Eğitim ve Bilim
2009, Cilt 34, Sayı 151

Education and Science
2009, Vol. 34, No 151

Preservice Elementary Teachers' Attitudes and Self-efficacy Beliefs toward Mathematics

İlköğretim Öğretmen Adaylarının Matematiğe Yönelik Tutum ve Özyeterlik Algıları

Erdinç ÇAKIROĞLU* Mine IŞIKSAL**
Orta Doğu Teknik Üniversitesi

Abstract

The purpose of this study was to explore the effect of gender and grade level on preservice teachers' self-efficacy beliefs and attitudes toward mathematics. The analysis was based on 358 elementary and middle school mathematics teachers enrolled in an undergraduate program at two public universities in Ankara. Results showed that there was no significant effect of gender and grade level of preservice teachers on their attitudes toward mathematics. On the other hand, results also revealed that there was found a significant effect of gender as males scored significantly higher than females in their mathematics self-efficacy and there was a significant effect of grade level as senior preservice teachers had the highest and sophomore had the lowest mathematics self-efficacy scores.

Key words: Pre-service Teachers, Self-efficacy Beliefs toward Mathematics, Attitudes toward Mathematics

Öz

Bu çalışmanın amacı, öğretmen adaylarının matematiğe yönelik özyeterlik algıları ve tutumlarının cinsiyet ve üniversite sınıf seviyesine göre anlamlı bir fark oluşturup oluşturmadığını incelemektir. Çalışma, Ankara'nın ilköğretim birinci ve ikinci kademe matematik öğretmeni yetiştiren iki üniversitesinde öğrenim görmekte olan 358 öğretmen adayıyla gerçekleştirilmiştir. Çalışma sonunda, öğretmen adaylarının matematiğe yönelik tutumlarının cinsiyet ve üniversite sınıf seviyesine göre anlamlı bir fark göstermediği bulunmuştur. Diğer yandan ise, öğretmen adaylarının matematiğe yönelik özyeterlik algılarının cinsiyet ve üniversite sınıf seviyesine göre anlamlı bir fark gösterdiği, erkek öğrencilerin kız öğrencilere oranla anlamlı düzeyde daha yüksek ortalamaya sahip oldukları bulunmuştur. Sınıf seviyesine göre ise bulgular, son sınıf öğrencilerinin en yüksek, ikinci sınıf öğrencilerinin ise en düşük ortalamaya sahip olduklarını göstermiştir.

Anahtar Sözcükler: Öğretmen adayları, matematiğe yönelik özyeterlik algısı, matematiğe yönelik tutum.

* Doç. Dr. Erdinç Çakıroğlu, ODTÜ, Eğitim Fakültesi, İlköğretim Bölümü, misiksal@metu.edu.tr.
** Dr. Mine IŞIKSAL, ODTÜ Eğitim Fakültesi, İlköğretim Bölümü, e-mail: misiksal@metu.edu.tr

Introduction

Bandura (1977) defined self efficacy as one's beliefs about his or her ability to achieve a certain level of accomplishment. A person's self-efficacy could impact the effort he or she put forth in a given situation and how long he or she persist on a given task (Goddard, Hoy, & Woolfolk-Hoy, 2004). Bandura (1994) claimed that a strong sense of efficacy increases human accomplishment and people with high assurance in their capabilities approach difficult tasks as challenges to be mastered rather than as threats to be avoided. People with high efficacy beliefs set themselves challenging goals and they increase and sustain their efforts in the face of failure. On the other hand, people who doubt their capabilities shy away from difficult tasks, which they view as personal threats. Additionally, people with low efficacy beliefs have low aspirations and weak commitment to the goals they choose to pursue. When faced with difficult tasks, they dwell on their personal deficiencies and all kinds of adverse outcomes rather than concentrate on how to perform successfully. That is, individuals with lower self-efficacy beliefs feel as if they do not have necessary skills to carry out a given tasks (Bandura, 1994).

Bandura (1986, 1997) postulated four sources of efficacy beliefs: mastery experiences, physiological and emotional states, vicarious experiences, and social persuasion. The sources of self-efficacy serves as a primary determinant of how individuals make choice, expend effort to achieve goals, and continue to completion of these goals (Bandura, 1997).

In the literature there were studies that examined self-efficacy in various academic areas, including mathematics (Hacket, 1985; Hackett & Betz, 1989; Pajares & Miller, 1994, 1995). Hackett and Betz (1989) defined mathematics self-efficacy as a situational or problem-specific assessment of an individual's confidence in her or his ability to successfully perform or accomplish a particular mathematics task or problem. Relationships between mathematics self-efficacy, and related constructs, including mathematics performance and attitudes toward mathematics, were studied by many researchers. However, as Swars (2005) also pointed out, there is limited number of studies when the preservice elementary teachers are concerned.

Learning mathematics is a lifelong process. Effective mathematics instruction must be planned and implemented throughout students' school years and it is essential to accept that teachers' attitudes and beliefs toward mathematics instruction can influence the strategies they use in their classrooms. Curriculum reforms related to mathematics education attempted to change preservice teachers' attitudes towards mathematics and teaching of mathematics (Rech, 1993).

Many researchers emphasized the importance of preservice teachers' attitudes and beliefs toward mathematics and teaching of mathematics in their professional development. Researchers agreed that a well qualified teacher should have positive attitudes and beliefs toward mathematics and teaching profession in order to have positive effect on their students' learning (Borko et al, 1992; Borko & Putnam, 1996; Haser, 2006; Shulman, 1986). Teachers of all grade levels have responsibilities not only to promote positive attitudes related to teaching mathematics, but also to teach mathematics in an effective way for engaging students in mathematical learning process. Buhlman and Young (1982) stated that teacher's attitudes and beliefs affect their teaching practices which also influence their students' attitudes and beliefs. If a teacher has negative attitudes towards mathematics or teaching mathematics, then this could have negative effect on classroom activities and students' attitudes towards mathematics.

Krows (1999) emphasized that many teacher education programs acknowledge the importance of teacher beliefs as they impact classroom behaviors. In this regard, many teacher education programs aim to improve their students' beliefs about teaching and learning. Some

teacher education programs explicitly attempt to influence their students' beliefs about most desirable methods of teaching and the most appropriate models of student learning where others attempt to strengthen their students' self-related beliefs regarding teaching. In both cases, the effectiveness of teacher education programs in reaching those goals mediated by their student's initial beliefs and beliefs that they developed throughout the program (Krows, 1999). Thus, it is important to understand the beliefs preservice teachers hold as they prepare to enter the profession. To state differently, great emphasis should be given to assess preservice mathematics teachers' beliefs about their ability to perform specific mathematical competences before going into the real classroom.

Investigation of gender differences in mathematics learning is still an important issue in mathematics education (Ercikan, McCreith, & Lapointe, 2005; Leder, 1992). In this sense, gender differences in mathematics self-efficacy beliefs are an interesting area to explore. Pajares and Miller (1997) suggested that investigation of gender differences in mathematics self-efficacy has not been explored thoroughly as between gender and mathematics performance.

In her study, Isiksal (2005) investigated the effect of gender and year in the program of study on preservice teachers' performance and mathematical self-efficacy beliefs. Results revealed that female preservice teachers had higher scores than males on mathematics performance, but no significant difference was detected with respect to mathematics self-efficacy. Similarly, Cooper and Robinson (1991) mentioned no gender difference on mathematics self-efficacy and mathematics performance among undergraduate students in public university.

Although there are research studies that focused on investigation of gender differences on mathematics performance and self efficacy at various grade levels, very few studies focused on preservice teachers (Isiksal, 2005). Similarly, this study aims to examine how preservice teachers' self-efficacy beliefs and attitudes toward mathematics differ based on their gender and grade level during their enrollment in the teacher education program. In general; the purpose of the present study was to address the following two questions:

1. Is there any significant effect of gender and grade level on preservice teachers' attitudes toward mathematics?
2. Is there any significant effect of gender and grade level on preservice teachers' self-efficacy beliefs toward mathematics?

Method

Participants

Data were collected from 98 (27.4 %) freshmen, 82 (22.9%) sophomore, 94 (26.3%) junior, and 84 (23.5%) senior preservice middle school mathematics teachers enrolled in an undergraduate program at two public universities in Ankara, Turkey. Participants' age ranged from 18 to 24 and they were students within the Elementary Mathematics Teacher Education (ELE) Programs in the department of Education Faculties. Data were collected at the end of the fall semester of 2004-2005 academic years. Participants of the study were asked whether they would voluntarily fill out the Attitude toward Mathematics and Mathematics Self-Efficacy Scales. In total 358, 230 female (64.2%) and 128 (35.8%) male preservice teachers participated in the study.

Instruments

In order to investigate preservice teachers' attitude toward mathematics, Attitude toward Mathematics Scale (ATMS) developed by Askar (1986) was used. The ATMS was a five-point Likert-type scale consists of 20 statements about attitudes towards mathematics and mathematics classes. There were 10 positive (e.g. I like mathematics, mathematics lesson is enjoyable) and 10 negative statements (e.g. I'm afraid of mathematics, Studying mathematics is annoying) in the Attitude toward Mathematics Scale. There were three possible responses to each statement namely; "strongly agree=4", "strongly disagree=0", and "undecided=2". Possible scores on the ATMS scale range from 0 to 80. For internal consistency, Cronbach's alpha for the ATMS was calculated as .83.

In order to determine mathematics self-efficacy beliefs of preservice teachers, Mathematics Self-Efficacy Scale (MSES) developed by Umay (2001) was used. The MSES was a Likert Type, using a five-point scale ranging from "Always = 5" to "Never = 1". Possible scores on the MSES range from 14 to 70. The scale consisted of 14 items (e.g. I can easily help people around, related to their mathematical problems, I realized that I'm losing my self confidence while studying mathematics). The Cronbach's alpha for MSES was calculated as .80.

The ATMS and MSES were administered to the all freshman, sophomore, junior and senior preservice elementary mathematics teachers in both universities. Completing the questionnaires required 20-25 minutes and questionnaires were administered to students during their regular class hours.

Results

Rasch Model

To analyze preservice teachers' attitudes toward mathematics and mathematics efficacy beliefs, stochastic Rasch model was used. Rasch model transforms raw data from the human sciences into abstract, equal-interval scales and equality of intervals is achieved through log transformations of raw data odds and by the probabilistic equations abstraction is accomplished (Bond & Fox, 2001). It's argued that one of the important benefits of the model is that it can provide estimates of item difficulty and person ability that are relatively invariant over different samples. Additionally, by using the Rasch model more accurate evaluation is allowed even respondents do not answer every item. In the analysis of data, mathematics attitude and mathematics self-efficacy scores of pre-service teachers' were reported in Rasch log odds units.

To describe the data, mean and standard deviation of the attitudes toward mathematics and mathematics self-efficacy scores for male and female students in all grade levels were computed (Table 1). In general, we could say that preservice teachers' attitudes toward mathematics (M= 2.36, SD= 1.66) and mathematics self-efficacy beliefs (M = 1.46, SD= 0.94) were high.

Table 1.
Mean Measures of Participants Based on Gender and Grade Level.

	Math Self-efficacy Mean (SD)			Attitudes towards Math Mean (SD)			
Grade Level	Female	Male	Total	Female	Male	Total	N
Freshman	1.19 (0.71)	1.53 (0.80)	1.33 (0.76)	2.16 (1.59)	2.56 (1.80)	2.33 (1.69)	98
Sophomore	1.23 (0.93)	1.36 (0.73)	1.27 (0.86)	2.21 (1.44)	2.41 (1.46)	2.28 (1.44)	82
Junior	1.38 (1.02)	1.88 (1.33)	1.56 (1.16)	2.16 (1.31)	2.36 (2.42)	2.23 (1.77)	94
Senior	1.70 (0.92)	1.66 (0.91)	1.68 (0.91)	2.66 (1.62)	2.51 (1.94)	2.61 (1.71)	84
Total	1.38 (0.92)	1.61 (0.98)	1.46 (0.94)	2.30 (1.50)	2.47 (1.92)	2.36 (1.66)	358

In order to test the effect of gender and grade level on preservice teachers' attitudes toward mathematics, two-way Analysis of Variance (ANOVA) was run. In Figure 1, the relationship between gender, year in program, and the gender and year in program interaction on attitude is given.

Results revealed that there was no significant main effect for gender [$F(1,349) = 0.69$, $p = .67$]. In other words, although males ($M = 2.47$, $SD = 1.92$) had higher scores compared to the females ($M = 2.30$, $SD = 1.50$), this difference was not significant. Similarly, results revealed that there was no significant main effect for grade level. That is; attitude scores of freshmen ($M = 2.33$, $SD = 1.69$), sophomore ($M = 2.28$, $SD = 1.44$), junior ($M = 2.23$, SD=1.77), and senior ($M = 2.61$, $SD = 1.71$) preservice teachers did not differ significantly [$F(3,349) = 0.53$, p =.66].

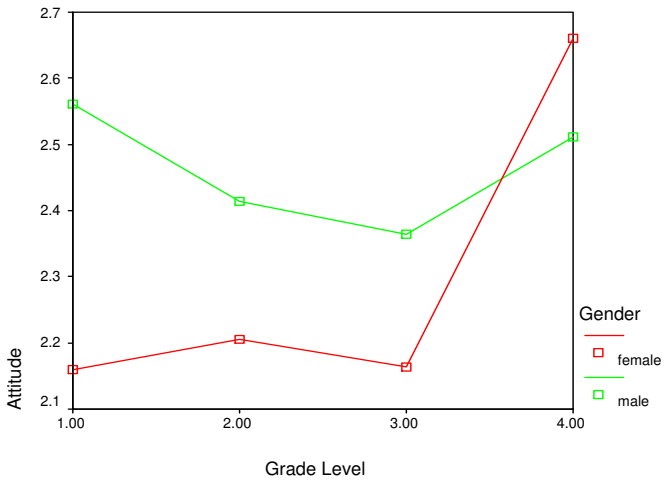

Figure 1. The relationship Between Gender, Year in Program and Attitude

In addition results revealed that there was no significant gender and year in program interaction on attitude. In other words, the effect of gender did not depend on the year in program. Despite the lack of statistical significance, we could note that males had higher attitude scores than females at their first, second, and third year enrollment in teacher education

program whereas females (M = 2.66, SD = 1.62) had higher attitude scores than males (M = 2.51, SD = 1.94) in their last year of program.

Similarly, in order to test the effect of gender and grade level on preservice teachers' self-efficacy beliefs toward mathematics, two-way Analysis of Variance (ANOVA) was run. Results revealed that there was a significant main effect for gender where males (M = 1.61, SD = 0.98) had significantly higher self-efficacy scores than females (M = 1.38, SD = 0.92), $F(1,350) = 5.08$, p = .025. Likewise, results revealed significant main effect for grade level $F(3,350) = 3.32$, p = .020 on preservice teachers' self efficacy scores toward mathematics. In order to reveal the difference, Bonferroni Post Hoc test was performed. Analysis showed that there was a significant mean difference between freshmen (M = 1.33, SD = 0.76) and senior (M = 1.68, SD = 0.91) preservice teachers (p = .031), between sophomore (M = 1.27, SD = 0.86) and senior preservice teachers (p = .014), and between sophomore and junior (M = 1.56, SD=1.16) preservice teachers (p = .022) respectively, where senior students had the highest and sophomore had the lowest self-efficacy scores. On the other hand, results revealed no significant mean difference between freshman and sophomore preservice teachers (p = .65), between freshmen and junior (p = .225), and between junior and senior preservice teachers (p = .685) on mathematics self efficacy scores.

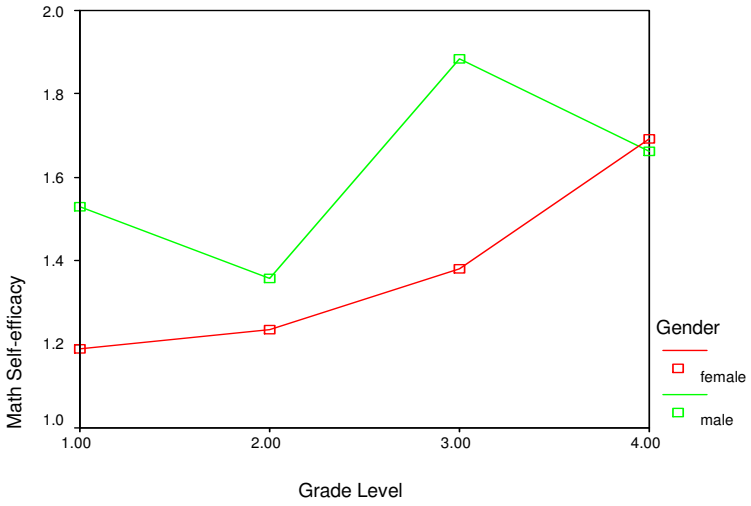

Figure 2. The relationship Between Gender, Year in Program, and Mathematics Self-Efficacy.

In addition results revealed that there was no significant gender and year in program interaction on math self-efficacy. In other words, the effect of gender did not depend on the year in program. Despite the lack of statistical significance, we could note that self-efficacy scores of males were higher than females at their first year, second year, and third year of their university education, on the other hand, females had higher self-efficacy scores (M = 1.70, SD = 0.92) than males (M = 1.66, SD = 0.91) in their last year of university education.

Discussion

In this study, the effect of gender and grade level on attitudes and self-efficacy beliefs of preservice teachers toward mathematics was investigated. Result revealed no significant effect of gender and grade level on mathematics attitudes of preservice teachers. In fact, this result was consistent with the meta-analysis carried out by Hyde, Fennema, Ryan, Frost, and Hopp (1990) where they found that gender differences in most aspects of mathematics attitude and affect were small. It was also found that pre-service teachers' attitudes towards mathematics

did not significantly differ based on their grade levels. From these results, it can be argued that the experiences they had with mathematics did not result in preservice teachers to develop differing attitudes based on gender and grade level. Results also showed that in their first year of university education, female preservice teachers' attitudes toward mathematics was lower compared to their male partners, whereas there was an increase in attitude scores of senior female pre-service teachers. It is possible argue that, as they are getting closer to their professional lives as teachers, female students develop more positive attitudes towards mathematics. Looking at mathematics not only as students any more, but as future teachers, may play a critical role in such attitudes. One should note here that, in Turkey, teaching is stereotypically seen as a female profession especially in elementary levels. Thus, to have a job that is welcomed by the society could be a factor affecting preservice female students' attitudes more than males.

According to the other findings of the study, there was a significant effect of gender and grade level on preservice teachers'self-efficacy beliefs about mathematics. It was found that male preservice teachers had higher self-efficacy beliefs about mathematics than females. This result supports other findings in the literature which were also indicated significant difference on mathematics self-efficacy scores in favor of males (Hackett & Betz, 1989; Pajares & Miller, 1994). Results also revealed significant effect of grade level on mathematics self-efficacy scores where senior pre-service teachers had significantly higher scores compared to the other grade levels. Those results were supported in the literature who examined the perceived mathematics self-efficacy of the freshman and senior students in the division of mathematics teaching (Isiksal, 2005; Umay, 2001). They emphasized the significant difference in terms of senior students with respect to mathematics self-efficacy. Our results also supported the assertion that mathematics efficacy scores of preservice teachers increased as their grade level increased indicating that teacher education programs could have an positive effect on the efficacy beliefs of pre-service teachers during their enrollment in program. Pre-service teachers' efficacy beliefs would benefit from teacher preparation programs that provide earlier and additional opportunities for vicarious experiences and verbal persuasion (Szabo, Bailey, & Ward, 2005). In other words, pre-service teachers' experiences in teacher education programs, both in mathematics and in educational classes, might affect their mathematics efficacy beliefs and attitudes toward mathematics positively.

To sum up, investigating gender differences regarding efficacy beliefs, and other cognitive and affective domains across different grade levels and studying the developmental process of those variables could yield valuable implications for further studies. In the current study, preservice teachers generally had higher attitudes towards mathematics, which did not yield differences based gender and grade level. However, when it comes to the efficacy beliefs, general level of preservice teachers were relatively lower than their attitudes. It was also interesting to observe that when the efficacy beliefs are concerned, both gender and grade level made a difference. These results indicate that teacher education institutions in Turkey should pay more attention to the efficacy beliefs of preservice teachers. As Bandura suggested, efficacy beliefs are influenced from mastery experiences, physiological and emotional arousal, vicarious experience, and social persuasion. Providing opportunities to preservice teachers that make use of such strategies could be an effective way for increasing their efficacy beliefs. In this sense, teacher education programs should provide more opportunities for pre-service teachers to have active and meaningful experiences with mathematics. Understanding pre-service teachers' efficacy beliefs while they are students is crucial to ensuring that new teachers will succeed in their practice. Future research may focus on the factors influencing these efficacy beliefs of preservice teachers.

References

Askar, P. (1986). Matematik dersine yönelik tutum ölçen likert tipi ölçeğin geliştirilmesi. *Eğitim ve Bilim, 62*(11), 31-36.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84,* 191-215.

Bandura, A. (1986). *Social foundations of thought and action: a social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1994). Self-efficacy. In V. S. Ramachaudran (Ed.), *Encyclopedia of human behavior* (Vol. 4, pp. 71-81). New York: Academic Press. (Reprinted in H. Friedman [Ed.], *Encyclopedia of mental health*. San Diego: Academic Press, 1998).

Bandura, A. (1997). Self-efficacy: The exercise of control. New York: W. H. Freeman and Company.

Bond, T. G., & Fox, C. M. (2001). *Applying the Rasch Model: Fundamental Measurement in the Human Sciences*. Mahwah, NJ: Lawrence Erlbaum Associates.

Borko, H., Eisenhart, M., Brown, C. A., Underhill, R. G., Jones, D., & Agard, P. C. (1992). Learning to teach hard mathematics: Do novice teachers and their instructors give up too easily? *Journal for Research in Mathematics Education, 23,* 194-222.

Borko, H., & Putnam, R. T. (1996). Learning to teach. In D. C. Berliner, & R. C. Calfee (Eds.), *Handbook of Educational Psychology.* New York: Macmillan Library Reference USA.

Bulmahn, B. J., & Young, D. M. (1982). On the transmission of mathematics anxiety. *Arithmetic Teacher, 38*(1), 34-35.

Goddard, R. D., Hoy, W. K., & Woolfolk-Hoy, A. (2004). Collective efficacy beliefs: Theoretical developments, empirical evidence, and future directions. *Educational Researcher, 33*(3), 3-13.

Hackett, G. (1985). Role of mathematics self-efficacy in the choice of math-related majors of college women and men: A path analysis. *Journal of Counseling Psychology,. 32*(1), 47-56.

Haser, C. (2006). *Investigation of preservice and inservice teachers' mathematics related beliefs in Turkey and the perceived effect of middle school mathematics education program and the school context on these beliefs.* Unpublished doctoral dissertation, Michigan State University.

Hackett, G., & Betz, N. E. (1989). An exploration of the mathematics self-efficacy/mathematics performance correspondence. *Journal for Research in Mathematics Education, 20*, 261-273.

Hyde, J. S., Fennema, E., Ryan, M., Frost, L. A., & Hopp, C. (1990). Gender comparisons of mathematics attitudes and affect: A meta-analysis. *Psychology of Women Quarterly, 14*, 299-324.

Isiksal, M. (2005). Pre-service teachers' performance in their university coursework and mathematics self-efficacy beliefs: What is the role of gender and year in program? *The Mathematics Educator, 15*(2), 8-16.

Krows, A. J. (1999). Pre-service teachers' belief systems and attitudes toward mathematics in the context of a progressive elementary teacher preparation program. Unpublished doctoral dissertation, The University of Oklahoma.

Pajares, F., & Miller, D. M. (1994). Role of Self-Efficacy and Self-Concept Beliefs in Mathematics Problem Solving: A Path Analysis. *Journal of Educational Psychology, 86*(2), 193-203.

Pajares, F., & Miller, D. M. (1995). Mathematics Self-Efficacy and Mathematics Performances: The Need for Specificity of Assessment. *Journal of Counseling Psychology, 42*(2), 190-198.

Rech, J. (1993). Comparisons of mathematical competencies and attitudes of elementary education majors with established norms of a general college population. *School Science and Mathematics, 93(3),* 141-144.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14.

Swars, S. L. (2005). Examining perceptions of mathematics teaching effectiveness among elementary preservice teachers with differing levels of mathematics teacher efficacy. *Journal of Instructional Psychology, 32(2),* 139-147.

Szabo, Z., Bailey, R., & Ward, R. (2005). Efficacy sources for preservice teachers. *Academic Exchange Quarterly, 9*(4), 166-171.

Umay, A. (2001). The effect of the primary school mathematics teaching program on the mathematics self-efficacy of students. http://www.qafqaz.edu.az/journal/number8.html