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# BAGAIMANA KEYAKINAN SISWA TERHADAP KEMAMPUAN MATEMATIKA MEREKA? SEBUAH ANALISIS PADA MASALAH MATEMATIS TERAPAN DI SMA

## *How Do Students Believe in Their Mathematical Abilities? An Analysis of Applied Mathematics Problems in High School*

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**Abstrak:** Penelitian ini bertujuan untuk mendeskripsikan profil kepercayaan matematika siswa terkait pemecahan masalah matematis terapan. Studi ini menggunakan metode *purposed-design survey*. Terdapat 24 siswa sekolah menengah atas yang menjadi responden pada penelitian ini. Setiap responden diberikan akses kepada sebuah link *google form* yang memuat 28 pernyataan dengan respon berupan skala likert, dan tujuh pertanyaan yang bersifat terbuka. Hasil penelitian dianalisis dengan beberapa tahapan yakni, reduksi data, penyajian data, verifikasi serta penarikan kesimpulan. Berdasarkan data yang diperoleh, dapat disimpulkan bahwa profil kepercayaan matematika siswa cenderung bagus dalam hal meyakini bahwa matematika merupakan ilmu yang dapat diterapkan pada berbagai aktivitas di kehidupan nyata. Namun, cenderung kurang dalam hal memahami apa yang dimaksud dengan masalah matematis terapan, sebagai akibat dari rasa kepercayaan yang belum baik terhadap kemampuan matematika yang mereka miliki. Selain itu, proses pembelajaran yang dilakukan guru di dalam kelas juga mempengaruhi profil kepercayaan matematika siswa. Penelitian ini diharapkan dapat memberikan pemahaman yang lebih luas mengenai kekuatan dan kelemahan siswa dalam hal kepercayaan terhadap mathematika yang terkait dengan masalah matematis terapan.

**Kata kunci:** kepercayaan matematika, masalah matematis terapan, siswa sekolah menengah atas

**Abstract**: This study aims to describe the profile of students' belief about mathematics related to applied mathematical problems. The purpose-designed survey method was used in this study. There were 24 high school students who were respondents in this study. Each respondent is given access to a google form consisting of 28 statements with a Likert scale response and seven open-ended questions. Finding result were analyzed by carrying out several stages, namely data reduction, data presentation, verification and drawing conclusions. Based on the data obtained, it can be concluded that the profile of students' belief about mathematics to be good in terms of believing that mathematics is a science that can be applied to various activities in real life. However, they tend to lack understanding of what is meant by applied mathematical problems, as a result of a lack of confidence in their mathematical abilities. Overall, the learning process carried out by the teacher in the classroom also affects the students' belief about mathematics profile. This research is expected to provide a broader understanding of the strengths and weaknesses of students in terms of belief about mathematics related to applied mathematical problems.

**Keywords**: belief about mathematics, applied mathematical problem, high school students

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## INTRODUCTION

Mathematics learning is given to all students to e quip them with problem solving skills that occur in real life (Kemendikbud, 2016). A problem can be interpreted as a situation that challenges someone intellectually, because the solution cannot be done directly by using a certain formula or algorithm. Problems whose situations are related to the real world and allow mathematical concepts, methods, and results to be involved in the solving process are known as applied mathematical problems (Blum, 2002).

In line with this, mathematics can be viewed as a science that consists of two parts, namely ways of thinking and ways of understanding. Definitions, theorems, axioms, proof of theorems and solutions of mathematical problems are called Ways of Understanding. Meanwhile, Ways of Thinking is the second part of mathematics which includes the entire way of thinking of a person in the form of characteristics of the mental act he does. Then, the ways of thinking will produce a product in the form of a member of the first part of mathematics, namely the ways of understanding (Harel, 2008b, 2008a).

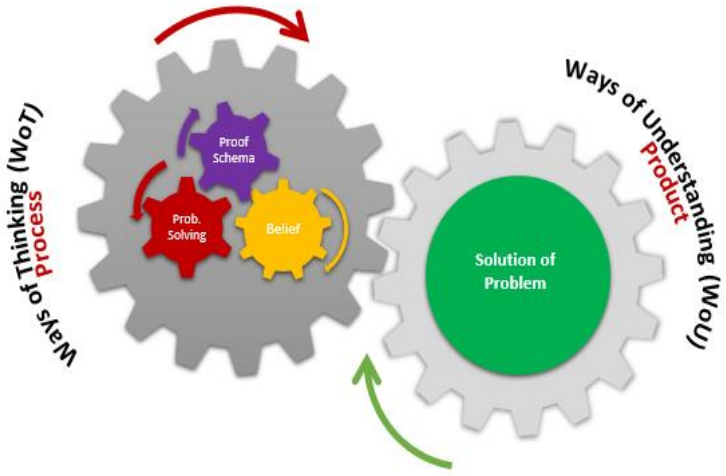


Figure 1. The relationship between Ways of Thinking and Ways of Understanding

As a result, the way of thinking consists of three things, namely the problem-solving approach, the proof scheme, and belief about mathematics (Harel, 2008c). The relationship between the ways of thinking and ways of understanding can be seen in Figure 1.

When solving a problem, a person can have various ways of thinking (Harel

& Diego, 2007). For example, a person can think whether there are alternative ways when he is doing problem solving or someone is trying to solve a problem with a heuristic strategy. Then, this way of thinking is called a form of problem-solving approach (Harel, 2008a). Belief in mathematics can be defined as a person's (student) belief about the nature of mathematics and the nature of mathematics learning (Kloosterman, 2002; Kloosterman & Stage, 1992). Apart from being part of the ways of thinking, belief in mathematics is also a personal factor that can affect student performance in solving applied mathematical problems (Mischo & Maaß, 2012).

Belief in mathematics is a person's view of mathematics itself. In particular, belief in mathematics is characteristic of one's interpretation of: (1) what is meant by mathematics; (2) how mathematics is formed; (3) what are the existing intellectual or practical advantages (Harel, 2008b). Beliefs related to mathematics can also be considered as one's belief in the nature of mathematics and the nature of mathematics learning (Kloosterman et al., 1996). Regarding applied mathematical problem solving, there are seven indicators that can describe students' beliefs in mathematics: (i) Views of problems in mathematics; (ii) Beliefs about the usefulness of mathematics; (iii) Beliefs in how mathematics is related to other subjects; (iv) Beliefs about mathematical word problems (applied mathematical problems); (v) Beliefs about the social context in which mathematics is studied; (vi) Beliefs about the teacher's role; (vii) Beliefs about self and mathematical abilities (Maiorca, 2016).

Several studies state that beliefs about mathematics are one of the things that affect student performance. Quantitatively, it was revealed that students who had low scores on aspects of beliefs about mathematics showed poor performance in solving mathematical problems (Rincon et al., 2020; Suthar & Tarmizi, 2010). The Programme for International Student Assessment (PISA) also conducted an analysis of the relationship between beliefs about mathematics and student performance in this study, particularly in the aspects of beliefs about self and mathematical abilities. The discussion presented by the (OECD, 2013) shows that Indonesian students have low confidence in their ability to solve mathematical problems. Then, this seems relevant to the mathematics literacy scores obtained by Indonesian students, which are below the international average.

Therefore, based on the explanation above, belief in mathematics is a component of the ways of thinking that will affect student performance in producing applied mathematical problem solving (ways of understanding). Several previous studies, especially on students in Indonesia, discussed beliefs about mathematics from several points of view. Research by (Yuanita et al., 2018) measures the effectiveness of applying realistic mathematics education to students' mathematical beliefs. Research by (Muhtarom et al., 2018) discusses the relationship between teachers' and students' beliefs of mathematics. These two studies tend to discuss student's beliefs about mathematics quantitatively. In addition, there is also research by (Umam & Kowiyah, 2018) conducting a case study on changes in student beliefs related to geometry problems.

Although there have been several studies regarding the close relationship between the level of students' beliefs about mathematics and their performance in solving mathematical problems. However, especially in Indonesia, there is still lack of descriptive studies outlining students' beliefs about mathematics. Further research to gain an understanding of the effect of beliefs on mathematics that students have on their performance in problem solving also needs to be done (Eynde et al., 2002). This study aims to obtain more descriptive information about the belief profiles in mathematics of students, especially high school students, related to applied mathematical problems. The results of this study are expected to give more descriptive knowledge about seven components in beliefs about mathematics according to Maiorca (2016).

## RESEARCH METHOD

In accordance with the research objectives, this study used a purposed-design survey method. A questionnaire was given to respondents online. Before the respondents filled out this questionnaire, the researcher revealed the purpose of the study and explained that the researcher would maintain the confidentiality of the respondent's personal data. This step is conducted in order to comply with the code of ethics in conducting research. Then, through this questionnaire, respondents were asked their willingness to answer all questions voluntarily. Comprehensively, the flow of this research is shown in Figure 2.

There were 24 respondents who filled out this survey completely. Respondents came from class X at one of the State Senior High Schools (SMAN) in West Java Province, Indonesia. Based on data on daily test scores, participants were divided into three categories with

The research instrument in the form of a questionnaire was developed based on seven indicators of belief in mathematics related to applied mathematical problems adapted from (Maiorca, 2016). Thus, in this study, respondents were required to determine their attitudes towards 28 statements on a Likert scale of 1 up to. 5, then answer seven open-ended questions.

The survey data in this study were analyzed by carrying out several stages, namely data reduction, data presentation, verification and drawing conclusions. Table 1 presents 28 statements according to the indicators of belief in mathematics and Table 2 presents seven open-ended questions.

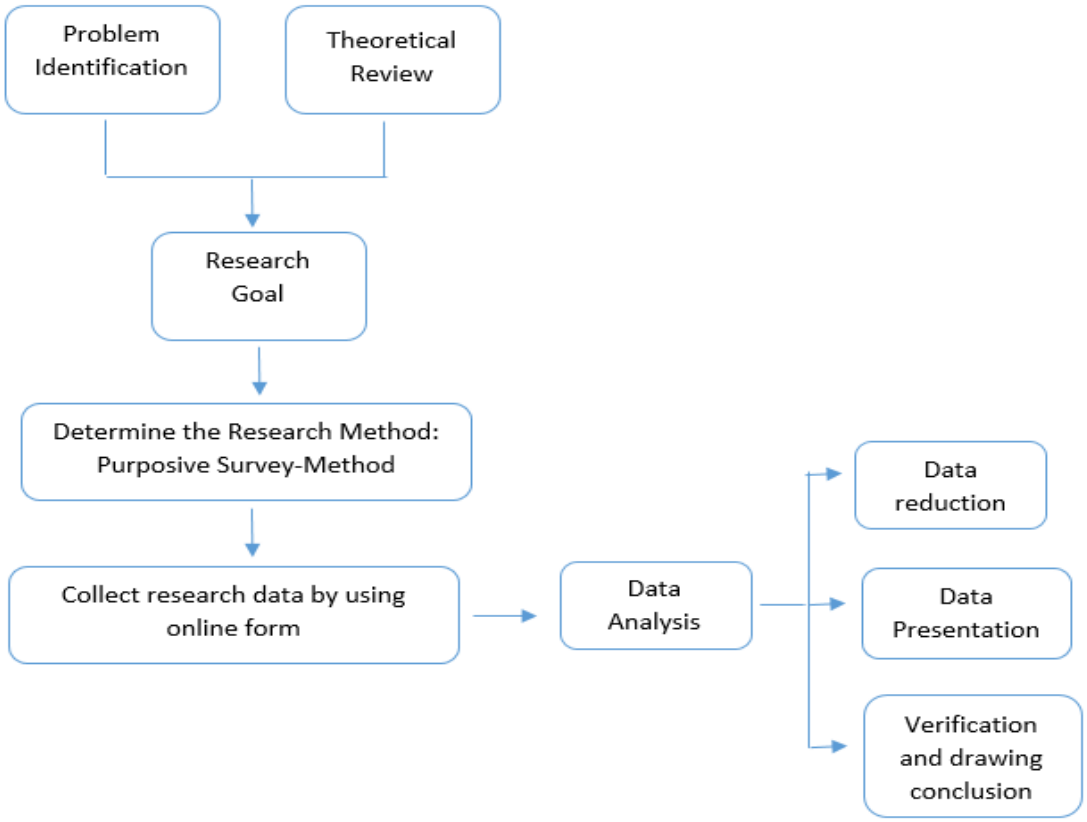


Figure 2. Research Flowchart

Table 1. Belief about Mathematics Indicators related to Applied Mathematical Problems (adapted from Maiorca, 2016)

| No. | Indicators | Statements |
|---|---|---|
| 1 | View of problems in mathematics | Mathematics is more than just doing addition, subtraction, multiplication, and division operation |
| | | Mathematics is about exploring new ideas |
| | | Maths is memorizing |
| | | Maths is about following the rules |
| 2 | Beliefs about the usefulness of mathematics | Math is useful outside of schools |
| | | Mathematics is an important subject to know |
| | | I never used math outside of school |
| | | Studying math is a waste of time |
| 3 | Beliefs about how mathematics is related to other subjects | I use math in my science class |
| | | Math is used to create technology that I use every day |
| | | Math is not used in my other classes |
| | | I don't use math in my daily life |
| 4 | Beliefs about mathematical word problems (applied mathematical problems) | There are math problems that cannot be solved by following a predetermined sequence of steps |
| | | Real-world related mathematical problems can be solved without remembering formulas |
| | | Any problem can be solved if you remember the right steps to follow |
| | | Most of the real world related problems can be solved using correct step by step procedures |
| 5 | Beliefs about social context in which mathematics is studied | Beliefs about the social context in which mathematics is studied |
| | | Mathematics can be learned from other students |
| | | Math can be studied alone |
| | | I can only learn math from my teacher |
| 6 | Beliefs about the teacher's role | The teacher's role is to guide learning |
| | | The teacher lets students think about finding out for themselves |
| | | The teacher's role is to provide answers to problems |
| | | All knowledge comes from the teacher |
| 7 | Beliefs about yourself and mathematical abilities | I usually do well in math |
| | | Math makes sense to me |
| | | Math is difficult |
| | | Math has confused me |

Table 2. Open Questions on Beliefs about Mathematics related to Applied Mathematical Problems (adapted from Maiorca, 2016)

| No. | Indicators | Questions |
|---|---|---|
| 1 | View of problems in mathematics | Do you think math can be used outside of school? |
| 2 | Beliefs about the usefulness of mathematics | Is mathematics a useful science? Explain your reasons! |
| 3 | Beliefs about how mathematics is related to other subjects | Do you use math when studying other subjects? If so, how is it used? |
| 4 | Beliefs about mathematical word problems (applied mathematical | Explain what you think about real-life math problems in maths lessons! |

| No. | Indicators | Questions |
|---|---|---|
| | problems) | |
| 5 | Beliefs about the social context in which mathematics is studied | What activities have helped you to learn mathematics? Why? |
| 6 | Beliefs about the teacher's role | In learning mathematics everything must be explained by the teacher or should students be given the opportunity to do their own search? Give an example (Explain)! |
| 7 | Beliefs about yourself and mathematical abilities | How do you use math outside of math class? |

## RESULT AND DISCUSSION

The data obtained from the questionnaire were then analyzed to find the respondent's mathematical belief profile. Based on 28 questions originating from seven main indicators, data were obtained such as those regarding the categories of students' beliefs in mathematics as in Figure 3 .

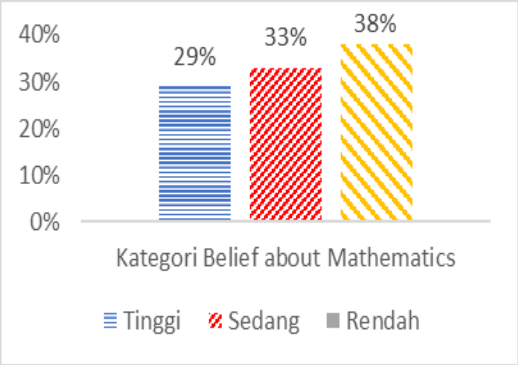


Figure 3. Percentage of Students' Belief in Mathematics Category

In more detail, Table 3 presents the results of the questionnaire for each indicator of the statement with an option in the form of a Likert scale.Tabel 3.

Table 3. The Category of Student's Belief for Each Indicator

| | Categories | | |
|---|---|---|---|
| | High | Moderate | Low |
| Indicator 1 | 17 | 66 | 17 |
| Indicator 2 | 25 | 54 | 21 |
| Indicator 3 | 17 | 66 | 17 |
| Indicator 4 | 13 | 42 | 45 |
| Indicator 5 | 21 | 21 | 58 |
| Indicator 6 | 13 | 33 | 54 |
| Indicator 7 | 21 | 25 | 54 |

*Result in %

Open question number one aims to express students' beliefs about the scope of problems related to mathematics. Through question number one, data is obtained that all respondents have confidence that mathematics will be related to problems that exist outside the subject matter of mathematics (outside of school). Furthermore, open question number two aims to find out whether students believe that mathematics is a useful science. The results of the questionnaire also showed that all respondents believed this. When asked to explain the reasons why students find mathematics useful, all respondents have various

answers. Table 4 below provides a summary of the diversity of response views regarding the reasons for the usefulness of mathematics.

Then, open question number three aims to reveal students' beliefs about the usefulness of mathematics when studying other subjects. There are 17% of respondents who answered no, and the rest answered that mathematics will be used when studying other subjects. Some of the subjects that students think will require mathematics are Physics, Chemistry, Economics, as well as the tables on the readings in Indonesian.

Open question number four expresses students' beliefs about math problems in the form of stories related to real life or can be referred to as applied mathematical problems. Based on the data obtained, Table 5 below provides a summary of the student's beliefs.

Table 4. Summary of Students' Answers Regarding the Reasons for Using Mathematics

| No. | The reason the students expressed |
|---|---|
| 1 | In my opinion, mathematics is useful because I can recognize the difference between multiplication, subtraction, addition, division, etc. |
| 2 | Mathematics is useful in everyday life such as trading, carpentry, determining distances |
| 3 | Math is useful for future work |
| 4 | Mathematics is useful because it can train accuracy in doing a job |
| 5 | Mathematics is useful because it can help us think rationally and logically |

Table 5. Summary of Student Answers Regarding Beliefs related to Applied Mathematical Problems

| No. | Students' Beliefs regarding Applied Mathematical Problems |
|---|---|
| 1 | Applied mathematical problems are complex problems compared to ordinary math problems, because they must first understand the information in the story. |
| 2 | Applied mathematical problems are math problems that are difficult for me to work on because they require precision |
| 3 | Applied mathematical problems are usually related to everyday life, we must be able to interpret or understand the meaning of the problem and turn the story into a mathematical model |
| 4 | Applied mathematical problems contain must be answered by writing down things that are known, asked, and answered (solution) |
| 5 | Applied mathematical problems are problems that contain addition, subtraction, and multiplication |

In order to obtain data on beliefs about the social context in which mathematics is studied, students are asked open question number five, namely "What activities helped Ananda in learning mathematics? Why?". A summary of students' responses to open question number five is presented in Table 6.

Table 6. Summary of Student Answers Regarding the Social Context in which Mathematics is studied

| No. | Students' Beliefs regarding Social Contexts Related to Mathematics |
|---|---|
| 1 | Mathematics can be used when making bird cages and wooden toy toys |
| 2 | Cooking activities can help learning mathematics, because cooking requires the right amount to get the perfect dish |
| 3 | Trade, related to calculating the quantity and price of goods, is an activity in which mathematics is studied |

The ability of students to solve applied mathematical problems is certainly influenced by the learning process they get. Thus, another indicator that is deemed necessary in determining students' beliefs in mathematics is beliefs about the role of the teacher. Through the question "Should all things be explained by the teacher in learning mathematics or should students be given the opportunity to do their own search? Give an example (Explain)! ", Data on student beliefs were obtained. A summary of student answers is shown in Table 7.

Table 7. Summary of Student Answers Regarding the Role of Teachers in Mathematics Learning

| No. | Student Beliefs regarding the Role of Teachers in Mathematics Learning |
|---|---|
| 1 | Not everything has to be explained by the teacher, students also need to be given the opportunity to learn on their own because students may find an easier way |
| 2 | There are other resources such as google and youtube that can help students learn math |
| 3 | There are things that must be explained by the teacher, but some are not. For example: The teacher tells the concept that will be used in solving the problem |
| 4 | The teacher had to explain all the materials because it made it easier for me to understand them |
| 5 | Teachers should correct student work so students know where the mistakes are |
| 6 | Students should be given the opportunity to do the questions independently first, then the teacher checks them. So that students are able to think more independently and creatively. |

Table 8. Summary of Students' Answers Regarding Belief in their Mathematical Abilities

| No. | Students' Belief Category | Reason |
|---|---|---|
| 1 | Good Mathematical Ability | Because I like math and math is a fun subject for me |
| 2 | Good Mathematical Ability | Because I can understand and solve problems well |
| 3 | Good Mathematical Ability | Because when the teacher explains I always listen and can answer questions given by the teacher |
| 4 | Middle Mathematical Ability | Because there is material that I can understand and there is material that I cannot understand |
| 5 | Low Mathematical Ability | Because I always got low marks |
| 6 | Low Mathematical Ability | I am still often not careful in doing math problems |
| 7 | Low Mathematical Ability | Because I find it difficult to remember math formulas |

The last indicator of belief in mathematics is an indicator that wants to reveal how students respond to their ability to do mathematics. The results of the questionnaire show that the data is diverse and in accordance with what students believe. A total of seven students stated that they have good mathematical skills, then five other students stated that they had sufficient mathematical abilities, and

the remaining 12 students believed that they did not have good mathematical skills. The reasons given by students are various, the summary is shown in Table 8.

Based on the explanation in the previous paragraphs regarding the results of the questionnaire related to students' beliefs in mathematics, related to applied mathematical problems, it can be seen that students initially have a uniform understanding, namely they believe that mathematics is a useful science not only during mathematics lessons. Students believe that mathematics can be used in various activities outside of mathematics learning hours (social activities and others), as well as in other sciences they are studying.

The results of this study are like conclusions (Harris et al., 2015) which discusses the relationship between students' beliefs about mathematics and their ability to solve problems in engineering. Thus, it is obtained the view that in order to be able to master problems in the field, each student must first master good mathematical mastery techniques. In addition, from another reference (Atnafu Ayele, 2016) is known that students are more convinced that mathematics can be more useful in the scientific field than in the social field.

Besides this, if it is related to students' beliefs about what is meant by applied mathematical problems, the answers given by students are varied and not entirely able to understand what is meant by applied mathematical problems. In line with this, students' beliefs about applied mathematical problems are influenced by students' beliefs about their mathematical abilities. In other words, students who have the belief that they have good mathematical abilities will tend to have a good understanding of what is meant by applied mathematical problems and how to solve them. In line with this (OECD, 2013) shows that the low PISA study results of Indonesian students are in accordance with their belief in their mathematical abilities to solve applied mathematical problems. The results of research by (Suthar et al., 2010) also become research that is in line with the fact that a good level of beliefs will produce good mathematical problem solving abilities as well.

In addition, a similar discussion is also found in the results of research (Lerch, 2004) that every student who has good beliefs about mathematics will not easily give up when he is faced with non-routine mathematical problems. In another study, the same thing was ex-

pressed (Callejo & Vila, 2009). In accordance with this, (Mason, 2003) has explained quantitatively the fact that students' beliefs about mathematics will affect their work results and the time they spend solving mathematical problems.

## CONCLUSION

Through this research it can be concluded that the students' belief profiles in mathematics tend to be good in terms of believing that mathematics is a science that can be applied to various activities in real life. Besides this, lack of understanding of what is meant by applied mathematical problems, and are associated with poor belief in their mathematical abilities. Overall, how the learning process carried out by the teacher in the classroom also affects the students' mathematical belief profiles. In addition, in order to obtain a more comprehensive belief in mathematics in the future, the researchers suggest that a similar study should be carried out using more respondents from various levels of education.


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