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The Role of Students' Developmental Psychology in Mathematics Learning

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ABSTRACT

Mathematics learning requires an approach that is appropriate to students' developmental stages to ensure optimal understanding. Developmental psychology plays a role in understanding the cognitive, emotional and social characteristics of students, so that learning can be tailored to their needs. This study uses a literature analysis method by examining various theories and research on developmental psychology and their implications for mathematics learning. The results of the study show that developmental psychology helps teachers adapt learning strategies to students' cognitive stages, overcome mathematics anxiety, and encourage social collaboration to increase learning motivation.

Keywords: Developmental Psychology, Mathematics, Learning

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INTRODUCTION

Mathematics learning has an important role in forming logical, critical and analytical thinking patterns in students (Sulistiani & Masrukan, 2016). As one of the main subjects in the education curriculum, mathematics not only requires conceptual understanding, but also mastery of complex problem-solving skills. However, the success of mathematics learning is greatly influenced by the characteristics of the psychological development of students (Damayanti et al., 2022). Therefore, understanding developmental psychology becomes an urgency that cannot be ignored in the process of learning mathematics.

Developmental psychology is a branch of science that studies the psychological changes of individuals from childhood to adulthood. In developmental psychology, the development of human behavior is also studied

systematically and intuitively, especially studying the physical structure, behavior and mental functions of humans throughout life, from conception to death (Tri Wisudaningsih, 2024). These changes include cognitive, emotional, and social aspects that play a role in learning. In the context of learning mathematics, understanding the stages of cognitive development of students is very important, considering that mathematics is often considered an abstract and challenging subject (Nurdiana, 2017)For example, Piaget's theory of cognitive development emphasizes that elementary school-age children are in the concrete operational stage, where they find it easier to understand mathematical concepts presented concretely rather than abstractly.

In addition to cognitive aspects, emotional factors also have a significant impact on mathematics learning. Many students experience math anxiety, which can hinder their ability to understand and solve math problems (Awal Nur et al., 2024)·Developmental psychology helps teachers recognize these signs of anxiety and design supportive learning strategies, such as creating a safe and conducive classroom environment and providing positive reinforcement to students. In the social context, interactions between teachers and students and relationships between peers in the classroom also play an important role in mathematics learning. Students who feel socially supported tend to have higher motivation to learn (Umbara, 2018). Developmental psychology provides teachers with insight into how to build positive relationships with learners and facilitate collaboration between them, making the learning process more effective.

The urgency of implementing developmental psychology in mathematics learning is also seen in the differentiation-based learning approach. Students have different learning speeds, learning styles, and abilities. By understanding their developmental characteristics, teachers can design learning that suits individual needs, thereby increasing active participation and student learning outcomes (Arviana & Siswono, 2014). In addition, developmental psychology helps in understanding how intrinsic and extrinsic motivation play a role in learning mathematics. Students who have intrinsic motivation tend to be more enthusiastic in facing mathematical challenges compared to those who only rely on extrinsic motivation such as grades or awards (Warmi et al., 2020). Teachers can use this insight to foster students' curiosity and interest in mathematics.Thus, a deep understanding of the developmental psychology of learners becomes an important foundation for teachers in creating meaningful, relevant, and enjoyable mathematics learning. This study aims to explore the role and urgency of developmental psychology in mathematics learning, so that it can provide guidance for educators in developing more effective learning strategies.

METHOD

The research method used in this study is a qualitative research method. Based on the object of study, this study is a literary or library research. The data sources used in this study are books, journals, articles, and other scientific works that are relevant to the object of study in this study. The main topic in this study is the role of developmental psychology in mathematics learning. Furthermore, to process and analyze the data, the author uses the content analysis method, namely an analysis of the content that focuses on the interpretation of cognitive theories of elementary school children. The data sources used in this study are books, journals,

articles, and other relevant scientific works. After all the data is collected, the next step is for the author to analyze the data and then draw a conclusion.

RESULTS AND DISCUSSION

Developmental Psychology

Developmental psychology is the study of factors that influence a person's development process from infancy to old age. This approach helps educators understand and support students' development in various aspects, including cognitive, social, emotional, and motivational. Developmental psychology helps us understand how individuals change and adapt throughout their lives. This is important for various fields, including mental health, social policy, and education. Education itself is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have spiritual religious strength, self-control, personality, intelligence, noble morals, and skills needed by themselves, society, nation, and state (Sianturi et al., 2024). Understanding the psychology of child development is a must for both parents and teachers, early childhood is an important period in the development of the child itself. In this golden period, children begin to be sensitive to various stimuli, each child individually will have different levels of sensitivity development along with the development and growth of each child (Sukatin et al., 2023). An understanding of developmental psychology is essential for teachers because it can help them understand and respond to each child's unique developmental needs.

Mathematics Learning

Learning mathematics is not only understanding the concept or the procedure, but many things can emerge from the results of the mathematics learning process. Meaningfulness in learning mathematics is marked by awareness of what is done, what is understood and what is not understood by students about mathematical facts, concepts, relations, and procedures (Mawaddah & Maryanti, 2016). Mathematics learning should be done interactively, inspiring, challenging, motivating, fun, and meaningful, and accommodate the development of students' creativity, talents and potential. Students can develop physically and psychologically according to their stages (Gusteti & Neviyarni, 2022). The characteristics of mathematics whose objects are abstract and hierarchical cause students to have difficulty in learning it. Therefore, students' psychological understanding when learning mathematics is very important to study. The psychological aspects of students include their thinking skills, emotions, interests, beliefs and self-schemes, and students' motivation in learning mathematics.

Effective mathematics learning depends not only on clear delivery of material, but also on an understanding of how students learn and develop cognitively, emotionally, and socially. Developmental psychology provides a strong foundation for teachers to design learning experiences that are appropriate

to the developmental stages of students. By understanding the factors that influence how students think and respond to learning, teachers can choose more appropriate methods and strategies to improve their understanding, overcome difficulties, and build intrinsic motivation. Therefore, understanding the role of developmental psychology in mathematics learning is essential to creating an effective and supportive learning environment for each student. The role of developmental psychology in mathematics learning is as follows:

Understanding Stages of Cognitive Development

Developmental psychology plays a crucial role in mathematics learning because it helps teachers understand how students think and learn based on their stage of cognitive development (Nurdiana, 2017). In the context of learning mathematics, Piaget's theory provides guidance on how children at the concrete operational stage (ages 7–11 years) more easily understand mathematical concepts through direct experience with real objects (Syafawani & Safari, 2024). For example, in learning the concept of fractions, students can be taught by dividing real objects, such as pizza or cake, into smaller parts. With this approach, abstract mathematical concepts become easier to understand because students can see, touch, and manipulate objects directly, in accordance with their way of thinking which is still concrete and tied to physical objects (Anggrita et al., 2024).

As learners enter the formal operational stage (ages 12 and up), their ability to think abstractly begins to develop. At this stage, they can process more complex mathematical concepts, such as algebra or geometry, that no longer require concrete representation. They begin to be able to understand mathematical symbols and use deductive logic to solve problems (TS Azzahra et al., 2023). In mathematics learning, this allows teachers to introduce more abstract concepts, such as linear equations or functions, without the need for physical aids. Teachers can provide problems that require students to think theoretically and use mathematical formulas or laws to solve problems, in accordance with their growing ability to think logically and abstractly.

The link between developmental psychology and mathematics learning shows the importance of an approach that is appropriate to the developmental stage of students. By understanding their cognitive development, teachers can design more effective mathematics learning that is appropriate to the way students process information (Syafawani & Safari, 2024). At the concrete operational stage, manipulative-based learning is very useful, while at the formal operational stage, a more theoretical and symbolic-based approach is more appropriate. This not only helps students understand mathematics better, but also supports the development of critical and analytical thinking skills that are essential in everyday life.

Managing Emotions and Reducing Math Anxiety

Math anxiety is a common phenomenon faced by many students, which can hinder their understanding of mathematical material. Math anxiety is a feeling of tension and fear of mathematics or an intense and negative emotional response to mathematics.(Setiawan, 2024). This anxiety often arises because students feel pressured or unable to cope with math tasks that are considered difficult or challenging. This feeling of anxiety can be caused by previous bad experiences, lack of self-confidence, or even the perception that math is an unpleasant or complicated subject (Rais, 2020). When this anxiety arises, students tend to avoid math tasks or find it difficult to focus, which ultimately disrupts their overall learning process. Developmental psychology reveals that this kind of anxiety is rooted in emotional factors that affect how students process information and face challenges in learning (Mardhatillatus & Afifah, 2022).

Developmental psychology provides guidance for teachers to recognize the signs of math anxiety and provide an emotionally supportive approach. One way to address math anxiety is to create a safe and positive learning environment, where students feel valued and are not afraid to make mistakes (Awal Nur et al., 2024). This approach involves providing emotional support that helps reduce any fear or stress that students may be feeling. For example, teachers can provide constructive feedback and focus on students' efforts, not just the end result. This can increase students' self-confidence and reduce their feelings of anxiety about mathematics. In addition, creating an inclusive classroom environment, where every student feels accepted and supported, can also reduce feelings of anxiety caused by fear of negative judgment.

In addition to creating a safe environment, developmental psychology also encourages the use of learning strategies that can reduce math anxiety. Teachers can provide rational explanations to their students why they should learn math, instill self-confidence in students that they can learn math well, eliminate negative prejudices against math, by providing simple to complex examples of the usefulness of math (Rais, 2020). In addition, introducing mathematical concepts gradually and in a fun way, such as through games or practical activities, can reduce the stress associated with learning mathematics (Setiawan, 2024). By understanding and addressing these anxieties through appropriate psychological approaches, teachers not only help students overcome their emotional barriers, but also encourage them to be more engaged and confident in learning mathematics.

Supporting Social Interaction

According to Vygotsky's theory, mathematics learning will be more effective if it is carried out in a social context that involves interaction between students, peer tutors, or teachers (Hartiningrum & Abdul Wahab, 2024). Vygotsky emphasized the importance of the social environment in cognitive development,

and he introduced the concept of the Zone of Proximal Development (ZPD), which refers to the distance between a learner's ability to complete a task independently and their ability to complete a task with the help of others. In the context of mathematics learning, this means that learners can understand more complex mathematical concepts if they are given guidance from more experienced individuals, such as teachers or peers, who are able to provide direction and support (Tamrin et al., 2011). Learning that occurs in this social context accelerates understanding because students do not only learn passively, but also actively discuss, ask questions, and collaborate with others to solve problems.

Social interaction in mathematics learning is very important because it can enrich students' understanding through various perspectives. For example, in group discussions, students can share different ways to solve math problems, and this allows them to develop a deeper understanding. Teachers can act as mediators who help guide the discussion, while peer tutors can provide direct support in a more informal and relatable way. In classroom life, good social relationships occur when students are accepted in their group and liked by their friends. This can be seen when students work on assignments in groups, discuss a math material, even compete in achieving learning achievements, and others. Not all students can understand the teacher's explanation directly, there are students who can understand lessons from peers, so interaction is needed (PK Sari & Sugeng, 2019). In addition, these social interactions create opportunities for learners to learn from their mistakes in a safe and supportive environment. Thus, Vygotsky emphasized that learning mathematics is not only about memorizing formulas or procedures, but also about collaborating and building understanding through constructive social interactions (Zebua et al., 2024).

Guidance within the ZPD allows learners to reach a higher level of understanding than they could achieve independently. For example, when a learner is having difficulty understanding an algebraic concept, a teacher or peer tutor can provide assistance in a way that is appropriate to their level of understanding, such as through guiding questions, simpler explanations, or providing more concrete examples (Hartiningrum & Abdul Wahab, 2024). This assistance not only enhances students' understanding of the mathematical concepts, but also accelerates the process of internalizing learning. As a result, students feel more confident and able to apply mathematical concepts independently after such in-depth social interactions. This approach shows that effective mathematics learning involves more than just delivering material, but also utilizing social contexts to enrich students' learning experiences (Fitriani & Maemonah, 2022).

Encouraging Learning Motivation

Developmental psychology plays a vital role in helping teachers understand what motivates students. Every student has different motivational factors, both

intrinsic and extrinsic. Intrinsic motivation refers to the drive to learn due to curiosity or personal satisfaction, while extrinsic motivation is more related to external rewards or prizes, such as good grades or recognition (RIP Sari, 2014). Developmental psychology helps teachers understand the internal factors that can influence student motivation, such as interests, emotional needs, or the need for challenge. With this understanding, teachers can more easily create learning conditions that support and stimulate students' intrinsic motivation, so that they are more engaged in learning mathematics.

Teachers can design learning activities that are interesting and relevant to students' worlds to build their intrinsic motivation. For example, by relating mathematical material to interesting real-life situations or by developing projects that allow students to apply mathematical concepts in practical contexts, teachers can increase their sense of relevance and enjoyment of mathematics (Warti, 2018). In addition, giving students the freedom to explore mathematical concepts in creative ways, such as through experiments or math games, can also trigger curiosity and a desire to learn more deeply (Umairah, 2020). In this way, students feel more empowered to learn mathematics independently, without feeling forced or pressured.

The importance of building this intrinsic motivation is so that students can feel personal satisfaction in the learning process and see mathematics not as a boring subject, but as a fun challenge. In addition, strong motivation in students will increase interest, willingness and high enthusiasm in learning, because motivation and enthusiasm have a close relationship (Pujilestari, 2018). Developmental psychology provides insight into how age and stage of cognitive development influence how learners respond to motivation. For example, younger learners may be more motivated by learning that involves games and social rewards, while older learners may be more interested in project-based learning that gives them opportunities to develop practical skills and critical thinking. Learners who are sufficiently motivated to engage in learning will select tasks that are within their capabilities, and begin activities immediately when given the opportunity, and exert intensive effort and concentration in carrying out learning tasks. Conversely, if their motivation is not strong enough, they will decide not to engage in learning activities (Jatmiko, 2015). It is stated that by designing learning that is in accordance with the motivation and developmental needs of students, teachers can create a more dynamic and empowering learning environment, where students feel more enthusiastic and motivated to continue learning mathematics.

Implementing Differentiated Learning

Developmental psychology provides teachers with vital insights into understanding individual differences in learners, including their learning styles, abilities, and needs. Each learner has a unique way of receiving and processing

information, which is influenced by factors such as cognitive, emotional, and social development (L. Azzahra & Darmiyanti, 2024). For example, some students are more likely to learn visually, who find it easier to grasp concepts through pictures, diagrams, or videos. On the other hand, some students may find it easier to learn with a kinesthetic approach, which involves physical activity, such as object manipulation or hands-on experimentation. Understanding these differences allows teachers to identify the most effective learning style for each student, so that math learning can be designed more appropriately and effectively (Almujab, 2023).

In addition, developmental psychology helps teachers recognize differences in ability and learning speed among students. Some students may already have a strong understanding of the basics of mathematics and can move on to more complex concepts quickly, while others may take longer to grasp the basics (Wahyuningsari et al., 2022). By knowing the abilities of each student, teachers can apply a differentiated approach to learning, where the material is adjusted to the level of understanding and learning speed of each student. For example, teachers can give more challenging tasks to students who are quicker in understanding the material, while providing additional explanations or more exercises to students who need more help. This ensures that each student can learn in a way that best suits their needs, without feeling left behind or overburdened.

With an understanding of these individual differences, teachers can also create an inclusive and supportive learning environment, where all learners feel valued and given a fair opportunity to thrive (L. Azzahra & Darmiyanti, 2024). Developmental psychology allows teachers to design more flexible learning, which can accommodate different learning styles and individual needs, thus creating a more personalized and meaningful learning experience. For example, by utilizing a variety of teaching methods, such as project-based learning, group discussions, or the use of educational technology, teachers can ensure that each student has the opportunity to access and understand mathematics material in their own way (Miqwati et al., 2023). Thus, mathematics learning becomes not only more effective, but also more enjoyable and empowering for every student.

Improving the Effectiveness of Learning Strategies

Understanding the cognitive, emotional, and social developmental aspects of students provides a strong foundation for teachers to choose more effective learning strategies. The role of Developmental Psychology is very important in the context of education and learning, because understanding the psychological development of individuals helps in designing educational approaches that are appropriate to the developmental stages of children or adolescents. Developmental psychology examines how individuals develop physically, cognitively, emotionally, socially, and morally. In the context of education,

developmental psychology helps teachers and educators to identify students' developmental needs and choose appropriate teaching strategies (Sianturi et al., 2024).

At the cognitive development level, learners at a younger age tend to be more helped by learning approaches that involve concrete objects and direct experiences (Aningsih, 2013;Syafawani & Safari, 2024). For example, fun math game-based learning can improve the understanding of basic math concepts such as numbers, shapes, and patterns. Through games, students can learn while interacting with their friends, so that they not only understand the concept but also develop social skills. This game-based learning is in accordance with their cognitive development stage, where they still need concrete objects to visualize abstract concepts (L. Azzahra & Darmiyanti, 2024).

On the emotional side, understanding students' feelings can help teachers design learning that can reduce their anxiety or fear of mathematics. Learning that involves group exploration or teamwork can be an effective way to create a supportive and enjoyable environment (Rais, 2020). When students work in groups, they can help each other and discuss solutions to math problems, which not only improves their understanding, but also strengthens their self-confidence and intrinsic motivation. Group work allows students to feel more comfortable in facing challenges, because they do not feel alone in learning (Kusmartiningrum et al., 2024). This approach also helps them overcome their fear of failure, as they can learn in a more collaborative and emotionally supportive atmosphere.

In addition, in the context of social development, students begin to develop better communication and collaboration skills. Group-based learning, discussions, or collaborative projects provide opportunities for students to share ideas and interact socially (Alwi et al., 2023). This is important, because social interaction can enrich their mathematical understanding through various perspectives obtained from peers. In today's digital era, the use of technology is also part of a very effective strategy, where students can use mathematical applications or software to practice, explore concepts more interactively, and get direct feedback (Zayyadi et al., 2017). Technology can provide opportunities for students to learn in a more independent and personalized way, while supporting their cognitive development in understanding more complex mathematical concepts (Rahadiantino, 2022;Saputra et al., 2023). Thus, by understanding cognitive, emotional, and social development, teachers can design more comprehensive and holistic learning strategies, which not only enhance mathematical understanding but also support the holistic development of students.

A deeper understanding of the role and urgency of developmental psychology makes mathematics learning more effective, adaptive, and meaningful for learners. By understanding their cognitive, emotional, and social

developmental stages, teachers can adjust learning methods accordingly, such as using concrete aids for younger learners or teaching abstract concepts for older learners. This understanding also allows for more inclusive learning, taking into account differences in learning styles and special needs, and relating mathematical concepts to everyday life. This increases learners' motivation, confidence, and readiness to apply mathematics in their lives, making it more relevant and impactful.

CONCLUSION

Developmental psychology plays a very important role in mathematics learning, as it provides a deeper understanding of how students think, learn, and develop according to their developmental stages. By understanding aspects of cognitive, emotional, and social development, teachers can design learning that is more effective and in accordance with the individual needs of students. Developmental psychology theories, such as Piaget's and Vygotsky's theories, help teachers choose the right learning methods, such as game-based learning, group exploration, or the use of technology, which can improve students' understanding of mathematics material. In addition, understanding individual differences, learning styles, and factors that motivate students allows teachers to create a more inclusive and supportive learning environment.

Based on this discussion, it is suggested that teachers study developmental psychology in the context of mathematics learning in more depth, so that teachers can better understand the characteristics of students at each stage of their development. Teachers also need to adapt learning approaches that are appropriate to the learning styles and emotional needs of students. Learning that involves social interaction, such as group discussions or peer tutoring, can help students overcome difficulties in understanding mathematical concepts. In addition, the integration of technology in mathematics learning can also facilitate more interactive and interesting learning for students, especially in the context of their cognitive development which is increasingly able to understand abstract concepts

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