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The Role of Educational Psychology in Mathematics Education at Schools

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A B S T R A C T

Educational psychology, as a branch of psychology, plays an essential role in education. Historically, it has contributed significantly to the evolution of mathematics education. Awareness of individual differences and the need for psychological intervention for students in mathematics learning shows how important the role of educational psychology is in mathematics education in schools. This study describes the role of psychology in mathematics education. This study uses a qualitative approach with a literature review methodology to discuss educational psychology's role in the learning process of mathematics, mathematics assessment, and mathematics education research.

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INTRODUCTION

Education is a deliberate and structured effort to create a conducive learning environment that facilitates students' active development (Irawana & Desyandri, 2019). This endeavor brings awareness that each individual possesses unique potential, differing intelligence, interests, and privileges. Consequently, numerous institutions strive to establish an ideal educational system. To this day, schools remain the primary educational institution where students can develop their unique potential.

Both in-class and out-of-class learning activities represent educational processes at school. According to Pane and Dasopang (2017), learning is an interactive process between students and educators involving instructional materials, delivery methods, learning strategies, and educational resources within a learning environment. Each element of the learning process is interrelated, with each playing a central role in every subject.

Mathematics, a core subject from elementary to high school, plays a crucial role in shaping scientific thinking and character development. Handoko (2017) states that mathematics is vital as the foundation of scientific knowledge, a tool, a support for logical thinking, and a means of character formation. Thus, mathematics education has a unique approach encompassing mathematical knowledge, skills, and attitudes. On the other hand, mathematics is perceived as a challenging subject that can induce anxiety (Amalia et al., 2021), leading to an increased focus on psychological perspectives within mathematics education research, particularly in educational psychology—a branch of psychology.

According to Cameron (2006) educational psychology systematically studies the processes and factors involved in an individual's learning activities. Furthermore, Tolland and Carrigan (2011) explain that educational psychology includes aspects of assessment, intervention, consultation, and research.

Educational psychology is an essential competency that teachers must master to improve the quality of mathematics instruction. Therefore, mathematics teachers are expected not only to understand mathematical content but also to be sensitive to the psychological state of their students during the learning process.

However, when students perceive mathematics as a difficult subject (Gafoor & Kurukkan, 2015), various issues stemming from this perception may arise in the learning process. 'Alwan (2022) revealed that students are more inclined to resort to cheating in mathematics due to the perception of its difficulty. Meanwhile, according to Ratnasari (2017) students low academic achievement in mathematics is also attributed to their lack of interest in the subject. These cases suggest that psychological factors play a significant role in mathematics learning.

This understanding underscores the importance of educational psychology in mathematics education. Therefore, this study aims to describe the role of educational psychology in the mathematics learning process, its role in the assessment of mathematics education, and its role in mathematics education research.

METHODOLOGY

This study adopts a qualitative approach using a literature review methodology. A literature review is a research method that relies on collecting literature-based data, which is then read, recorded, and processed into research analysis (Darmalaksana, 2020). In this study, the literature sources used include articles related to psychological issues in mathematics education and educational psyohology.

The selection of the literature review method is based on several advantages it possesses. First, this method allows researchers to comprehensively access and analyze various perspectives and findings from previous research (Zed, 2008). Second, literature reviews provide a strong theoretical foundation for understanding the studied phenomena in greater depth (Snyder, 2019). Third, this method helps researchers identify gaps in previous research and formulate more focused and relevant research questions.

The literature review process involves several key stages, including data collection, analysis, and synthesis. The initial stage involves collecting relevant literature materials from various sources such as books, journals, research reports, and other academic publications. The second stage focuses on reviewing and examining the collected literature to identify key concepts, theories, and findings relevant to the research topic (Webster & Watson, 2002). The third stage involves analyzing and synthesizing the information gathered to develop comprehensive insights into the research topic. This is followed by organizing and categorizing the findings into meaningful themes and patterns. The final stage involves writing a coherent narrative that integrates various theoretical perspectives and research findings while maintaining critical analysis throughout the discussion.

RESEARCH RESULT AND DISCUSSION

The Role of Educational Psychology in the Mathematics Learning Process

In this regard, mathematics education is unique due to its use of symbols and numbers. However, this is often considered a challenge for students whose cognitive development is still in the early concrete operational stage. Consequently, it often requires students to engage in more intensive thinking, which contributes to the stigma that mathematics is a difficult subject. (Gafoor & Kurukkan, 2015), Therefore, what needs to be emphasized is the approach or learning theory applied in mathematics instruction, such as cognitive learning theory, which enables teachers to understand the cognitive development levels of students. This understanding allows teachers to adapt both the content and the method of delivering mathematics lessons. After all, the stigma that mathematics is a difficult subject has reduced students' interest in learning, which in turn negatively impacts their mathematics performance. (Sirait, 2016).

According to Bature (2020), the role of educational psychology in mathematics education includes creating a conducive learning environment, establishing a student-centered classroom, and focusing on the development of each student's unique potential.

Educational psychology contributes to creating a pleasant and effective mathematics learning experience through interventions. These interventions are aimed at influencing the development of students' brain function, cognition, behavior, and emotional regulation (Toland & Carrigan, 2011). These elements are intricately reflected in theories of mathematics learning and in the models or approaches used in mathematics instruction.

The basis of mathematics learning lies in theories such as mental discipline theory, behaviorist learning theory, cognitive learning theory, and humanistic learning theory (Lestari, K. E., & Yudhanegara, 2019). These theories can be applied throughout mathematics instruction because, fundamentally, learning theories are the principles of the learning process itself. For instance, cognitive learning theory aligns with the structured nature of mathematics, which progresses from simple to complex and is interconnected from one topic to another. To achieve optimal learning, it is essential to understand students' cognitive development. These theories, integral to educational psychology, form the foundation for thought processes and actions in mathematics education, highlighting the crucial role educational psychology plays in shaping mathematics learning.

Various mathematics teaching models are also developed with students' psychological factors in mind, such as the SAVI model (Somatic, Auditory, Visualization, Intellectual), AIR model (Auditory, Intellectual, Repetition), and MID (Meaningful Instructional Design), among others. According to Lestari and Yudhanegara (2019), the SAVI model, for example, involves movement and sensory experiences alongside intellectual engagement. Similarly, the VAK and AIR models emphasize that learning should leverage sensory input. These models are based on the understanding that people can achieve their full potential by utilizing their dominant senses (Rambe & Aisyah, 2023). In the process of teaching mathematics, teachers can consider applying these methods, such as in topics on plane and solid geometry. This illustrates how educational psychology inspires the development of innovative learning models.

It is evident that educational psychology influences every element of the mathematics learning process. Educational psychology serves as an integral component of mathematics education, fostering cognitive and emotional development to enhance learning outcomes, aiming to foster brain development, cognition, behavior, and emotional regulation for a more authentic educational experience.

The Role of Educational Psychology in Mathematics Assessment

Although many students consider mathematics difficult, there are also students who thoroughly enjoy it. Those who favor mathematics often prefer it over lengthy reading materials or complex sentences. Gardner (1989) posits that people possess different dominant intelligences, leading to varying levels of interest and achievement among students.

Gardner (1989) identifies logical-mathematical intelligence as one of the types of intelligence within individuals. Students with high logical-

mathematical intelligence tend to excel in working with numbers and symbols, and are generally more adept in mathematics than their peers.

Nevertheless, mathematics is a compulsory subject in Indonesia from elementary through high school. In accordance with the curriculum, all students are required to complete mathematics coursework, regardless of their individual intelligences.

Educational psychology supports mathematics assessment by safeguarding students' rights to successfully complete mathematics education. Mathematics assessments are adapted to fit students' unique intelligences. Various assessment models have been developed to align with students' intelligence types, such as musical intelligence-based assessments (Lalita, 2019), kinesthetic intelligence-based assessments (Dewi, 2019), and interpersonal intelligence-based assessments (Adawiyah, 2019).

Lalita (2019) Developed an assessment model for students with musical intelligence, aiming to more effectively measure learning outcomes through music-based mathematical questions. This approach is designed to help students with dominant musical intelligence optimally understand mathematics problems and unlock their potential, as it aligns with their dominant multiple intelligence. Similarly, Dewi (2019) Created an assessment tailored to students with kinesthetic intelligence, aiming to enhance learning evaluations through kinesthetic-oriented mathematical problems. This approach is designed to encourage students to move more actively and feel more optimal in learning through physical movement, enabling them to tackle mathematical problems effectively as it aligns with their dominant multiple intelligence. In parallel, Adawiyah (2019), Devised an assessment for students with interpersonal intelligence, aiming to effectively evaluate mathematical learning outcomes based on each student's unique interpersonal skills. Designing questions tailored to students' multiple intelligences can be adopted and applied to various mathematics topics, considering that differences in multiple intelligences may lead to diverse approaches students take in learning mathematics.

These developments underscore the role of educational psychology in mathematics assessments, affirming its purpose to protect and facilitate students' rights to successfully complete mathematics education.

The Role of Educational Psychology in Mathematics Education Research

Contrary to the common perception that mathematics is a difficult subject and therefore unpopular, many students are highly fond of mathematics. Typically, those who enjoy mathematics prefer it over lengthy, complex texts.

Mathematics, as a subject, is unique because it involves symbols, abstractions, and generalizations (Ferrari, 2003), making mathematics education a field rich with research potential. Educational psychology provides a unique perspective in mathematics education research, focusing on psychological aspects within the learning process. Below are some areas of educational psychology research in mathematics education:

a. Interest in Mathematics Learning

Student interest in learning refers to a student's attraction to academic pursuits (Jack & Lin, 2017). Hidayat & Widjajanti (2018) define interest in learning as a student's positive state, fostering enthusiasm in educational activities, often demonstrated through enthusiasm, curiosity, and active engagement. Interest plays a vital role in mathematics, as it drives students' academic performance.

Interest in learning mathematics significantly affects students' academic performance, particularly through active engagement that enhances understanding and academic achievement. Several studies reveal that high interest in learning mathematics positively correlates with improved learning outcomes. For instance, students who enjoy mathematics tend to exhibit a stronger desire to learn, which positively impacts their academic achievements (Harefa, 2023).

Teachers can make efforts to spark students' interest in learning mathematics by using an appropriate learning theory approach that focuses on joyful learning. Joyful Learning enhances students' interest and learning outcomes in mathematics by making the learning process enjoyable and engaging (Ramadhani et al., 2024).

In research trends, studies on mathematics learning interest have evolved to explore how internal factors, such as self-motivation and interest, influence learning outcomes. Meta-analytic studies indicate that learning interest has a substantial positive effect on students' mathematics academic achievement, with a high effect size, reflecting the consistency of these findings across previous research (Ili et al., 2021).

b. Mathematics Self-Efficacy

Self-confidence is a unique and essential aspect of students' lives. A confident student can complete assignments or exams effectively, and is less likely to engage in dishonest behaviors, such as cheating. Self-efficacy, or confidence in one's abilities, is crucial in mathematics learning, as low self-confidence often correlates with poor mathematics performance.

Mathematics self-efficacy, or students' confidence in their mathematical abilities, has a significant influence on the learning process. Students with high self-efficacy demonstrate greater perseverance when facing mathematical challenges, which overall enhances their learning outcomes (Hutagalung, 2016). Conversely, students with low self-efficacy tend to experience anxiety, which impedes their achievement in mathematics (Masitoh & Fitriyani, 2018).

Concrete steps are needed to build students' self-efficacy by providing positive affirmation and encouraging them to develop their self-efficacy through collaboration. Offering rewards and recognition for students' mathematical achievements can motivate them and enhance their self-efficacy. Additionally, group activities and peer mentoring can create a comfortable environment for students, allowing them to learn from each other and build their self-efficacy (Aswin & Herman, 2022).

The study of self-efficacy in mathematics continues to develop as researchers seek to understand its impact on academic achievement. In recent

years, research has highlighted the importance of interventions that enhance self-efficacy, such as problem-based learning, which has proven effective in improving both self-efficacy and student achievement (Setiyani & Rokhmaniyah, 2023). This research demonstrates that efforts to boost self-efficacy can help students achieve better academic results

c. Mathematics Anxiety

Mathematics anxiety is a psychological disorder involving feelings of fear and worry when facing mathematics (Mutodi & Ngirande, 2014). Woodard (2004) identifies symptoms such as nervousness, difficulty concentrating, mental blanks, and even nausea when attending math classes. Research has demonstrated that mathematics anxiety negatively affects students' mathematical connection skills (Haerudin et al., 2021), learning outcomes in mathematics (Barroso et al., 2021), and conceptual understanding of mathematics (Ramirez et al., 2013).

Mathematics anxiety negatively impacts learning by hindering students' problem-solving skills, especially in tasks that require critical thinking and high concentration. Students with high mathematics anxiety often have lower academic performance and struggle to apply mathematical concepts effectively (Novak & Tassell, 2017).

Teachers need to make efforts to prevent and reduce students' mathematics anxiety by applying mindfulness practices in mathematics instruction. However, before doing so, teachers should also receive adequate pedagogical training to understand mathematics anxiety and how to address it (Horne, 2022). By implementing mindfulness practices, students will be able to manage the mathematics anxiety they experience and also improve their focus during mathematics lessons (Bautista, 2023).

Research trends show an increased focus on factors that mediate the relationship between mathematics anxiety and learning outcomes, such as self-regulation and motivation. Problem-based learning approaches have been found to reduce anxiety and enhance students' mathematics achievement (Meriyati et al., 2018). Meta-analytic studies further reveal that anxiety associated with advanced mathematical tasks has a more substantial negative impact than basic tasks, underscoring the need for targeted interventions to address this anxiety (Namkung et al., 2019).

d. Mathematics Disposition

A positive attitude towards mathematics is known as mathematical disposition (Kusmaryono et al., 2019). Mathematical disposition reflects a student's tendency to apply mathematical thinking in daily life. According to Lestari and Yudhanegara (2019), mathematical disposition includes aspects such as confidence, flexibility, interest, perseverance, self-reflection, and self-assessment in applying mathematics to real-life situations. Research indicates that mathematical disposition can predict success in mathematics learning. For instance, Azizah (2023) found that mathematical disposition affects students'

problem-solving abilities, while Desthiani & Izzati (2022) noted its influence on students' performance in arithamtics.

Mathematics disposition significantly affects learning by encouraging students to actively engage in problem-solving and critical thinking. Students with a strong mathematical disposition tend to have greater problem-solving skills and maintain a strong motivation for learning, which, in turn, contributes to improved academic outcomes (Kamid et al., 2021). Research also shows that developing this disposition through strategies such as problem-based learning can improve students' perceptions of mathematics and enhance their problem-solving skills (Hutajulu et al., 2019).

Research trends on mathematical disposition continue to expand, especially focusing on how this disposition plays a role in context-based learning, such as ethnomathematics and real-life applications. For instance, ethnomathematics-based learning has been shown to increase students' mathematical disposition by connecting mathematics to culture and real-life experiences, thereby boosting their interest and engagement (Ulya & Rahayu, 2021).

Additionally, collaborative approaches, such as group investigation, have been tested as methods to enhance mathematical disposition and problem-solving skills. In this collaborative learning model, students not only build mathematical understanding but also increase confidence, flexibility, and self-evaluation skills regarding their solutions (Islamiati et al., 2021).

From a longitudinal perspective, mathematical disposition has proven relatively stable over time, although students show varying preferences for context-based versus abstract problem-solving. This highlights the importance of sustained and adaptive approaches to developing students' mathematical disposition holistically, which can positively impact their learning outcomes in the long term (Lin & ChunTai, 2016).

e. Mathematics Resilience

Mathematical resilience is the ability to assess, adapt, and improve from setbacks encountered in mathematics learning (Zanthy, 2018). This concept is central to mathematics education, as many students experience significant challenges in mathematics (Johnston-Wilder et al., 2014).

Mathematics resilience deeply influences learning, as students with strong mathematical resilience tend to face challenges and setbacks with a positive attitude, enabling them to persist in solving complex problems. Research shows that students with high mathematical resilience are more successful in overcoming mathematical difficulties, as they demonstrate higher emotional regulation and curiosity, which aid in problem-solving (Attami et al., 2020).

Teachers need to build a positive perception of mathematics and create social support. Teachers can use peer-mentoring or peer-tutoring methods to support students in overcoming difficulties in mathematics (Khairunnisa, 2023). These efforts can strengthen students' positive perception of mathematics and work towards enhancing their mathematical resilience.

In recent research trends, mathematical resilience has been examined as a key factor in mathematics learning across different contexts. For instance, the use of problem-based learning with metacognitive approaches has proven to enhance students' resilience and support better learning outcomes in mathematics problem-solving (Hutauruk et al., 2019). Additionally, blended learning during the pandemic has helped increase students' resilience and mathematical literacy, indicating that flexible teaching methods can support mathematical resilience in dynamic learning environments ((Murni & Juandi, 2023).

Meta-analytic research suggests that mathematical resilience is influenced by psychological factors such as self-efficacy and self-concept, as well as social factors like teacher support and a positive learning environment. The development of mathematical resilience has also been focused on students from disadvantaged backgrounds to help them achieve higher academic performance, particularly in mathematical literacy (Xenofontos & Mouroutsou, 2023).

CONCLUSIONS AND RECOMMENDATIONS

Mathematics is a unique subject because it encourages students to actively engage in numerical processing, abstraction, and generalization. However, mathematics education goes beyond just logical and arithmetic skills; it involves underlying mental processes that contribute significantly to students' success in mathematics. All of this is closely linked to the role of educational psychology.

The role of educational psychology in mathematics education encompasses the learning process, assessment, and research. In the learning process, educational psychology is represented through various theories and teaching models. Educational psychology also plays a role in mathematics assessment, as seen in the development of multiple-intelligence-based mathematics tests. Furthermore, educational psychology contributes to mathematics education research, evidenced by the extensive studies conducted on psychological aspects of mathematics education.

As a recommendation for improving mathematics education, it is time for educators to begin studying educational psychology and applying it in their teaching processes. The hope is that this will help dismantle the intimidating stigma around mathematics, creating an effective learning experience tailored to students' developmental stages, and fostering interest in mathematics—a fundamental knowledge that remains integral to human life.

ADVANCED RESEARCH

This research is limited to the literature review method, so future studies could employ other approaches, such as systematic literature review and meta-analysis, to achieve a broader and more comprehensive description. Additionally, this study focuses only on three aspects of mathematics learning that are influenced by educational psychology. Future research could expand to other areas in mathematics education that educational psychology could

address, such as challenging behaviors in mathematics learning, learning regulation in mathematics, or myths in mathematics education that impact students' psychological states.

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