A Study of the Validity and Reliability of a Mathematics Lesson Attitude Scale and Student Attitudes

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Attitudes of the students towards mathematics lessons are very important in terms of their success and motivation. The purpose of this study is to develop a scale for the assessment of primary school students' attitudes towards mathematics courses in the 2nd and 3rd grades, to analyse its validity-reliability structure and to determine the students' attitudes towards mathematics. Emotional facial expressions are used in the scale because students can have reading and writing literacy difficulties in the 2nd and 3rd grades. The study group of this research consisted of 350 primary school students studying in the 2nd and 3rd grades of primary schools located in Northern Cyprus. The Cronbach alpha reliability coefficient of the scale was 0.92. Factor analysis results suggested that the scale was gathered in one factor and total variance explained was 57.796% for one factor. In general, it is suggested that students' attitudes towards mathematics were 'happy '.

Keywords: Attitude scale, emotional facial expressions, mathematics education.

INTRODUCTION

Darwin (1965) stated that using facial expressions has a very crucial role in delivering emotional messages. Results of some studies show that babies recognize feelings as a result of facial expressions (Bowbly, 1969; Field et al., 1983; Field, Woodson, Greenberg & Cohen, 1982). The recognition of feelings, like happiness, anger, fear, surprise, sadness and hatred, in four and five-year-olds reaches the same level as adults (Camras, 1986; Ekman & Friesen, 1971; Felleman et al., 1983; Izard, 1971). Moreover, facial expressions, such as those depicting happy, sad, surprise and angry emotions were suggested by Cüceloğlu (1968).

Emotional facial expressions were also used in one of the studies which analysed how children between the years of four and six perceive themselves, their teachers and their parents. As a result of this study, it has been observed that children mostly prefer 'happy' facial expressions, while defining their teachers, parents and themselves. While gender is an important variable in the perceptions of children towards their parents and themselves, no difference has been found between the genders (Çelik, Tuğrul & Yalçın, 2002).

Emotional facial expressions were also used by Trehearne et al. (2003) in a study on the student attitudes towards reading and writing surveys. In the survey, the first face that was shown to the students was very happy; the second face was not quite as happy as the first face but still happy; the third face was neutral, and the fourth face was feeling sad or not-good. Moreover, Cunningham (2008) also explored the use of facial expressions. The reasons for using facial expressions are that they are suitable for students of all ages, and it is proved that facial expressions are important in social communications.

Families and teachers have a great role in the development of children's communication skills, having an impact on both the social and psychological development of children. Since children acquire basic emotional facial expressions in preschool, they can match a facial expression to an emotional situation (Pollak et al., 2000; Rahmatian et al., 2013).

In primary school, the positive attitudes and behaviour of teachers are important factors in the

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doi: 10.12973/eurasia.2015.1349a

State of the literature

- Using facial expressions has a very crucial role in delivering emotional messages. The reasons for using facial expressions are that they are suitable for students of all ages, and it is proved that facial expressions are important in social communications.
- Because of traditional education, economic and inadequate training reasons, students' attitudes towards mathematics course might be low in primary mathematics education.
- Attitudes towards mathematics are very important in the teaching and learning processes of mathematics. Researchers concluded that a positive attitude towards mathematics leads students towards success in mathematics.

Contribution of this paper to the literature

- The main contribution of this paper to the literature is to develop a scale for the assessment of 2nd and 3rd grades primary school students' attitudes towards mathematics courses by using facial expressions.
- Using facial expressions to measure the attitudes of the 2nd and 3rd grade students with reading and writing difficulties towards mathematics lesson not only differentiate this scale from other mathematics scales but also increase the success level of students in mathematics lesson.
- This paper provides a significant contribution to the literature on the attitude level of the primary school students towards mathematics lessons.

development of children's positive attitude and behaviour towards mathematics lessons (Aiken, 1970a; Ilie, Barsan & Truța, 2013; Kulm, 1980).

Attitudes towards mathematics are very important in the teaching and learning processes of mathematics. Researchers concluded that a positive attitude towards mathematics leads students towards success in mathematics. An attempt to improve attitudes towards mathematics at the lower level provides a base for higher studies in mathematics. It also affects the achievement in mathematics at secondary school level (Ma & Xu, 2004).

Different definitions of attitudes towards mathematics are seen in the literature; however, there is a lack of common definition. Attitudes cannot be observed directly, observing people by examining their behaviour or attitudes, using various scales, are more appropriate for making comments (Daskalogianni & Simpson, 2000; Leder, 1985). Several definitions on the concept of attitude exist in the literature and these definitions emphasize different aspects of the attitude.

Attitude is defined as the negative or positive reaction tendency of individuals towards a particular object (Haladyna, Shaughnessy & Shaughnessy, 1983; McLeod, 1992). Hart (1989) argued that attitude is an emotional response, a body of beliefs and related behaviour based on the subject. Individual beliefs on the basis of mathematics and behaviour can be defined in a more complex manner. According to some researchers, "attitudes towards mathematics" are the pattern of beliefs and feelings associated with mathematics (Daskalogianni & Simpson, 2000). The definition of a 'positive' or 'negative' attitude definition clearly depends on the definition of the attitude itself. A 'positive' attitude indicates the positive emotional trend towards the subject while a 'negative' attitude indicates the negative emotional tendency towards the subject.

According to Middleton and Spanias (1999), research indicates that success in mathematics is a powerful influence on the motivation to achieve. As indicated by Dickinson and Butt (1989), students will find a task more enjoyable when they have a moderately high probability of success, as compared to one with a lower chance of success.

In Turkey, most of the students think that the mathematics lesson is very difficult and they cannot be successful in this lesson in primary school. These beliefs continue throughout their school life, causing concerns, thus their attitudes towards the mathematics lesson tend to be negative (Baykul, 1999b).

If students like mathematics lessons, their motivation and learning desires increase towards the lessons. Motivation contributes to the ability to solve problems. Based on several problem-solving models, O'Neil and Schacter (1997) developed the CRESST model of problem solving that incorporates four elements: content understanding, problem-solving strategies, metacognition and motivation. In their model, motivation comprises three components: self-efficacy, effort and worry. Several researchers showed that high levels of worry are associated with low cognitive performance (Hembree, 1990; Khakpour, 2012; Pajares & Urdan, 1996; Seipp, 1991).

Baykul (1990a) developed a scale having 30 items to measure the attitudes of teacher candidates towards a mathematics lesson. This scale was developed for the research of changes in the attitudes towards the mathematics and science course from the fifth grade of primary school to the last grade of high school (or equivalent education level) and some factors thought to be associated with the success of the student selection examination. In Brazil, Utsimi and Mendes (2000) analysed the 6th, 7th and 8th grade students' attitudes towards mathematics, according to different independent variables. Moreover, some researchers examined the relationship between anxiety and attitudes towards mathematics, and, as a result, it has been

pointed out that there is a high relationship between mathematics attitudes and mathematics anxiety (Sewagegn, 2013; Yenilmez & Ozabacı, 2003; Dodeen et al., 2014). In addition to these, Aşkar (1986) developed a Likert type scale regarding mathematics attitudes. Later, some researchers analysed the relationship between the students' attitudes towards mathematics and their success in the mathematics lesson, and it has been found that there is a significant relationship at the medium level between the students' attitudes towards mathematics and their success in the mathematics lesson (Peker & Mirasyedioğlu, 2003).

Moreover, another scale was developed by Çelik and Bindak (2005) to measure the mathematics attitudes of university students studying in the Department of Primary School Teaching in the Education Faculty. The scale consisted of 20 items. The results showed that significant differences were found between the attitudes of the students towards mathematics, according to the students' high school departments in which they graduated. Starting in the first year of primary school, children between the ages of 6-7 were at the age of playing their games and developing concrete thinking. They perceive as a whole and have short attention spans in terms of their general characteristics. Therefore, the best method that suits the characteristics of children at this age is sentence analysis (Bilir, 2005).

Children first begin to formally learn to read and write in primary school. However, the idea that a child's first reading and writing experience is before schooling is now fully settled in the literature (Barr & Johnson, 1997; Burns, Roe & Ross, 1992; Ruddell & Ruddell, 1995). Yılmaz (2008) stated in one of his studies that most of the students had problems in reading comprehension in the first years of primary education.

When the literature is reviewed, it is seen that children have difficulties in reading and writing comprehension. Based on this reality, the scale has been developed using emotional face expressions to measure the mathematics attitudes of primary school students as being different from the other mathematics attitudes scales. Since it is argued that student attitudes towards mathematics be addressed to improve student achievement in mathematics then the children's attitudes towards mathematics who have difficulties in reading and writing comprehension are also important.

The goals of curricula in many countries in the world include both basic literacy and numerical skills, and also cognitive efficacy which require ability to apply these skills to new problems. However, a large part of the world, especially in developing economies, all the schools are able to come to the point of not achieving these goals. Because of traditional education, economic and inadequate training reasons, students' attitudes towards mathematics course might be low in primary mathematics education. As a result of this situation,

students' mathematics anxiety and achievement levels are affected in a negative way. Thus, especially in developing countries, measurement of students' attitudes towards mathematics course attracts the attention of many researchers and teachers. Mathematics education cannot grow without close relationships to mathematics, and other areas in technological- economic world. However, there exists a risk that by adopting standards, methods and research contexts from other well-established disciplines, the applied nature of mathematics education may be undermined. Potential for providing high quality mathematics instruction for all students is a crucial. It addresses four conditions necessary for achieving this goal: high quality curriculum; a stable, knowledgeable, and professional teaching community; high quality assessment that is aligned with curricular goals; and stability and mechanisms for the evolution of curricula, assessment, and professional development (Wittmann, 1995).

The purpose of this study is to develop a scale for the assessment of 2nd and 3rd grades primary school students' attitudes towards mathematics courses, to analyse its validity-reliability structure and to determine the students' attitudes towards mathematics. In this study, primary school students in the 2nd and 3rd grades were used as a population. It is important to determine the attitudes of 2nd and 3rd grades students towards mathematics courses, since they will be trained intensively in mathematics courses after the 3rd grade. Based on this fact, it was necessary that we develop a scale in this area. Using facial expressions to measure the attitudes of the 2nd and 3rd grade students with reading and writing difficulties towards mathematics lesson not only differentiate this scale from other mathematics scales but also increase the success level of students in mathematics lesson. Therefore, this scale will be useful for the studies aimed at determining the attitudes of 2nd and 3rd grades primary school students towards mathematics courses.

METHOD

Participants

The sample of the study consisted of 350 primary school students in the 2nd and 3rd grades, studying in Northern Cyprus, with the aim of determining their attitudes towards mathematics courses. In this study, a stratified random sampling method was used. Stratified random sampling is a process in which certain subgroups are selected for the sample in the same proportion as in the total number (Fraenkel & Wallen, 2006). For this study, a sample was used that was made up of 29% of the target population. There were 1190 students from all regions. Data for the tests of reliability

and validity were obtained from this sample of 350 students from five regions (25 schools) surveyed in 2014.

Instrument

The Attitude Scale of the Mathematics Lesson (ASML) included ten questions. Emotional facial expressions, like very happy, happy, neutral, unhappy were used to determine the attitudes of the students towards the mathematics lesson. Also, descriptive statistics were applied in the evaluation.

Attitude Scale of the Mathematics Lesson (ASML)

During the process of developing the Attitude Scale of the Mathematics Lesson, the first step was to determine the attitudes of the students regarding the mathematics lesson. Many scale developing studies and attitude scales towards mathematics lessons were also examined, specifically Aşkar (1986) and Duatepe & Çilesiz (1999). In the instrument, emotional facial expressions were used, based on information from the study by Trehearne (2003). Making use of the item pool, a draft form was created for the data collection instrument concerning students' attitudes towards mathematics. Also, attention was paid to including negative items for the scale too. Field experts working in an elementary school and elementary mathematics teacher education were asked to indicate their views on the content validity and face validity of the instrument.Initially, the scale consisted of 12 questions formed by 15 field experts. As a result of the pre-application, two negative items, which had a lower reliability factor, were omitted from the scale.

Cronbach's alpha is the most commonly used measure for assessment of reliability because of its convenience and efficiency. This coefficient (α) is a general form of the KR20 formula to be used in calculating the reliability of items that are not scored right versus wrong, as in some essay tests, where more than one answer is possible (Ozdamli, 2009; Yaya & Baskan, 2012). The total coefficient of Cronbach alpha reliability of the scale was calculated as 0.92. Studies show that an estimated value of 0.70 and above for the coefficient of reliability value for each test is counted as satisfactory (Hung et al., 2010). The questions were designed to measure students' attitudes. Based on the feedback from the students, some corrections were made in terms of the meaning of the statements and the final version of the scale was developed. Afterwards, the scale was applied and the data was analyzed.

Procedure

When the literature was reviewed, it was seen that different application types were used in the process of applying a scale. The applications can be classified into four groups, which are called: face-to-face, mail, phone and computer applications (Aiken, 1997b). In this study, the face-to-face application method was utilized for the Attitude Scale of the Mathematics Lesson. First of all, necessary permission was granted from the Ministry of Education and Culture at the stage of applying the Attitude Scale of the Mathematics Lesson, and then the scale was applied to the students from randomly selected primary schools in Northern Cyprus, with the aim of keeping in mind the principle of volunteer selection. The participants were informed about all necessary information regarding the scale.

A pre-test was applied to the students to understand whether they understood the facial expressions or not. While the questions towards the mathematics lesson were read loudly, the students were asked to put their fingers on the related question and to colour the emotional facial expressions, like 'very happy', 'happy', 'neutral', and 'unhappy'. To obtain the total score for each participant, four points for the 'very happy' and one point for the 'unhappy' were given, and the total number of responses was graded between one and four. Also, the mean value of each question was taken into account and was evaluated between 1.0 and 4.0.

Data Analysis

SPSS 20.0 was used to analyse the data obtained from the application of the scale. Primarily, normal distribution analysis, which contains the operations of mean, median, mode, standard deviation, variance, minimum and maximum values, range, skewness and kurtosis were conducted for validity and reliability tests. As in many studies, (Ekici, 2005; Namlu & Odabaşı, 2004; Peterson et al., 2000; Yazıcı et al., 2009) Kaiser-Meyer-Olkin (KMO) Bartlett's test of sphericity (BTS) was applied and the Principal Component Analysis and Varimax Rotation were calculated. The structure validity factor analysis of the scale and internal consistency reliability test were examined by the coefficient of Cronbach Alfa. Besides these, total correlations were calculated to determine the relations of the scale items (Kahn, 2006; Kerlinger, 1973). The size of the sample must be taken into consideration while conducting factor analysis with multiple variables in scale development (Preacher & MacCallum, 2002; Sapnas, 2004). It was observed in the literature that the minimum size of sample should vary from 100 to 250 (Sapnas, 2004). Therefore in this study, the scale was applied to 350 students.

FINDINGS

Validity Results of the Attitude Scale of the Mathematics Lesson

Before conducting factor analysis, normality was checked by inspecting the skewness-kurtosis values. These values were found within the range of ±2. However, in the results of the tests of normality, Kolmogorov-Smirnov and Shapiro-Wilk indicated significant results, violating this assumption; however, it was reported as quite common in large samples (Pallant, 2007).

The factor analysis, which is a flexible data analysis, is considered as the most powerful method for the application of structure validity (Kahn, 2006; Kerlinger, 1973). Kaiser-Meyer-Olkin and Bartlett's test of sphericitywere conducted to determine the appropriateness of the factor analysis of obtained data from the study group. Kaiser-Meyer-Olkin (KMO) value must be over 0.60, whereas the value of 0.91 KMO is considered as the most suitable value for factor analysis (Table 1) and the results of Bartlett's test of sphericitymust be meaningful (Namlu & Odabaşı, 2007).

As a result of the analysis, it is seen that communalities differed from 0.44 to 0.73. Moreover, initial eigenvalues of nine items out of ten were lower than one and the scale was gathered in one factor. Total variance of the scale is explained clearly in Table 2 where it can be seen that the scale has only one factor and the cumulative percentage was 57.796% for one factor. As seen in Figure 1, scree plot graphic, vertical axis shows eigenvalues, and horizontal axis shows the factors. Combination of the points obtained from matching the factors with their eigenvalues forms the graphic. High acceleration and high decline give the number of important factors in the graphic. Horizontal lines show the proximity ofthe additional variances' contributions of the factors (Büyüköztürk, 2007). According to the Scree Plot Graphic, the plot where the graphic curve sharply decline is the place of first factor, so this scale can be stated as it has one factor. Additionally, total variance value of one factor is 57.796%. 30 % and more total variance value are accepted to be sufficient in scale having one factor (Büyüköztürk, 2009). Eigenvalue and variance percentage of one factor can be seen in Table 2. According to Table 2, the eigenvalue of the scale is 5.780, and the variance is 57.796.

RESULTS AND DISCUSSION

Students' Scores on the ASML

Table 3 shows the obtained data of students' attitudes towards mathematics courses. Because the scale contains 10 statements, the minimum point one can get was 10, the maximum was 40, and its range was 30. The mean for the total was 30.4 (or 30.4/10=3.04 for ten statements), whereas the standard deviation point was calculated as 8.33 (or 0.833 for ten statements). As the value obtained was above 3.04 the

Table 1. KMO and Bartlett's Test.

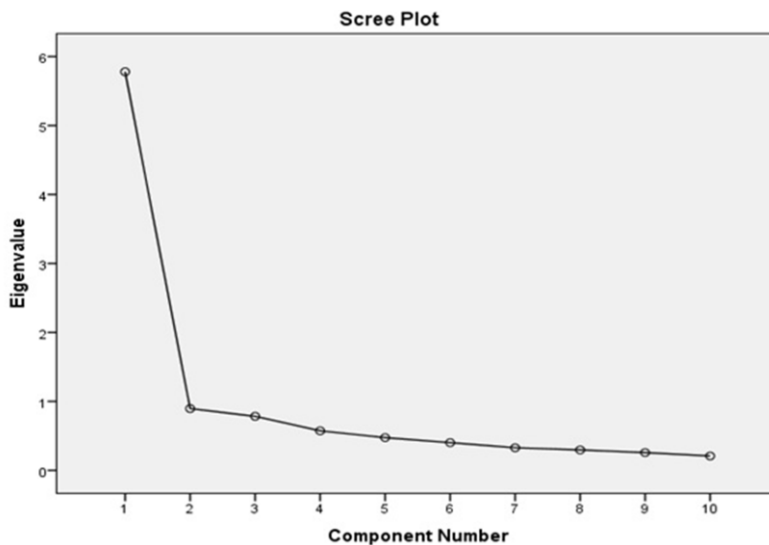| Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.911
Bartlett's Test of Sphericity	Approx. Chi-Square	2092,168
	df	45
	Sig.	0.000

Figure 1. Four-step Modeling Cycles

results reflect that, in general, student attitudes towards the mathematics lesson were 'happy'.

The statement for "How do you feel when you are doing a maths course?" obtained a mean value of 3.62. This statement received the highest mean value of students' attitudes in the questionnaire form, in comparison to the other questions. As the value obtained was above 3.26, the results reflect that, in general, students feel 'very happy' in their maths course.

In the questionnaire form, another question regarding "how does it feel doing mathematics in your free time?" obtained the lowest mean value. After the calculations of the given data and the opportunity of meeting students face to face, this was the expected result. As maths is a difficult and abstract course, students prefer to do more enjoyable courses in their free time, such as playing games, drawing, playing music or doing PE (physical education), etc. Yet again, this question obtained a mean value of 2.72, which lies between the values of 2.51 – 3.25. Therefore, this indicates that it makes students feel 'happy' to be doing maths in their free time.

On the other hand, another item that stated "I do not find it difficult to understand the maths course"

Table 2. Total Variance

	Total Variance Explained					
	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5,780	57,796	57,796	5,780	57,796	57,796
2	,896	8,963	66,760			
3	,783	7,835	74,594			
4	,573	5,732	80,326			
5	,475	4,753	85,079			
6	,402	4,018	89,097			
7	,328	3,277	92,374			
8	,297	2,966	95,340			
9	,258	2,578	97,918			
10	,208	2,082	100,000			

Extraction Method: Principal Component Analysis

Table 3. Student Attitudes towards Math Courses

Questions	Mean ($\overline{X}$)	Standard Deviation (SD)
How do you feel when you are doing a math course?	3.34	1.05
How does it make you feel when you are doing mathematical calculations?	3.13	1.00
"What I learn in my math course I use in my daily life" with which idea do you emotionally agree to?	3.04	1.04
"Math courses do not frighten me" which facial expression would you reply with for this idea?	3.13	1.05
How do you feel towards the follow statement when the teacher says: "We will be doing a math course all day"?	3.02	1.11
"I do not find it difficult in understanding math course" which facial expression would you reply with for this idea?	2.77	1.31
How does it make you feel doing mathematics in your freetime?	2.72	1.28
How do you feel when you are faced with a mathematical problem?	3.10	1.04
"The course I mostly like is math" which facial expression would you reply with for this idea?	3.04	1.03
Do you believe that math courses are enjoyable?	3.08	1.10

received the mean value of 2.77 which lies between the values of 2.51 – 3.25. Therefore, this indicates that they did not find it difficult to understand the maths course. Baykul (2005c), Bozkurt & Sahin (2013), argued that often, the reason behind the students' having difficulty in elementary mathematics was the teacher's lack of use of effective material and not putting across concrete solutions while solving the problem. Therefore, this result is not in line with their work. Therefore, this can result in misunderstandings due to the lesson being abstract and it shows that the mathematics lesson can be difficult when the topics are not concrete. Many of the students have experienced learning difficulties and illustrated poor mathematical performances due to mathematics anxiety, when following their teacher's explanation of a new mathematics topic (Hlalele, 2012). For the reasons related with economics and curricula not constructed well, lack of teaching materials used in mathematics courses make it more difficult issues that are difficult to understand. As the students learn mathematics, they start to enjoy it. However, in developing economies, it must be considered that students are not able to relate the mathematics course to everyday life and fear from mathematics lessons, thus the mean value of the items of this scale might be low, if it is applied in developing economies.

Moreover mathematics education is a civil rights issue. Robert Moses argues that children may be doomed to second-class economic status in our increasingly technological society who are not quantitatively literate. It has been much discussed in the literature: poor children and children of color are consistently shortchanged when it comes to mathematics. Most of the mathematical knowledge discussed in recent reform documents, such as the National Council of Teachers of Mathematics' (2000) Principles and Standards for School Mathematics, can be seen as a core component of intelligent decision making in everyday life, in the workplace, and in our democratic society. (Schoenfeld and Conner, 2002)

Another statement, which we asked was: "we will be doing a maths course all dayobtained, the mean value, in comparison with the other questions. This question received a mean value score of 3.02, which is expressed as 'happy'. Primary school first grade students' attitudes towards mathematics courses have been shown to be very high, however, as the grade level increases the students' attitudes were reported to decline (Altun, 1995). The mean value obtained by students for "what I learn in my maths course I use in my daily life" obtained a score of 3.04. The received value was between 2.51 – 3.25, which meant a 'happy' expression. So it can be interpreted that students are beginning to use the studied data in maths courses as part of their daily life

and what students have learnt reveals competence in the statement "data, which is useful for me". This result is especially due to the latest development of mathematical programmes and newly written course books, which prove that these are useful factors.

The statement "the maths course doesn't frighten me" obtained a mean value of 3.13. This result indicates that students are not afraid of maths courses and they made this explicit through expressing the 'happy' emotion. Ünlü (2007) stated that students liked maths courses and found them interesting.

CONCLUSION

According to the results of the study, generally, the attitude of the students towards mathematics lessons was 'happy'. Moreover, as a result of factor analysis to determine the factor structure of the adapted scale, it was decided to keep ten items in the scale measuring a particular structure. Factor analysis results revealed that the scale has one factor. Thus, this scale provides a contribution to the literature review with the feature of measuring the attitudes towards mathematics lessons in one factor.

Findings related to the validity and reliability of the scale showed that the scale has the quality of measuring the attitudes of the 2nd and 3rd grades primary school students' towards the mathematics lessons. The Cronbach alpha reliability coefficient of the scale was measured as 0.92. Since the scale was developed for 2nd and 3rd grades in a primary school, if the scale going to be used for different samples, there is a need for re-analyzing the reliability and validity studies of the scale.

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