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INTEGRATING THE PHILOSOPHY OF MATHEMATICS AND INFORMATION TECHNOLOGY TO ENHANCE STUDENT UNDERSTANDING IN LEARNING

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ABSTRAK

Penelitian ini bertujuan untuk mengeksplorasi konsep-konsep filsafat matematika dan model-model pengajaran yang diterapkan dalam pendidikan matematika dari perspektif filsafat pendidikan. Penelitian ini menganalisis berbagai sumber yang terkait dengan filsafat, filsafat pendidikan, filsafat matematika, dan kaitannya dengan model-model pengajaran, termasuk yang berbasis Teknologi Informasi. Data dikumpulkan dari sumber-sumber sekunder, seperti buku, artikel, dan jurnal terakreditasi yang diterbitkan antara tahun 2019 dan 2024. Metode penelitian yang digunakan adalah telaah pustaka dengan pendekatan kualitatif, dengan fokus pada analisis referensi yang terkait dengan studi filsafat, filsafat pendidikan, dan model-model pengajaran matematika yang dikaitkan dengan filsafat dan Teknologi Informasi. Temuan penelitian ini mengungkapkan bahwa: 1) filsafat matematika memainkan peran penting dalam meningkatkan kualitas pendidikan matematika; 2) model-model pengajaran matematika harus dihubungkan dengan filsafat pendidikan melalui penerapan konsep-konsep kehidupan nyata; dan 3) integrasi Teknologi Informasi dalam model-model pengajaran mendukung efektivitas proses pembelajaran. Penelitian ini diharapkan dapat memberikan kontribusi dengan memberikan wawasan tentang peran filsafat matematika dalam konteks model-model pengajaran berbasis Teknologi Informasi..

ABSTRACT

This study aims to explore the concepts of the philosophy of mathematics and the teaching models applied in mathematics education from the perspective of educational philosophy. The research analyzes various sources related to philosophy, philosophy of education, philosophy of mathematics, and their connection to teaching models, including those based on Information Technology. Data was collected from secondary sources, such as books, articles, and accredited journals published between 2019 and 2024. The research method employed is a literature review with a qualitative approach, focusing on the analysis of references related to the study of philosophy, educational philosophy, and mathematics teaching models linked to philosophy and Information Technology. The findings reveal that: 1) the philosophy of mathematics plays a crucial role in enhancing the quality of mathematics education; 2) mathematics teaching models should be connected to educational philosophy through the application of real-life concepts; and 3) the integration of Information Technology in teaching models supports the effectiveness of the learning process. This study is expected to contribute by providing insights into the role of the philosophy of mathematics in the context of Information Technology-based teaching models.

1. INTRODUCTION

Mathematics for centuries has been considered an abstract and pure scientific discipline, where universal truths are discovered through logistical deduction (Manurung et al., 2023). As a branch of philosophy, philosophy of mathematics studies the nature, basis and meaning of mathematics itself. This philosophy tries to answer fundamental questions such as what mathematics really is, how humans understand it, and how mathematics reflects reality in the world. According to (Isnaintri et al., 2023), understanding the philosophy of mathematics in depth allows students to see mathematics not only as a collection of rules and formulas, but also as a fundamental way of thinking in understanding the world.

With the advancement of information technology (IT), mathematics education has undergone significant changes (Yogyanto et al., 2024). IT-based learning models offer various innovations that allow students to learn in a more interactive, visual, and flexible manner. Through mathematical software, simulations, and online learning platforms, mathematical concepts can be explored more deeply and

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visualized more concretely. (Wahyuni et al., 2024) argue that IT-based learning provides students with opportunities to understand mathematics from diverse perspectives and more dynamic approaches, thereby enhancing their motivation and engagement in the learning process.

The connection between the philosophy of mathematics and educational technology has become increasingly relevant in the context of modern learning. The philosophy of mathematics provides a framework for students to understand the essence of mathematics underlying the technology they use in learning (Asad et al., 2022). With the appropriate technological approach, abstract mathematical concepts can be more easily comprehended, as technology provides visualizations and interactive models that help students grasp the fundamental principles of mathematics. According to Siswanto et al. (2024), technology serves as a supportive tool that reinforces philosophical understandings of mathematics.

Fauzi & Hayya (2022) further state that IT-based learning creates opportunities for a more personalized approach to mathematics education. Technology enables the learning process to be tailored to the individual needs and abilities of students. This aligns with the philosophy of mathematics, which emphasizes the development of logical and analytical thinking skills. With the aid of technology, students can utilize various resources such as graphical visualizations, virtual object manipulation, or interactive explorations to understand mathematics in ways that best suit their learning styles (Putri & Siswanto, 2024).

On a deeper level, the philosophy of mathematics highlights the beauty, order, and logic within mathematics, which are often difficult to approach through traditional methods. However, IT-based learning provides students with opportunities to experience mathematics as more than just numbers and symbols. Technology helps students discover the structure and harmony inherent in mathematics and understand how mathematics serves as a language connecting abstract ideas to physical reality (Asad et al., 2022). Thus, technology makes the philosophy of mathematics more accessible and relevant in learning.

In this digital era, the integration of the philosophy of mathematics with IT-based learning models has become increasingly important in addressing the challenges of modern education (Siswanto et al., 2024). Technology not only enhances students' academic achievements but also fosters critical and creative thinking skills, which are the primary goals of mathematics education. By combining the philosophy of mathematics and technology, students are not only taught "how" to solve problems but also understand "why" and "for what purpose" mathematics is applied. This creates a balance between understanding abstract concepts and practical applications in everyday life, ultimately shaping a generation that is not only proficient in mathematics but also aware of its meaning and relevance in the real world.

2. METHODS

This research is a type of library research carried out by collecting information from various sources, such as reference books, articles, results of previous research, notes and journals that are relevant to the topic being studied (Sugiyono, 2019). The data used in this research is secondary data, which includes accredited articles or journals published between 2020 and 2024, as well as books by philosophers, both national and international. The literature used to support this study includes various perspectives in educational philosophy, mathematical philosophy, as well as mathematics learning models related to information technology. The library research process includes steps such as selecting a topic, collecting supporting information, determining the focus of the study, classifying reading material according to the research focus, reading and recording relevant material, reviewing and enriching the reading material, and finally preparing reports or articles related to the research. the focus of this research.

3. RESULT AND DISCUSSION

Results

Before *IT Based Learning*

The learning model is a structured framework that organizes the steps or syntax in the learning process, with the goal of achieving the desired competencies or learning outcomes. Understanding learning models is crucial for teachers as these models guide them in designing and implementing the teaching and learning process. As explained by (Siswanto & Firmansyah, 2024), learning models encompass curriculum planning, material preparation, and classroom management. In this regard, learning models not only assist teachers in designing systematic learning experiences but also facilitate the achievement of specific educational goals (Rokhman et al., 2022). The success of implementing a

learning model highly depends on selecting an appropriate model that aligns with the subject matter, basic competencies, and students' abilities, especially in challenging subjects like mathematics.

The primary function of a learning model is to serve as a guide for teachers in conducting the learning process from the beginning to the evaluation phase . This model becomes an essential reference in designing effective and systematic teaching strategies. According to Astiwi et al. (2024), a learning model serves to generate changes in students' behavior, create a supportive learning environment, and foster good interactions between teachers and students. Additionally, learning models also facilitate the development of innovative curricula and engaging instructional materials, thus increasing student involvement in the learning process. Ultimately, a well-designed learning model will yield more optimal learning outcomes, while also sharpening students' creative and critical thinking abilities.

The rapid development of Information Technology (IT) has significantly impacted innovations in learning models, particularly in mathematics education (Alenezi et al., 2023). IT has enabled the development of more effective and efficient learning media and created limitless interaction spaces between teachers and students. In the context of mathematics education, integrating technology helps students better understand abstract concepts in a more visual and interactive manner. This is crucial in subjects often perceived as difficult, such as mathematics, where abstract concepts can become barriers to student comprehension. With the presence of technology, students can more easily visualize and interact with the material being taught.

Furthermore, technology also plays an essential role as a tool for delivering information in the learning process. Schramm (Syah et al., 2024) state that technology functions as a medium for transmitting information that supports the teaching and learning process. In mathematics education, the use of IT not only enhances the effectiveness of learning but also enriches the teaching methods employed by teachers. IT-based learning models allow teachers to present mathematical concepts in more creative and innovative ways, thereby increasing student engagement and participation in the learning process. This demonstrates that technology plays a crucial role in enriching students' learning experiences.

The integration of the philosophy of mathematics and IT-based learning models also makes a significant contribution to improving students' mathematical abilities. The philosophy of mathematics, which focuses on a deep understanding of mathematical concepts, can be applied in developing IT-based learning models. This creates a strong synergy between mathematical theory and its application in daily life, making it easier for students to relate abstract concepts to real-world situations. By using this approach, mathematics learning becomes more relevant and engaging for students.

In the application of IT-based learning models, various models grounded in the constructivist paradigm can be employed to enhance active student participation (Siswanto et al., 2024). Constructivist learning models emphasize the importance of students' active roles in the learning process, where they must build their own understanding through exploration and interaction with the material. Information technology can support this paradigm by providing interactive learning tools and resources, allowing students to explore the concepts being taught more effectively.

Realistic Mathematics Education (RME) Model

The RME model is a mathematics learning approach developed by Hans Freudenthal, which emphasizes the importance of connecting mathematical concepts with students' real-life contexts (Ulfah et al., 2020). RME focuses on understanding mathematics through direct experience and everyday situations, allowing students to construct mathematical knowledge in a constructive way. This approach encourages students to investigate, discuss, and collaborate in solving problems relevant to their lives. Literature studies show that RME is effective in improving students' understanding and motivation in mathematics because it provides real world contexts and fosters deeper and more meaningful learning (Herlinda et al., 2023).

The integration of RME with information technology has also shown positive results, with technology enriching the learning experience through simulations and visual aids that support the exploration of mathematics in broader contexts. RME helps students not only understand mathematical concepts but also develop critical thinking and problem-solving skills. The application of information technology (IT) in this model is highly relevant because RME is based on students' real-life experiences and everyday events (Agusta, 2020). By utilizing IT, the learning process becomes more engaging and easier to implement, making students more interested in learning mathematics.

Based on this explanation, it can be concluded that there is a close relationship between the philosophy of mathematics and the information technology-based learning model. Mathematics learning must be grounded in the philosophy of mathematics, which views mathematics as a human social activity and part of culture. The philosophy of mathematics also plays a role in the progress of human civilization, as mathematics serves as a language, art, and pillar of civilization development. In the context of

education, the philosophy of mathematics significantly contributes to the learning process through its views on inputs, processes, and outputs. However, in practice, obstacles often arise in learning due to insufficient attention to the role of the philosophy of mathematics.

Project-Based Learning (PjBL) Model

The PjBL model, as defined by Sukackė et al. (2022), is a learning approach that focuses on learning activities based on real-life problems relevant to daily life, done in groups. This model is designed to allow students to solve problems through project work, giving them direct experience in facing the challenges at hand. In this context, the use of Information Technology (IT) greatly supports the PjBL model, both as a medium and a learning tool to help students complete their projects. According to (Putri et al., 2020), the steps in the PjBL model begin with posing a big question that gives students the task of solving problems or conducting activities. The topic raised must be relevant to reality and begin with in-depth research. Next, students and teachers collaborate to design a project plan, including problem-solving strategies and the selection of activities that are relevant to supporting information. Creating a project schedule is also an important step, where teachers and students arrange a clear schedule with a planned timeframe to complete the project.

The next process involves monitoring students and carrying out the project, where the teacher is responsible for overseeing students' activities and providing guidance throughout the project. After the project is completed, the teacher provides assessment and feedback on students' work. Learning evaluation is conducted through reflection, where students are asked to reflect on their experiences and feelings during the project. These steps ensure that the projects produced not only achieve learning goals but also provide a deep experience for the students.

The use of IT in each step of the PjBL model enables students to more easily access various sources of information and digital experimental tools, which support data exploration and analysis (Nurhasnah et al., 2020). With technology, the learning process becomes more dynamic and interactive, enhancing student engagement and helping them better understand the material. IT enriches the learning experience by providing tools and resources that effectively support the completion of the project.

Problem-Based Learning (PBL) Model

The PBL model is a learning approach designed to help students find and solve real-world problems. In this model, students are presented with real-life situations that require problem-solving by gathering information and applying strategies they have created, which are then presented (Siswanto & Peni, 2023). In line with Arend's perspective, PBL aims for students to face authentic problems so they can build their own knowledge, develop inquiry competencies, and enhance their independence and self-confidence. This model is also considered effective in improving skills relevant to the current globalization era. Therefore, the application of IT in PBL can help students enhance their skills and solve learning problems more effectively.

The implementation of the PBL model involves five main steps according to Arends (2012). The first step is orienting students to the problem, where learning objectives are explained, required learning tools and materials are introduced, motivation is provided, and the problem to be solved is presented to the students. The second step involves organizing students, where they are divided into small groups and briefed about the problem they will solve. In the third step, students are encouraged to gather information, conduct experiments, and research to gain explanations and solve the problem they face. The fourth step in PBL is preparing reports, where students are assisted by the teacher in compiling a group work report by dividing tasks among group members. The final step is analyzing and evaluating the process and results, where students are guided by the teacher to reflect on and evaluate the process and results of their research. Each step ensures that students not only acquire new knowledge but also develop analytical and evaluative skills.

The application of IT in each step of PBL strongly supports the learning process by providing tools that help students collect and analyze information, as well as present their work. Technology enriches the learning experience by enabling students to access additional resources and collaborate effectively in project completion. With IT, the PBL process becomes more dynamic and interactive, increasing student engagement and deepening their understanding of the material being studied.

Problem-Solving Model

The problem-solving model in mathematics education focuses on developing students' skills in identifying and solving problems through a systematic and structured approach. This model, often applied in mathematics learning, teaches students to recognize problems, plan solution strategies, implement the plan, and evaluate the results (Yulianti & Herpratiwi, 2024). Research shows that this approach is effective

in enhancing students' critical thinking and problem-solving skills as it teaches them to apply mathematical knowledge in varying and challenging situations. The implementation of the problem-solving model often involves the use of information technology to provide visual aids and simulations that enrich the learning experience, helping students understand and solve problems in a more dynamic and interactive way (Rusdi et al., 2020). As a result, students' ability to apply mathematical concepts practically and creatively increases, preparing them to face real-world mathematical challenges.

The general steps or syntax in the problem-solving learning model, according to Polya (Resti & Palupy, 2024), include: first, understanding the problem at hand; second, planning the solution approach; third, executing the plan made; and fourth, reviewing the solution to ensure that the provided solution is correct and adequate. These steps provide a clear structure for students in the problem-solving process, allowing them to systematically develop critical and creative thinking skills. With the integration of IT, each step in the problem-solving model can be strengthened, from understanding the problem with access to various sources of information, to planning and implementing solutions using digital tools, and evaluating and reviewing results with the help of analysis technology. This not only improves the effectiveness and efficiency of learning but also facilitates a more interactive and in-depth learning experience for students.

Discovery Learning Model

The Discovery Learning model, developed by Jerome Bruner and inspired by Piaget's theory, emphasizes the importance of students' active role in the learning process. This model aims to engage students directly in exploring and organizing their own learning. In this approach, students are encouraged to discover and understand the material independently through various systematic steps. These steps include providing stimulation to create learning interaction conditions that support exploration, identifying problems and formulating hypotheses, gathering data and conducting experiments to test the hypotheses, and processing data to obtain new information. Additionally, students are asked to prove concepts through real-life examples and ultimately make generalizations to draw conclusions from the fundamental concepts discovered (Caesaria et al., 2024; Nurhayanti et al., 2021).

The application of information technology (IT) in the Discovery Learning model holds significant potential to increase the effectiveness and efficiency of each learning stage. Technology can be used to provide engaging initial stimulation, such as multimedia or simulations, that assist students in exploring the material (Siswanto & Andriyani, 2024). During the data gathering and experimentation phase, technology offers easy access to various digital information sources and interactive experimental tools that allow students to investigate in a deeper manner. With technological tools, the data analysis process becomes more structured and efficient, enabling students to process information better and faster.

The integration of technology in the Discovery Learning model makes learning more dynamic and interactive. In addition to gaining information from textbooks, students can directly interact with the material through digital platforms, applications, and other online tools. Technology supports active exploration and problem-solving in a more creative manner, and allows students to learn from various sources and perspectives. This also promotes the development of critical and analytical thinking skills, which are important in the learning process. Overall, the use of technology in Discovery Learning enhances student engagement and deepens their understanding of the subject matter, making the learning process more responsive to students' needs and the times, and ultimately improving student learning outcomes and skills.

Discussion

The A learning model is a structured framework that outlines the steps or processes in education to achieve the expected competencies or learning outcomes. According to Idhayani et al. (2023), a learning model involves curriculum planning, lesson preparation, and the management of the learning environment. This model serves as a crucial guide for teachers in designing and executing the learning process, ultimately supporting the achievement of educational objectives. The success of implementing a learning model heavily relies on choosing an appropriate model that aligns with the lesson content, core competencies, and student abilities, especially in complex subjects like mathematics.

The primary function of a learning model is to provide a systematic guide for teachers throughout the teaching process, from initiation to evaluation. Taningrum et al. (2024), Hanama et al. (2024) and Wahyuni et al. (2024) emphasize that the purpose of a learning model is to bring about changes in student behavior, create a supportive learning environment, and foster positive interactions between teachers and students. Furthermore, this model facilitates the development of innovative curricula and engaging teaching materials, which can increase student participation. A well-designed learning model leads to

more optimal learning outcomes and hones students' creative and critical skills, ensuring that the learning process is more effective.

The advancement of information technology (IT) has significantly impacted innovation in learning models, particularly in mathematics education. IT enables the development of more effective and efficient learning media and creates a broader interaction space between teachers and students. IT helps in understanding abstract concepts through visual and interactive means, which is crucial in mathematics. The integration of mathematical philosophy with IT-based learning models strengthens students' mathematical abilities. The Realistic Mathematics Education (RME) model, developed by Hans Freudenthal, utilizes IT to enhance students' motivation and interest by connecting mathematical concepts to real-life contexts.

Moreover, the Project-Based Learning (PjBL) and Problem-Based Learning (PBL) models also incorporate IT to support real-world problem-solving-based learning processes, enriching each step by facilitating easier access to information and digital experimentation tools. IT also supports the Problem Solving model by providing information centers and efficient learning tools. Finally, in the Discovery Learning model, developed by Jerome Bruner, IT plays a role in providing initial stimulation and interactive experimental tools, enriching the learning experience and helping students develop critical and analytical thinking skills.

4. CONCLUSION

Philosophy has a significant influence on the learning process. Since philosophy involves critical thinking, every learning activity of students inherently includes philosophical elements. The application of philosophy in each learning activity can indirectly make the teaching and learning process, particularly in mathematics, more effective and efficient. A learning model is necessary to guide the steps or procedures in the learning process. The integration of information technology (IT) within the learning model greatly supports this process, making it more engaging, boosting student motivation, and making learning more practical, effective, and efficient.

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