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APPLICATION AND REFLECTION OF PHILOSOPHY ON ELEMENTARY SCHOOL MATHEMATICS CONTENT

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Abstract. The current disruptive era demands many changes in various areas of life. Likewise, the technological transformation has significant unavoidable consequences. This is where it is necessary to consider a strong foundation for students from the elementary level. This article examines the application and reflection of philosophy on the content of elementary school mathematics in Indonesia. The background of this study is the need for an era where there is a need for constructive mathematics learning from an early age towards learning the Industrial Revolution 4.0. The purpose of this study is to identify (1) the nature of symptoms or objects of application and reflection of philosophy in elementary mathematics (ontological reasons), (2) how to obtain or manage symptoms or objects (epistemological reasons), (3) the benefits of symptoms or objects (axiological reasons), and two-way understanding of phenomena and objects (hermeneutics). Data is obtained based on relevant sources such as journal articles, books, and previous research results supported by qualitative analysis. The results of this study indicate the need to reveal the application and reflection of philosophy in low-grade mathematics content through the ontology of mathematics, epistemology, axiology, and hermeneutics.

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INTRODUCTION

The initial pillar in the formation of critical, logical, and systematic thinking skills starts from learning mathematics at the elementary school level (Tsani et al., 2025). However, in practice, many students still experience difficulties in understanding the basic concepts of mathematics in depth (Wiryana & Alim, 2023). Mathematics learning is often trapped in a mechanistic and procedural approach, where students are only directed to memorize formulas and solve problems without understanding the conceptual meaning contained therein (Dahlan, 2018; Schoenfeld, 2020). This has led to a negative perception of mathematics as a difficult and decontextualized subject (English, 2017). Problems related to daily life in mathematics learning are only used as a source of inspiration for concept discovery or formation, so that students only apply existing concepts, not examine and interpret mathematical concepts themselves (Jeheman et al., 2019; Warmi, 2019). This causes the form of mathematics to tend to be rigid and far from the origin of the construction of mathematical concepts, causing mathematics learning to be limited to knowledge transfer (Risdiyanti & Prahmana, 2021).

These conditions indicate an urgent need to reflect on the approaches used in learning mathematics. Reviewing the material and process of mathematics learning from a philosophical perspective is one possible approach. Philosophy is the foundation of human thinking in the academic world as a reasoning process in seeking and exploring science (Fadli, 2021). Philosophy plays a very important role in solving problems in education and everyday life (Sadewo et al., 2022). The philosophical approach provides a strong reflective foundation in understanding what mathematics is (ontology), how mathematical knowledge is obtained (epistemology), what values it contains (axiology), and how mathematical meaning can be interpreted (hermeneutics) (Ernest et al., 2016; Paul Ernest et al., 2016).

Ontologically, mathematics is not only understood as a tool for calculating but also as structures and patterns that exist abstractly in the human mind and in natural phenomena

(Zalukhu et al., 2023; Zulmaulida & Saputra, 2024). Epistemologically, students' understanding is actively built through the process of social interaction and learning experiences, not just knowledge transfer (Sierpinska & Lerman, 1996). Axiologically, mathematics can be a vehicle for character building through instilling values such as perseverance, consistency, and honesty (Diputera et al., 2024; Zulmaulida et al., 2024). While hermeneutically, students need to be trained to interpret symbols, representations, and meanings of mathematical concepts in contexts relevant to their lives (Fried & Dreyfus, 2014).

This study shows the need for an approach that is able to bridge the mastery of concepts with a complete understanding of mathematics. Existing research has not holistically described the role of philosophy in learning mathematics, especially in elementary schools (Fadli, 2021; Veronica et al., 2022; Sadewo et al., 2022; Bintoro, 2021; Zalukhu et al., 2023). By examining the content of mathematics learning from a philosophical perspective, teachers are expected to develop learning strategies that are more reflective, contextual, and transformative. The hope is that there will be a more profound understanding of the content of elementary mathematics that not only fulfills the cognitive aspects but also builds existential, ethical, and meaning awareness of mathematics itself. This study is also expected to be a contribution in developing mathematics learning models that are rooted in philosophical thinking and relevant to the modern educational context.

RESEARCH METHODS

The method used in writing this article uses literature study supported by qualitative data analysis. Literature research is theoretical research, references, and other scholarly literature related to culture, values, and norms developed in the social context under study (Mirzaqon & Purwoko, 2017). Through this literature study, several sources of theory and literature that are relevant to the topic of discussion will be studied. According to Kuhlthau (Mirzaqon & Purwoko, 2017), the steps in the literature study are as follows: 1. Selection of topics, 2. Exploration of information 3. Determining the focus of research 4. Collection of data sources 5. Preparation of data presentation 6. Preparation of reports. Data at the time of writing the article were used to analyze ancillary data. Secondary data is the source of research data obtained indirectly by researchers through intermediary media (Sari & Asmendri, 2020). The research continued with qualitative research, using the flow of Miles and Huberman (Miles et al., 1994), namely (1) data reduction; (2) data presentation; and (3) conclusion drawing and verification. We analyzed the validity of the research data using triangulation techniques, which included observation, interview, and documentation. Researchers made observations when mathematics learning took place in the classroom. Furthermore, researchers confirmed the results of observations through interviews and supporting documents, namely students' math learning outcomes.

RESULTS AND DISCUSSION

This research has gone through six stages of literature study so that the research results can be obtained. The first stage is the determination of the topic of study, which specifically discusses the application and reflection of philosophy on the content of elementary school mathematics. The second stage through information exploration involves searching and identifying keywords through VOSviewer, ScienceDirect, ProQuest, and Google Scholar applications with keywords: philosophy in elementary mathematics content, ontological philosophy, epistemological philosophy, axiological philosophy, and hermeneutics philosophy. The third stage determines the focus of the research, namely learning mathematics in elementary schools in Indonesia. The fourth stage examines and identifies aspects of the influence of philosophy on the mathematics content of elementary school students in terms of axiology, ontology, epistemology, and hermeneutics in depth through the identification that has been found previously. The fifth stage is preparing to present data based on the sources that have been obtained, which are used as the main material for the article. At this stage, through the review of notes, books, final assignments, and journal articles, the data was reduced to 21

literature sources, which became the main material of the 53 literature sources collected. The sixth stage is the preparation of a report, which is then outlined in an article with the title of the application and a reflection of philosophy in elementary school mathematics content. These stages are supported by qualitative data to emphasize the study related to the application and philosophy in elementary school mathematics content.

Based on these stages, the results of the analysis of the concept of elementary learning in terms of ontology, epistemology, axiology, and hermeneutics are obtained. This study shows that ontologically elementary school mathematics learning can be interpreted as a social activity by bringing together subjective and objective knowledge. Epistemologically, elementary school mathematics is empirical or experience-based mathematics that involves students' horizontal and vertical mathematizations. Axiologically, elementary school mathematics learning has intrinsic goals (mastery of mathematics is beneficial for itself), extrinsic (mastery of mathematics to be applied in everyday life), and systemic (mastery of mathematics can be developed in the arena of community engagement). Moreover, the values contained in learning mathematics can be provisions and guidelines for elementary school students in facing the challenges of today's era. In hermeneutics, elementary school mathematics is built gradually from concrete mathematics, concrete models, and formal models, and the last is formal mathematics. In general, the results are summarized in the Figure 1.

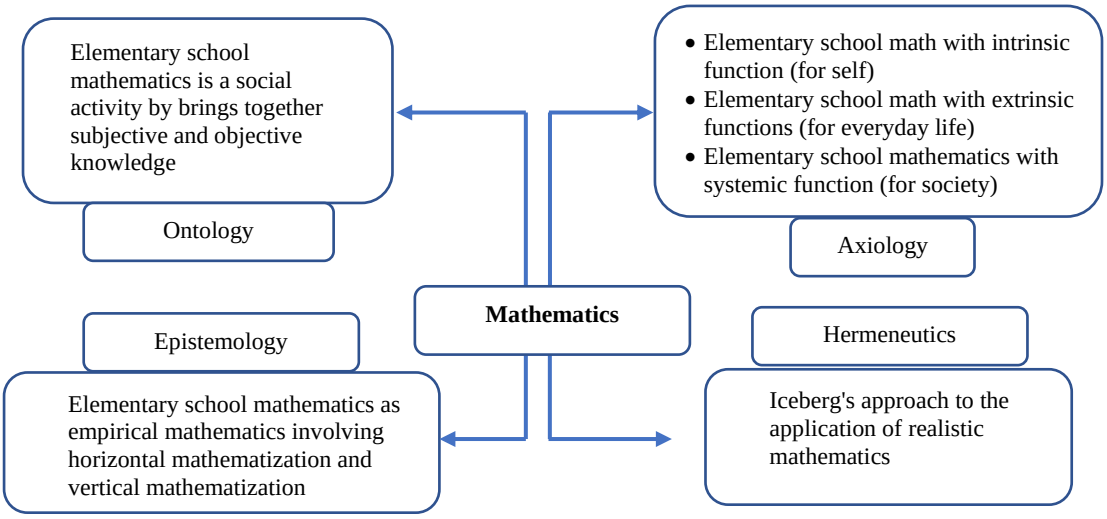

Figure 1. Philosophy of mathematics content in elementary school

Philosophy of mathematics content perspectives in Figure 1 above will each be fully explained as follows.

Ontology of Mathematics Learning in Elementary School

The ontological approach concerning mathematics is a reflection to capture mathematical reality as it is found (Marsigit, 2004). The starting point is to seek understanding according to the roots and fundamentals of mathematical reality. Mathematics has an important role in elementary school learning. The role of mathematics as a whole (Ebbutt and Straker, 1995; Marsigit, 2014), namely: (1) Mathematics is the study of patterns and relationships. Children need to be aware of the relationship between repetitive ideas and mathematical ideas. These relationships and ideas become a common thread throughout the course; (2) Mathematics is a way of thinking, where mathematics is a strategy for organizing, analyzing, and synthesizing information; (3) Mathematics is art characterized by internal order and consistency. Children need guidance in recognizing and appreciating the underlying order and consistency as they build their understanding of mathematics; (4) Mathematics is a language that uses well-defined terms and symbols. Learning these terms and symbols improves students' ability to communicate with themselves about science, the real world, and mathematics (Marsigit, 2014).

Ebbutt and Straker argue that school mathematics is an activity or activity of students in finding patterns, conducting investigations, solving problems and communicating their results

so that it is more concrete (Marsigit, 2014). According to Hans Freudental, the same thing (Marsigit, 2013) Mathematics is a human activity and must be associated with reality. Meanwhile Paul Ernest et al. (2016) figures who represent the Socio-constructivist define mathematics as social interaction. The nature of learning elementary school mathematics is to bring together subjective and objective mathematical knowledge through social interaction to obtain mathematical concepts to test and represent new knowledge that has been obtained by students (Marsigit et.al, 2022). Social interaction between students and teachers will be able to provide critical activities for correcting concepts so that students will get concept improvements, and finally, their subjective knowledge of mathematics is the same as their objective knowledge. From the same source, it is explained that through the process of social negotiation, the reconstruction of mathematics learning in its culture shows a clear process of new mathematical knowledge, which can be in the social sphere (subjective) or the individual sphere (objective). To acquire or learn objective knowledge of mathematics, students need to develop procedures or steps in solving mathematical problems. Through these steps, students will obtain mathematical concepts that have been actualized in themselves so that it can be said that their mathematical knowledge is subjective. This shows that social interaction in learning mathematics is important to bring subjective knowledge of mathematics closer to objective knowledge (Marsigit, 2013).

Mathematical ontology has an important role in the development of mathematics, such as clarifying mathematical concepts, increasing efficiency and accuracy, and improving student understanding (Zulmaulida & Saputra, 2024). With the help of ontology, students can relate mathematical theories to the real world, and this supports more profound understanding and better application. Here an example of the realization of school mathematics is presented through qualitative data in this study, namely mathematics learning that utilizes mathematical tasks with cultural contexts and lego assistance to understand the concepts of multiplication and division in grade 3 elementary school, which is shown in figure 2. This mathematical task uses the context of Prambanan Temple accompanied by a Hypothetical Learning Trajectory (HLT), which occurs to students when counting activities are taking place. The activity shows the process of subjective knowledge to objective knowledge that is appropriate for elementary school students through social interaction in the process of solving mathematical problems.

Figure 2. Documentation of lego grouping by students

Thus, the essence of studying elementary school mathematics is to bring together subjective and objective knowledge of mathematics through social interaction to obtain mathematical concepts to test and represent new knowledge that has been obtained by students.

Epistemology of Mathematics Learning in Elementary School

If viewed from the epistemological aspect, mathematics develops a numerical language that allows for quantitative measurements (Suedi, 2016). With concrete, contextual, and measurable concepts, mathematics can provide answers accurately. In learning mathematics, a

person constructs mathematics through a process of adaptation and organization. The development of a student's mental structure depends on the knowledge that students acquire through the process of assimilation and accommodation.

Mathematics is divided into two, namely pure mathematics and empirical mathematics. As one opinion states, "Mathematical knowledge consists of pure intuition and constructs"(Kravanja, 2023). Pure mathematics can be said as mathematics that has an abstract object of study in the mind. Mathematics is the science of regularities, the science of organized structures starting from elements that are not defined, to elements that are defined to axioms or postulates and finally to proofs. While the mathematics of empiricism is mathematics that has a concrete object of study or empiricism. Mathematical empiricism emphasizes experience to acquire knowledge Ernest. This empirical statement discusses mathematical concepts that have empirical origins and mathematical truths that have empirical justification, names derived from observations of the physical world. Thus in empirical mathematics it can be described as human activity (Cantoral et al., 2018; Morgan, 2001). Therefore, the meaning of mathematics can be said to be an active, dynamic, and generative process because human activities are not static. Mathematical reasoning is inductive and deductive reasoning. Inductive thinking is defined as thinking from specific things to general, deductive thinking is defined as thinking from general to specific (Christou & Papageorgiou, 2007; Lerman, 2020). Mathematics seeks truth starting with inductive means, but in order to continue to generalize what is true for all circumstances, it must be proven deductively.

The mathematics used in primary education is empirical (Putri, 2017). Empirical mathematics is following the characteristics of students in elementary schools, where logical operations can be carried out oriented to objects or events that are directly experienced by students. In this regard, according to Hans Freudental (Dhoruri et al., 2006), mathematics must be connected with real life and mathematics as a human activity, so that when students do mathematics learning activities, there is a process of mathematization in them. According to Treffers, there are two kinds of mathematization namely: (1) horizontal mathematization and (2) vertical mathematization (Agustianti Fuad & Zulkarnaen, 2022). Horizontal mathematization processes from the real world into mathematical symbols. The process occurs in students when they are faced with problems in real-life situations. While vertical mathematization is a process that occurs in the mathematical system itself. Horizontal mathematization is more emphasized to form a solid mathematical construction so that vertical mathematization is more meaningful for students (Haji, 2013).The activities related to horizontal mathematization and vertical mathematization are described in the Table 1 (Haji, 2013).

Table 1. Difference Between Horizontal Mathematization and Vertical Mathematization

Horizontal Mathematization	Vertical Mathematization
a. identify or describe specific mathematics in a general context, b. schematic, c. formulate and visualize problems in different ways, d. find relationship, e. find regularity, f. recognize isomorphic aspects in different problems, g. transfer real-world problems to math problems, and transfer real-world problems to known math problems	a. finding strategies to solve problems b. linking relationships between mathematical concepts or applying formulas/formula findings, c. represent the relation in a formula, d. prove regularity, e. refine and customize models, f. using different models, g. combine and integrate models, h. formulate mathematical models, and i. generalize

Learning mathematics in elementary schools focuses on the truth of mathematics based on experience. This is an opportunity for teachers to make learning mathematics enjoyable for students, through the application of innovative student-oriented approaches, such as a contextual approach to learning mathematics. Based on physical properties, low-grade elementary school children are very active so they easily feel tired and need rest (Marini et al., 2022; Wangid & Purwanti, 2020). The implication is that in learning mathematics, teachers can take advantage of

student activity in learning activities that involve motor activities, such as presenting learning in the form of games but of course by giving attention to the time and material in mathematic that is deemed appropriate to be used as a game. Mental qualities, in this age group, children love to learn. Teachers must be able to facilitate students to acquire mathematical knowledge with various activities that emphasize learning experiences. Thus, epistemologically studying mathematics in elementary schools involves empirical mathematics which emphasizes the experience of students while exploring knowledge through horizontal and vertical mathematization processes.

In other words, mathematics is positioned as knowledge that can be obtained through the learning process (Zalukhu et al., 2023). The following examples of empirical mathematical activities through the qualitative data of this study include mathematical tasks given to students that consist of 3 activities, namely: (1) arranging legos according to the concept of place value; (2) arranging legos and counting the number of legos using the concept of multiplication; and (3) disassembling legos to divide the same number of legos using the concept of division. After students are asked to arrange Legos according to the Prambanan Temple building as a context, the Legos used will be counted based on the color of the Legos. More details of the explanation are illustrated in Figure 3. Students are asked to group the Legos used according to the color that has the agreed place value weight. This activity shows the process of horizontal mathematization.

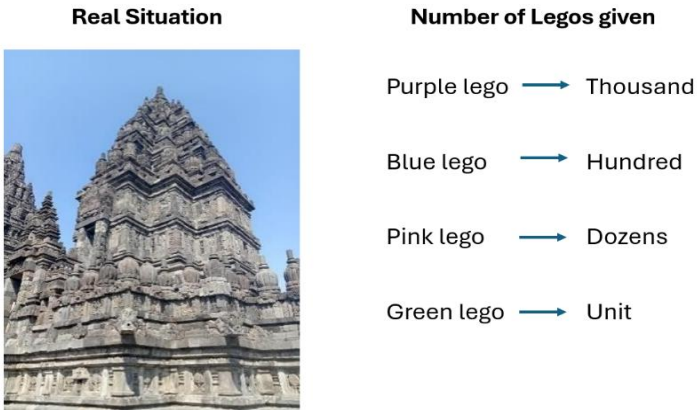

Figure 3. Mathematical Task Number Operations

Examples of empirical mathematical activities through the qualitative data of this study include mathematical tasks given to students that consist of 3 activities, namely: (1) arranging legos according to the concept of place value; (2) arranging legos and counting the number of legos using the concept of multiplication; and (3) disassembling legos to divide the same number of legos using the concept of division. After students are asked to arrange Legos according to the Prambanan Temple building as a context, the Legos used will be counted based on the color of the Legos. Students are asked to group the Legos used according to the color that has the agreed place value weight. The activity in Figure 4 and Figure 5 shows the horizontal mathematization process.

Figure 4. Lego assembling and First group Worksheet Results on Multiplication Activities

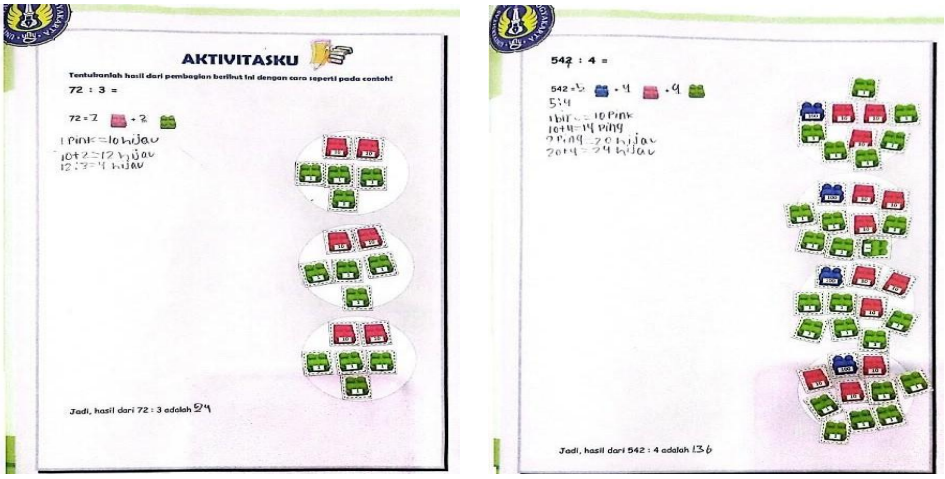

Figure 5. Student Worksheet Documentation in Division Activities

Axiology of Mathematics Learning in Elementary School

Axiology is a science that investigates the nature of values (Mayasari et al., 2022; Syafitri et al., 2021). In relation to mathematics, the axiological approach studies philosophically the nature of the value of mathematics (Marsigit, 2004). Axiology discusses the values contained in mathematics, such as truth, accuracy, and rigor. By understanding these values, we can understand the objective and universal nature of mathematics (Zulmaulida et al., 2024). One of the goals of learning mathematics is to appreciate the usefulness of mathematics in life, that is, curiosity, attention and interest in learning mathematics, and a persistent and confident attitude in problem solving (Hakim, 2019).

The value of mathematics contains at least four dimensions, including mathematics has value because of its meaning, mathematics has value because of its uniqueness, mathematics has value because of its purpose, and mathematics has value because of its function. Each dimension of the value of mathematics is always related to the nature of values that are intrinsic, extrinsic, or systemic. If a person masters mathematics only for himself then his mathematical knowledge is intrinsic. If someone can apply mathematics to everyday life, then mathematical knowledge is extrinsic. If someone can develop mathematics in the social arena of the mathematics community, then his mathematical knowledge is systemic (Marsigit, 2011). However, the developed mathematical values must be accompanied by critical thinking, because mathematics is nothing but critical thinking itself. Mathematical acumen can see into the future through the teleological concept that what happens in the future can at least be photographed through the present. However, there are still other values related to the level of quality. In the first quality, the value of mathematics only appears on the outside, while in the second, third, and so on, the value of mathematics is already metaphysical. Concerning quality improvement, teachers need to continuously evaluate the shortcomings or strengths of their teaching in the context of better learning and learn new techniques that are more interesting and effective (Naima et al., 2023). A teacher must be able to master ways of organizing classes, utilizing teaching resources, achieving teaching goals according to student abilities, developing evaluation systems, handling individual differences, and realizing a certain teaching style according to needs. Thus the teacher will be able to reflect the teaching style well and flexibly.

Axiologically, when elementary school students do mathematics learning activities, there is a mathematization process consisting of horizontal mathematics and vertical mathematics (Marsigit et.al, 2022). Axiology also discusses how mathematics can be applied in everyday life. By understanding the application of mathematics in everyday life, we can understand the truth of mathematics more deeply (Zulmaulida et al., 2024). Qualitative data in this study related to mathematics learning by utilizing mathematical tasks with cultural context and Lego tools obtained the axiology of mathematics content in elementary schools, which can be formulated from intrinsic, extrinsic, and systemic values. For intrinsic value, when students

arrange Legos to resemble Prambanan Temple, they are not just playing but also building a deep understanding of patterns and regularities that are at the core of the concepts of multiplication and division. Students enjoy the beauty of mathematics through explorative activities without the pressure of results. The extrinsic value gained through cultural context and concrete tools makes math real and meaningful in students' lives. Activities such as counting the number of reliefs or temple towers with Legos practice counting skills, problem-solving, and connecting the lesson to the world around them. It also hones communication, collaboration, and creative thinking skills, which are important 21st-century competencies. The systemic value of this learning is that it contributes to cultural preservation and strengthens contextual education. This learning supports the Merdeka Curriculum and the strengthening of the Pancasila Learner Profile by bridging local values and global numeracy literacy and forming a generation that loves culture and is critical and creative.

The values contained in learning mathematics can be provisions and guidelines for elementary school students in facing the challenges of today's era. Mathematics is like a queen and at the same time a servant in science. As queen, mathematics has strict protocol rules because of its consistent axiomatic deductions. As a servant, mathematics has a soul to help other sciences. This illustrates that mathematics needs to be mastered by a learner, both in its application and in its mindset. School mathematics, which is part of mathematics, is chosen based on the development interests, abilities, and characteristics of students, and the development of science and technology is expected to be in line with the demands of students' needs to face the challenges of future life. Teachers must teach axiological values in mathematics to students. This can help students understand the importance of these values in mathematics and in everyday life (Zulmaulida et al., 2024). In addition, teachers should also teach students to appreciate the process of learning mathematics, not just focus on the end result. Thus, students can understand that math is not only about solving problems, but also about the learning process and the values contained in it.

Hermeneutics Learning Mathematics in Elementary School

The development of mathematics cannot be separated from the essence of hermeneutic philosophy (Marsigit et.al, 2022). Hermeneutics is the study of interpretation (Follesdal, 2001; George, 2020) which means the process of thinking or understanding something from one's mind. Hermeneutics can be interpreted as an art as well as a method for finding meaning in all human experiences to build a shared life of virtue (Saptono, 2012). Hermeneutics in elementary school mathematics learning can be found in the Iceberg approach, which is an iceberg of realistic mathematics. Iceberg's approach is an approach that adheres to constructivism (Haji, 2013). This approach is based on Realistic Mathematics Education (RME), which can help students model a mathematical problem so that students can find their mathematical concepts step by step.

Frans Moerland describes the mathematization process in RME learning as an iceberg formation process (Dhoruri, 2010). There are four levels in the iceberg (Handayani et al., 2021; Juana et al., 2022) that is: 1) concrete mathematics, where in this activity the teacher has a role to manipulate objects in the student's environment as a means of meaningful learning. Giving a concrete problem to students can motivate students in learning because students know the usefulness of the material they are studying; b) a concrete model, where this activity is a bridge from a concrete context to modeling. Students are encouraged to move from concrete mathematics to concrete models. After students understand the problem in a concrete situation, students can use pictures, symbols, or graphics to create a concrete model through various manipulations (Wahyuni & Jailani, 2017); c) Formal model, where the use of models and strategies is not only shown in concrete situations given in the learning process but the model must also be used in general in different situations. At this stage students are encouraged to design models that are used to solve other problems that are different from the context of the previous problems; d) Formal mathematics, which is the culmination of the Iceberg approach.

In this study, a qualitative analysis of the implementation of utilizing mathematical tasks with cultural context and lego tools was conducted so that an example of hermeneutics can be shown through the following Figure 6.

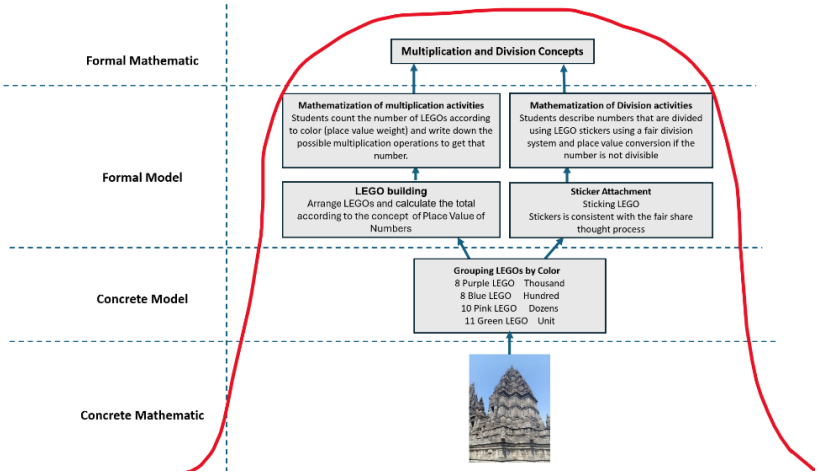

Figure 6. Example of Learning Math with the Iceberg Approach

More fully, Figure 6 shows that the iceberg approach helps students to model a problem from a real context into a formal mathematical model in the form of formal mathematical notation. This approach is an adoption of previous research (Sugiman et al., 2025). Thus, hermeneutically, elementary school students' mathematics learning can be through the iceberg approach to realistic mathematics learning. This iceberg approach allows students to have a conducive environment that makes it easy for students to develop their imagination. In teaching and learning mathematics, the development of students' imagination is much more important than logic. If logic can take them from one place to another, imagination can take them everywhere. Imagination is necessary for free thinking. The paradigm of teaching and learning mathematics must be changed; not just learning or just applying mathematics, but it must go beyond and start producing it (Djauhari, 2015).

CONCLUSIONS AND SUGGESTIONS

In this technological era, 21st-century skills that are prepared for students from basic education will lead students to be better prepared to survive and compete in the future. Mathematics learning in elementary schools becomes the basis for further learning and also in other subjects. Therefore, learning mathematics in elementary schools needs to be carried out optimally. Ontology, elementary school mathematics learning, brings together subjective and objective knowledge of mathematics through social interaction to obtain mathematical concepts for students. Epistemologically, elementary school mathematics learning involves empirical mathematics, which emphasizes student experience while exploring knowledge through horizontal and vertical mathematization processes. Axiologically, the value of mathematics obtained in learning mathematics includes intrinsic, extrinsic, and systemic values. Hermeneutic mathematics learning can be found in the Iceberg approach, which gradually includes concrete mathematics, concrete models, formal models, and formal mathematics.

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