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Thinking of Optimizing the Role of Mental Imagery through PjBL for Mathematically Literate Life: Systematic Literature Review

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Abstract

The demands of literate life are increasingly crucial in this era, because being literate means being able to deal with real problems in life using certain scientific concepts, including mathematics concepts. Meanwhile, humans are capable of 'creating', 'ideas' and 'doing' according to what is 'imagined' in their minds. As Rene des Cartes said: Cogito Ergo Sum. So, one of the main aspects is the role of mental imagery for each individual. This article discusses theoretically the role of mental imagery through Project-based Learning to build mathematical literacy. Articles are built with a systematic literature review. It was concluded that mental imagery plays an important role in building mathematical models, presenting aspects of the problem in the form of meaningful mathematical illustrations. Conversely, mental imagery also plays an important role in translating mathematical concepts into ideas and concrete forms in the context of life. Both of these are very suitable to run in project-based learning. Because the project leads students to develop ideas and be creative according to their imagery.

Keywords: Mental Imagery, Project-based Learning, Mathematical Literacy, Systematic Literatur Review.

INTRODUCTION

Ideally, mathematics is always present in human activities, including in Indonesia. Historical evidence supports the claim that mathematics is ingrained in Indonesian society. The proof is that there are many cultural masterpieces with extraordinary mathematical content. Such as the temples, the lodok land distribution system in the Manggarai-Flores culture, or woven and carved motifs. The proof contains mathematical content, even though it is not called mathematics. But for Indonesia, the PISA results for mathematical literacy are always in the bottom 7th rank (Hewi & Shaleh, 2020). Why does this happen?

The main problem, among other things, is that learning methods are not yet optimal in empowering things that are crucial in students and their environment. One of the things is the role of mental imagery for each individual to generate ideas, create and act according to what is imagined in his mind, and then, solving the real-live problem. As Rene des Cartes said: Cogito Ergo Sum (Angelos, 2020).

In this era, the demands of life to be literate in mathematics are increasingly crucial, meaning that humans are not only required to master the theory of mathematics on paper, but must live their knowledge, use mathematics in solving everyday problems. So, one of the best learning models is project-based learning. The research team will examine the concept in order to obtain a scientific reference base for educators and students to understand and realize a combination of mental imagery and problem-based learning to build mathematical literacy.

METHODS

Literature Search Procedure

This type of research is a Systematic Literature Review. The research article search flowchart is adopted from Moher's opinion, as follows (Moher et al., 2009):

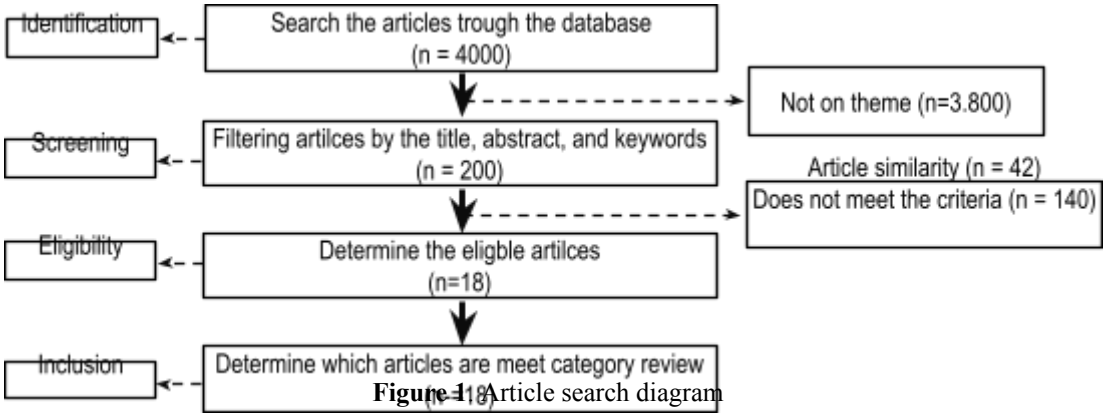

Figure 1. Article search diagram

Researchers search for related literature with the help of the Publish or Perish application. Search sources are focused on electronic databases including Scopus, Google Scolar and Crossref. The search process uses keywords: Mental Imagery, Project-based Learning, Mathematical Literacy, Systematic Literatur Review. But researchers also use personal collection literacy which is known to contain the concept of mental imagery, mathematical literacy or project-based learning. The researcher selects the literature to select literature that is in accordance with the objectives of this study.

RESULTS AND DISCUSSION

Mental Imagery on Math Working

Actually, every man working on consciousness of what will doing. Bars stated that the strategy of treating consciousness as a variable has now become standard in the study of subliminal vision, blindsight, and implicit cognition. We can easily apply it to mental imagery, yet we rarely do so (D'Angiulli, 2021). The main aspect here is mental imagery. A person, on his way of life, must have a main thing in the mind, and it is about mental imagery on a matter.

Mental imagery is the representation and accompanying experience of any sensory information without direct external stimulus, and operate in the human mind (Kajikawa & Schroeder, 2015; Loureiro et al., 2022; Suica et al., 2022). Mental imagery divided based on the sensory modality being simulated, such as visual, auditory, tactile, gustatory, olfactory and motor (Donoff, n.d.; Nanay, 2018; Pearson & Kosslyn, 2013). Mental imagery plays a crucial role in all cognitive processes (María Angeles Gonzalez;Jesús A. Dopico; Alfredo Campos, 2021). We see, in making graphs that are used in economics, politics, physics, health report, etc; to facilitate the understanding of mathematical concepts and models.

Research results by Kaune et al., show that metacognitive and discursive activities play an important role as subject independent indicators for the teaching quality (Kaune et al., 2011). Here, metacognitive is conscious thinking about what is known and what is not known, while, discursive is related to the ability to reason to determine the logical conclusions. Here, metacognitive and discursive are two parts of capital to be able to live mathematically.

Regarding mathematics, a clear picture in the human mind can be realized in the form of writing, pictures, graphics or other forms, either on paper or on a computer screen (Bills, 2003). Humans can make a house plan, complete with calculations of the materials needed and the value of money that must be prepared.

Mathematical Literacy

Mathematical literacy is an individual's ability to formulate, employ and interpret mathematics in various contexts, which includes reasoning mathematically and using mathematical concepts, mathematical procedures, mathematical facts and mathematical tools to describe, explain and predict phenomena (OECD, 2019). PISA describes briefly as follows:

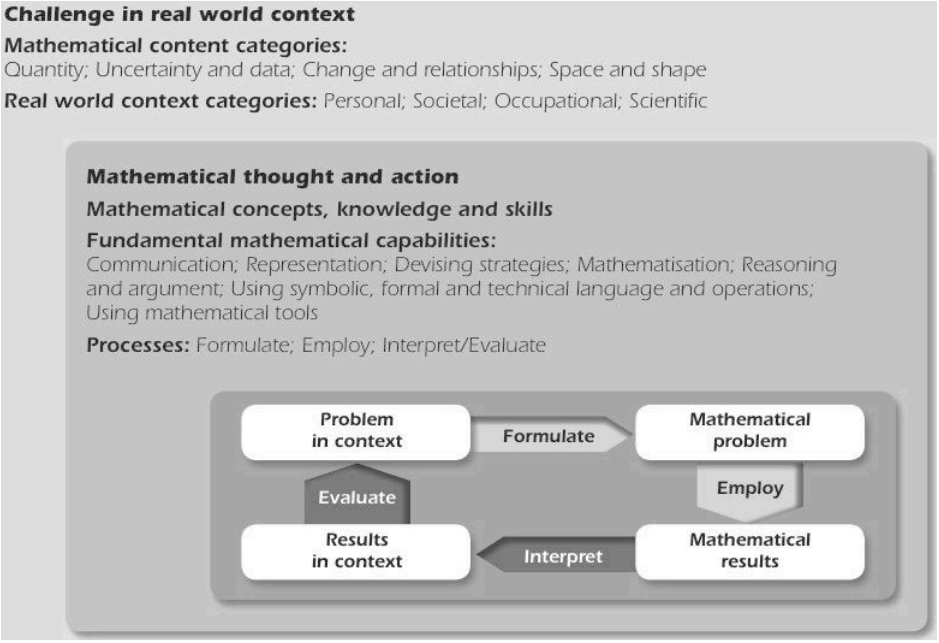

Figure 2. Mathematical Literacy Diagram by PISA

The demands of mathematical literacy oblige the transformation of mindset from 'mathematics as a subject' to 'mathematics is a life activity'. All parties, including students, teachers and parents, must change their perspective, from just pursuing academic qualifications to forming mathematical skills. According to Wardono et al, to achieve mathematical literacy, people must be able to think logically, analytical, systematic, critical, and creative (Wardono et al., 2016).

As the PISA diagram above, the first step is translating the real problem into a mathematical problem. From the variate aspects of real problems, we must identifying the mathematical aspects, recognising mathematical structure (including regularities, relationships and patterns) of existing problems, and then turned into mathematical variables or mathematical figures or other mathematics symbols. Then, it is modeled into a mathematical problem. Models can be in the form of mathematical equations or inequalities, mathematical geometric shapes, mathematical number patterns, mathematical data presentations, or other mathematical forms.

In the second step, we work mathematically on the model that has been built. Logic and mathematical operations are enforced. Creativity is needed to organize the mathematical concepts suitable for the model. Here, are we devising and implementing strategies, using mathematical tools, applying mathematical facts, rules, algorithms and structures, manipulating numbers, graphical and statistical data and information, algebraic expressions and equations, and geometric representations. New illustrations can be presented, to help with concepts, logic or mathematical calculations. All mathematical thinking is carried out to reach a solution to a given problem.

In the third step, the mathematical solution obtained is matched again with the initial problem. Here it is necessary to explain how the initial data in the problem affects this solution. The fourth step, this solution needs to be evaluated so that it meets the reasonableness of the real context. Critical and logical thinking is needed in order to determine the scope of this solution to real problems, and how to limit mathematical concepts to this mathematical solution, so that it is truly feasible to apply to a real problem.

Project-based learning with mental imagery charges to build Mathematical Literacy

Learning by doing is the best way for students to truly experience the mathematical content they are learning for themselves. Through independent projects, individuals or groups of students produce real work, and act directly to apply science concepts and vice versa act directly to build science concepts by solving real-life challenges by utilizing all the resources in their environment. So, one of the best learning model is Project-based Learning (PjBL). Through PjBL, the character of hard work, communication skills, ability to use technology, reasoning skills, and critical thinking skills will be formed. This follows the demands of a mathematically literate life. Educated students deal with real problems and produce real work, so they have experience, artifacts in memory and new ideas can be formed.

Project-based learning is a learning model that focuses on student activities in making projects related to everyday concepts or problems (Munahefi et al., 2023). PjBL is based on the assumption that students need opportunities to construct knowledge by solving problems by asking and describing questions, designing and conducting investigations, collecting, analyzing, and interpreting information and data, drawing conclusions, and reporting findings (Kokotsaki et al., 2016). There are six advantages of PjBL (Guo et al., 2020), namely being guided by leading questions, focusing on learning objectives, participating in educational activities, collaboration between students, using supporting technology, and creating real works/artifacts.

Based on the definitions and opinions of the experts above, PjBL can be designed by collecting mental imagery content in students' written reports. In this case, the project produces a written work, and it is obligatory to include mathematically meaningful illustrations in the written report. Making illustrations requires mental imagery and creativity. As the results of LeBoutillier's research, it was reported that a diverse sample of creative individuals is related to the use of mental images in the creative process (LeBoutillier & Marks, 2003).

Related to this idea, in PjBL, one of the ways proposed is that students are asked to solve contextual problems by having to display meaningful mathematical illustrations. This illustration stimulates the mobilization of students' mental imagery abilities. The thing to note is that an illustration contains a thousand meanings. This means that students are encouraged to think complexly, critically and logically so as to produce a meaningful summary. Referring to Amalric and Dehaene's research results, suppressing mental imagery is very helpful in activating both parts of the human brain (Amalric et al., 2018). Thus, PjBL with mathematical illustration charge really supports empowering students' brains, and certainly supports students to be mathematically literate.

In the following, the role of mental imagery is presented, related to the stages of the mathematical literacy process (according to PISA, as shown in **Figure 2**):

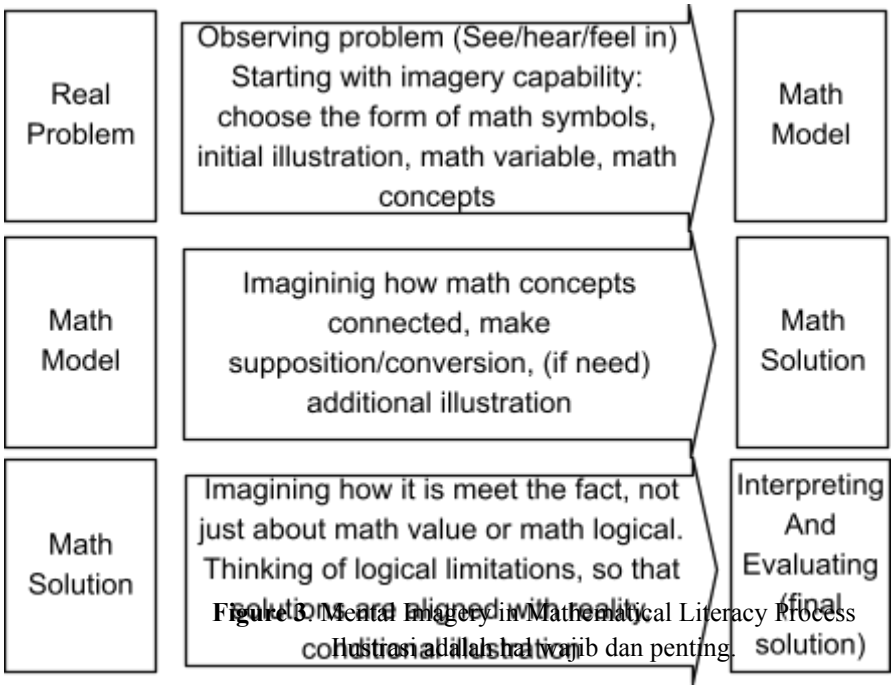

Figure 3. Mental Imagery in Mathematical Literacy Process
Ilustrasi adalah hal wajib dan penting.

CONCLUSION

Some of the things that can be concluded from this analysis are as follows: (1) mental imagery needs to be emphasized in learning to form students' thinking stability in dealing with real problems or living with mathematical literacy; (2) PjBL contains mental imagery to help students develop creative and complex ideas.

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