies in cognitive, affective and psychomotor aspects of teaching and learning mathematics. The approach used in previous researches were only focused on issues related to material or physical domain, yet non-material or metaphysical domain is not included in the discussion and observation (Nik Azis, 2009). Therefore, there is a need to come out with something contemporary and updated with the current need to identify students' interpretation on mathematics.

This study is specifically focusing on the metaphors and images held by secondary school students about mathematics. In this study, the term images of mathematics refer to mental representation of an individual in doing mathematics which might involve oral, graphical, figurative and linguistic representation. They may relate with the belief, opinion, feeling, emotion and attitude of the

Corresponding Author's email: roselah@tmsk.uitm.edu.my

individual on mathematics and mathematics learning (Roselah, 2012).

Metaphors are used to describe a difficult situation with a much easier and more understood words (Latterell & Wilson, 2017). This situation involves implicit comparison. The thing that is explained is known as target and the words used to explain it is known as resource. Therefore, metaphor is a way of communication by using a term or a word that is representing an idea or a thing literally to replace a word or a term to suggest similarity or analogy between them (Oniccah, 2017). According Lakoff & Johnson (2005), any metaphor created by an individual has a similarity and difference among those involved. For example, if metaphor of tools related to mathematics is a calculator, the individual might know the similarity and difference between mathematics and a calculator. In this study, metaphor that is chosen by the secondary students in several multiple-choice written questions form is at least in a certain aspect is influenced by their experience. Finally, the term conceptions referred to abstraction for patterns that has been generalized from perception and mental operation order. (Nik Azis, 2009)

II. MATERIALS AND METHODS

This study employed the survey design, and the data were collected through written question forms. Using convenience sampling, the question forms were distributed to 143 form five students who attended an Additional Mathematics workshop from two secondary schools in the district of Maran, Pahang, Malaysia. The design of the written question form was adapted from the research conducted by Roselah (2015). The written question form consists of four parts which are background information, metaphors related to mathematics, sources of mathematics, mathematics characteristics and mathematics learning images. The students were classified as achievers if their mathematics performance during PT3 is either A, B or C. Otherwise, the students were categorized as non-achievers. During the data collection, discussion among the students was not allowed in order to obtain unbiased and independent results from the study.

III. RESULTS AND DISCUSSIONS

Among the 143 respondents, 84(58.7%) were classified as achievers while 59(41.3%) were non-achievers. Female students constitute 71.3% while male students were 28.7% of the sample. Eighty six percent of the students indicate that they were interested in mathematics. The grade distribution for PT3 were 23(16.2%) students with grade A, 26(18.2%), 35(24.5%), 34(23.8%), 24(16.8%), 1(0.7%) for grade B, C, D, E and F respectively. Majority of the students chose educators (teachers, lecturers) and entrepreneurs as their career plan.

A. Images of Mathematics

Data on images of mathematic learning were classified into four main categories, namely, learning mathematics in the classroom with teachers involved, learning mathematics in the classroom without teachers, mathematical presentation such as numbers, symbols and mathematical tools, and real-life application. 143studentswere involved in drawing their experience on learning mathematics. 142 drawings were collected and analysed while one participant submitted blank pages. Table 2 shows the types of drawing on students experience in learning mathematics for achievers and non-achievers.

Table 1. Types of Drawing

Types of Drawing	Achievers	Non-achievers	Total (%)
Teachers involve in learning mathematics	45 (53.6%)	38 (65.5%)	83 (58.4%)
Learning mathematics without teachers	23 (27.4%)	15 (25.9%)	38 (26.8%)
Others (symbols, textbook, calculator, etc)	15 (17.8%)	5 (8.6%)	20 (14.1%)
Real life application	1(1.2%)	0(0%)	1(0.7%)
Total	84(100%)	58 (100%)	142 (100%)

In general, 58.4% of the drawings involved images of a teacher in the classroom, 26.8% showed students learning without a teacher, 14.1% are other types of drawings such as mathematical symbols, books and tools (calculator, compass, etc) while only 0.7% involved real life application. The preference on the types of drawing does not show much difference between achievers and non-achievers with majority of the students from both groups drew mathematics learning in the classroom with a teacher (Teacher Centred Learning) while there was some indication of Student Centred Learning taking place. Figures 1 to 4 show samples of the drawings. Teacher centred learning is still the common approach in teaching mathematics where students rely heavily on teachers' guidance. Students' comments on their own drawing showed much evidence of exam-oriented approach in mathematics learning whereby only one achiever drew a real-life application of mathematics, which is an electric circuit board (Figure 4).

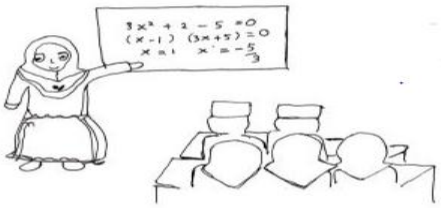

Figure 1. Drawing with image of teacher in classroom

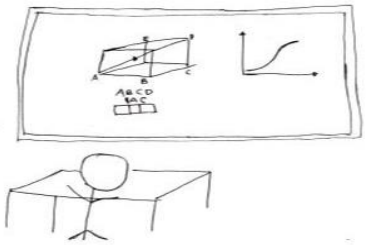

Figure 2. Drawing shows learning without teacher

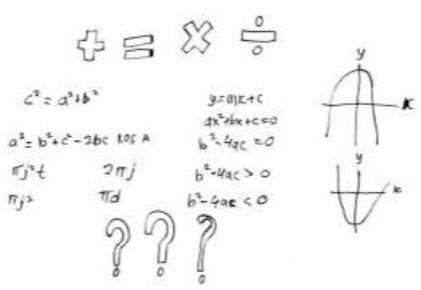

Figure 3. Drawing with mathematical symbols

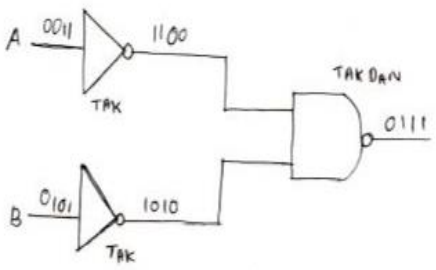

Figure 4. Drawing on real life application

B. Metaphors Related to Mathematics

Students were asked to choose the items that represent mathematics with respect to activities, instruments, professions and elements. The items in the written question form to gauge the data for metaphors related to mathematics were multiple responses type. By looking at the pattern on the rate of responses by both groups as shown in Figure 5, 6, 7 and 8, there is no significant difference between the two groups for the four aspects explored. For metaphors regarding activities related to mathematics, majority of students from both groups choose 'solving riddle', followed by 'doing magic 'and the lowest rate of response is for 'baking pizza'. These imply that most students compared solving mathematics problems as solving riddles where you need to think of something tricky and use all available information to solve problems. If they are able to solve problems especially the difficult ones, they feel they have some magical ability. For metaphors regarding instruments, 'calculator' was the most popular choice for both groups, followed by rulers and pencils. Calculator is regarded as the students' best friend as it helps them to do mathematical operations and speed up calculations. Both groups showed the same pattern regarding professions where most students regarded trader (businessman) and engineer as the professions that are most related to mathematics. Lastly, for elements related to mathematics, 'number' was the most preferred choice, followed closely by graph, formula and equation, with music being the most not related. This finding is not surprising since these four elements were embedded in their mathematical learning since year one in secondary schools. The findings that showed no difference between achievers and non-achievers can be attributed to the students going through the same mathematical learning experience, teaching methods, almost the same demographic profile

and the type of school.

In general, the above findings is consistent with Roselah (2012) who studied the images of mathematics held by the diploma students of a certain program, except for professions but differ from that of other studies such as Bozik (2002), and Atallah (2003).These differences may be due to the differences in the background of the students with respect to their mathematical learning experience and institutional teaching approach.

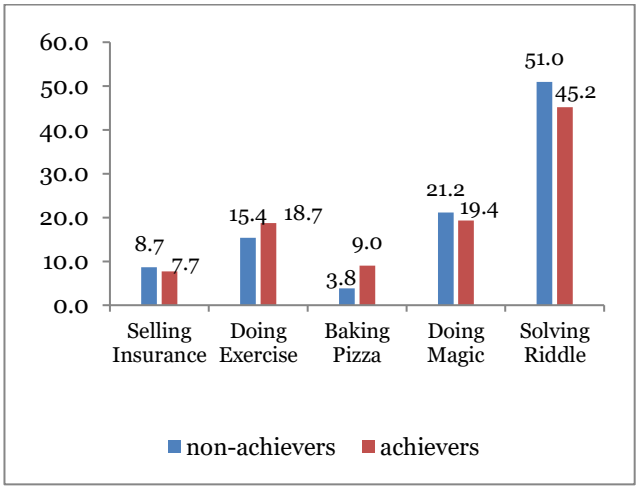

Figure 5. Activities related to mathematics

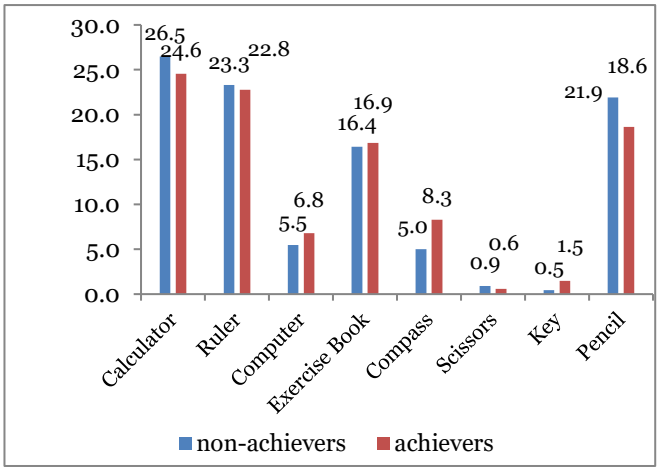

Figure 6. Instruments related to mathematics

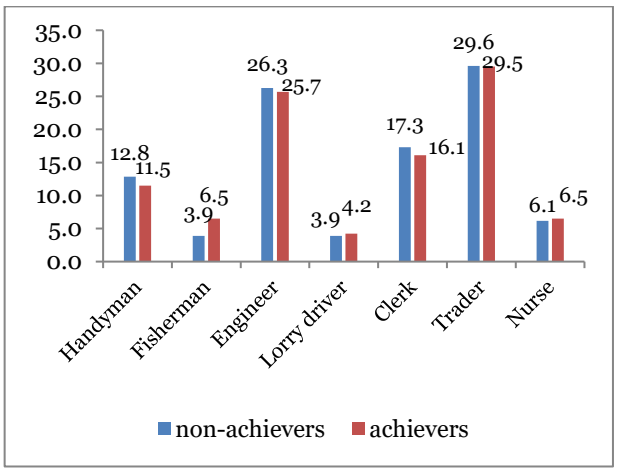

Figure 7. Professions related to mathematics

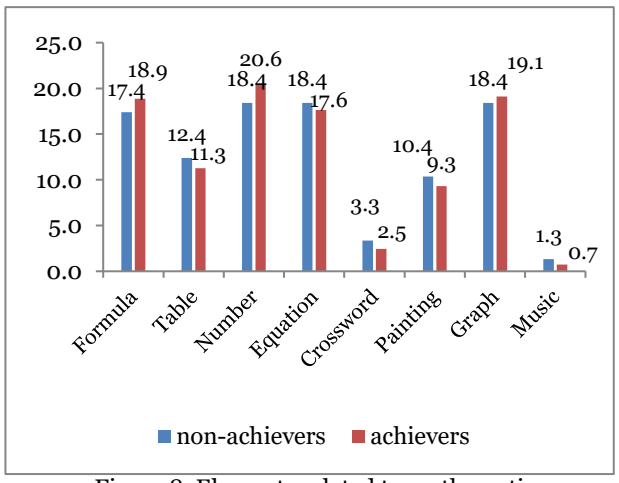

Figure 8. Elements related to mathematics

C. Characteristics of Mathematics

Students' perception on the nature of mathematics was obtained through four statements on the source of mathematics and the students rated the statements on a 5-point Likert scale. They were also given five items related to the characteristics of mathematics, namely, dynamism, truthfulness, concreteness, origin and importance of mathematics.

On dynamism of mathematics, majority of achievers (31.3%) believe that there are not many changes in mathematics. On the other hand, most non-achievers (28.8%) believe that mathematics is always changing. Most achievers and non-achievers seem to agree that mathematics is true in some situations (75% & 62.7% respectively). Nevertheless, 20.2% of achievers and 27.1% of non-achievers agree that mathematics is true in all situations. 34.5% of achievers agreed that mathematics can be presented concretely while another 36.9% chose mathematics may be presented concretely. For non-

achievers, majority of them believe that mathematics can be presented concretely (33.9%), nevertheless the same percentage (33.9%) are unsure. The statement that some mathematics are produced by human beings are supported by most of the achievers (47%) and most of the non-achievers (37.3%). Quite a number of non-achievers 33.9%) believe that mathematics is totally produced by human beings. On the importance of mathematics, both achievers and non-achievers agree that mathematics is very valuable (65.5% and 66.1% respectively) while another 28.6% of achievers and 30.5% of non-achievers agree that mathematics is valuable.

The conclusion drawn from the findings on the characteristic of mathematics is that both groups seem to agree on truthfulness, origin and importance of mathematics but somewhat disagree on the dynamism and concreteness of mathematics. Figure 9,10, 11, 12 and 13 present a comparative visual view on the preference for each characteristic of mathematics between achievers and non-achievers

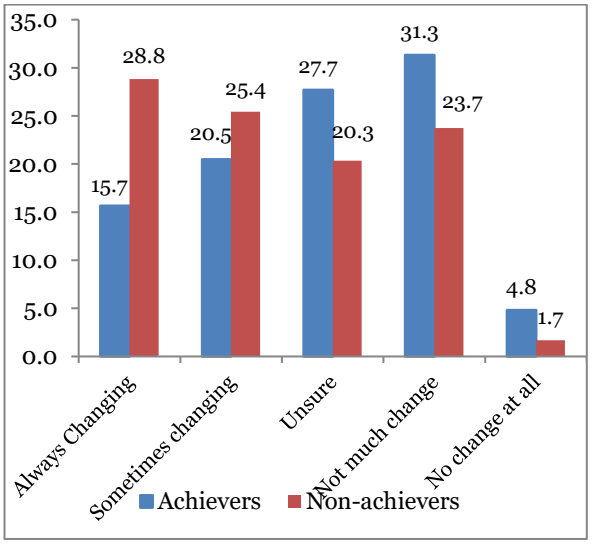

Figure 9. Perception toward Dynamism of Maths

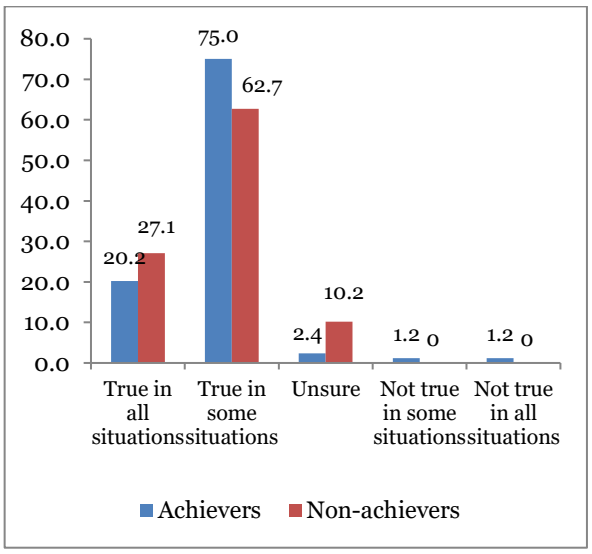

Figure 10. Perception toward Truthfulness of Maths

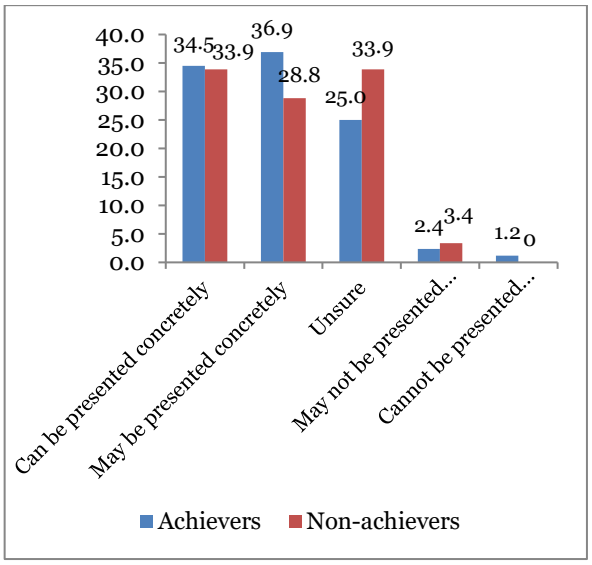

Figure 11. Perception toward Concreteness of Maths

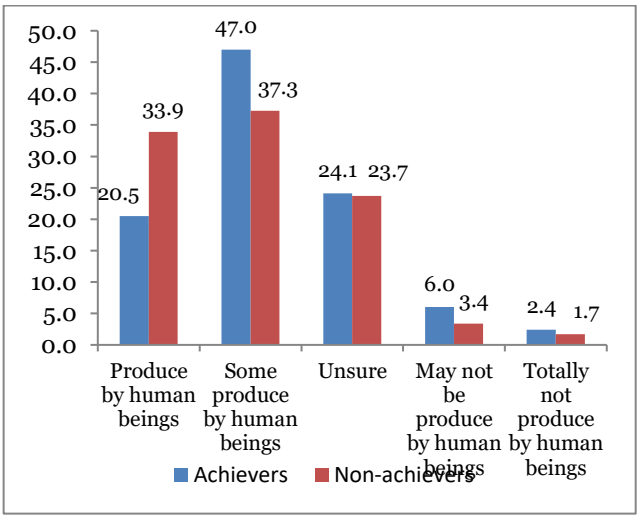

Figure 12. Perception toward Origin of Maths

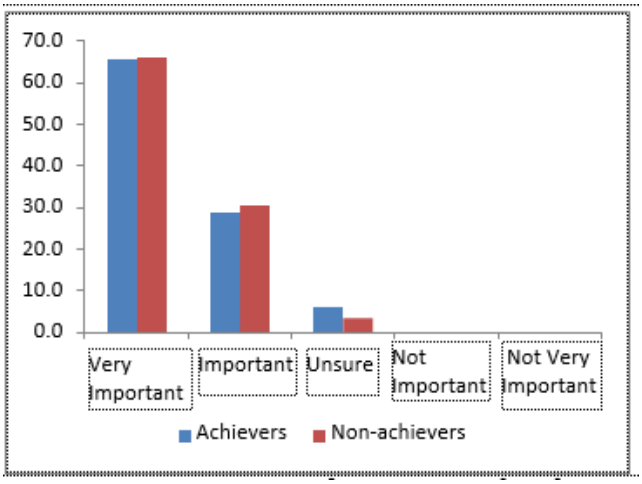

Figure 13. Perception toward Importance of Maths

IV. CONCLUSION

Overall, images and metaphors on mathematics for the achievers and non-achievers are categorized into two main contexts in their life, the school and their daily routine as teenagers. The reality of teaching and learning in the classroom might focusing too much on mastering the skill but lacking in developing knowledge engagement that lead students to give attention to the use of mathematics knowledge in their basics responsibilities towards themselves, the society and the environment. Images and metaphors related to mathematics, learning mathematics and using the right mathematics ideas mostly focus on the level of external understanding instead of internal. Both factors, lack in understanding and imbalance in mathematics learning involving metaphysical or spiritual domain need to be observed in detail. As the conclusion, the results of this study are aligned with the results of other studies related to metaphors and images of mathematics and mathematics learning conducted by Roselah (2015) and Nik Azis (2009). Based on Roselah (2015) findings, the images and metaphors of diploma students are mostly focusing more to physical aspect meanwhile Nik Azis (2009) found that images of mathematics learning of secondary school students implied teachers' centred learning.

One implication of the study is that the students need to be exposed to the learning activities based on the universal integrated approach. This philosophical, psychological and sociological approach is based on the belief of the creator or the trust in religion which sees human and learning as an integrated domain as stated in the National Education Philosophy (Nik Azis, 2008a). In this study the images of mathematics learning among the secondary students are merely fulfilling the cognitive needs related to intellectual aspect. Universal integrated approach believed that mathematics learning involves dynamic interaction on spiritual and behavioural aspects.

V. ACKNOWLEDGEMENT

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)].

VI. REFERENCES

Attalah, F. 2003, *Mathematics through their eyes: Students conceptions of mathematics in everyday life*. Unpublished doctoral thesis, Concordia University, Canada.

Bozik, M. 2002, The college student as learner: insight gained through metaphor analysis. College student journal. Retrieved fromhttp://findarticles.com/p/articles/mi

Furinghetti, F. 1993, Images of mathematics outside the community of mathematicians: Evidence and explanations. *For the Learning of Mathematics*, 95(4), 195-205.

Goodwin, D. M. 2007, *Exploring the relationship between high school teachers' mathematics history knowledge and their images of mathematics*. Unpublished Ed.D. thesis, University of Massachusetts Lowell, United States.

Inan, C. 2015, Investigation of the perceptions of students on mathematics course via the pictures they draw. *Universal Journal of Educational Research*, 3(11), 800-809.

Lakoff, G. & Johnson, M. 2005, Metaphor we live by, Chicago, Illinois: University of Chicago Press.

Latterell, C. M., & Wilson, J. L. 2017, Metaphors and mathematical identity: Math is like a tornado in Kansas. *Journal of Humanistic Mathematics*, 7(1), 46-61.

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, Universiti Malaya, Kuala Lumpur.

Nik Azis, N. P. 2009, *Nilai dan etika dalam pendidikan Matematik*. Kuala Lumpur: Penerbit Universiti Malaya.

Noyes, A. 2006, Using metaphor in mathematics teacher preparation. *Teaching and Teacher Education*, 22, 898-909.

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

Rock, D., & Shaw, J. M. 2000, Exploring children's thinking about mathematicians and their work. *Teaching Children Mathematics*, 6(9), 550-555.

Oniccah, T. 2017, Metaphors for Learning Mathematics: An Interpretation Based on Learners' Responses to an Exploratory Questionnaire on Mathematics and Learning. *International Journal of Secondary Education*. Vol. 5, No. 6, 70-74.

Roselah, O. 2015, *Konsepsi matematik dalam kalangan pelajar Diploma Sains Aktuari*. Unpublished doctoral thesis, University of Malaya, Kuala Lumpur, Malaysia.

Roselah, O. 2012, Images of mathematics held by students of Diploma Actuarial Science. *Procedia -Social and Behavioral Sciences*, Volume 8, 219-227.