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THE INVESTIGATION OF MIDDLE SCHOOL STUDENTS' EPISTEMOLOGICAL BELIEFS AND THEIR ATTITUDES TOWARD PROBLEM SOLVING: THE SAMPLE OF RURAL AREA

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Abstract: The purpose of this study was to examine the epistemological beliefs of middle school students in rural area and their attitudes toward solving mathematical problems according to gender and class level variables. It was also necessary to determine whether the epistemological beliefs of middle school students in rural area had predicted their attitudes toward mathematical problem solving. The research was carried out using the survey model, which is one of the descriptive research methods. The participants of the survey consisted of 435 middle school students in three state schools in a large provincial rural area. Personal data form, mathematics problem solving attitude scale and epistemological beliefs scale were used as data collection tools. Nonparametric tests were used when the data were analyzed since they did not show normal distribution. According to the results obtained, mathematical problem-solving attitude and epistemological beliefs did not differ according to gender. It was also observed that the mathematical problem-solving attitude and epistemological beliefs of students had decreased according to class level. According to the results of the regression analysis, epistemological belief was found to be a significant predictor for mathematical problem solving.

Key words: Attitude, epistemological belief, middle school students, problem solving, rural area

1. Introduction

Ever since human beings existed, they have wondered about the world they live in and are constantly searching for knowledge. They later arranged and classified the knowledge they had previously gathered randomly. The classification of this knowledge has led to many scientific fields. Various researches have been done in many scientific fields such as mathematics, science and social sciences, and the new knowledge have been added to existing knowledge. As well as knowledge, people have also interested in perspectives, beliefs, and attitudes to knowledge. This curiosity to knowledge and to know has established the formation of philosophy of knowledge.

The term epistemology was formed through the combination of Greek "episteme" (information) and "logia" (science/ theory). Epistemology, which means information philosophy as the word meaning, is a field of study that deals with questions such as what information is, what are the resources for, how people know, and mainly information (Deryakulu, 2014). In other words, we can tell that epistemology investigates the nature of the information and how is formed.

Epistemological beliefs can be described as personal beliefs of individuals about what information is, how the learning occurs on the whole (Hofer & Pintrich, 1997). The conducted researches indicated that epistemological beliefs have important effects in learning and teaching procedure as one of the fields of individual differences. So, in recent years, psychologists and educators have increasingly shown an interest in the epistemological development and beliefs of individuals (Deryakulu, 2014).

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Based on the definition given above, we can say that epistemological belief is the perspective of an individual to the knowledge. The perspective of knowledge can also effects thinking skills on knowledge, knowledge learning skills of people. One of the most important of these skills is problem-solving skills.

The influence of epistemological beliefs of an individual on learning and teaching processes suggests that it may also have an impact on problem-solving ability, which is an indication of an effective learning process. According to Öngen (2003), beliefs of individuals on knowledge and learning (epistemological beliefs) influence their mental processes and the strategies they decide to use against complex problems, and therefore also affect problem-solving skills (as cited in Aksan, 2006, p.2). So, there can be said that epistemological beliefs including the subjective beliefs on knowledge and to know are influential on mental processes determine how individuals should behave against a problem. One of these mental processes is problem solving.

Problem solving is to know what should be done in situations not knowing what to do (Altun, 2014). In the problem-solving process, a person faces with a problem that he has not faced before, tries to find suitable strategies to solve this problem, and tries to solve the problem using these strategies correctly. According to Baki (2014), problem solving is one of the most important elements of mathematics and mathematics which is at the beginning of the scientific and analytical thinking process. Therefore, it is possible in mathematics education to make students gain necessary abilities through problem solving.

When the aims of the mathematics curriculum considered, it is aimed that the learners develop upper cognitive knowledge and abilities, effective use of predicting and manipulating in their mind abilities, develop positive attitudes toward mathematics, and express their thoughts and reasoning easily during the problem-solving process (MEB, 2018). This statement shows the importance and place of problem solving in the mathematics program.

The quality of an education program can be understood by looking at the quality of the individuals educated through the program. There can be said the person experience qualified education process that if an individual can do the research, can obtain the knowledge, can use the obtained knowledge, can add new knowledge to existing knowledge, in short if he can show the target behaviors aimed at the program. According to Yazgan and Bintaş (2005), a qualified education program is expected to raise people who can "solve problems". The ability to acquire this important problem-solving skill requires a long, planned and programmed process.

Students often face a problem with prior knowledge and experience orientation (Posamentier & Krulik, 2016, p.3). The person's previous knowledge and experience shows the attitude of that person in the form of approaching a person, object or situation. These knowledge and experiences also shape their belief in knowledge and to know. In particular, the students living in rural area are deprived of many facilities according to other students makes their knowledge and experience limited compared to other students. This suggests that there may be some relationship between the epistemological beliefs of the students who are studying in rural area, which is the main aim of our research, and attitudes toward problem solving.

The first area that comes to mind when there is a problem is mathematics. Mathematics, which is perceived by students as a completely abstract field, is a course that most people have a negative attitude. The students who are able to solve a problem that they have encountered in everyday life can be afraid and withdrawn when they meets the same problem under the name of mathematics course, can display negative attitude.

The success or failure of a student on the subject may also depend on the attitude toward the course as well as the learner's knowledge and skills related to the course. According to Çanakçı and Özdemir (2011), the success of a student in mathematics or problem solving depends not only on their level of knowledge but also on their beliefs and attitudes. A student who realizes the contribution of math in mental development and the importance in real life, enjoys dealing with mathematics. This explanation executes the degree of importance of the individual's beliefs and attitudes toward problem solving as well as problem solving success.

According to Deryakulu (2014), the individuals' attitudes toward solving the mathematical problem reflect their perception on perspective to the problem of the individual, the belief that he can solve the problem, and his perceptions of the quality of the problem. While some people think that they cannot solve the problem through finding the faced problem complex, some of them also like to try to find solution through approaching from different angles. This is due to the epistemological beliefs as well as the attitude of the individual toward problem solving.

When the relevant literature is examined, there are some studies on epistemological beliefs that are examined in terms of various variables. The results of these studies vary due to factors such as sample, age group, and so on. For example, Eroğlu (2005) found significant differences between teacher candidates in terms of gender and classroom variable in some aspects of epistemological beliefs in their work with teacher candidates. Demir (2012) stated that gender does not affect the epistemological beliefs of teacher candidates. Demirel (2014) also found that the epistemological beliefs of the females were more developed than the males, while they did not find a meaningful difference in terms of class level in the study of the epistemological beliefs of teacher candidates in terms of variables such as gender and class.

There are also studies on epistemological beliefs of secondary school and high school students. Kurt (2009) found that epistemological beliefs of high school students were more developed than junior high school students, resulting in the fact that female students had more developed beliefs in terms of epistemological beliefs at the dimension of correctness of knowledge in the study that epistemological beliefs of middle school and high school students were examined in terms of various variables. Başer Gülsoy, Erol and Akbay (2015) stated that the scientific epistemological beliefs of boys and girls were similar in their studies with middle school students. In addition, there are numerous studies in the literature where different aspects of epistemological beliefs are examined in terms of various variables (Ayaz, 2009; Eren, 2007; Karataş, 2011; Karhan, 2007; Özbay, 2016; Sadıç, 2013; Uysal, 2010).

There are also studies examining the students and teacher mathematical problem-solving skills and attitudes toward solving mathematical problems. Çokçalışkan (2012) has found that the gender had not have an important effect on attitude and behavior in the study examining the relationship between primary school mathematics and classroom teachers' attitudes and beliefs about mathematical problem solving in terms of gender and grade level. Özgen, Ay, Kılıç, Özsoy and Alpay (2017) found that there was no significant gender effect and that the grade level had a meaningful effect on the problem-solving attitude in the study examining the attitudes of middle school students toward problem solving in terms of various variables. On the other hand, Yılmaz (2007) found that secondary school students had a negative attitude toward problem solving in general in the study examining the relation between attitudes toward solving the mathematical problem and their metacognitive skills of secondary school students.

We also encounter the studies which examines the relationship between epistemological beliefs of university students, teachers and managers, and problem-solving abilities. Aksan (2006) examined the relationship between epistemological beliefs of university students and problem-solving abilities according to various variables. At the end of the study, it was revealed that epistemological beliefs influence the problem-solving ability of the person, and gender also influences both epistemological beliefs and problem-solving skills. Yılmaz (2014) investigated the relationship between the epistemological beliefs of elementary and secondary school teachers and administrators and their approaches to problem solving and found that people who developed epistemological beliefs also developed problem solving skills. In addition, in this study it has seen that females have more developed beliefs than males in some dimensions of epistemological beliefs. Hıdıroğlu and Özkan Hıdıroğlu (2016) examined the relationship between mathematical modeling process and epistemological beliefs considered as multi-dimensional problem-solving process and stated that teachers who have high epistemological beliefs are making more efforts in problem solving process and have approach to problem from different angles.

As it can be seen when the related literature is searched, there are many studies about these two issues. But there is not any study examining the relationship between epistemological beliefs and mathematical problem-solving attitudes. There are very few studies performed with middle school

students in the rural area concerned with both epistemological beliefs and attitudes toward mathematical problem solving when the conducted researches were considered. Furthermore, the effects of gender and grade level were not clearly propounded on epistemological beliefs and attitudes toward solving mathematical problems.

In this context, the aim of our study is to examine the relationship between the epistemological beliefs of middle school students in rural area and attitudes toward mathematical problem solving in terms of the variables of gender and class level. The study also examined whether the epistemological beliefs of these students have an impact on problem-solving attitudes. Within this scope, the following sub-problems will be sought for response:

1. Are the attitudes of middle school students in rural area to solve mathematical problems significantly differ according to gender and grade level?

2. Do the epistemological beliefs of middle school students in rural area differ significantly by gender and grade level?

3. Does the epistemological beliefs of middle school students in rural area predicts the attitudes toward mathematical problem solving in a meaningful way?

2. Method

2.1. Design of the Research

The research was carried out with the field survey model, which is one of the descriptive research methods. This model is a survey to determine the current state of the phenomenon or problem to be investigated. The questions are mostly searched for answer such as what the current state of the event or problem is that needs to be investigated, and where we are (Çepni, 2007, p.35). For this reason, the use of this model was considered to be suitable for revealing the relationship between secondary school students' attitudes toward solving mathematical problems and their epistemological beliefs and examining them according to various variables.

2.2. Participants

The participants of this study are middle school students located in three state schools in a large provincial rural area in Turkey. The participant group were consisted of 105 fifth grade, 105 sixth grade, 112 seventh grade and 113 8th grade students. There are total of 435 middle school students, 236 females and 199 males, depending on the gender variable. The frequency and percentage distribution of the participant group are given in Table 1 according to gender and grade level.

Table 1. *Frequency and percentage distribution of participant group in terms of gender and grade level*

Grade	Female		Male		Total	
	f	%	f	%	f	%
5th grade	60	13.8	45	10.3	105	24.1
6th grade	48	11.1	57	13.1	105	24.1
7th grade	64	14.7	48	11.1	112	25.8
8th grade	64	14.7	49	11.3	113	26
Total	236	54.3	199	45.7	435	100

As seen in Table 1, it is understood that the students selected for the participant group were distributed in close percentages in terms of grade level and gender variables.

2.3. Data Collection Tools

Since the epistemological beliefs and mathematical problem-solving attitudes of the students were examined in terms of gender and grade variables, the personal information form was used to determine the grade and gender of the participants. Mathematics problem solving attitude scale and epistemological belief scale were used as data collection tools in the research.

2.3.1. Mathematical Problem-Solving Attitude Scale

The mathematical problem-solving attitude scale is a measure developed by Çanakçı (2008). The scale was included 9 positive and 10 negatives in total of 19 items formed in likert type consisting of 5 options. The scale has two dimensions and measures the students' attitudes toward the problem and problem solving in the first dimension (Favoring Dimension) at 10 items and at the second dimension measures the students' attitudes related to their own, teacher and process (Instruction Dimension) at 9 items. The scale is a likert type scale with 5 options and it is rated as strongly agree (5), agree (4), undecided (3), disagree (2), strongly disagree (1).

In the scope of validity studies for Mathematical Problem-Solving Attitude Scale, techniques were utilized for testing content and structure validity. Time invariance (test-retest) and split test techniques were used in scope of reliability studies of Mathematical Problem-Solving Attitude Scale. The Pearson correlation coefficient calculated using the test-retest technique was found to be 0.89. Cronbach Alpha internal consistency coefficients were 0.84 for the whole Mathematical Problem-Solving Attitude Scale. The measurement reliability coefficient (Cronbach Alpha) was 0.74 in this study.

2.3.1. Epistemological Belief Scale

In this study, data were obtained by using the Epistemological Beliefs Scale. This scale is a 5-point Likert-type scale developed by Conley, Pintrich, Vekiri and Harrison (2004) and is rated as strongly agree (5), agree (4), undecided (3), disagree (2), strongly disagree (1). The adaptation of the scale to Turkish and the reliability and validity studies at primary education level were carried out by Özkan (2008).

The epistemological belief scale consists of 24 items and measures 3 sub-factors including source, development and justification of knowledge. The measurement reliability coefficient (Cronbach Alpha) was found as 0.76 in this study.

2.4. Data Analysis

In this study, statistical program was used for the analysis of data. The variables used in the study was tested whether distributed normal. And, it was determined that the variables were not normally distributed according to the obtained data. Therefore, non-parametric tests were used during the analysis. Mann Whitney U-Test was used to analyze students' attitudes toward mathematical problem solving and epistemological beliefs according to gender. The Kruskall Wallis H-Test was used to analyze mathematical problem-solving attitudes and epistemological beliefs according to grade level variables. In addition, simple regression analysis was conducted to analyze the prediction level of the students' epistemological beliefs on mathematical problem solving.

3. Findings

In this section of the work, the results of data analysis are presented in the tables and data have been interpreted in accordance with the table.

3.1. Findings toward the 1st sub-problem

The Mann Whitney U-Test results of the scores obtained from the Mathematics Problem Solving Attitude Scale regarding the students' attitudes toward mathematical problem solving whether differed significantly by gender are given in Table 2.

Table 2. *Mann Whitney U-Test results of the attitudes of middle school students toward mathematical problem solving regarding gender*

Group	N	Average Rank	Total Rank	U	p
Female	213	210.35	44804.00	22013.00	.213
Male	222	225.34	50026.00		

It was found that there was not any significantly difference when the attitudes of middle school students toward mathematical problem solving examined according to gender (U=22013; p>0.05). In other words, it can be said that there is no meaningful effect of gender on attitudes of middle school students toward mathematical problem solving. It was determined that there was no statistically significant difference although the mean of male students at the attitude toward problem solving (average rank = 225.34) higher than the mean of the female students at the attitude toward problem solving (average rank = 210.35).

The results of the Kruskall Wallis H-Test for the scores obtained from the Mathematics Problem Solving Attitude Scale, regarding whether the students' attitudes toward solving mathematical problems differ significantly from the grade level, are given in Table 3.

Table 3. *Kruskall Wallis H-Test results of secondary school students' attitudes toward solving mathematical problems in terms of grade level*

Grade	N	Average Rank	Sd	X^2	p	Sig. Difference
5th grade	106	247.16	3	20.576	0.000	5-8
6th grade	104	240.58				6-8
7th grade	112	208.83				
8th grade	113	178.96				

There was a significant difference when the secondary school students' attitudes toward solving mathematical problems were examined according to grade level [$X^2(3) = 20.576$, $p<0.05$]. In other words, the grade level variable has a significant effect on the attitudes of middle school students toward mathematical problem solving. In addition, it was also found that this difference was seen between 5th and 8th grades and 6th and 8th grades. According to these obtained findings, it can be said that the attitudes of the 5th and 6th graders toward problem solving are more positive than the 8th grades attitudes toward problem solving. It can be said that the problem-solving attitude has decreased due to the increase of grade level.

3.2. Findings toward the 2nd sub-problem

The Mann Whitney U-Test results of the scores obtained from the Epistemological Beliefs Scale, regarding whether the epistemological beliefs of the students differ significantly by gender, were given in Table 4.

Table 4. *Mann Whitney U-Test results of secondary school students' epistemological beliefs in terms of gender*

Group	N	Average Rank	Total Rank	U	p
Female	213	207.68	44235.00	21444.00	.093
Male	222	227.91	50595.00		

There was not any significant difference when the epistemological beliefs of middle school students were examined in terms of gender (U = 21444; p> 0.05). In other words, it can be said that the gender of secondary school students has no meaningful effect on epistemological beliefs. Although the average for male students 'epistemological beliefs (rank average = 227.91) are higher than the average for female students' epistemological beliefs (rank average = 207.68), there was no statistically significant difference.

The results of the Kruskal Wallis H-Test for the scores obtained from the Epistemological Beliefs Scale regarding whether the students' epistemological beliefs differ significantly in terms of grade level, are given in Table 5.

Table 5. *Kruskal Wallis H-Test results of middle school students' epistemological beliefs according to grade level*

Grade	N	Average Rank	Sd	X^2	p	Sig. Difference
5th grade	106	222.64	3	9.891	.020	5-8
6th grade	104	241.19				6-8
7th grade	112	221.57				7-8
8th grade	113	188.77				

There was a significant difference when epistemological beliefs of secondary school students were examined according to grade level [X^2 (3) = 9.891, $p<0.05$]. In other words, the grade level variable has a significant effect on the epistemological beliefs of middle school students. In addition, the mean (rank average = 118.77) of the epistemological beliefs of the 8th grade students remained at a lower level than the other classes. It was seen that the epistemological beliefs decreased while the class level increased.

3.2. Findings toward the 3rd sub-problem

The results of the regression analysis conducted in order to predict the epistemological beliefs of students in mathematical problem-solving attitudes, are given in Table 6.

Table 6. *Regression analysis results regarding estimation of mathematical problem-solving attitude*

Variable	B	Std. Error	B	T	p	Bilateral r	Partial r
Constant	1.855	.168	-	11.033	.000	-	-
Epist. Belief	.492	.049	.432	9.966	.000	.432	.432

$R = 0.432$ $R^2 = 0.187$ $F_{(1-433)} = 99.314$ $p = .000$

According to the results of regression analysis, it was seen that the epistemological belief is a significant predictor on mathematical problem solving ($R = 432$, $R^2 = 0.187$, $F(1-433) = 99.314$, $p <0.05$). There is a moderate and meaningful relationship between epistemological belief variable and attitudes toward mathematical problem solving. Epistemological belief describes about 19% of the total variance in attitudes toward solving mathematical problems. When bilateral and partial correlations between epistemological beliefs and mathematical problem-solving attitudes are examined, it is seen that there is a positive and moderate relationship ($r = 0.432$) between predictor and predicted variables.

4. Discussion and Conclusion

In this section, the research results are placed in the light of findings and interpretations, and epistemological belief and mathematical problem-solving attitude in mathematics education are discussed together with the literature on the application.

The relationship between the mathematical problem-solving attitudes of students and gender variables was examined in the study. There was no statistically significant difference according to the gender of the students. In other words, the gender of students does not affect their mathematical problem-solving attitudes. Yücel and Koç (2011) emphasized that students who attended to 6th, 7th and 8th grade showed a positive attitude toward mathematics and gender difference did not affect the mathematic attitude of the students in their study conducted to determine student attitudes toward mathematics course, mathematics achievement levels and gender relations. The reason for the emergence of this situation may be due to importance of mathematics course for the students encountered during their life and it has an important weight in the taken exams. It is stated by Çanakçı (2008) that gender does not affect

problem solving attitude in the study to develop the mathematical problem-solving attitude scale with middle school students. Özgen et al. (2017) found that gender did not make a difference in mathematical problem-solving behavior in their study. However, the results are also in the literature contrary to the results of this study. In the study with primary school teachers, Çokçalışkan (2012) has reached to the conclusion that gender influences attitudes toward solving mathematical problems. When evaluated together with the findings obtained in this study and the findings obtained in other studies, it can be said that mathematical problem-solving attitudes of the students generally do not differ according to gender.

The relationship between mathematical problem-solving attitudes, which is another finding of the study, and grade levels was examined and found a meaningful difference. It was observed that this difference was between the 5^{th} - 8^{th} and 6^{th} - 8^{th} graders. As the grade level increases the subjects become more abstract, more difficult, and the anxiety of the students due to the entrance examination of high school can be shown among the reasons of this situation (Özgen et al., .2017). When the literature is examined, similar results appear. In the study conducted by Çanakçı (2008) with middle school students, mathematical problem-solving attitude was different according to grade levels. In this study of Çanakçı (2008), it is stated that this difference in grade levels is between 6^{th} and 8^{th} grades. In another study, between class and problem-solving attitude, it was stated that there was a difference between 5^{th} -6^{th}, 5^{th} -7^{th} and 5^{th} -8^{th} grade. As it is seen in the conducted studies, it was revealed that the problem-solving attitude of the students becomes negative as the grade level increases. It can be said that the attitudes toward mathematical problem solving generally become more negative as the grade level of the students increases in line with the conducted studies.

The epistemological beliefs of middle school students did not show a statistically significant difference according to gender. In other words, the gender of the students did not affect their epistemological beliefs. According to this conclusion, the fact that the students in the study group exhibited their epistemological beliefs in the same way can be interpreted as the gender variable does not affect the epistemological belief level in this sample. When the literature is examined, there are different conclusions on this subject. Some studies have found that male students have more developed beliefs (Meral & Çolak, 2009; Sadıç, Çam & Topçu, 2012). In some studies, it has been found that female students have more developed beliefs (Boz, Aydemir and Aydemir, 2011; Balantekin, 2013). Similar to the findings of the conducted study, there are also studies that there was no significant difference in terms of gender variable (Aydın & Ertürk, 2017; Başer Gülsoy, Erol & Akbay, 2015; Koç & Memduhoğlu, 2017; Tüken, 2010). There may be multiple reasons for the differences observed between the results of the conducted researches. The use of different measurement tools, having different characteristics of the study sample, grade level, the presence of the sample in rural or urban area, cultural differences and psychological conditions of the sample can be counted among this (Aydın & Ertürk, 2017).

There was a significant difference between epistemological beliefs of the students when the epistemological beliefs of the participants were examined in terms of grade levels. This difference shows that the beliefs of the fifth-grade students are higher than the eighth-grade students. The results obtained are both compatible and vary with studies conducted on different age and grade levels. In the study conducted by Boz et al. (2011), it was investigated that the relationship between the epistemological beliefs of the students and the grade level in the study with 4^{th}, 6^{th} and 8^{th} grade students in primary education. According to the study results, it was determined that the beliefs of the students were less developed as the grade level increased. Koç and Memduhoğlu (2017) investigated whether epistemological beliefs of teacher candidates differ according to gender, grade level, department variables and it was determined that grade level variables did not affect epistemological beliefs of teacher candidates. Kurt (2009) stated that the students who were in the sixth, eighth and tenth grades showed a more advanced epistemological belief as their grade level increased In the study conducted with their secondary school students. In their studies performed with university students, Karabulut and Ulucan (2012) stated that fourth-grade students had higher beliefs for scientific epistemological beliefs of first and fourth year students. It can be based on various reasons that the results of the studies conducted on grade level variable are so different as to be opposite to each other. The cultural structure of the study group, the differences in the used measurement tools, the approach

of the authors to the research topic and the interpretation of the results can be considered as the reason of this differentiation (Yeşilyurt, 2013).

In the last findings of the research, it is seen that epistemological belief is a significant predictor for mathematical problem solving according to the results of the conducted regression analysis. The variable of epistemological beliefs accounts for about 19% of the mathematical problem-solving attitude. It can be said that there was a significant relationship between mathematical problem-solving attitudes and epistemological beliefs of middle school students. Danacı and Pınarcık (2017) investigated the effects of epistemological beliefs of teacher candidates on problem solving skills and level of strength and found a relationship between problem solving and epistemological beliefs. Aksan (2006) and Hacıömeroğlu (2011) found that there is a relationship between epistemological beliefs and mathematical problem solving in their study. When the results of the related study and the conducted the studies considered, it can be said that there is a relationship between epistemological belief and mathematical problem solving in general meaning.

4. Recommendations

In line with results of the study, the following suggestions have been made:

- More different qualitative studies can be conducted with wider sample group in depth on order to investigate the reasons of the increase in mathematical problem-solving attitudes and epistemological beliefs of students while the grade level increases.
- In the context of this results, in order to develop epistemological beliefs and attitudes toward mathematical problem solving of secondary school students, learning environments where pupils can express themselves comfortably and where their worries can be minimized should be created and problem-solving activities that can reveal these effects should be included in the courses.
- The limited number of middle school students' attitudes toward epistemological beliefs and mathematical problem solving were examined in this study. The relationship between attitudes toward epistemological beliefs and mathematical problem solving should be studied extensively with broader sample studies. The factors affecting epistemological beliefs and their attitudes toward mathematical problem-solving of students should be determined by qualitative or mixed studies.

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