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Analysis of Context Utilization in Mathematics Learning Based on Teacher Competency

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Abstrak

Pemahaman konteks matematika merupakan kemampuan yang penting dikuasai siswa dalam rangka memaknai matematika. Namun data lapangan menunjukan pemahaman konteks yang dimiliki siswa masih tergolong rendah. Tujuan dari penelitian ini adalah menganalisis pemanfaatan konteks yang dilakukan oleh guru dalam pembelajaran matematika serta mengetahui faktor – faktor apa saja yang menjadi penghambat sekaligus pendukung pemanfaatan konteks dalam pembelajaran matematika. Penelitian ini menggunakan pendekatan kualitatif dengan metode penelitian fenomenologi. Partisipan penelitian ini adalah guru matematika sekolah SLTA sebanyak 8 orang yang sudah mengajar setidaknya 2 tahun. Hasil penelitian ini menunjukan bahwa pemanfaatan konteks yang dilakukan oleh guru dalam pembelajaran matematika masih mengalami keterbatasan baik dari segi metode penyampaian maupun dari segi jenis konteks yang digunakan. Adapun faktor – faktor yang menjadi penghambat sekaligus pendukung pemanfaatan konteks dalam pembelajaran matematika yaitu kemampuan guru, jenis dan tingkat kesulitan materi, kemampuan dan motivasi siswa, serta ketersediaan media.

Kata kunci: Konteks, Pembelajaran Matematika, Fenomenologi

Abstract

Understanding the context of mathematics is an important ability for students to master in order to interpret mathematics. However, field data shows that students' understanding of the context is still relatively low. The purpose of this study is to analyze the use of context by teachers in learning mathematics and to find out what factors inhibit and support the use of context in learning mathematics. This study uses a qualitative approach with phenomenological research methods. The participants of this study were 8 high school mathematics teachers who had taught for at least 2 years. The results of this study indicate that the use of context by teachers in learning mathematics is still experiencing limitations both in terms of the method of delivery and in terms of the type of context used. The factors that inhibit and support the use of context in learning mathematics are the ability of the teacher, the type and level of difficulty of the material, the ability and motivation of students, and the availability of media.

Keywords: *Context, Learning Mathematics, Phenomenology*

1. INTRODUCTION

Mathematics is an abstract discipline that follows a sequential order beginning with the most fundamental concepts and progressing to the more complex ones (Pauji et al., 2023). Students are better able to see how mathematical ideas might be used in their life when they have an understanding of mathematics in a manner that is not abstract. They are able to recognize real-world scenarios, such as financial management, measurement, planning, or data analysis, that call for the application of mathematical concepts. The context that was employed was not a made-up scenario but rather was based on his life or derived from a truth (Sugilar et al., 2019). Students have the confidence to believe that mathematics is beneficial and relevant to their life as a result of this understanding. Using context when kids are studying mathematics is a powerful strategy that can assist pupils solve difficulties (Febrianty et al., 2022). Students are able to use their understanding of the context of mathematics to analyze situations, recognize difficulties, and discover solutions when they are able to apply mathematical principles. Students can build strong problem-solving skills that will be valuable in their future lives by understanding context, which helps students see how mathematics can be applied in a wider context. Context lets students realize how mathematics can be applied in a wider context.

Pupils who understand the context of mathematics are better able to enhance their critical thinking skills (Sunaryo & Fatimah, 2019).They develop the ability to analyze problems, recognize patterns, and understand the connections between different mathematical ideas. This not only helps them memorize formulas and procedures, but it also gives them a deeper understanding of the concepts themselves. Students benefit from a deeper comprehension of mathematics as a whole when they are able to view it as an integrated system, which is made possible when they have a firm grasp of its historical and cultural foundations. Students' motivation and interest in mathematics can be increased when they have a better understanding of the context in which mathematics is used (Aji et al., 2021). Students typically develop a greater interest in mathematics and are more driven to learn the subject when they can make apparent connections between it and other aspects of their lives. Contextually aware people are better able to dispel the misconception that mathematics is nothing more than dry and uninteresting theory, and instead see it as an engaging and rewarding field of study.

The teacher's ability regarding how to communicate mathematics to students will affect the learning outcomes obtained by students (Kariadinata et al., 2019). Presenting mathematics in a way that is adapted to the context of students' conditions is an important part of the role of a mathematics teacher. Students must be presented with real and abstract contexts from mathematics so that the learning they get can be felt more meaningful. Mathematics can be thought of as a chameleon (Johnston-Wilder et al., 2010) disappearing against the backdrop of the real world and sometimes only visible to those who know what they are looking for. Therefore, part of the math teacher's job is to help students identify aspects of real-life situations where mathematics is relevant. Teaching math using context should carried out since the start of learning (Kurniawan & Susanti, 2021). Students will develop their individual ability to see mathematics and have the opportunity to make use of mathematics in the world around them if we consistently link new concepts with practical applications and provide them with opportunities to behave as investigative mathematicians and problem solvers (Windyariani, 2019).

Regarding the current face of Indonesian education, especially the ability to understand students' mathematical contexts as presented in the results of the numeracy ability test, Indonesia still has a low quality compared to other countries if you reflect on the results of PISA (Program for International Student Assessment) and TIMSS (Trends in International Mathematics and Science Study). PISA results in 2015, out of an average score of 490 Indonesia only got a math score of 387 (OECD, 2016), while in 2018 Indonesia got a math score of 379 (OECD, 2019). TIMSS Indonesia results scored 395 in 2015 out of an average total of 500 participants (Guhn et al., 2016). Based on

these results, Indonesia is in a lower position, even under a small country like Vietnam (Kemendikbud, 2017). These results are partly due to the fact that students in Indonesia are not accustomed to working on the types of numeracy test questions so that students have difficulty solving them (Gusmawan & Herman, 2022)

In the current Indonesian education system, at each final evaluation for each level of education a Minimum Competency Assessment test will be given, which includes a numeracy or mathematical literacy test. Numeration and Mathematical literacy is the ability possessed by someone to use their mathematical knowledge in explaining events, solving problems, or making decisions in everyday life (*Asesmen Kompetensi Minimum*, n.d.). Among the parts of numeration ability and important mathematical literacy is the application of mathematics to problem solving in various contexts (Van den Heuvel-Panhuizen, 2014).

Some field data shows that students' mathematical literacy abilities are still in the low/less category. The research entitled "Analysis of the Ability of Class VIII Students in Solving Numerical Literacy Problems" (Ate & Lede, 2022) shows 73.3% of students are in the very poor category and 26.7% are in the less category, so it can be concluded that in general the ability deep students solving about numeracy literacy is still low. Another study entitled Analysis of Students' Mathematical Literacy through PISA Questions (Masfufah & Afriansyah, 2021) concluded that students' mathematical literacy skills were still low, this was evident from the results of students' work on solving everyday problems which was relatively low. The research entitled "Analysis of Students' Ability in Solving Geometry Problems in the Minimum-Numeration Competency Assessment in Elementary Schools" (Sari et al., 2021) shows that students' ability to solve geometry problems in the Numerical Minimum Competency Assessment (AKM) is still low, namely by having a percentage of 17.65%. Likewise, research entitled "Analysis of Numerical Ability in the Development of Minimum Ability Assessment Questions for Class XI High School Students to Solve Science Problems" (Winata et al., 2021) shows that students' numeracy abilities are still low. It is known that 61.90% of students scored below 50. The percentage of wrong answers for the 3 indicators was 64.76%; 48.57% and 44.67%. In the study entitled "Analysis of Numerical Literacy Skills in Grade 5 Elementary School Students" (Rahmwati, 2021) showed that 7 out of 12 students had low numeracy literacy skills and the rest had moderate numeracy abilities.

The low ability of students' mathematical literacy can be caused by various factors. Apart from the conceptual complexity of the participant matter, low mathematical literacy skills can be caused by apparent inaccuracies and/or the teacher's inability to present it in a coherent/meaningful way (Quilter & Harper, 2006). Some teachers do not use context in learning not because they don't want to, but because of limited knowledge about how to use a context in learning (Kurniawan & Susanti, 2021). Understand the context of questions and translate it into the language of mathematics is a challenge when solving mathematical literacy problems. Therefore, the biggest challenge for teachers in improving students' numeracy skills is to help them better understand the context in math word problems. If learning mathematics is still done by relying only on formulas and equations, this becomes contradictory to the need to answer math questions in the context of the real world every day.

Four context categories were defined and used to classify the assessment items developed for the PISA survey (OECD, 2017). The four contexts are as follows: **1) Private**, i.e. problems classified in the category of personal context focusing on activities of oneself, family, or group of peers; **2) Jobs**, namely problems that are classified in the category of work contexts centered on the world of work. items categorized as work may involve (but are not limited to) such things as measurement, costing and ordering of building materials, payroll/accounting, quality control, scheduling/inventory, design/architecture, and work-related decision making; **3) Societal**, i.e. problems classified in the social context category focus on one's community (whether local, national or global). They may involve (but are not limited to) matters such as voting systems, public transport, government, public

policy, demography, advertising, national statistics, and the economy; And **4) Scientific**, namely problems classified in the scientific category related to the application of mathematics to nature and issues and topics related to science and technology. Certain contexts may include (but are not limited to) areas such as weather or climate, ecology, medicine, aerospace sciences, genetics, measurement, and the world of mathematics itself. Items that are intra-mathematical, in which all the elements involved are included in the world of mathematics, including in a scientific context.

The use of context when learning mathematics itself is able to provide better results compared to context-free learning. Previous research entitled "Developing Mathematical Questions of PISA Model by Using Jambi Context" (Charmila et al., 2016) found that the questions developed had several potential effects, namely involving various basic mathematical abilities in the solving process. In addition, it is also able to attract interest and motivate students so that they are challenged to solve problems. These questions also provide a stimulus for students to think critically using their own reasoning in solving them. Another previous study entitled "The Effect of Use of Leaf Context on Students' Learning Outcomes" (Lisnani, 2019) found that there was an effect of using leaf context on student learning outcomes in fractions, namely the use of leaf context really helped students in learning mathematics.

2. METHOD

This research uses a qualitative approach with a type of phenomenological research that will describe the condition of using the context in teaching mathematics conducted by teachers. Phenomenology is the best method used to explain something, with this method we will get a general and in-depth description of the object we want to examine or know based on appearances on the object (Nuryana et al., 2019). The instrument in this study was the researcher himself with the data collection techniques used were interviews and observation. The interview was carried out online using the app google *meet* which was conducted in the period 12-20 May 2023. The type of interview used was a semi-structured interview with the consideration that information from the participant could be conveyed in more detail (Creswell, 2012).

The participants used in this study were 8 school teachers in Bandung who were selected using a technique purposive *sampling*. The aspects that were considered in the selection of subjects were teachers who had at least graduated from a bachelor's degree (S1) so that the teachers who were sampled were teachers who had sufficient basic knowledge regarding the use of context when learning mathematics. Another aspect is teachers who have taught at school for at least two years and have a certificate as an educator so that it can be ascertained that the teachers sampled are professional teachers who already have experience in teaching. Interviews were conducted in depth so that the results obtained could be more open (Sugiyono, 2014).

The data were analyzed in stages, namely data reduction, data display, then continued with drawing conclusions and verification (Miles & Huberman, 1994). Data from interviews and observations were adjusted to each other then the coding step was carried out, namely open coding, axial coding, dan selective coding. *Open coding is* the process of dividing, analyzing, comparing, conceptualizing, as well categorizing data. Axial *coding is* a process connecting categories with subcategories, then rearranging the data that has been categorized to relate to the emerging analysis. Third phase selective *coding is* a way to connect other categories that require improvement and then arrange them into a sentence systematically (Mohajan & Mohajan, 2022). Then the researcher analyzed the results and concluded by making a descriptive presentation of the data.

3. RESULT AND DISCUSSION

A. How Important is the Utilization of Context in Learning Mathematics?

The researcher asked 8 teachers who were the participants about their opinion whether it was important to use context when learning mathematics. In general, they have the same opinion that the use of context when learning mathematics is very important. Among the reasons given by the participants is because learning using context is one way to support students' interest and motivation when learning. Many students always ask "What are the benefits of me learning mathematics", this question can be answered by using the context when teaching mathematics. This result is in line with what was stated (Silaban & Mauliadi, 2019), namely learning using context apart from creating fun and meaningful learning, the implementation of learning like this indirectly makes it easier for students to learn mathematical concepts. Meaningful learning itself is a derivative of the curriculum used in Indonesian education today, namely the independent curriculum.

Another reason from the participants regarding the importance of using context when learning mathematics is that the evaluation, assessment or exam curriculum in Indonesia currently requires the ability of students to connect mathematics with context. The assessment referred to here is more specifically the participants mentioning AKM and SNBT.

Apart from the importance of using context, some participants argue that it is okay not to provide context when learning mathematics. This is dependant on the overall level of ability possessed by the learner. Some students may have an easier time understanding mathematics when it is presented in context, while other students may have trouble understanding mathematics when it is presented in an abstract form. However, a significant number of students have trouble understanding mathematics when it is presented in context, but they understand very quickly when mathematics is presented in an abstract form without having to be bridged with context. Mathematics itself is essentially context-free. Context is not the main goal, context can be seen as an aid but in the end mathematics must be returned to its original form as an abstract thing (Suryadi, 2010).

B. How do teachers use context in learning mathematics?

In the previous discussion it was discussed that all participants agreed on the importance of using context in learning mathematics. This is partly relevant to implementation in class, but partly contradicts what teachers do when teaching mathematics. The results of interviews and observations show that some teachers present a limited number of contexts for learning mathematics. The way the teacher presents the context by the researcher is summarized into two methods, namely first by using it as a stimulus at the beginning of learning, and secondly by including it in application practice exercises. The following table shows the method used by the teacher in presenting the context in learning mathematics and also the percentage of context questions given (CQG) when evaluating learning:

Table 1. How to Present the Context in Learning Mathematics

No	Participant Code	How to Present Context		CQG
		Stimulus at the Beginning	Application in practice questions	
1	AS	Limited	Always	50%
2	AZ	Limited	Limited	30%
3	IN	Limited	Limited	30%
4	IM	Never	Limited	10%
5	MI	Always	Limited	25%
6	RM	Never	Never	20%
7	KR	Limited	Limited	25%
8	KA	Always	Always	25%

It is clear from the information presented in the table that is located above that educators implement learning contexts in a wide variety of distinct methods. The frequency with which teachers

implement various instructional strategies also varies. There are certain scenarios in which the instructor will consistently present this strategy, while others will only do so on a case-by-case basis, and yet others will not be discussed at all. Only two out of the eight instructors consistently used the context as a driving force at the beginning of the learning process. Four out of every eight teachers use context as a stimulant at the beginning of the learning process, but only a select few of these teachers do so. In the meantime, two out of every eight instructors have never used context as a stimulus at the start of the learning process. Only two out of the eight instructors consistently give the mathematical context in the form of applications in the practice questions. Five out of the eight instructors give the mathematical background in the form of application in practice questions; nevertheless, the number of questions presented is restricted. In the meantime, one out of every eight educators will never include a mathematical context in the form of an application in the practice questions they give their students. The constraints that are placed on the teacher's ability to convey the mathematical context that is supplied to the pupils are the result of a number of issues, one of which is that, according to some teachers, the delivery of mathematics in the form of context takes more time than learning mathematics outside of context. During this period, the teachers themselves have a limited amount of time to teach in addition to a significant amount of curricular guidance material, all of which needs to be communicated. In addition, some educators explained that they did not use context while instructing students because they did not have the time to prepare lessons and instead adhered strictly to the progression or learning design outlined in the textbooks they employed. In the next discussion, more aspects, including some that are more in-depth, will be examined.

The difference in the method used allows the results of the students' understanding to be obtained to be different. Researchers found that teachers who used context from the start or understood it in learning had prior knowledge of context-based approaches or methods for learning mathematics. Since the beginning of learning, they have created context-based learning designs so that they are better prepared for teaching and learning practices in class. In addition to the learning concept that they instill in students, it also gives a more natural impression. This is in line with research (Darto et al., 2022) which concluded that learning mathematics through context in general can improve students' mathematical communication abilities. Unlike the teacher who only uses context when evaluating student learning. Learning like this results in a disconnected understanding of concepts. Students are not familiar with the contextual situations of mathematics because when learning students are not taught such things.

The context used by teachers in learning mathematics is also divided into several types. The types of contexts that are often used are grouped into four types, namely: 1) Contexts related to personal life; 2) Context related to life at school or work; 3) Context related to community and social life; 4) Context related to more scientific and abstract activities (OECD, 2017). The following table shows the types of contexts that teachers use when teaching mathematics:

Table 2. Types of Contexts Used in Learning Mathematics

No	Participant Code	Context Type			
		Context 1	**Context 2**	**Context 3**	**Context 4**
1	AS	Always	Always	Limited	Limited
2	AZ	Limited	Always	Limited	Limited
3	IN	Limited	Always	Limited	Never
4	IM	Limited	Limited	Limited	Never
5	MI	Limited	Limited	Limited	Limited
6	RM	Limited	Never	Never	Never
7	KR	Limited	Limited	Always	Never
8	KA	Limited	Limited	Never	Never

From the table we can see that not all types of context by the teacher have been accommodated given to students. The first context discusses the types of contexts related to students' personal lives, both life in the family or life with peers. In this context, all participants have accommodated it, although not always given it. As many as 87.5% of new participants could convey this context in a limited amount. The second context discusses the types of contexts related to students' lives at school and in the work environment. This context is the context most often used by participants in learning mathematics. 37.5% of the participants always associated this second context, 50% in limited numbers, and 12.5% never used this context. This second context is considered to be the type of context that best suits the needs of students. This is because when students are presented with contexts that are appropriate to their majors, according to their future, according to the type of work they expect, students will be more motivated to study it. This is based on students' awareness that they need this to support their future careers. Mathematics does play a vital part in a variety of professions, including the sciences, technologies, engineering, the corporate world, and the financial world (Khairiyah, 2019).

Students who have a solid foundation in the context of mathematics are in a strong position to meet the obstacles that they will confront in the working world. They are able to solve problems, do data analysis, and make decisions based on the information they have gleaned from it thanks to their proficiency in mathematics. The third context discusses the context related to the student's environment and social life. In this context, 12.5% of participants always use this context, 62.5% in limited quantities and 25% never use it. The fourth context discusses contexts related to more scientific and abstract activities. This context is the type of context that is rarely given by teachers. As many as 37.5% convey this context in limited quantities and 62.5% never convey it. Even in terms of AKM and SNBT, this type of context is presented in quite a large number. This context is indeed the most difficult context for teachers to explain and for students to understand.

The different contexts given lead to different understanding results obtained by students (Sulistiawati et al., 2015). Students who are familiar with various types of contexts will have more understanding than students who only get some contexts or who do not get certain types of contexts at all.

C. Factors that Inhibit and Support Utilization of Context in Learning Mathematics

In the previous discussion, we already know that the use of context in learning mathematics has not been fully given to students. Both based on the method of delivery and the type of context used, there are still teachers who convey it in limited numbers or not at all. Based on data from interviews and observations, researchers found several factors that inhibit or limit as well as support the use of context in learning mathematics. These factors are: 1) Teacher ability; 2) Types of Material and Level of Difficulty; 3) Ability Level and Student Motivation; and 4) Availability of Media.

1) Theacher's ability

The researcher found that the teacher's limitations in using context were due to the teacher's understanding of the basic concepts of a material which was still limited. The results of the interviews show that some teachers have difficulty finding contexts that can be related to mathematical concepts. The researcher also found that even though the teacher knows the right context, the teacher still experiences problems related to the right method to convey the context. Teachers still experience difficulties in moving from non-context to context and from context to non-context again. This is supported by (Kurniawan & Susanti, 2021) which reveals that the teacher's ability to choose a context and the teacher's ability to apply the right method to use influences students' understanding of the context.

2) Type of Material and Level of Difficulty

The results of interviews with the participants showed that not all materials could context. This depends on the type of material and the level of difficulty. Materials such as analytic trigonometry, limits, or advanced algebra are best presented in an abstract form. Teachers can focus on using context on the same material but at a simpler level such as basic trigonometry and basic algebra. Mathematical concepts can be made more understandable for children by employing strategies such as computer simulations, mathematical games, and physical models, according to some educators. The utilisation of actual case studies or stories that involve more abstract mathematical ideas is another option for teachers. For instance, explaining how the matrices concept is utilised in the field of computer graphics or how the Pythagorean theorem is utilised in the process of determining the distance between two points.

3) Student Ability and Motivation

There are students who understand mathematics more in an abstract form so that when faced with a mathematical context these students experience difficulties. But there are also students who experience difficulties when learning abstract mathematics but will understand better when given mathematics in context. Student motivation will greatly influence what type of context is chosen. Broadly speaking, this is in accordance with research results (Nurul Hikmah & Hendra Saputra, 2020), namely the level of motivation is directly proportional to the results obtained by students. For example, students majoring in electronics will be more motivated when exponential material is presented in the context of resistor applications.

4) Media Availability

In line with research (Supriyono, 2018), the use of media is important to support student development, especially for students who have context limitations. Understanding mathematics based solely on verbal explanations is challenging because the subject frequently deals with abstract topics. Students may find it easier to conceptualise abstract mathematical ideas through the use of visual representations such as drawings, diagrams, and graphs. Students are able to better comprehend mathematical concepts and make connections between those concepts and the real world as a result. In certain materials, the availability of media is very supportive in efforts to use context in learning mathematics. Like the example of geometry material, the context provided will be easier to understand when there is adequate media to support student understanding.

4. CONCLUSION

The use of context in learning mathematics is very important in order to build meaningful learning and involve students in learning. The method of conveying context can be done at least by two methods, namely given at the beginning as a stimulus or delivered in the form of practice questions. The results of the study show that of the two types of methods, not all teachers use them optimally, in other words, there are still many limitations. Teachers who use context early on or understand it in learning have prior knowledge of context-based approaches or methods for learning mathematics. Since the beginning of learning, they have created context-based learning designs so that they are better prepared for teaching and learning practices in class. The type of context used by the teacher has also not been thoroughly conveyed. Of the four types of contexts that exist, most teachers only deliver 2 or 3 contexts.

The factors that support and hinder the use of context when learning mathematics are: 1) Teacher ability; 2) Types of Material and Level of Difficulty; 3) Ability Level and Student Motivation; and 4) Availability of Media.

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