

## **DEVELOPMENT OF SELF-EFFICACY SCALE REGARDING PROSPECTIVE PRE-SCHOOL TEACHER TOWARD TEACHING MATHEMATICS\***

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### **Abstract**

*The purpose of this study is to develop a scale in order to determine the self-efficacy beliefs of the prospective teachers towards teaching mathematics, who are being educated in pre-school teacher program. After the scale was applied to 113 people for reliability and validity study, it was observed that items are gathered in three dimensions. These were named by researchers as “Preparing and Using Course Materials”, “Negative Self-Efficacy Perception” and “Positive Self-Efficacy Perception”. The reliability of the sub-dimensions was calculated respectively as .87, .80 and .78. As a result of the factor analysis, the reliability of the scale that consists of 22 items, were calculated as .89.*

**Keywords:** *Pre-school Education, Prospective Teachers, Self-Efficacy, Teaching Mathematics.*

### **1 INTRODUCTION**

Individuals' beliefs play an influential role in their cognitive, affective, motivational, and selection processes (Bandura, 1977). The concept of efficacy belief consists of two components: self-efficacy and outcome expectations. While self-efficacy pertains to one's beliefs in one's own capability, outcome expectations refer to perception of the possible consequences of one's actions. It has been suggested that individuals with high self-efficacy perception make more efforts, are more persistent and patient to achieve their goals (Askar&Umay, 2001). Teachers' attitudes, beliefs, and behaviors have a significant effect on students' preparation and their academic success (Taskin-Can, Canturk-Gunhan & Ongel-Erdal, 2005). The research literature indicates that there is a strong relationship between teachers' self-efficacy perceptions and their classroom practices. Furthermore, teachers with high self-efficacy demonstrate more willingness and excitement toward teaching (Bikmaz, 2004).

Schmitz (2000) identifies self-efficacy beliefs as a protector factor against job stress. He argues that teachers with high self-efficacy are more motivated and satisfied in their job. It seems that the differences among teachers' levels of self-efficacy beliefs create behavioral dissimilarities in their classroom management techniques, openness to new teachings methods, or their willingness to give feedback to children with learning difficulties. This situation also affects students' motivation and success (Yılmaz, Koseoglu, Gercek & Soran, 2004). Thus, determination of teachers' self-efficacy beliefs is important considering its relations to students' outcomes. Developing a teachers' self-efficacy perception scale in relation to particular areas, such as mathematics and science, is vital to acquire knowledge about teaching practices in these particular areas to support teachers. Similarly, since these scales can give feedback about teacher-training programs, it can be useful to apply them to teacher candidates.

Given that people encounter mathematics everyday in their life, learning mathematics is essential. Besides having an adequate mathematic education, students' beliefs and attitudes have a significant role in their mathematical

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learning. As pertinent research literature shows, teachers have a significant role in the formation of students' beliefs regarding mathematics. Preschool years are an important period in this respect. In order to introduce mathematics to young children in an appropriate way, the educators should understand mathematics properly and its role in everyone's lives. Moreover, preschool teachers should understand the development of children's mathematical perception. Preschool teachers' knowledge about their own mathematical perception can help them understand those of children. Teachers who are aware of their own mathematical perception and students' attitudes and beliefs about mathematics are more efficient in teaching mathematics (Fennema, Carpenter, Franke, Levi, Jacobs & Empson, 1996).

During the early childhood period, children learn the ideas and skills that can support their future education. There is an expert consensus among researchers that early mathematics education is particularly important in children's development of positive attitudes toward mathematics. This seems to be because in this period, children have most likely not developed fear of mathematics (Umay, 2003). Playful, stress free and nonjudgmental features of early childhood educational settings make introducing mathematics possible to young children without any fear easier than in upper grades. Young children learn mathematical thinking through observation and invention. Hence, instead of teaching mathematical concepts and skills through direct instruction, children should be taught mathematical knowledge and skills through hands-on experiences. Thus, early childhood education teachers' role should be to prepare an encouraging environment and guide children whenever children ask help to solve the problems they may not be able to solve by themselves (Greenberg, 1993; cited in Aktas, 2004). As the child-teacher interaction has an important role in daily mathematical instruction, teacher should have sufficient knowledge about how to teach mathematical concepts and skills to young children (Aktas, 2004).

In light of the above discussion, it is suggested that determining the level of pre-service teachers' self-efficacy beliefs about mathematics may have a contribution to understand how pre-service teachers are benefited from teacher training programs. It may also be important to determine the effectiveness level of teacher training programs on pre-service teachers' so that steps can be taken to improve the programs. The purpose of this study is to describe the development of self-efficacy beliefs scale of prospective preschool teachers' oriented mathematics education.

## **2 METHODOLOGY**

The research was conducted with quantitative perspective by using survey technique as data collection way. In this study, validity and reliability of scores on the scale have been investigated by expert opinion, factor analysis techniques and internal reliability investigation.

### **2.1 Participants**

The participants of this study are 113 student teachers at department of preschool education in Dokuz Eylül University, Buca Faculty of Education. The application of scale has been applied to 113 teacher candidates in the 2004-2005 spring terms. In this study, 27.4% of the participants (n=31) are first-grade, 20.4% of the participants (n=23) are second-grade, 26.5% of the participants (n=30) are third-grade and 25.7 % of the participants (n=29) are fourth grade.

### **2.2 Preparation of Scale Items**

First of all, in order to develop the scale, literature scanning has been performed and the scales regarding to self-efficacy have been examined. The dimensions of the scale have been determined at the result of the factor analysis. All of the items were listed in random order and rated on a 5-point Likert-type scale (1 for never, 2 for rarely, 3 for sometimes, 4 for usually and 5 for always). The negative items are graded in the form of opposite of above grading. The increase in the points indicates that individual's self-efficacy perceiving regarding to mathematics training is high; the decrease indicates that individual's self-efficacy perceiving regarding to mathematics training is low.

### **2.3 Content Validity**

Content validity indicates whether the property measured of items comprising the scale is adequate or not in terms of quality and number (Buyukozturk, 2006). Three experts and three preschool teachers have expressed their opinions about the items in scale and scale's convenience to the subject for the content validity of the scale. The scale has taken its final form by omitting and arranging some items in the light of their suggestions. The trial scale consists of 28 items which 17 of them are positive and 11 of them are negative.

**2.4 Analysis of Data**

Analysis of data was conducted by using the packet program SPSS 12.00. Exploratory factor analysis, item analysis, correlation analysis, internal consistency and descriptive statistic techniques have been used in the analysis.

**3 FINDINGS**

In this section, exploratory factor analysis related to validity of scale and the findings of reliability studies are presented in sequence.

**3.1 Structure Validity**

In order to determine what infrastructures constitute self-efficacy about teaching mathematics for prospective pre-school teachers, exploratory factor analysis is used for providing structure validity. The goal of factor analysis is to reduce “the dimensionality of the original space and to give an interpretation to the new space, spanned by a reduced number of new dimensions which are supposed to underlie the old ones” (Rietveld & Van Hout 1993: 254). Before factor analysis, it is seen that whether the sample is appropriate or not for factor analysis. The amount of Kaiser-Meyer-Olkin (KMO) index is calculated for this. KMO index is found as .799 for this sample. This finding is interpreted as the sample is sufficient (Akgul & Cevik, 2003). Furthermore, the diagonal amounts of Anti-image Correlation Matrix are calculated for sufficiency of the sample. It is determined that the second item in scale is 0.440 (weak) and it is removed from the scale. (2nd item: I think I don’t have as good dominant of mathematics as my other friends in the same branch.) With removing the second item, the KMO index is raised as .820. Whether the data comes from multivariate normal distribution or not is tested with Bartlett’s Sphericity Test. In the result of Bartlett Sphericity Test, because of Approx. Chi-Square: 1487.668 and  $p < .01$ , the results are qualified significant.

Exploratory factor analysis is initiated with 27 items. When the first analysis results are examined, the items are collected under 7 factors whose eigen value is higher than 1. However, when Scree Plot graphic is examined, the line is clearly broken after the third point that means existence of three factors that point. With varimax rotation, it is determined that the items separate to three factors. According to the values attained in the result of rotation, it is decided the items stay in the scale provided that one item has minimum 0.3 factor load in only one factor and one item partaking in more than one factors has the load in one factor being higher than minimum 0.1 value in another factor. After the factor analysis, because five items in the scale take part in more than one factors and the load of these items in one factor is not higher than 0.1 value in another factor, these items are removed from the scale. In the scale consisting of 22 items in its final form, before rotation Principal Component Analysis (PCA) Factor 1 loadings of these items and after Varimax rotation, factor loadings and factor common variances are indicated in Table 1.

Table 1. Factors’ loadings obtained in the result of factor analysis  
After The Rotation Factor Loadings

| Item No. | Factor 1 Loadings | Factor 1 | Factor 2 | Factor 3 | Factor Common Variances |
|----------|-------------------|----------|----------|----------|-------------------------|
| 9        | .553              | .793     |          |          | .667                    |
| 10       | .685              | .857     |          |          | .766                    |
| 11       | .683              | .811     |          |          | .708                    |
| 12       | .666              | .772     |          |          | .649                    |
| 13       | .613              | .576     |          |          | .433                    |
| 16       | .620              | .609     |          |          | .471                    |
| 19       | .669              | .543     |          |          | .493                    |
| 3        | .482              |          | .525*    |          | .336                    |
| 5        | .565              |          | .555*    |          | .437                    |
| 14       | .366              |          | .767*    |          | .667                    |

|    |      |       |      |      |
|----|------|-------|------|------|
| 15 | .430 | .488* |      | .329 |
| 17 | .542 | .593* |      | .443 |
| 22 | .604 | .723* |      | .584 |
| 24 | .380 | .710* |      | .608 |
| 26 | .527 | .516* |      | .396 |
| 4  | .516 |       | .708 | .531 |
| 6  | .622 |       | .530 | .460 |
| 18 | .604 |       | .345 | .421 |
| 23 | .638 |       | .528 | .518 |
| 25 | .378 |       | .461 | .257 |
| 27 | .582 |       | .614 | .488 |
| 28 | .471 |       | .719 | .550 |

Variances: Total % 50.96;

Factor-1: % 19.90;

Factor-2: % 16.69;

Factor-3: % 14.37

\* This items are negative and they are graded by reading the scale in reverse.

As it is seen in Table 1, the first factor explains 19.9 % of total variance concerning the scale, the second does 16.69% and the third does 14.37%. Total variance the three factors explain is 50.96%. After rotation, it is determined that the scale's first factor consists of seven items ( 9,10,11,12,13,16,19) , the second consists of eight items (3,5,14,15,17,22,24,26) and the third consists of seven items (4,6,18,23,25,27,28) . Factor load values of the items taking part in the first factor are between .543 - .857. Factor load values of the items in the second factor are between .488 - .767. The values in the third factor are between .345 - .719. Because the items in the first factor emphasize the perception of prospective pre-school teachers about preparing and using course materials, this factor is named as "Preparing and Using Course Materials". Since the items in the second factor emphasize the negative perception of prospective pre-school teachers about teaching mathematics, this factor is named as "Negative Self-Efficacy Perception" and since the items in the third factor emphasize the positive perception of prospective pre-school teachers about teaching mathematics, the factor is named as "Positive Self-Efficacy Perception". The items taking part in every factor are indicated in Table 2.

Table 2. Factors and items

| Factors                              | Items   |
|--------------------------------------|---|
| Preparing and Using Course Materials | 9. I can enable children to trust themselves with activities on the subject of mathematics.     |
|                                      | 10. I can enable children to become skillful at addition one-digit numbers by using objects.    |
|                                      | 11. I can enable children to become skillful at subtraction one-digit numbers by using objects. |
|                                      | 12. I can organize activities while I teach mathematics.  |
|                                      | 13. I can take children's interests while I teach mathematics.                                  |
|                                      | 16. I can prepare worksheet suitable for the subject in order to evaluate mathematical skills.  |
|                                      | 19. I can enable children to comprehend matching and grouping with activities I prepared.       |
|                                      | 3. I think I cannot help children get mathematical skills.                                      |
|                                      | 5. I think I could not learn mathematical concepts very well.                                   |

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|                                   |  |
|-----------------------------------|--|
| Negative Self-Efficacy Perception | 14. I think mathematics education I took is not sufficient for effective mathematics teaching.       |
|                                   | 15. I don't know necessary methods and techniques to teach mathematics.                              |
|                                   | 17. I don't know where I should start as teaching children mathematical concepts.                    |
|                                   | 22. I have deficiencies on the subject of teaching time concept.                                     |
|                                   | 24. Mathematics education I took is not sufficient to teach mathematical concepts effectively.       |
|                                   | 26. I don't have much information on the subject of children's mathematical development.             |
| Positive Self-Efficacy Perception | 4. I can make children get skill of presenting troubles in mathematical problems they confront.      |
|                                   | 6. I can enable children to develop a positive attitude for mathematics in the period of pre-school. |
|                                   | 18. I feel sufficient on the subject of teaching dimensional concepts, large size, small size, etc.  |
|                                   | 23. I trust myself on the subject of teaching children mathematical concepts.                        |
|                                   | 25. I know the mathematical development of age group I work very well.                               |
|                                   | 27. I believe I can constitute effective mathematical base on children I work.                       |
|                                   | 28. I can make students love mathematics.  |

With the aim of determining reliability of determined dimension, corrected item-total correlations are firstly calculated. Secondly, t test is used for significance of difference between item points of upper 27% and lower 27% groups determined according to total point (Table 3).

Table 3. Corrected item-total correlations and t values concerning 27% lower-upper group difference

| Factor                               | Item No | Corrected item-total correlations | t Value* |
|--------------------------------------|---------|-----------------------------------|----------|
| Preparing and Using Course Materials | 9       | .417                              | -4,050   |
|                                      | 10      | .589                              | -5,264   |
|                                      | 11      | .598                              | -5,376   |
|                                      | 12      | .571                              | -6,283   |
|                                      | 13      | .521                              | -5,409   |
|                                      | 16      | .547                              | -6,638   |
|                                      | 19      | .613                              | -6,042   |
| Negative Self-Efficacy Perception    | 3       | .451                              | -6,025   |
|                                      | 5       | .548                              | -5,610   |
|                                      | 14      | .359                              | -5,363   |
|                                      | 15      | .415                              | -4,926   |
|                                      | 17      | .514                              | -8,822   |
|                                      | 22      | .593                              | -7,431   |
|                                      | 24      | .384                              | -4,315   |
| Positive Self-Efficacy Perception    | 26      | .490                              | -6,934   |
|                                      | 4       | .419                              | -4,099   |
|                                      | 6       | .541                              | -6,511   |
|                                      | 18      | .517                              | -7,940   |
|                                      | 23      | .613                              | -6,481   |
|                                      | 25      | .342                              | -5,325   |
|                                      | 27      | .523                              | -6,779   |
| 28                                   | .376    | -3,268                            |          |

\* p<.05

According to Table 3, the corrected item-total correlations change between 0.342 and 0.613. Since the parameters of attained item-test correlation are not negative, zero or around zero (Tavsancil, 2005), it is said that internal consistency of means is high and so there is construction validity. The results of t test which is performed between item average points of upper 27% and lower 27% groups show that the differences are significant for all the items. This finding shows all of the items in the scale are distinguishing. Also, with the aim of determining the relationship among the scale's factors, correlation among factors is examined and attained results are given in Table 4.

Table 4. Correlations Concerning the Scale's Factors

| Scale   | Item Number | Average | Standard Deviation | Correlation |         |         | Total |
|---------|-------------|---------|--------------------|-------------|---------|---------|-------|
|         |             |         |                    | Factor1     | Factor2 | Factor3 |       |
| Factor1 | 7           | 30,48   | 4,27               | -           |         |         |       |
| Factor2 | 8           | 29,61   | 6,24               | .430**      | -       |         |       |
| Factor3 | 7           | 29,48   | 3,74               | .596**      | .482**  | -       |       |
| Total   | 22          | 89,57   | 11,65              | .788**      | .848**  | .798**  | -     |

\*\* p< 0.01

As it is seen in Table 4, there are positive and significant relationships among the scale's factors and between factors and total point.

### 3.2 Reliability

In the result of exploratory factor analysis, the reliability of the factors and the whole of the scale, which consists of 22 items and 3 factors, are attained by calculating the coefficient of Cronbach Alpha reliability. Besides, in order to put forward the scale's determination another sample group which was composed of 89 prospective pre-school teachers was applied the scale. The Cronbach Alpha reliability and test-retest reliability coefficients are given in Table 5.

Table 5. Cronbach Alpha Values of Scale Sub-Factors

|  | n   | Preparing and Using Course Materials | Negative Self-Efficacy Perception | Positive Self-Efficacy Perception | Total |
|--|-----|--------------------------------------|-----------------------------------|-----------------------------------|-------|
| Cronbach's Alpha Reliability Coefficient | 113 | 0.87                                 | 0.80                              | 0.78                              | 0.89  |
| Test-retest Reliability                  | 89  | 0.87                                 | 0.82                              | 0.85                              | 0.92  |

In addition to Cronbach Alpha value, the reliability is studied with Split-Half Model. The scale is separated into two groups. Alpha value of the first group with 11 items is found as 0.85, the second's value is found as 0.86. In correlation between two groups, a linear relationship in the direction of positive is found as 0.817. Spearman-Brown, giving the relationship between halves, equal halves parameter: 0.899 and Guttman halves parameter is found as 0.896. When attained values are regarded, it is said that the validity and the reliability of the scale are high.

## 4 CONCLUSION

In this study, a scale is developed to determine pre-serves preschool teachers' self-efficacy beliefs about mathematics education. This scale consisted of 22 items. Based on the result of the analysis, three dimensions were identified:

- Preparing and using course materials,
- Negative self-efficacy beliefs, and
- Positive efficacy beliefs.

After the completion of Factor Analysis, the reliability of three dimensions was determined to be 0.87, 0.80, and 0.78, respectively. The reliability of the scale was 0.89. The second application of the scale resulted in a Cronbach Alpha reliability of 0.92. The results of this study indicated that the developed scale is a reliable and valid means of measurement to determine pre-serves preschool teachers self-efficacy beliefs about mathematics education.

This developed scale was applied only to pre-serves preschool teachers who are studied at Dokuz Eylül University, Buca School of Teacher Education. For future research, it is suggested that using this scale with different populations can contribute to determine a broader applicability of this scale. Developing this scale was intended to help researchers understand preschool teacher candidates' beliefs about mathematics education.

## REFERENCES

- [1] Akgul, A. & Cevik, O. (2003). "Istatistiksel Analiz Teknikleri: SPSS'te İşletme Yonetimi Uygulamaları". Ankara: Emek Ofset Ltd. Şti.
- [2] Aktas, A.,Y. (2004). "Okul Öncesi Donemde Matematik Eğitimi". Adana: Nobel Yayıncılık.

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- [3] Askar, P. & Umay, A. (2001). "İlköğretim Matematik Öğretmenliği Öğrencilerinin Bilgisayarla İlgili Özyeterlik Algısı". *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, 21, 1-8.
- [4] Bandura, A. (1977). "Self-efficacy: Toward a unifying theory of behavioral change". *Psychological Review*, 84, 191-215.
- [5] Bikmaz, F. (2004). "Sınıf Öğretmenlerinin Fen Öğretiminde Özyeterlik İnancı Olceğinin Gecerlik ve Güvenirlik Çalışması". *Milli Eğitim Dergisi*, 161.
- [6] Buyukozturk, S. (2006). "*Sosyal Bilimler İçin Veri Analizi El Kitabı*". PegemA Yayınları, Ankara.
- [7] Fennema, E., Carpenter, T. P., Franke, M. L., Levi, L., Jacobs, V. R., Empson, S. B. (1996). "A Longitudinal study of learning to use children's thinking in mathematics instructions". *Journal for Research in Mathematics Education*, 27, 403-434.
- [8] Rietveld, T. & Van Hout, R. (1993). "*Statistical Techniques for the Study of Language and Language Behaviour*". Berlin – New York: Mouton de Gruyter.
- [9] Schmitz, G., S. (2000). "*Zur Struktur und Dynamik der Selbstwirksamkeitserwartung von Lehrern*". Ein protektiver Faktor gegen Belastung und Burnout, Digitale Dissertation. FU Berlin.
- [10] Taskin-Can, B., Canturk-Gunhan, B. & Erdal-Ongel, S., (2005). "Fen bilgisi Öğretmen Adaylarının Fen Derslerinde Matematik Kullanımına Yönelik Özyeterlik İnancının Belirlenmesi". *Pamukkale Eğitim Fakültesi Dergisi*, 17, 41-46.
- [11] Tavsancıl, E. (2005). "*Tutumların Ölçülmesi ve SPSS ile veri analizi*". Ankara: Nobel Yayıncılık.
- [12] Umay, A. (2003). "Okul Öncesi Öğretmenliği Adaylarının Matematik Algılayışları", *Ömep Dünya Kongre Toplantısı ve Konferansı Bildiri Kitabı*, Cilt;1, s. 175-183. Ankara: Kök Yayıncılık.
- [13] Yılmaz, M., Koseoglu, P., Gerçek, C., Soran, H. (2004) "Öğretmen Özyeterlik İnancı". *Bilim ve Aklın Aydınlığında Eğitim Dergisi*, 58.