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Research Article

Developing an Attitude Observation Form towards Mathematics

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Abstract

In this research, it was aimed to develop an Attitude Observation Form towards Mathematics which is expected to help students learn mathematics better. The steps followed in this process are; literature review, creating an item pool, taking expert opinions, implementation, analyzing the distribution characteristics of the scores, validity and reliability studies. A valid and reliable observation form was developed through the analyses done. The Attitude Observation Form towards Mathematics can be used to determine students' attitudes. It is expected to be a form which teachers can use. In addition, it can also be used in experimental studies where the number of the participants is low. It is believed that the use of this observation form will contribute substantially to the validity of the research in which the relation between attitude and success, or the effects of a method on attitude are examined.

Key Words

Attitude • Attitude towards mathematics • Observation form • Attitude observation form towards mathematics

* This research is based on the first author's master's thesis.

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Since mathematics has a scope of application in all branches of science and is as old as human history, it has a special place in education (Soylu, Işık, & Konyalıoğlu, 2004). The development of all other branches of science is heavily dependent on mathematics (Altun, 2000). We use mathematics not only in science but also in solutions to problems we encounter in everyday life. As mathematics is so important, mathematical behaviors also are at every level and in every field, from pre-school education programs to higher education programs (Baykul, 2004). That is why most of the students devote most of their studying time to mathematics (Yağmur, 2012). All these show the need to raise successful students in mathematics, and in order to raise successful students in mathematics it is necessary to examine the variables that affect the success in mathematics.

Many variables affect mathematical success. According to Çalışkan (2014); academic self-concept, possession of strategic behaviours, attitude, value, self-efficacy, class repetition, time allocated to study, academic self-perception, cognitive entry behaviors (pre-learning), family characteristics, possession of computer and hardware, possession of educational materials, socioeconomic status, self-regulation skills, motivation, and anxiety are some of these variables. As there are many variables that affect success, it is difficult to find answers to the questions "which variables are more important than others?" and "which one should be improved first?" In this case, two criteria can be employed: "variables related to the individual" and "variables that are changeable". It is not very meaningful to improve other variables without improving the variables related to the individuals. For example, for a student who has a negative attitude towards mathematics, the upper socioeconomic level of his/her family may not be sufficient for his/her success. Teachers are also limited in what they can do for unchangeable variables. In this case, for success in mathematics; changeable variables that are related to the individual, such as mathematics self-concept, possession of strategic behaviors, attitude, value, self-efficacy, time allocated to study, academic self-perception, pre-learning, self-regulation skills, motivation, and anxiety gain importance. These variables can be categorized as cognitive and affective.

Learning mathematics is a cognitive activity. However, emotions play a significant role in mathematics learning of students (Reyes, 1984, p. 558). The importance of mathematics, the importance of emotions in learning mathematics, and the fact that students have got away from mathematics in recent years have increased the awareness of the importance of affective factors in learning mathematics (Çalışkan, 2014). One of the affective factors is attitude. Attitude is regarded as important because it directs the behavior (Tavşancıl, 2014). Attitude can be an important determinant in engaging in mathematics. According to Abalı-Öztürk and Şahin (2015), the importance of attitude towards mathematics in raising successful individuals in international standards cannot be denied. It is necessary to measure the attitude towards mathematics and mathematics teaching at every stage, and carry out education in accordance with the results obtained (Avcı, Çoşkuntuncel, & İnandı, 2011).

Thurstone described the attitude as "sum total of a man's inclinations and feelings, prejudice or bias, preconceived notions, ideas, fears, threats, and convictions about any specified topic" (Robinson, 1975). The attitude towards mathematics is defined as "liking or disliking mathematics, a tendency to engage in or avoid mathematical activity, a belief that one is good or bad at mathematics and a belief that mathematics is useful or useless" (Neale, 1969, as cited in Akay & Boz, 2011).

Much research has been done on the relationship between attitude towards mathematics and success in mathematics. Different results were obtained in these studies. Whereas there are studies indicating a positive and

meaningful relationship between attitudes towards mathematics and success in mathematics (Akdemir, 2006; Kumandaş & Kutlu, 2011; Peker & Mirasyedioğlu, 2003; Savaş, Taş, & Duru, 2010; Sezgin, 2013; Taşdemir, 2008; Yenilmez, 2007; Yenilmez & Özabacı, 2003; Yıldız, 2006; Yıldız & Turanlı, 2010; Yücel & Koç, 2011), there are some other studies that show a low relationship (Ekizoğlu & Tezer, 2007; Ma & Xu, 2004; Papanastasiou & Zembylas, 2004; Robinson, 1975).

We can explain the different results in research with Robinson's (1975) ideas on the relationship between attitude and success. Robinson claims that there is a possibility that there is no linear relationship between attitude and achievement, and there may not always be a positive relationship as expected. Sometimes, individuals with negative attitudes can achieve great success. The possibility that the attitude does not have a strong relationship with success requires the research to be conducted more carefully. Robinson suggests that the reason for this controversial relationship between attitude and success may be the "difficulty of measuring attitude".

Attitude is completely internal and therefore it is difficult to measure and assess it (Robinson, 1975). Attitude scales are frequently used to measure attitudes. However, some limitations of attitude scales are emphasized in the literature. According to Robinson (1975), teachers must not be hasty and sure in making assessments of attitude from students' overt behavior and expressed opinions. It is difficult to make assessments of attitudes from examples that define ideas, beliefs, intentions, and behaviors. Actual tendency may differ from those expressed. For this reason, expressed opinions are not necessarily indicators of actual behavior, and actual behavior is not necessarily a result of attitudes. According to Tavşancıl (2014), individuals may not respond in accordance with their actual emotions to the sentence, adjective or expression sequence in the attitude scale. "Social Desirability effect" is one of the most important factors that threatens the validity of attitude scales. For this reason, it can be argued that new research has to be conducted in order to measure the attitude.

Attitude scales, mathematics diaries and observation method are used to measure attitudes towards mathematics. As mentioned earlier, attitude scales have limitations. Robinson (1975) exemplifies these limitations. It is certain that there will be limitations to other methods that would be suggested instead of attitude scales. But, having alternatives to measure the attitude enables the researchers the opportunity to choose one of these alternatives in different situations. Taking this into consideration, the idea of developing "a measuring instrument other than scales to measure attitude" has been the starting point of this study. This idea has led the idea of developing "attitude observation form" since according to Sechrest (1969), inferences about attitudes must be based on the behavior of individuals. In addition, Sechrest points out that behavior should be observed in its natural environment in order to increase the validity of outcomes from behavior (Sechrest 1969, as cited in Tavşancıl, 2014). For example, we can argue that a student has a negative attitude towards mathematics who is absent from mathematics or does not do his/her homework (Tavşancıl, 2014).

The Purpose and Importance of the Study

In this research, it was aimed to develop "Attitude Observation Form towards Mathematics" (AOFTM) which is expected to help students learn mathematics better.

The significance of the research is, indeed, expressed indirectly under the heading of the problem statement. It will be tried to be expressed more clearly here. It is expected that the research will contribute to potential research consumers, i.e., practitioners and researchers (Balci, 2001).

Teachers will be able to use this observation form to assess their students' attitudes towards mathematics. It is believed that the observation form is simple enough for practitioners to use and analyse easily. Therefore, they will be able help their students learn mathematics better. Although mathematics is a cognitive task, affective characteristics also play an important role in learning mathematics. Detection of students with negative affective characteristics may be effective in helping them learn.

As also stated in the problem statement section, attitude scales are frequently used to measure attitude, and attitude scales have some limitations. According to Karasar (2002), when collecting data from participants with techniques other than observation techniques, people tend to behave as they would like to be, rather than as they are. Non-verbal behaviors could also be observed and there are few artificial elements in observations (Büyüköztürk, Kılıç-Çakmak, Akgün, Karadeniz, & Demirel, 2012, p. 143). Indeed, an observation form also has limitations. It is expected, however, that the observation form to be developed will be an alternative in assessing the attitude towards mathematics and might be used in research where appropriate. For example, the observation form can be used to measure attitude in experimental studies that specifically test the effect of attitude. In addition, researchers can support the results obtained through other methods with the results obtained through the observation form. According to Büyüköztürk et al., (2012), observations can be used to support and complete the data obtained through other methods.

This research is expected to be an example for researchers who will develop an observation form. It is believed that the research will be a guideline for the development of the observation form, and provide information for the applicability of the observation.

As a result, it can be stated that this study presenting an alternative based on teacher observation in assessing the attitude toward mathematics is important.

Method

Research Model

In this study, an observation form was developed to be used in assessing attitude towards mathematics. The steps followed in this process are; literature review, creating an item pool, taking expert opinions, application, analyzing the distribution characteristics of the scores, validity and reliability studies.

Study Group

Data for the research were gathered from 62 students studying in the Vocational and Technical High School in a district center. Observation process required a limited size of working group. However, it can be argued that the size of the working group was sufficient for the analysis to be performed. As a general rule in the measurement tool development studies, it is stated that the sample size should be at least 5 times the number of observed variables (Büyüköztürk, 2002). Of all the participants, 8.1% (5 students) were in grade nine, 33.9% (21 students) were in grade ten, 32.3% (20 students) were in grade eleven and 25.8% (16 students) were in grade twelve. 4.8% (3 students) of the students were female and 95.2% (59 students) were male.

Literature Review and Creating an Item Pool

Three sources were used to write the observing units of the attitude towards mathematics observation form (Karasar, 2002). The first one was related research (Alkan, Güzel, & Elçi, 2004; Aşkar, 1986; Çalışkan & Serçe, 2016; Duatepe & Çilesiz, 1999; Kandemir, 2007; Ministry of Education [MEB], 2009; Organisation for Economic Co-operation and Development [OECD], 2004; Önal, 2013; Şengül & Dereli, 2013; Tabuk & Hacıömeroğlu, 2015; Tavşancıl, 2014; Yaşar, Çermik, & Güner, 2014; Yücel & Koç, 2011). The second was teachers' views. Teachers were asked and requested to answer and express their opinions about the question "what behavior or behaviors of a student can inform us about his/her attitude towards mathematics". The third was students' views. Students were asked to write "what they think about mathematics". After reviewing related studies, teachers' views and student opinions, 74 observation units were written. The examination of the related studies (especially attitude scales) for the purpose of writing observation units was expected to contribute to the content validity of the observation form to be developed. While examining attitude scales for writing observation units, "behavioral component" was the focus (Erkuş, 2003). As is known, attitude includes three components: thought, feeling and behavior. This structure necessitates the inclusion of items that include feelings, thoughts, and behaviors in attitude scales. For the purpose of this study, the items including the behavioral components of attitude scales were examined. The belief that the feelings and thoughts of the individual are reflected in the behavior was the reason for this process.

74 observation units were evaluated according to certain criteria. These criteria were; observability, significance, time interval, setting and memorability. These criteria had a filtering function. Observation units in the item pool were first evaluated in terms of "observability" criterion. Observation units that cause concerns were eliminated in terms of observability. The observation units were then examined in terms of "significance". When the whole is divided into smaller sections, it becomes easier to observe. It should be divided into small sections that do not impair significance (Karasar, 2002). According to this criterion, observation units were tried to be expressed in small sections with significance. Observation units which could not meet this criterion were removed from the pool. Another criterion was the time interval, that is, the period during which the observation is made. Time interval is an effective criterion in the selection of observation units. In order to have a systematic, reproducible observation, it was decided to observe a student during one lesson (40 minutes). Observation units that could not be observed in a class hour were eliminated. Another criterion was the setting. Observation units that could be observed in the classroom setting were selected. Another measure was memorability. As observation results were recorded by memory-based notes, memorable observation units were selected (this is important to control reactivity and not to disturb the natural setting). The number and the length of the observation units should be small and short for the sake of memorability. Memorability was not considered as an essential criterion. However, especially for the initial observations, it was considered to be important until the observer mastered them. According to these criteria, the trial observation form included 11 observation units. These criteria, and the difficulties and limitations caused by the nature of the observation process necessitated a small number of observation units. Considering the observational process in this study, the small number of observation units is acceptable.

Taking Experts' Opinions

The draft form containing 11 observation units was presented to 3 experts for their opinions. Two experts work in the department of educational programs and teaching. These experts have studies on attitudes and measuring attitudes. The other expert is in the field of testing and evaluation. Experts approved the items on the trial form. For this reason, no correction, addition, or removal of the observation unit was performed on the draft form.

Data Collection

The observation form to be developed in this study was prepared in accordance with the "intermittent observation" as one of the "participant observation" types. This decision was made considering the objective of the observation form to be developed and other conditions. In intermittent observation, observation units are observed at certain time intervals or at sampled time intervals. The researcher determines the duration of the observation according to the objective. Everything that is viewed and listened to to obtain information (data) is an observation unit (Karasar, 2002, p. 159). Observation units should be easily remembered at the time of observation. For this reason, the observer should often review the observation units, especially in the initial observations. In order to control the reactivity and not to disturb the natural environment, the observation results should be recorded by memory-based notes. Memory-based notes require observation units to be short and memorable. Taking this information about the application of observation into consideration, during the process of observation in this study, the observation form was not used, observation units were remembered, and memory-based notes were recorded without being interpreted. The observation form prepared to record observational results was designed as a rating scale.

Initially, only one student was observed. This is important to keep the observation units in mind and to master them. When the observation units are remembered and practically acquired, the number of students to be observed is increased. However, a maximum of 3 students were observed in a class. Before the class to be observed, in order to observe the fifth observation unit, students were assigned homework. Students were given a problem and to volunteer to solve it on the board (for observation units 1, 3 and 10). The student or students were observed according to the observation units and marking was made during the relevant observation periods (first class, second class, third class). After the first observation was completed for all the students in the class, the second observation was completed for all the students. When the second observation was completed, the third observation started. After the first, second and third observations were made and marked, if the observation unit was observed in all three observations "yes, observed" was marked, if it was observed in one or two observations, "sometimes observed" was marked, and if it was not observed in any of the three observations "no, not observed" was marked. This observational process was completed between 17.10.2016 - 06.12.2016.

It is necessary to be aware of the potential problems that may arise in the observational process and to take measures to prevent these problems. According to Shaughnessy, Zechmeister, and Zechmeister (2016), these problems are reactivity and observer bias. The problem of reactivity arises when the presence of an observer influences the behavior observed. Observer bias occurs when researchers determine what behaviors they choose to observe, and when the observers' expectations about behavior lead to systematic errors in the identifying and recording behavior. In this study, memory-based recording method was used to control reactivity. In this way,

the observer's presence was tried to be hidden. In this research, the master student is frequently reminded by the thesis advisor of the observer bias.

Data Analysis

The statistical techniques used in the analysis of the data are shown in Table 1.

Table 1

The Statistical Techniques Used in the Analysis of the Data

Process	Statistical Technique
• Evaluation of univariate normal distribution	<ul style="list-style-type: none"> • Coefficient of skewness • Examination of arithmetic mean-median-mode values • Graphics
• Item analysis	<ul style="list-style-type: none"> • Pearson product-moment correlation coefficient • t-value • F value
• Hypothesis testing	<ul style="list-style-type: none"> • Pearson product-moment correlation coefficient
• Classification-sequencing validation	<ul style="list-style-type: none"> • Double Consistency Index
• Reliability	<ul style="list-style-type: none"> • Cronbach alpha internal consistency coefficient • Spearman-Brown split-half reliability coefficient

Findings

Distribution Characteristics of Scores in Attitude Towards Mathematics Observation Form

Before analyzing the validity and reliability, it is recommended to examine the distribution characteristics of scores (Tavşancıl, 2014; Tezbaşaran, 2008). In this study, while examining the distribution characteristics of the scores; univariate normal distribution and some descriptive statistics on the distribution characteristics of the scores were examined. In evaluating the univariate normal distribution condition, the coefficient of skewness, arithmetic mean-median-mode values and graphics were examined. Some descriptive statistics related to the coefficient of skewness, arithmetic mean-median-mode values and distribution characteristics are given in Table 2 below.

When the values of the coefficient of skewness, arithmetic mean-median-mode given in Table 2 are examined, it can be said that the scale scores are approximately normally distributed. According to Büyüköztürk (2011), when the coefficient of skewness is within the interval (+1, -1), it could be argued that the scores do not deviate significantly from the normal distribution. The close values of arithmetic mean-median-mode could be taken as a criterion of the fact that the distribution is nearly normal. Moreover, when the graphics (histogram, box line graphic, normal Q-Q chart) are examined, it is found that the scores do not show excessive deviations from the normal distribution.

Table 2

Descriptive Statistics of Distribution of Observation Form Raw Scores

Descriptive Statistics	Score
Arithmetic mean	21.67
Standard deviation	4.039
Lowest score	14
Highest score	29
Variance	16.320
Range	15
Skewness	-.187
Kurtosis	-1.034
Median	22
Mode	25

Findings Related to the Validity of Attitude Towards Mathematics Observation Form

In the validity studies of Attitude towards Mathematics Observation Form, item analysis, hypothesis testing and classification-sequencing validation were done.

In this study, for item analysis, "item analysis based on correlations", "item analysis technique based on difference of lower-upper group means" and "item analysis through simple linear regression method" were used. The results of the analysis are given in Table 3.

Table 3

Item Analysis Results

OU*	r	t	F
1	.810	8.895**	114.313**
2	.511	2.872**	21.200**
3	.642	9.220**	42.164**
4	.738	4.950**	71.640**
5	.742	7.795**	73.334**
6	.832	10.256**	135.084**
7	.400	3.373**	11.438**
8	.852	12.907**	158.525**
9	.304	1.884***	6.130**
10	.812	12.907**	116.282**
11	.633	4.391**	40.194**

* OU: Observation Unit, ** $p < .05$, *** $p > .05$

When Table 3 is examined, it is found that the item-total test correlation coefficients ranged from .304 to .852, the t-values obtained by comparing the lower-upper 27% group means with the independent groups t-test ranged from 1.884 to 12.907, and the F values ranged from 6.130 to 158.525. Correlation coefficient of the ninth observation unit is low and the t-value is not significant. For this reason, it was decided to remove the 9th observation unit from the observation form.

A hypothesis was constructed and tested to obtain evidence for the validity of Attitude towards Mathematics Observation Form. Accordingly, the hypothesis "there is a low correlation between the scores obtained from the attitude towards mathematics observation form and the scores of the affective entry characteristics for mathematics" is tested. The correlation coefficient between the scores obtained from the observation form and the scale was .119 ($p > .05$).

Another process for testing the validity of the Attitude towards Mathematics Observation Form is the validity of classification-sequencing. The double-consistency index was calculated to examine the classification-sequencing validity. With this aim, the scale items are divided into two halves, items with odd numbers and items with even numbers. The total scores of the individuals for both halves were obtained and the individuals were ranked by their total score. Lower-upper groups were defined in the sequenced data. The number of individuals in both the lower-upper groups according to the rate of 27% in the data set was 17. The number of individuals in both the odd and even numbered forms in the lower group was 13; the number of individuals in both the odd and even numbered forms in the upper group was 8. When these values were placed in the calculation formula, DCI (Double Consistency Index) was calculated as follows $CT=1-|(17-8)+(17-13)/34|=0.62$. Therefore, it can be asserted that the observational form consistently classified above the middle level.

Findings Related to the Reliability of Attitude Towards Mathematics Observation Form

The Cronbach Alpha internal consistency coefficient and split-half reliability were calculated to test the reliability of the Attitude towards Mathematics Observation Form. The Cronbach Alpha internal consistency coefficient was .890. The Spearman-Brown split-half correlation coefficient value was calculated as .813.

Discussion

In this research, it was aimed to develop the Attitude towards Mathematics Observation Form which is expected to help students learn mathematics better. To achieve this, literature review, creating an item pool, taking expert opinions, application, analyzing the distribution characteristics of the scores, validity and reliability studies were carried out.

To develop the observation units, the related studies (especially attitude towards mathematics scale development studies), teachers' opinions, and articles containing students' opinions on mathematics were examined. Based on these three sources, 74 observation units were developed. While developing the observation units, it could be argued that focusing on the behavioral components of the attitude scales improved the content validity of the form. Attitude includes three components: thought, feeling and behavior. According to [Tavşancıl \(2014\)](#), the feelings and thoughts of the individual are reflected in the behaviour, so attitude directs behaviour. For this reason, predictions about attitudes are based on behavior ([Erkuş, 2003](#)). Based on this theoretical knowledge, the study focused on the behavioral component of the examined attitude scales to design the observation units.

74 observation units were written for the draft form. 11 observation units remained in the draft form at the end of the assessment according to some criteria. The small number of observation units which remained in the draft form might lead to criticism that the content validity of the observation form is low. According to [Erkuş \(2003\)](#), the high internal consistency coefficient can be a very important proof about the content validity. The high internal consistency coefficient provides indirect evidence that the items measure the same behavior area. The internal consistency coefficient of the developed observation form was calculated as .890. It could be argued that this value provides evidence for the content validity of the observation form.

The small number of observation units could be seen as a limitation of observation. However, the time allocated for observation and the setting required a small number of observation units. For example, the

observation form developed in this study is a form that can be used during one class time and in classroom setting. For this reason, behaviors that can not be observed in the classroom environment and are unlikely to occur during one class hour were not included in the observation form. In addition, attention was paid to keep the number of observation units small and the observation units short, because the observation results would be recorded by memory-based notes method in order to control the reactivity and not to disturb the natural setting. The memory-based notes method requires that the observation units be short and memorable.

It is recommended to collect multiple sources of evidence in validity studies (Acar, 2014; Tezbaşaran, 2008). Item analysis, hypothesis testing and classification-sequencing validity were done in the validity studies of Attitude towards Mathematics Observation Form. Item analysis can give clues about the construct validity of the measuring instrument (Tavşancıl, 2014). Through item analysis, the answer to the question "which items in the scale will make it more reliable and valid" is tried to be found (Tezbaşaran, 2008). In other words, item analysis is carried out to develop a measuring instrument consisting of the items with the desired qualifications. Item analysis can be done in different ways (Erkuş, 2003; Tavşancıl, 2014; Tezbaşaran, 2008). These are, "item analysis based on correlations", "item analysis based on difference between lower-upper group means", and "item analysis with simple linear regression technique". These three methods were used in this study. The use of three methods facilitated decision making. As a result of the item analysis, item-total test correlation coefficients ranged from .304 to .852, and the t values obtained by comparing the lower-upper 27% group means with the independent groups t-test ranged from 1.884 to 12.907, and the F values ranged from 6.130 to 158.525. The correlation coefficient of the ninth observation unit was low (.304). The items with correlation coefficients between .20 and .30 must be removed from the test (Erkuş, 2003). First, it was decided not to remove this item from the test. However, when t-value and F value were examined, it was seen that t-value was not significant and the F value was lower than other observation units. The correlation coefficient between this observation unit and the other observation units was also low. Furthermore, when this observation unit was removed, the internal consistency coefficient increased. According to Tavşancıl (2014), if the internal consistency coefficient increases when an item is removed, the item is removed from the measuring instrument, because a low item-total correlation decreases reliability. For this reason, it was decided to remove the 9th observation unit from the observation form. Descriptive statistics of the ninth observation unit (the course materials are complete) were examined. According to this, 43 people got 3 (yes, observed) and 19 people got 2 (sometimes observed) points. The arithmetic mean was 2.69. These values could be a consequence of the lack of need for extra materials except for course books and notebooks during the lessons. It could be argued that the basic course materials are already brought to the classroom whether the students have a positive or negative attitude towards the subject. However, when materials are needed other than the basic course materials, students' behavior may change whether they have a positive or a negative attitude. Therefore, we can conclude that "the course materials are complete" is not an indication to predict attitude.

Another process completed to obtain evidence for the validity of Attitude towards Mathematics Observation Form was hypothesis testing. Hypothesis can be tested for construct validity (Tavşancıl, 2014). Accordingly, the hypothesis that there is a low correlation between the scores from "attitude towards mathematics observation form" and "affective entry characteristics for mathematics" scale was tested. The belief that there would be a low correlation between the scores obtained from the attitude scales to which students reacted and the scores they obtained from the attitude observation form was the reason to develop this hypothesis. The theoretical

foundations of this belief could be explained as follows: According to [Robinson \(1975\)](#), the actual tendencies may differ from what is expressed. For this reason, the expressed opinions may not be the absolute determinants of real behavior. According to [Tavşancıl \(2014\)](#), individuals may not react to the sentence, adjective or expressive sequences in accordance with actual emotions on the attitude scale. “Social desirability effect” is one of the most important factors threatening the validity of attitude scales. For these reasons, different attitudes can be obtained when they are identified through different instruments ([Tezbaşaran, 2008](#)), and the information obtained through observation may contradict the results obtained through other methods ([Büyüköztürk et al., 2012](#)). In order to test the hypothesis, the correlation coefficient (the scores obtained from the scale meet the assumptions of the relevant statistics) between student scores obtained from the Attitude towards Mathematics Observation Form and the Affective Entry Characteristics Scale for Mathematics developed by Çalışkan & Serçe (2016). The correlation coefficient between the scores from the observation form and the scale was .119 ($p > .05$). It can be considered that this study supports the abovementioned theoretical knowledge and contributes to the construct validity of the observation form.

Another process to test the validity of the Attitude towards Mathematics Observation Form was classification-sequencing validity. According to [Acar \(2014\)](#), classification-sequencing analysis should also be included in validity analyses. Double-consistency index was calculated for classification-sequencing validity. The logical basis of the double-consistency index bases on the belief that, if the test consistently classifies (distinguishes consistently), the individual classified in the upper group (successful) in the first half of the test will be again in the upper group in second half of the test; and the individual classified in the lower group (unsuccessful) in the first half of the test will be again in the lower group in second half of the test ([Erkuş, 2003, p.109](#)). After the classification-sequencing analysis, the double-consistency index was calculated as .62. It can be argued that the observation form made a valid classification above the middle level.

In order to test the reliability of the Attitude towards Mathematics Observation Form, methods that require only a single application were preferred. These are the Cronbach alpha internal consistency coefficient and split-half reliability. For Likert-type scales, it is recommended to firstly test the instrument for internal consistency ([Tavşancıl, 2014; Tezbaşaran, 2008](#)). The cronbach alpha internal consistency coefficient of the form was .890. This value can be interpreted as an indication that the observation form makes accurate measurements. The Cronbach alpha coefficient can also give clues about the validity of the observation form. According to [Tezbaşaran \(2008\)](#), the Cronbach alpha coefficient is a measure of the internal consistency (homogeneity) of the items in the scale. The higher the Cronbach alpha coefficient of the scale is interpreted as the fact that, the items in the scale are composed of items that are consistent with each other and that control the elements of the same properties. In addition, the Spearman-Brown split-half correlation coefficient of the observation form was calculated as .813.

The highest score that could be obtained from the Attitude towards Mathematics Observation Form was 30, the lowest score was 10. High scores mean that the attitude towards mathematics improved positively.

Conclusion and Suggestions

As a result of the analyses made, a valid and reliable observation form was developed. Attitude towards Mathematics Observation Form can be used to determine students' attitudes. It is especially believed to be a form that teachers can use. However, it can also be used in experimental studies where the number of the participants

is small. It is believed that the use of this observation form will contribute substantially to the validity of the research in which the relation between attitude and success, or the effects of a method on attitude are examined. The fact that observation takes a long time makes it almost impossible to use this form in survey research where more participants are involved.

Observation forms do not cover all behaviors that could be sign of the feature to be observed, because setting and time are established for observation. Therefore, the observation form is limited to the behaviours that will probably appear in established setting and time. It does not even have the chance to include any possible behaviors. It is confined to the behaviors that certainly appear in established setting and time. However, the superiority of observation over other scales through which individuals express themselves must not be ignored. Of course, each method has its limitations. Supporting the obtained data through other methods may help overcome these limitations. It is expected that the observation form developed in this study can be used to support the data obtained through other methods.

Implications

1. By taking this observation form as an example, observation forms can be developed to identify the attitude in other fields.
2. Attitude scales and other ways of identifying the attitude other than the observation form can be investigated.
3. Observational methods other than observation forms can be investigated to identify attitude, such as “use trace” which is one of the indirect observation types. “Use trace” is the physical evidence of use (or nonuse) of items.

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