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Mathematics and Mathematics Education Values: An Analysis of Implementability in Mathematics Learning at Madrasah

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ABSTRACT

Integrating values into all aspects of the learning process for a particular subject is an important part of education. Students must not only develop cognitively, but the formation of attitudes and characters must also be in line with the overall educational goals. Mathematics, as one of the core subjects that students must learn, must also reflect the values embedded in it. The success of mathematics education can be assessed through the values conveyed during the learning process. This study aims to explore and analyze teachers' understanding of Mathematical Values and Values in Mathematics Education, as well as how these values are conveyed in the classroom. This study aims to explore and analyze teachers' understanding of Mathematical Values and Values in Mathematics Education, as well as how these values are conveyed in the classroom. This study uses a qualitative approach with a case study design. Data were collected through interview techniques from 4 mathematics teacher informants determined by percussive sampling techniques. Data analysis uses an intractic model in line with the data collection process through three activities simultaneously; (1) data condensation; (2) data display, and (3) drawing conclusions/verification. The results of the study indicate that teachers' understanding of Mathematics values [rational values] and Mathematics education values are very important in improving students' logical thinking skills, and providing a comprehensive understanding of mathematics in developing their problem-solving skills. In mathematics teaching practices, teachers convey mathematical values during problem-solving activities, where students must understand various mathematical equations, concepts, and methods. While Mathematics education values (MEV) are conveyed during the problem-solving phase and reinforced at the end of the teaching and learning activities.

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A. INTRODUCTION

Several research results show that there is an influence of teachers on quality teaching that involves values to help them continue to work successfully in the classroom. It is widely accepted that education is not value-free, even Aspin in Leicester & Modgil (2005) shows the existence of values everywhere because they permeate all aspects of education. These values then become the foundation for all school activities and all institutions and institutions of society that are committed to the education of future generations. Values are at the heart of education, both in philosophical foundations and in practical activities in schools (Toker Gökçe, 2021). For example, students find pictures or mottos that show explicit or implicit messages on

the walls of the school. It is also at the heart of quality teaching because students learn best in learning situations that are consciously structured around positive values of caring and concern for student progress. Consciously, values are integrated into various aspects of school life through cooperative interactions between the principal, teachers, students, and parents.

The discussion of values in education has long been a significant topic across various disciplines. Values play a central role in the educational process at multiple levels, from institutional frameworks and curriculum development to classroom interactions (Le Métais & Tabberer, 1997). These values serve as the foundation for building both the personal and social identities of students. The concept of values has been explored in numerous fields such as anthropology (Murdock & Kluckhohn, 1962), psychology (Kohlberg, 1981); (Krathwohl et al., 1956a); (Barker & Rokeach, 1975), and general education (Beyer, 2001); (Kalogeropoulos & Clarkson, 2019). However, despite the ongoing importance of values in education, research specifically focusing on values in mathematics education has only recently begun to garner attention (Suwandi, 2022). Values are, in fact, a primary theme in shaping educational policies, bridging the gap between theoretical understanding and the practical knowledge students acquire throughout their education (Halstead & Taylor, 2000).

In Indonesia, the concept of education is closely linked to the idea of "humanizing humans" as introduced by Ki Hajar Dewantara, where education serves as a means to develop human potential in alignment with societal values (Tilaar, 2004). Education is viewed as a process of positioning individuals in their rightful place, both as individuals who contribute positively to themselves and to their surrounding environment. Ivanilic relates this to the provisions of the National Education System Law No. 20 of 2003 (Syabilah Marshanda (2023), which emphasizes that the aim of education is to produce individuals who can grow and thrive among those who possess skills and values worthy of emulation. Consequently, education is not solely about the acquisition of knowledge, but also about the inculcation of positive moral values, which ultimately shape the character and attitudes of students within society.

Mathematics has traditionally been regarded as a discipline focused on critical and analytical thinking. This approach is often associated with the positivist perspective, which tends to separate facts from values (Prior, 1990). Mathematics is seen as a field that prioritizes objectivity and absolute truth, devoid of moral or ethical values. However, within the context of education, values in mathematics play a significant role in shaping students' thinking processes. According to Bloom's Taxonomy Krathwohl et al. (1956), education is not solely concerned with cognitive abilities but also encompasses the affective domain, such as ethics and morals, which are crucial in decision-making during the learning process and problem-solving. Therefore, values in mathematics education not only enhance conceptual understanding but also foster ethical awareness in mathematical thinking.

The importance of values in mathematics education can be viewed from two main perspectives: the values embedded in the process of mathematics education and the intrinsic values within mathematics itself (Dede, 2006). The values in mathematics education include formalism, instrumental understanding, the relevance of theoretical knowledge, accessibility, as well as evaluation and reasoning. On the other hand, the intrinsic values of mathematics encompass objective rationality, control over progress, and openness to mystery (Tiong Seah, 2019). Instilling these values is crucial in shaping students' personalities, particularly in

relation to character development based on spiritual values, as emphasized in the Indonesian education system. Mathematics education not only aims to enhance students' cognitive skills but also seeks to integrate spiritual and social values that support the holistic development of students' character (Qutni, 2018)(Azzuhro & Salminawati, 2023).

Several international studies indicate that mathematics education can serve as an effective tool for instilling humanistic values that are essential for the social and economic development of society. Mathematics education, when designed with an approach that integrates humanistic values, not only aids students in understanding mathematical concepts but also helps shape their attitudes and character, promoting social justice and enhancing social awareness. Adler (2015) found that the integration of social values into mathematics instruction can foster students' character development and raise their awareness of social issues. Artigue (2017) demonstrated that the application of humanistic values in the mathematics curriculum can enrich the learning experience and support greater social awareness. Artigue (2017) further explored how mathematics education can influence students' social attitudes, concluding that a critical approach to mathematics contributes to the development of more equitable and inclusive attitudes. Aslan (2019) identified that a values-based approach in mathematics education positively impacts students' social and economic development, helping them become more sensitive to social issues. Lubienski (2020) revealed that integrating values of justice and inclusion in mathematics education contributes to more equitable and balanced learning outcomes across all students. These studies suggest that mathematics education, when integrated with humanistic values, holds significant potential to support more inclusive and sustainable social and economic development.

Research conducted in Japan by Ueda et al. (2014) revealed that the lack of value integration in elementary mathematics instruction can affect the overall quality of education. Mathematics teachers in Japan often face challenges in conveying values in their teaching, particularly due to the open-ended nature of the instructional approach, which tends to focus on mastering formal mathematical concepts. Meanwhile, Tiong Seah (2019) emphasized that students' cognitive and affective abilities in mathematics education are developed through the incorporation of values. However, empirical research on the integration of values in mathematics instruction remains limited Zhao et al. (2023); Liman (2013), and many mathematics teachers still struggle to explicitly convey these values in the classroom.

Based on various research findings mentioned above, it is evident that values in mathematics education are not only crucial for mastering mathematical concepts but also for shaping students' attitudes and character. The values instilled through mathematics education can help students develop creative and constructive thinking skills, which are essential for addressing global challenges. This study aims to explore and analyze teachers' understanding of mathematical and mathematics education values, as well as how these values are conveyed or integrated into their mathematics teaching practices. Thus, it is hoped to reveal that in mathematics instruction, teachers not only impart knowledge of mathematical concepts and content but also play a role in shaping students' personalities by instilling mathematical and educational values throughout the learning process. This is important because a teacher's role extends beyond teaching; they are also educators. As such, all teachers, including mathematics

teachers, are responsible for the development of students' attitudes and behaviors throughout their educational journey.

B. METHODS

This study employs a qualitative approach with a case study design aimed at exploring and understanding the application of values in mathematics and mathematics education by teachers in Madrasah. Data were collected through one-on-one interviews or focus groups to explore data on the topic of mathematics values and mathematics education values, and how these values are conveyed during classroom learning. The informants in this study were four (4) mathematics teachers determined using the purposive sampling techniques. Observations of participants in the context of classroom learning, the Madrasah environment, and learning device documents. While data analysis uses the interactive model (Miles dan Huberman, 2014), namely the data analysis process is carried out in line with the data collection process through three activities simultaneously; (1) data condensation; (2) data display, and (3) drawing conclusions/verification. The following is a picture of the interactive model:

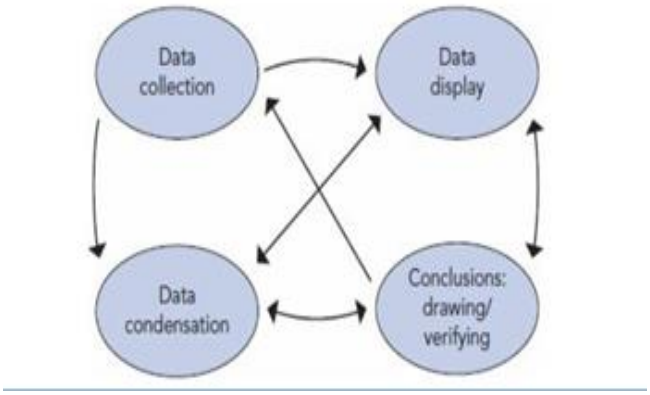

Figure 1. Miles Model Data Analysis

Meanwhile, checking the validity of data in the qualitative research tradition, by Lincoln and Guba (1985) stated that truth-worthiness in qualitative research is also highly demanded but does not use terms as in quantitative research. To meet the accuracy of data and its reliability, Yin (2014) suggests that researchers should document as many of their case study procedures as possible. Some of the ones used in this study are credibility, transferability, dependability, and confirmability. To meet the credibility standards, various techniques and strategies are carried out including being at the research location for a sufficient amount of time [prolonged engagement]; observation activities are one of the data collection techniques, using participant observation; triangulation is an effort to verify findings by checking their truth from various sources; peer debriefing, which involves colleagues who tend to be critical of the research process and results, analysis of negative case analysis, especially in theory development strategies; and conducting member checks with the perpetrators. Meanwhile, to meet the transferability standards, the key is determined by how rich the information provided is related to the research context (setting). So that readers of the results of this study can understand comprehensively and holistically and find out what the description of the research context (setting) is like in order to be transferred to its general validity. In Creswell's terms, it is called

a rich and thick description of the research results. Finally, the standards of dependability and confirmability, basically depend on the clarity of the "trace record" from which the concepts and theories come. And if the track record is clear, then there is no reason to question the dependability and confirmability of the results or findings of qualitative research.

C. RESULT AND DISCUSSION

The research on Mathematical Values and Mathematics Education Values focuses on understanding how teachers comprehend these values, which specific Mathematical and Educational Values can be conveyed during the mathematics learning process, and how teachers deliver these values during classroom instruction. Based on the research data collected, the following sections provide a detailed explanation of the findings and discussion of the results regarding Mathematical and Mathematics Education Values:

1. Teachers' understanding of mathematics and mathematics education Values

a. Mathematical Values

Based on the interview results, the teachers' understanding of Mathematical Values (MV) is illustrated by the following excerpts:

Researcher: *What is your opinion on mathematics as a field of knowledge?*

Response 1: *Mathematics, as a field of knowledge, has a clear theoretical foundation. A single mathematical concept can consist of several concepts, axioms, or theorems. Therefore, to understand one mathematical concept, we sometimes need to grasp several other concepts to complete our understanding. Moreover, many problems encountered in everyday life are related to mathematics.*

Response 2: *I view mathematics as a systematic arrangement of concepts. We can understand one concept based on our prior knowledge, and we can even predict the solutions to more complex mathematical problems based on our current understanding.*

Response 3: *Mathematics is considered a field of knowledge because we must understand each mathematical concept in its entirety. This means that to solve a mathematical problem, we must comprehend several preceding rules or concepts. Thus, our understanding of a single mathematical concept will be complete and unchanged, even if the form of the mathematical problem is altered.*

Researcher: *What are the essential elements found in mathematics?*

Response 1: *At a glance, when studying mathematics, we encounter various shapes, symbols, and texts. All of these must be understood in terms of their meanings to help us grasp the mathematical ideas they represent.*

Response 2: *The essential element to understand when solving mathematical problems is the value of each symbol in a specific mathematical concept. Misunderstandings or the inability to find a solution set can occur if we do not grasp the meaning of each symbol in a formula or equation.*

Response 3: *Since mathematical equations are composed of various symbols or signs, the essential elements in mathematics are these symbols or signs and their meanings. Different symbols or signs indicate different concepts. For example, the letter "a" might represent a coefficient in an algebraic equation, while "A" often denotes a specific set. We must understand these symbols well to be aware of the mathematical concept being discussed.*

Mathematics is viewed as an idea that refers to theory. As a scientific discipline with a clear theoretical foundation, mathematics enhances one's logical thinking abilities, at least providing provisional answers to problems faced. This value highlights the importance of mathematics education for students to provide a comprehensive understanding of mathematics, which is essential for developing their problem-solving skills and preparing them for specific challenges. This understanding indicates that the mathematics teachers involved in the study possess an understanding of rational values, which are part of mathematical values. Mathematics is seen as a collection of objects or symbols that can be used as tools to concretize problems. This demonstrates that teachers recognize mathematics as an abstract discipline involving symbols that need to be defined for proper understanding, reflecting their grasp of the objectivism values inherent in mathematical values.

Mathematics is not merely understood as arithmetic but as an applied scientific discipline. It is perceived as a solution to social problems, not just mathematical resolutions. The correctness of mathematical results, in the sense that each problem's solution can be clearly measured and verified, should be open as a solution to complex issues, particularly in the context of school mathematics, which trains students to discover new ideas with clear arguments (Control-progress values). Openness values pertain to the complex nature of mathematics, requiring the ability to analyze various theorems, ideas, problem-solving strategies, and arguments that can serve as the basis for asserting specific truths and, if possible, discovering new theorems. Mystery values involve mathematical relationships and pattern exploration. In mathematics, solutions must be systematic, with each element interconnected and logically explained, ensuring that the truth of the solutions is accountable.

b. Mathematics Education Values (MPV).

Researcher: *What is your opinion as an educator on the importance of teaching mathematics in schools?*

Response 1: *The importance of teaching mathematics in schools lies in the fact that mathematical activities focus not only on the final result but also on the process of obtaining that result. Education emphasizes both the process and the outcome.*

Response 2: *Mathematics is an important component of the school curriculum because it requires students to work diligently to understand mathematical concepts thoroughly, ensuring that their results can be reliably justified.*

Response 3: *As an educator who hopes for students to grow into responsible individuals, learning mathematics is crucial because it equips students to solve problems related to daily life. The expectation is that learning mathematics will ultimately benefit the surrounding community.*

Response 4: *Mathematics, as a subject within the school curriculum, is relevant to the school environment, which must be structured by rules to ensure effective interaction among school members. In studying mathematics, adhering to rules is essential for solving problems.*

Researcher: *If it is indeed important, what educational values can be derived from teaching mathematics in schools?*

Response 1: *The values derived from teaching mathematics in schools include fostering good and correct behavior in students. Mathematical activities focus on finding definite truths that are non-negotiable and universally applicable.*

Response 2: *Mathematics education can cultivate self-awareness in students by habituating them to explore various possible solutions to a problem while adhering to rules to ensure the validity of steps and solutions.*

Response 3*: Learning mathematics can be used to develop students' character by encouraging openness and communication with diverse peers. Mathematical activities often involve discovering patterns and relationships between different forms or equations to solve problems.*

Response 4: *Mathematics is important for teachers in building a sense of responsibility in students. Mathematics requires ensuring that methods and results are accurate, which trains students to continually check their answers. This ensures that when presented, their solutions are accountable and reliable.*

The interview results indicate that teachers understand the deductive nature of mathematics (Formalistic - Activist view), where discovering various truths to find a specific truth is a characteristic of mathematics. Consequently, the truth values can be generalized. Learning and understanding how mathematics operates, including following rules in operations and using formulas (Instrumental understanding/ learning), reflects values related to showing relationships among mathematical concepts, whether in numerical, graphical, or diagrammatic form (Relational understanding/ learning). Additionally, mathematics serves as a means to address problems in social and cultural contexts (Relevance-Theoretical knowledge). The perception that mathematics is a field suited only to those with specific mathematical talents (Accessibility - Special) suggests that individuals who understand mathematics do not easily regard themselves as superior to others. The practice of having students review or question their problem-solving steps ensures that the final solution presented is well-reasoned and difficult to dispute (Evaluating-Reasoning).

2. Applicability of Mathematics and Mathematics Education values

Based on the teachers' understanding of Mathematical Values (MV) and Educational Values in Mathematics, it was observed that while these values are conveyed during the mathematics instruction process, not all aspects of these values may be effectively communicated or internalized by students. According to the interviews with teachers participating in this study, the conveyed Mathematical Values include:

a. Mathematical Values (MV)

Researcher: *In your opinion, which values in mathematical activities can influence students' development?*

Response 1: *In my view, when students engage in mathematical activities, they subconsciously develop their ability to seek evidence for a truth from a set of solutions. Consequently, students are able to explain each step of problem-solving, whether it is simple or complex.*

Response 2: *Through mathematical activities, students gradually recognize the benefits of learning mathematics for solving everyday problems. This understanding helps students realize that mathematics is not just about formulas but also relates to their surrounding environment.*

Response 3: *The systematic nature of mathematics assists students in developing anticipatory skills. This means students become accustomed to hypothesizing solutions and establishing the necessary steps to address problems. Furthermore, students develop a sense of adherence to rules, as the steps taken to solve mathematical problems must comply with established guidelines.*

Response 4: *Engaging in mathematical activities impacts students' confidence in presenting their findings. Often, students are required to demonstrate and illustrate mathematical concepts to facilitate better understanding.*

Response 5: *Mathematical activities contribute to the development of students' systematic thinking processes and enhance their ability to explain concepts to others. Students are trained to simplify complex information to arrive at straightforward solutions to problems.*

Students' ability to reason or argue for each idea or solution proposed aids in developing their argumentative skills (Hypothetical reasoning) when facing or solving specific problems. This habit, when practiced consistently, fosters logical thinking (Logical Thinking) and the ability to explain abstract concepts in concrete terms (Abstraction). Such skills naturally develop in students due to their frequent engagement with symbols, signs, or diagrams (Materialism), where each element has a distinct meaning and is placed in different contexts.

Researcher: *How do you communicate mathematical values to students?*

Response 1: *The primary goal of teaching mathematics is to ensure that students understand the material. However, while students are solving problems, we typically emphasize the benefits that are expected to arise from their engagement in mathematics. This approach aims to impact their character development positively.*

Response 2: *We communicate the benefits of solving mathematical problems during the process of working on mathematics exercises. This helps ensure that the values embedded in mathematics influence students' personal development.*

Response 3: *We discuss the benefits of engaging in mathematical activities for student's personal growth while they are working on mathematical problems. This is often more effective when students are working on word problems, as these problems involve multiple steps to convert narrative text into formal mathematical expressions.*

Mathematical values are conveyed by teachers during problem-solving activities, where students must understand various mathematical equations, concepts, and methods. Students are expected to solve mathematical problems systematically. Additionally, teachers prepare a variety of mathematical problems to instill the aforementioned values, as routine problems alone may not effectively convey mathematical values (MV). Therefore, teachers predominantly assign non-routine mathematical problems.

b. Mathematics Education values

Some of the values in the mathematics education process above, if described in detail, then through mathematics education can instill values in students about the following things:

Researcher: *As an educational process, what values can be instilled in students through mathematics education?*

Response 1: *Learning mathematics can ensure that students are precise in solving the problems they encounter, as mathematics teaches students to provide accurate answers, both in terms of the steps taken and the final results. Consequently, mathematics education can impact students by fostering a habit of analyzing and critically evaluating information rather than accepting it at face value, allowing them to respond clearly to the information they receive.*

Response 2: *The importance of mathematics education for personal development includes fostering creativity. Mathematics teaches students to explore various problem-solving approaches and to find solutions that are both effective and widely accepted.*

Accuracy in problem-solving is crucial as every step taken to resolve an issue is rigorously verified and thoroughly examined. Therefore, students are expected to develop a focused personality, ensuring precision in determining steps when addressing or solving problems. Solutions that adhere to operational rules or follow clearly established theorems will provide clarity for each proposed solution. As a result, students become accustomed to presenting clear and reliable information. Regular practice in analyzing complex problems helps students develop effective problem-solving plans (conjecturing) and hones their intuition in predicting the appropriate steps for resolving issues.

Truthfulness and adherence to rules in solving problems influence students' consistency. The validity of the results and adherence to rules should not be easily swayed or influenced by information from other sources. Furthermore, creativity in discovering various possibilities and establishing effective problem-solving strategies is expected to enhance students' creativity in mathematics. Consequently, students are encouraged to cultivate creativity when tackling or resolving complex problems.

Researcher: *How are mathematical values conveyed to students?*

Response 1: *To motivate students and maintain their enthusiasm for learning mathematics, we explain the benefits of mathematics education for their development into better individuals at the end of each session. We use the values of mathematics education as reinforcement to make learning mathematics seem more beneficial to the students.*

Response 2: *We integrate the values of mathematics education into the learning process itself. We emphasize the benefits of solving mathematical problems as a way to inspire students throughout their problem-solving activities.*

Response 3: *We discuss the benefits of engaging in mathematics for personal development during material reinforcement sessions. We explain the purpose of each mathematical topic, which helps students understand why learning specific content is important for addressing problems in their surrounding environment.*

Mathematics Education Values (MEV) are conveyed during the problem-solving phase and reinforced at the end of the teaching and learning activities. This approach is implemented to stimulate students' motivation for learning mathematics and to demonstrate the significance of the educational process. According to teachers, conveying these values is crucial, as some students still perceive mathematics as having limited meaning, viewing it merely as practice in solving mathematical problems. They may question the purpose of learning mathematics.

Communicating Mathematical Values (MV) during the teaching process helps students understand that mathematics is not just a set of concepts found in textbooks but also a field of study that can be broadly applied to solve various real-world problems. Meanwhile, Mathematics Education Values (MEV) play a crucial role in maintaining students' positive attitudes towards learning mathematics. Given the tendency for students to have a negative perception of mathematics, which often results in a lack of interest, integrating these values into teaching can transform the perception of mathematics from a mere collection of concepts and formulas into a field that fosters genuine interest and engagement.

D. CONCLUSION AND SUGGESTIONS

This study shows that teachers' understanding of Mathematics values [rational values] and Mathematics education values are very important in improving students' logical thinking skills, and providing a comprehensive understanding of mathematics in developing their problem-solving skills. Openness values relate to the complex nature of mathematics, which requires the ability to analyze various theorems, ideas, problem-solving strategies, and arguments that can serve as a basis for asserting certain truths and, if possible, discovering new theorems. Mystery values involve mathematical relationships and pattern exploration. In mathematics, solutions must be systematic, with each element interconnected and explained logically, ensuring that the truth of the solution can be accounted for.

In mathematics teaching practices, teachers convey mathematical values during problem-solving activities, where students must understand various mathematical equations, concepts, and methods. Students are expected to be able to solve mathematical problems systematically. While Mathematics education values (MEV) are conveyed during the problem-solving phase and reinforced at the end of the teaching and learning activities. This approach is applied to stimulate students' motivation in learning mathematics and show the importance of the educational process. Communicating Mathematical Values (MV) during the teaching process helps students understand that mathematics is not just a collection of concepts found in textbooks, but also a field of study that can be widely applied to solve various problems in the real world.

The issues of values in mathematics education are quite complex (Hill et al., 2021), which is largely due to the complexity of the concept of value itself. The reality is that values in mathematics education can be assessed in mathematics, mathematics teaching and learning, and mathematics education. Therefore, it is very important to build a broader value construction and a stronger theoretical foundation for further research in this area. Of course, more attention should be paid to issues concerning values as a construction from a socio-

cultural perspective, in other words, issues about the value of mathematics education for the holistic development of students in their future as adult members of society. Finally, it is clear that there is a need for more interdisciplinary exchanges and collaborations between mathematics educators, educators based on other disciplines.

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