PRIMARY SCHOOL MATHEMATICS MOTIVATION SCALE

Ezgi Ersoy,MS
Cumali Oksuz, PhD
Adnan Menderes University , Aydin, Turkey

Abstract

This study was aimed at developing a scale for determining motivation of primary school students towards learning Mathematics. A preliminary form of the scale included 74 Three-point scale items and data was collected from a total of 482 participants who were 3rd and 4th grade primary students. For construct validity, varimax orthagonal rotation connects with exploratory factor analysis was used. In the result of factor analysis, the scale involves in one factor explaining 42.46% of total variance. Based on the result of item analysis, the scale consisted of 33 items of which 29 were positive and 4 were negative. The overall Cronbach-alpha coefficient of the scale was high (α= 0.94) indicating that it was a fairly consistent measure.The results of the study indicate that the scale named as primary school mathematics motivation scale (PSMMS) has good psychometric properties and is reliable and valid. It can be used reliably in future educational researches

Keywords: Primary school mathematics, motivation, scale development

Introduction

Teaching mathematics should not be merely considered as enabling students to acquire basic operational skills as well as problem solving skills. Having considered the long term process of education, the importance of each mathematics lesson offered should be kept in mind with regard to its value to the students' current educational lives, its contribution to their further learning and to their endeavours to do mathematics with self-confidence; perhaps even to pursue a profession in that journey. To this aim, while designing the ideal classroom environment, the identification of how close or far the practices are from that ideal will help to reach the aim. It is significant to design an ideal classroom atmosphere considering the affective and psychomotor acquisitions along with the cognitive ones. To accommodate these features, knowing the level of each student's motivation in mathematics is a significant tool to support students in reaching both close and far goals. However, it is also important to treat motivation as a goal. In this sense, it is identified that motivation has an impact on the type, continuity and frequency of learning activities, and students' motivational and functional status during this process (Schiefele and Rheinberg, 1997).

Motivation expressed as an internal stimulus encouraging individuals to take an action (Allen, 1999, p. 463) is also defined as a force activating individuals, providing continuity and directing behaviours in terms of goals (Pintrich & Schunk, 2002). Therefore, students' motivation affects their learning (Gardner, 1985; Brophy, 1988; Wigfield, 1994). Each individual is different, and none of them has exactly similar cognitive, affective and psychomotor features. From this point, motivation leading students' learning enables students to explore the importance of mathematics for their life and for the world and to comprehend the benefits of mathematics. In addition to this, besides mathematics' own potential, one's own mathematical potential which is effective in constucting mathematical knowledge and skills such as mathematical interest and self-confidence will be supported by motivation and so, effective learning will be fulfilled.

Scales developed in motivation and their scope are explained as follows. Keller, examining theories of motivation developed ARCS Motivation Model (Keller, 1987a). According to Keller, there are four components of student motivation: Attention, Relevance, Confidence and Satisfaction. Using this ARCS model, Keller later developed Instructional Materials Motivational Survey (IMMS) (Keller, 1987b) for instructional design including 36 likert type items. Here, again, the IMMS instrument has four factors, namely Attention, Relevance, Confidence and Satisfaction for promoting and sustaining motivation. This questionnaire was adapted to Turkish by Kutu and Sozubilir (2011) and a validity and reliability study was conducted. In this study, a survey was constructed as two factors and including 24 items. In order to name the factors, they took into account of the original titles of the factors of the survey. Thus, the first factor was named "Attention-Relevance" and second factor was named "Confidence-Satisfaction".

Pintrinch and De Groot (1990) developed a scale to determine students' metacognitive skill levels (Motivated Strategies for Learning Questionnaire) (MSLQ). Uredi (2005) adapted this scale into Turkish as "Motivational Strategies Scale for Learning"(Ogrenmeye İliskin Motivasyonel Stratejiler Olcegi) including 44 test items. MSLQ, developed by Pintrich Smith, Garcia ve McKeachie (1991), was adapted to Turkish by Buyukozturk, Akgun, Ozkahveci ve Demirel (2004) and a validity and reliability study was conducted. Named as OGSO, the scale consists of two main subscales. Results of their analyses show that the first subscale, Motivation, has six factors, and the second subscale, Learning Strategies, has nine factors. Similarly, Shia (1998) developed a motivation scale by using MSLQ. Then, Dede (2003) adapted Shia's scale into Turkish and developed a scale measuring instrinsic and extrinsic motivation. Umay (2002) developed "The Achievement Motivation Scale" based on "Attribution Theory", which was developed by considering cognitive field theorists and "Motivation Achievement Theory" developed by Atkinson. Asik (2006) also developed "Motivational Regulation Scale" having two dimensions as effort and self-competence.

When examining mathematics related scales, no direct mathematics-motivation scale could be found aside from some scales adapted from regular motivational scales into the mathematics field as a whole or in part. Yavuz, Ozyıldırım ve Dogan (2012) adapted Nicholls ve colleagues' (1990) scale of "Method motivation Adaptation Scale" into Turkish as "Mathematics Motivation Scale" and used it with 6th, 7th and 8th grade students. Aktan and Tezci (2013) adapted one of the subdimensions of MSLQ, Motivational Strategies Scale, into mathematics as "Mathematics Motivation Scale"(MMS) to determine students' use of motivationel strategies in mathematics courses. The scale consists of 6 subdimensions -- intrinsic motivation, exstrinsic motivation, subject value learning belief, self competence and exam anxiety. Similary Liu and Lin (2010), adapted MSLQ scale into mathematics as "Mathematics Motivated Strategies For Learning Questionnaire" (MMSLQ). Moreover, Fennema-Sherman's (1976) nine scale of attitude inventory has a scale for motivation as "Effectance Motivation Scale"; Galbraith and Haines (2000) developed a mathematical motivation scale to use at undergraduate level having the subdimensions of interest in mathematics, enjoyment of mathematics, and intellectual stimulation; Tapia and Marsh developed a motivation scale to understand students intentions to avoid or choose mathematics; Fogarty and colleagues developed mathematics attitudes scales involving motivational factors at undergraduate level; Pierce and his colleagues developed a scale named "Affective Engagement Scale" involving interest and intellectual stimulation factors which are included under motivation.

In this study, some national and international studies about motivation are mentioned and constructs underlying motivation are discussed. As seen in the studies noted above, motivation is generally a focus of interest by many researchers. It can be said that some scales about motivation have been used in mathematics but the number of scales of motivation in mathematics is limited. According to the literature, it can be seen that there is a lack of scales paying attention to the principles of mathematics teaching and students' targeted skills considering mathematics learning in primary school and primary school students' features. In this regard, there is a need to form a reliable and valuable scale to determine students' motivation towards mathematics learning at primary school. Determining students' motivation towards mathematics learning will be helpful to develop strategies to increase the level of motivation and to strengthen teaching methods and techniques. Information about validity and reliability of the scale, findings and discussion constitute the content of this study.

Method

Working Group and Testing of the Scale

A testing form of the scale planned for the validity and reliability study was applied to 482 third and fourth grade students in Aydın central county. Data from twelve students were taken out of the analysis because of wrong or missing information in the questionnarie used. In the application form of the scale, items 1 and 14 were used as inverse items to control the consistency of answers and, based on the control items, 82 questionnaries which were determined as filled in carelessly were excluded in the process of analysis. The scores of 388 students which would be subject to the analysis were converted into standardized Z (±3,40) score values to avoid outliers and after that data from 41 students were excluded from the analysis as a result of this process. Finally, data from 347 students were used in the analysis. Answers for the questionnaries were transferred to the computer by scoring from 3 to 1 for the choices of "Agree", "Slightly Agree" and "Disagree". For validity and reliability analysis SPSS 15 package programme was used. The results of the analysis were presented in findings of this paper.

Kaiser-Meyer-Olkin (KMO) test was used in order to determine sampling adequacy. According to the results, KMO value was found as 0.94. Thus, KMO value, which was found as a criteria for the adequateness of the sample size, was accepted as an indicator that the sample size was adequate. In addition, the distribution of data must be normal for factor analysis. In the analysis, Bartlett's test of sphericity was found significant ($\chi 2$=14762.91; p=.00). Barlett coefficient's being significant was accepted as an indicator to use factor analysis to analyze data.

Item Preparation

For the process of the scale development, scale items were prepared firstly. In this process, essential attributions of motivation towards learning mathematics in primary school were extracted by reviewing the resources on motivation and motivation in mathematics learning. Then, scale items were developed considering these essential features of motivation. These essential attributions were also defined by considering behavioral views of motivation, based on using reward-punishment approach; humanistic views of motivation, based on realizing and fulfilling self-potential as human beings; and cognitive views of motivation, based on beliefs, expectations, needs and understanding of the learner. They were also defined by considering sub-theories and concepts under these theories. Similarly, review of the items in current motivation scales and research findings about motivation in the literature (Aktan & Tezci, 2013; Asık, 2006; Balaban, 2002; Baser, 2007; Dede, 2003; Christophel, 1990; Dede & Argun, 2004; Dede & Yaman ,2006; Dogan, 2012; Gomleksiz & Kan, 2012, Kutu & Sozbilir, 2011; Nicholls, 1990; Pintrinch & De Groot, 1990; Shia, 1998; Tuan, ,Chin & Shieh 2005; Yavuz, Ozyıldırım & Dogan,2012) also provided the researcher with a conceptual framework in the process of item development. In this sense seventy themes were composed (perceptual difficulty, understanding, learning the aim of the lesson, attention-concentration, interest to the lesson, getting bored, curiousty, material, need, willingness to learn, participation, peer support, group work, peer-comparison, achievement etc.) and related items were written down under these themes. Then, through organizing, reorganizing and combining of these initial seventy themes, eight themes of preliminary form of the scale emerged as "Feeling of success-failure, Need for Learning, Expectation (Parent, Teacher and Society), Acceptability (Parent, Peer and Society), Perception of Effort-Performance, Self-competence, Participation and Value-Esteem". In this sense, it was predicted that the developed scale might have 8 dimensions. Finally, 83 items of "Mathematics Motivation Scale" to understand students' motivation towards learning mathematics was developed. To provide content validity, which means determining the extent to which this scale measures all facets of the expected behaviours (Balcı, 2005), expert opinions were gathered. Based on the suggestions of two experts, studying in psychological counseling - guidance and mathematics education (excluding the researcher), 9 items were removed from the scale. As a result of this process, a pool of 74 items were left for preliminary form of the scale. The scale was also reviewed by a linguist expert and some items were modified or corrected. Motivations of primary school students towards learning mathematics were aimed to be identified by a three point-grading scale. Choices of "Agree", "Slightly Agree" and "Disagree" were used in the scale.

Ethical Issues Considered in the Process of the Scale Development

In the process of the scale development some ethical issues were considered as follows; special attention was paid to express scale items as original, scales were applied in the classroom settings where the researcher presented, participation to fill out the scale was completely *voluntary*, thus participants were not obliged, scales filled out were reviewed carefully and the scales with wrong or missing information were excluded, results of analysis were presented clearly and unethical practices such as plagiarism, falsification, fabrication was avoided.

Findings

Scale Construction

Primary School Mathematics Motivation Scale (PSMMS) was subjected to exploratary factor analyses to verify the construct validity of the study. Factor analysis revealed a structure with items clustered into nineteen underlying factors having eigen values of 1 or more and explaining 50.7 percent of the total variance. Because there were too many factors extracted, there were a few items clustered into the last eighteen factors and there was no meaningful integrity created under these factors, the researcher decided to examine the screeplot of principal component analysis (see Figure.1). When looking at the change point in shape of the plot, one component above that change point was seen. Thus, the scale was considered to retain only one factor where the majority of variables loadied substantially.

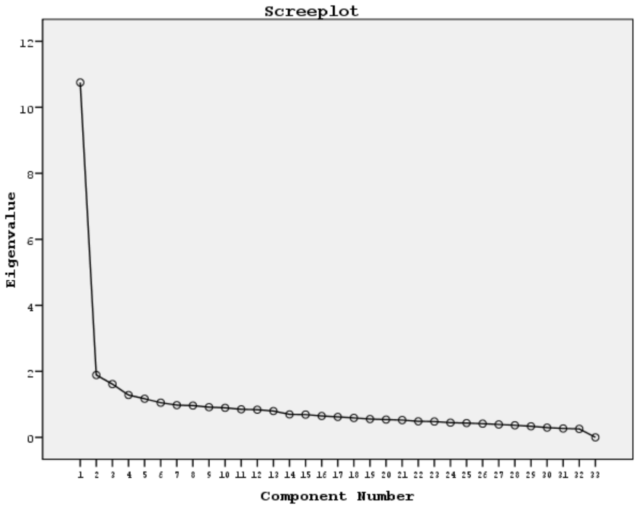

Figure 1. Screeplot of Principal Component Analysis

In the development of the scale, 0.50 factor loading was accepted as base, and as a result of the factor analysis, 41 items (Items of 4, 6, 9, 11, 13, 15, 16,18,19, 22, 24, 26, 27, 29, 30, 32, 34, 35, 39, 41, 42, 44, 45, 47, 48, 49, 51, 52, 53, 55, 56, 58, 59, 60, 61, 62, 65, 66, 68, 70, 72) loaded with more than one factor or that had loadings below 0.50 were removed from the scale. In final, 33 items consisting of positively and negatively worded items were included in the scale. A factor loading, which expresses the relationship of each variable to the underlying factor, must have a 0.50 or more loadings on a component. Hovewer, a minimum *factor loading* of *0.30* could be accepted for a scale having a few items (*Buyukozturk,* 2002). Thus, attention was paid when choosing a scale item to make sure its loading was minimum 0.50 to be a part of an underlying component. As a first step of factor analysis, principal components analysis revealed the presence of only one component with eigen values exceeding 1, explaining 43.46 percent of the total variance. A minimum of thirty percent of variance could be accepted for the one factor solutions of factor analysis (Buyukozturk, 2007). As a result of the factor analysis of PSMMS, a total of 33 items as comprising 4 negatively worded and 29 positively worded items were included in the scale.

Item analysis of the scale

Item analysis was performed to assess the performance of individual test items on the assumption that the overall quality of a test derives from the quality of its items. As a result of factor analysis of PSMMS items, items' factor loadings, items' total correlations and item *t*-test values (the top 27% and the bottom 27% by assessment score) are presented in Table 1.

Table 1: Factor loadings, item-total correlations and *t* values of PSMMS items

Item No	Factor loading	Item -total Correlations	Item *t* (Top %27-Bottom %27) values	Item No	Factor loading	Item -total Correlations	Item *t* (Top %27-Bottom %27) values
1	.732	.591	6.205***	18	.583	.471	2.704***
2	.724	.579	5.822***	19	.622	.489	4.479***
3	.669	.501	4.066***	20	.715	.579	4.628***
4	.693	.526	5.473***	21	.725	.592	5.613***
5	.575	.442	3.952***	22	.589	.452	5.237***
6	.678	.540	4.473***	23	.636	.500	3.970***
7	.592	.443	2.707***	24	.683	.554	6.979***
8	.797	.665	7.951***	25	.728	.594	5.133***
9	.734	.591	6.205***	26	.655	.516	2.851***
10	.643	.503	4.703***	27	.695	.571	4.512***
11	.655	.517	5.724***	28	.668	.524	4.332***
12	.687	.545	3.965***	29	.635	.502	4.528***
13	.614	.473	3.566***	30	.759	.627	6.474***
14	.693	.565	5.055***	31	.615	.476	4.636***
15	.583	.437	2.857***	32	.586	.436	2.841***
16	.643	.506	2.649***	33	.768	.630	6.770***
17	.716	.580	4.961***				

[1] n = 347 [2] $n_1 = n_2 = 93$ ***p< .001

As can be seen in the table illustrated above, an analysis was performed to compare the mean scores and to define difference based on the total item means between high-low-27-percent group in respect to students' mathematical motivations. Independent t-test was calculated to compare 347 participants' mean score of the top 27% (n=93) and the bottom 27% (n=93) by assessment score. When examining Table 1, it can be seen that t values of the difference of item points of lower and upper groups with 27% vary between 0.436 ($p<.000$) and 0 .665 ($p<.000$) and the t-test result among 33 items is found significant ($p<0.001$). As can be seen from the table , the item-total score of the upper-group with 27% is significantly higher than the item-total score of the lower-group's with 27% ($p < 0.001$) considering all the items. In general, the item-total correlation values of .30 or higher can be accepted as an adequate value for discrimination of participants (Buyukozturk, 2005). As a result of the comparision, it can be said that the groups were distinctively different from each other in respect to their scores of each of the 33 items individually and their total scale score. According to *t* values it can also be said that two extremes of the factor were adequately differentiated for the factor and total score. Thus, 33 scale items are considered as having higher levels of reliability and as measuring the same behaviors.

Reliability Study of the Scale

The internal consistency coefficient obtained from the answers to the 33 items was calculated through Cronbach Alpha reliability coefficients. Calculating the Cronbach Alpha coefficient was known as one of the most frequently used approaches to address the reliability of scales in research. The internal consistency coefficients of the scale was found as 0.94. According to Ozdamar (2004), it can be highly reliable if the internal consistency coefficient is between 0.8 and 1.00. Thus, the value of the alpha as the criteria of reliability of the scale was found adequate for the reliability of PSMMS.

Administration and Scoring scale

The final form of PSMMS has 33 items and a three point grading system. Thus, the maximum scoring from the scale is 99 while the minimum scoring is 33. Items of 3, 5, 9 and 11 have to be coded reversely. Gaining higher scores indicates more positive motivation of primary school students towards learning mathematics. The mean of the scale is 66, and interpretations of the acquired scores would be done according to ±1 , ±2, or ±3 *standard deviations* from the mean based on the normal distribution. If the interpretation is done as stating "low level motivation, middle level motivation and high level motivation", then the scores between 33 and 49 would mean low level motivation; the scores between 50 and 82 would mean middle level motivation and the scores between 83 and 99 would mean high level motivation. If the interpretation is done as stating "very low level motivation, low level motivation, middle level motivation,high level motivation and very high level motivation", then the scores between 33 and

43 would mean very low level motivation; the scores between 44 and 54 would mean low level motivation; the scores between 55 and 77 would mean middle level motivation; the scores between 78 and 88 would mean high level motivation and the scores between 83 and 99 would mean very high level motivation.

Discussion

In this study, the aim was to develop a scale for determining motivation of primary school students towards learning mathematics. Due to a lack of scales in literature, specifically constructed for mathematics and especially measuring the motivation in mathematics of primary school students, this scale, constructed according to the theories of motivation, fills a major gap. As a result of the factor analysis done to determine PSMMS's factor construct developed in this study, the scale was considered to have only one factor. In general, the item-total correlation values of 0.30 or higher can be accepted as an adequate value for discrimination of participants (Buyukozturk, 2005). It was observed from item analysis that item test correlations met the need of 0.30 requirement. Thus, the scale items were considered as having higher levels of reliability and as measuring the same behaviors. The significance of each correlation was examined by *t* test and it was concluded that items have adequate power to predict the items' total score.

As a result, Primary School Mathematics Motivation Scale (PSMMS), which consists of 1 factor and 33 items comprising 4 negatively worded and 29 positively worded items, came into existence.

In general, motivation scales as generally comprising learning strategies are seen in literature up to a factor of 15 with a variety of different names. In the beginning of this study, when the themes were constructed based on the motivational theories, it was predicted that the developed scale might cluster into eight factors. Mainly, the motivational scales were observed to come out at least having two factors as intrinsic motivation and exstrinsic motivation. When examining scales involving mathematical motivation (Tapia & Marsh,2004; Galbraith & Haines, 2000; Yavuz, Ozyıldırım & Dogan, 2012; Aktan & Tezci, 2013), it is evident that they were prepared mostly for undergraduate level and clustered into two or three factors. Because of the results of the mentioned studies, it was predicted that the the scale developed in this study might have eight factors or at least two factors. Hovewer, the scale came out having only one factor including items that have some of the important attributes of the theories of motivation. Intrinsic motivation and exstrinsic motivation are not differentiated from each other in this scale. Thus, it does not give an idea of whether students' motivation in mathematics is intrinsic or exstrinsic, but instead measures students' motivations towards mathematics by one factor. When examining the scale in respect to the factor and the total score it can be said that the scale discriminates the groups, which were distinctively different from each other. In this sense, the scale can be used for the purpose of general surveying and determination of motivation of mathematics in general.

Finally, the results of the study indicate that the scale determines the students' motivation towards learning mathematics. It can measure motivation of students for learning mathematics by a single construct. By reversing negatively worded items (items of 3, 5, 9, 11) and scoring the scale, acquiring higher scores (total score) indicates more positive motivation and acquiring lower scores indicates more negative motivation among primary school students towards learning mathematics.

According to the results of the PSMMS's validity and reliability study, it can be claimed that the scale is ready, reliable and valid to determine motivation of primary school students towards learning mathematics. It is suggested to repeat validty and reliability studies on groups of different students and to analyze the scale through confirmatory factor analysis (CFA). Moreover, Aktan and Tezci's (2013) adaptative version of one of the sub-dimensions of MSLQ, Motivational Strategies Scale, into mathematics as "Mathematics Motivation Scale"(MMS) to determine students' use of motivational strategies in mathematics courses is suggested to be used in the same groups for criterion validity.

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Primary School Mathematics Motivation Scale(PSMMS)	I agree	I slightly agree	I disagree
1. Mathematics is an easy subject for me			
2. I would like to raise my hand in mathematics class			
3. I get bored in mathematics class			
4. Topics in mathematics are interesting for me.			
5. I get annoyed in mathematics class			
6. I would like to participate in activites in mathematics class			
7. Mathematics exams are easy for me			
8. I like mathematics class			
9. Mathematics is a difficult subject for me			
10. I listen to mathematics subject carefully.			
11. I am afraid of solving mathematics problems thinking that I can't do			
12. I repeat the topics I learned in mathematics class			
13. I am happy when I am successful in mathematics class			
14. I think that mathematics improves my intelligence			
15. I would like to know how mathematical topics arose.			
16. I think that what I am learning in mathematics is necessary for my future			
17. I feel more confident when I succeed in mathematics.			
18. I can use the things that I learned in mathematics in daily life.			
19. I am good at in skills of making prediction in mathematics subject.			
20. I can explain the things that I learned in my own words in mathematics subject.			

21. I repeat the topics that I didn't understand in mathematics subject.			
22. I ask teacher about the topics that I couldn't understand in mathematics class.			
23. I study mathematics because I think what I've learned is necessary for me.			
24. I can explain reasons of the use of procedures while solving mathematics problems.			
Primary School Mathematics Motivation Scale(PSMMS)	I agree	I slightly agree	I disagree
25. I become more willing to learn new topics while learning current topics in mathematics subject			
26. I am aware of the benefits from what I've learned in mathematics subject.			
27. I am curious about what I would learn in new topics in mathematics lesson.			
28. I like finding more than one solutions to mathematics problems.			
29. I can build up a connection between mathematical topics and topics in other subjects.			
30. When I get stuck in a topic in mathematics I investigate that topic from different resources.			
31. I think that what I am learning is necessary to learn new topics in mathematics.			
32. I can express the things that I learned in mathematics through different ways (drawings, figures, tables etc.)			
33. I can build up a connection between my current learnings and previous learnings in mathematics.			