Primary school pupils' images of mathematics

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Abstract. Images of mathematics are one of the critical elements of students' knowledge in mathematics learning. The knowledge is formed through students' various activities and experiences throughout their lives, including mathematics education events. This study examines the images of mathematics held by three primary school pupils of one small town located on the outskirts of Pahang. Data were collected through unstructured interview sessions and written question forms. One Year 4 male pupil, one Year 5 male pupil, and a Year 6 female pupil were selected using the convenience sampling method. Several matters related to the images of mathematics learning and metaphors related to mathematics are discussed in this paper.

1. Introduction

Today, various common factors are associated with mathematics learning among primary school pupils, such as cognitive, affective, technological, and cultural factors [1-3]. All these factors are seen to have implications on the achievement of primary school pupils in mathematics. Therefore, an extensive and in-depth study is critically needed to identify specific components or aspects in general factors that influence primary school pupil achievement in mathematics subjects. In this context, the research should focus on the research question such as what, why, and how, and not merely on what influences student achievement in mathematics.

Mathematics subjects are seen to provide less meaningful experiences in daily life to help primary school pupils develop good values and to enable them to function as successful mathematics practitioners in society [4]. Whether this indeed happens during the teaching and learning of mathematics obtained by primary school pupils from preschool to a certain stage in their lives is a question mark. Thus, the understanding or knowledge held by the primary school pupils about mathematics is seen to have an important place in the research setting and research agenda. Although mathematics plays a supporting role in many contemporary studies, there are very few studies that focus specifically on the images of mathematics held by primary school pupils based on local molds.

Images of mathematics involve personal mental pictures of mathematics. Such images involve a personal representation or depiction of mathematics using a particular visual, narrative, verbal, or other forms of representation. Such representations can involve cognitive and affective dimensions. The images of mathematics held by an individual may contain implicit elements that the individual is unaware of or displayed to the public without conscious consideration. According to Picker and Berry [2], the widespread public image in western society on mathematics is something that is difficult, cold, abstract, theoretical, highly rational, but essential and masculine. Furthermore, mathematics is also
Literature Review

In their research,HttpGet and Inan [12] pointed out the importance of mathematical images and metaphors in mathematics education. They asserted that educators use mathematical images and metaphors to provide students with a comprehensive understanding of mathematics. These images and metaphors can be used to explain mathematical concepts, facilitate problem-solving, and enhance students' conceptual understanding. However, the use of mathematical images and metaphors in the classroom can vary significantly depending on the cultural, educational, and societal contexts. Therefore, it is crucial to understand the cultural and educational differences in the use of mathematical images and metaphors in mathematics education.

The previous studies have found that students in various countries have different perceptions of mathematics, and these perceptions can significantly affect their mathematical learning. For instance, students in Turkey obtained 64 different mathematical images and metaphors [5-6] and students' mathematics images [2-7] are included in this research. According to the study, students who have positive perceptions of mathematics are more likely to achieve higher academic performance. On the other hand, students who have negative perceptions of mathematics are more likely to experience mathematics anxiety and perform poorly in mathematics. Therefore, it is essential to understand the cultural and educational differences in the use of mathematical images and metaphors in mathematics education.
Sumpter [16], in their study on the conception of mathematics through drawings and questionnaires, they found out that the lower grade students have a more positive attitude towards mathematics than the higher-grade students. A study by Laine et al. [17] on students' drawings also found out that the lower-grade mathematics classes have a positive emotional atmosphere compared to the higher-grade classes. A study by Epstein et al. [18] investigates young people's imagination on mathematics. They found out that Mathematics is represented as a secret language and a difficult subject with a lot of works.

From the study carried out on primary school pupils, the results show that mathematics lesson is more like a game and they like it more if it involves games and fun activities. They possess a positive attitude and positive atmosphere towards mathematics as compared to the higher grade students.

3. Methodology
This study was conducted on a small group of primary school pupils in Jengka, Pahang, where two male pupils and a female pupil were selected as the participants of the study. According to Merriam [19], there is no rule or procedure to determine the participants' size. One pupil from each Year 4, Year 5, and Year 6 class were selected using the convenience sampling method. Thus, the selection of the participants does not imply the overall primary school pupil population. The results only represent the group of participants selected in the study.

This study used a case study design, which involved qualitative and quantitative data. Generally, data were compiled through unstructured interview sessions and written questions form. For the unstructured interview sessions, participants were interviewed one-by-one, recorded in audio and video, and took about 20 minutes to 30 minutes, depending on the time taken by each participant. Apart from the interviews, data were also collected using the written questions form adapted from Osman [20], which consists of demographic information and multiple-choice questions on metaphors related to mathematics learning such as activities, instruments, occupation, and elements. Since only three participants were involved in the study, the written question form was analyzed by listing the choice of metaphors selected by the Year 4, 5, and 6 pupils for each component.

The qualitative data were analyzed in four phases. The first phase was converting recordings of interviews to transcribed form. The second phase was to develop the case study for each participant, followed by across case analysis. The third and final stage was to identify the three aspects of the fundamental questions related to primary school pupils' images of mathematics; 1) mental pictures of mathematics learning, 2) metaphors related to mathematics learning, and 3) images of mathematics learning.

4. Results and Discussion
This section discusses the research findings based on the questions of the study. The discussion covers three aspects of the fundamental questions related to images of mathematics held by primary school pupils.

4.1. Mental Pictures of Mathematics Learning
The first concept is on the mental pictures that supplied information to matters involving the learning of mathematics. In particular, the respondents were asked to express their descriptions while learning mathematics. It focuses on what, why, and how. All respondents agreed that learning mathematics is a subject related to computation. They firmly stated that mathematics is closely related to timetables and the basics of calculation, such as addition, subtraction, multiplication, and division. This finding is not surprising since those elements are embedded in their mathematical learning for primary schools.

The second concept was the respondents' point of view upon hearing the words "learning mathematics." Generally, the responses describe their thoughts that occur promptly and reflexively. Collectively, two of the respondents mentioned numbers. According to their further explanation, numbers are very closely related to calculations. These can be explained through their previous answers
when they were asked about matters related to learning mathematics. The following passage illustrates an excerpt of a Year 5 participant related to the issue discussed. In this passage, P denotes the researcher or interviewer, while S indicates the study participant.

\[
P : \quad \text{What comes to your mind when I say } "\text{learning mathematics}"? \\
S : \quad \text{I would think of numbers… and the operations of addition, multiplication, division, and subtraction.} \\
P : \quad \text{Why do you associate it with the operations of addition, multiplication, division, & subtraction?} \\
S : \quad \text{Those are important things to remember.} \\
\]

However, a participant has described the joy of solving questions or tasks as the response to the words learning mathematics. The following passage illustrates an excerpt of a Year 4 participant related to the matter discussed.

\[
P : \quad \text{What comes to your mind when I say } "\text{learning mathematics}"? \\
S : \quad \text{A feeling that } "\text{makes us happy}". \\
P : \quad \text{Why do you think } "\text{makes us happy}"	ext{?} \\
S : \quad \text{When we can correctly answer mathematics questions, we able to do mathematics exercises.} \\
\]

4.2 Metaphors Related to Mathematics Learning

The participants' choices of metaphors related to mathematics learning can be classified into four components, namely process, toolbox, social, and formal (Table 1). The three participants unanimously relate solving riddles to process; calculator and ruler to toolbox; fisherman, businessman, bank manager, and engineer to social and numbers and tables to formal. As with findings from previous studies [21], most of the participants perceived learning mathematics as an act of solving riddles. They have to use their brain to think, using all available information, but still, there is uncertainty about the solution obtained. It is interesting to note that two participants perceived doing mathematics as an act of worship, whereby getting rewards and blessings not only in this world but also in the hereafter. All participants chose a calculator and ruler as the metaphor for toolbox, fisherman, businessman, bank manager, and engineer for social and numbers and tables for formal components related to mathematics. Yet, in real life, one's perception of mathematics involves a mixture of the four components in different percentages. Furthermore, because of the possibility of a particular individual case stating more than one component, then a clear explanation for such a case is not possible.
| Components   | Choices of metaphors                                                                 |
|--------------|-------------------------------------------------------------------------------------|
| Process      | Year 4, 5, and 6 participants chose mathematical learning as solving riddles.       |
|              | Year 5 and 6 participants chose mathematical learning as a religious act and physical exercise. |
|              | Year 4 and 6 participants chose mathematical learning as selling insurance.         |
|              | Year 6 participant chose mathematical learning as baking pizza.                    |
| Toolbox      | Year 4, 5, and 6 participants chose calculators and rulers as mathematical instruments. |
|              | Year 5 and 6 participants chose computers, exercise books, and pencils as mathematical instruments. |
|              | Year 4 and 6 participants chose a compass as a mathematical instrument.            |
| Social       | Year 4, 5, and 6 participants chose businessman, bank manager, engineer, and fisherman as the occupations related to mathematics. |
|              | Year 5 participant chose nurse as the occupation that is related to mathematics.  |
|              | Year 4 participant chose carpenter as the occupation that is related to mathematics. |
| Formal       | Year 4, 5, and 6 participants chose numbers and tables as mathematical elements.    |
|              | Year 4 and 5 participants chose equations as a mathematical element.                |
|              | Year 4 and 6 participants chose formula as a mathematical element.                 |
|              | Year 5 and 6 participants chose drawings as mathematical elements.                 |
|              | Year 5 participant chose the clock as a mathematical element.                     |
|              | Year 6 participant chose graph as a mathematical element.                         |

4.3 Images of Mathematics Learning
Images portrayed were in the form of the participants' drawings on their learning mathematics experiences. The majority of the participants drew numbers and activities related to numbers. In these regards, the primary school pupils' images of mathematics learning seem to be consistent with their standard selection of numbers as their choices of metaphor related to the learning of mathematics. In particular, primary school pupils describe numbers and calculations as the important elements in mathematics learning. Figure 1 to Figure 3 shows the drawings by the three participants, which signify their learning mathematics experiences.
5. Conclusion

In general, this study shows that interpretation on drawings, selections as well as explanations made by primary school pupils on metaphors related to mathematics learning allows ideas to be formed about their self-perceptions of mathematics learning. Regarding the images of mathematics learning, the findings of this study are in line with Inan [12], who found that the images of mathematics belonging to primary school pupils are focused on calculation activities that involve the use of numbers. Bland [22] claimed that the data on images and metaphors could be richly rewarding, exciting, and high quality when the preparatory work is done well and all the features of the research activity are considered. This study might give a glimpse of effective ways to collect and interpret information through images, as freehand drawing is an exciting and valuable means of gathering data for young learners. Lastly, the current emphasis in primary school mathematics education is on mastering basic skills and being positive towards mathematics, as well as the teacher-centered, student-centered, or technology-centered teaching and learning approaches according to specific contexts as advocated by the National Philosophy of Education. However, this study found that primary school pupils held images of mathematics teaching and learning that are only centered on the use of numbers alone.
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