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Teaching Anxiety and the Mathematical Representations Developed through WebQuest and Spreadsheet Activities

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Abstract: The purpose of this study was to find out the effects of mathematical representations developed through WebQuest and spreadsheet activities on the teaching anxiety level of the pre-service elementary school teachers in mathematics. The number of pre-service elementary school teachers involved in this study was seventy three. Thirty five of the participants were in the experimental group and thirty eight of them were in the control group. Whereas the participants in the experimental group developed WebQuest activities during seven weeks of mathematics instruction, the others in the control group did spreadsheets activities in the classroom. The researchers used a Liker-type questionnaire, the Mathematics Teaching Anxiety Scale (MATAS) including twenty three items as pre- and post-tests to investigate teaching anxiety level of the participants in mathematics. After the collection of the data, the researchers used the independent samples t-test and ANCOVA to analyze the quantitative data. The study indicated that there was a statistically significant difference found in terms of teaching anxiety level between the groups favoring the one who developed WebQuests. In other words, developing WebQuest activities reduced the teaching anxiety levels of the pre-service elementary school teachers more than doing spreadsheet activities in mathematics.

Key words: Internet, use of technology, WebQuests, spreadsheets, teaching anxiety, mathematics

INTRODUCTION

There are many factors, such as prior-knowledge, gender, instruction, self-confidence, motivation, pedagogical content knowledge, use of technology and so forth appearing to affect students' anxiety and success in mathematics (Vinson, 2001; Altermatt and Kim, 2004; Abramovich and Cho, 2006; Malinsky *et al*., 2006; Iossi, 2007). For instance, according to Altermatt and Kim (2004) and Malinsky *et al*. (2006), gender is a great factor influencing students' mathematics anxiety. They stated that female students had higher anxiety level in mathematics than male students. Likewise, several studies claimed that having negative experiences in mathematics can produce negative results in learning and teaching mathematics (Uusimaki and Nason, 2004). Therefore, Vinson (2001) stated, mathematics anxious teachers may serve to foster the early development of mathematics anxiety among their students. On the other hand, Iossi (2007) claimed that strategies for minimizing anxiety involve curricular strategies, instructional strategies and non-instructional strategies. In particular, using technology as well as self-paced learning, math anxiety courses, distance learning and psychological treatments reduce mathematics anxiety (Goldberg and Waxman, 2003).

Furthermore, several research studies reported that the use of technology plays prominent roles in teaching and learning mathematics and has positive impacts on students' motivation and achievements in mathematics (NCTM, 2000; Drier, 2001; Abramovich and Cho, 2006; Halat, 2008a; Wachira *et al*., 2008; Yao Lin, 2008). For example, Abramovich and Cho (2006) stated that one of the main tenets of mathematics education is to have an appropriate use of technology in teaching and learning of mathematics at all grade levels. In Principles and Standards for School Mathematics of National Council of Teachers of Mathematics, it is reported that computers are essential tools for teaching, learning and doing mathematics. They furnish visual images of mathematical ideas, they facilitate organizing and analyzing data and they compute efficiently and accurately (NCTM, 2000).

Furthermore, Yao Lin (2008) claimed that pre-service teachers have great attitudes toward the use of computers

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and web based resources in teaching mathematics. According to Yao Lin (2008), the interactive web sites can provide a rich environment for student learning activities. Using interactive web sites could be helpful for the students in the organization and representation of their data. Therefore, mathematics teachers should be able to appropriately use a variety of computer tools such as, geometer's sketchpad, spreadsheets and so forth and utilize the Internet as a resource in the mathematics classrooms (Dodge, 2001). WebQuests have become important in many educational areas and have received considerable attention from teachers and educators since it was proposed and developed by Dodge (2001), Yoder (1999), Kelly (2000), March (2000) and Halat (2008a). Moreover, Halat (2008b) found that WebQuests had positive effects on the motivation of the pre-service elementary school teachers in mathematics.

In addition, research has documented that spreadsheets have been used in teacher education and K-12 classrooms to explore a variety of mathematical concepts and to help students solve problems for more than two decades (Bright, 1989; Baki *et al*., 2000; Isiksal and Askar, 2005). There are many benefits of using spreadsheets. For example, the spreadsheets allow students to talk about essential mathematical concepts without using algebraic notation (Neuwirth, 1996). Therefore, in this study the researchers tried to find out the impacts of developing WebQuest-based activities and doing spreadsheet activities on the teaching anxiety level of pre-service elementary school teachers in mathematics.

Wei and Chen (2006) claimed that one of the rapidly emerging uses of the Internet is web-based activities. Besides, WebQuest is a computer-based learning and teaching model in which learners are actively involved in an activity or situation and use the Internet as a resource. WebQuest has become prominent in many educational areas and has received considerable attention from teachers and educators since it was proposed and developed by Dodge (2001), Yoder (1999), Kelly (2000), March (2000) and Hassanien (2006). According to Schofield (1995), the use of technology in teaching and learning has positively influence the motivation and achievement of students. Likewise, Wei and Chen (2006) argued that the Internet has a great impact on both students and teachers. It must also be remembered that although the web has a lot of valuable information, it is also full of useless information. The misuse of the Internet concerns parents, educators, administrators, teachers and others (Mason, 2000). Dodge (2001) proposed and developed a WebQuest model, new teaching and learning technique, which uses the Internet in the classroom and meets the concerns of those expressed above.

In addition, several research studies showed that an instruction that uses WebQuest-based applications in the classrooms had positive effects on students' attitudes toward mathematics learning (Halat and Jakubowski, 2001; Halat, 2008a). Moreover, according to Halat (2008b), the followings are several strengths of WebQuests: is an alternative teaching technique that enhances students' motivation in class; serves as an alternative assessment tool of student's learning; gives teachers an idea of the students' degree of acquisition of knowledge and implementation of the knowledge; enhances teachers' higher-order thinking skills, such as finding topic-related Web sites and examining and selecting professional, well-prepared and reliable Web sites; requires students to be active learners.

During the last two decades, the use of spreadsheets has been very popular in teacher education and K-12 classrooms (Hunt, 1995; Edwards and Bitter, 1989; Cinar and Ardahan, 2003; Dede and Argun, 2003). These researchers believe that spreadsheets offer the potential to encourage students to explore and express mathematical ideas that they are likely to use when solving problems. The spreadsheets can help students move from specific examples to generalized relationships. According to Edwards and Bitter (1989), one of the beauties of using spreadsheets is that it is possible to set up calculations, change some cell values and look at the effect on the results immediately. Today, it is clear that educational research supports the use of spreadsheets both in teacher education and K-12 classrooms. There are many benefits of using spreadsheets. For example, the spreadsheets allow students to talk about essential mathematical concepts without using algebraic notation. Edwards and Bitter (1989) claimed that students can answer a variety of questions based on one problem and see the relationships among the variables as number change. The spreadsheets allow mathematical concepts to be shown through concrete and numerical examples (Neuwirth, 1996). Moreover, Sgroi (1992) claimed that it allows the students to apply a variety of mathematics skills, both thinking and computing. The spreadsheets build an ideal bridge between arithmetic and algebra and allow the student free movement between the two worlds (Friedlander, 1998).

Today mathematics anxiety is a common phenomenon for many students. According to Baloğlu (1999), mathematics anxiety comes first among the most vital problems in teaching and learning mathematics. Mathematics anxiety is equated with poor performance and avoidance of certain subjects in school mathematics (Acelajado, 2004). Richardson and Suinn defined mathematics anxiety as feelings of tension and anxiety

that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations (Engelhard, 1990). The research has showed that there were many studies done on the mathematics anxiety with the pre-service teachers (Austin *et al*., 1992; Sloan *et al*., 1997; Newstead, 1998; Vinson, 2001; Uusimaki and Nason, 2004; Brady and Bowd, 2005; Idris, 2006). For example, according to Uusimaki and Nason (2004), the origin of the pre-service teachers' negative beliefs and anxiety about mathematics could be attributable to prior school experiences. Moreover, they found that pre-service primary school teachers' negative experience and anxiety about mathematics are attributed to the teachers rather than to other factors, such as mathematical concepts.

On the other hand, mathematics teaching anxiety is a frequent fear of the pre-service teachers. It may reflect real or perceived knowledge deficits in mathematics content as well as in mathematics teaching skills (Levine, 1993). Gardner and Leak (1994) defined the teaching anxiety as anxiety experienced in relation to teaching activities that involve the preparation and execution of classroom activities. Mathematics teaching anxiety can be defined as teachers' feelings of tension and anxiety which occurs during teaching mathematical concepts, theories and formulas or during problem solving (Levine, 1993; Peker, 2006).

In recent years, there are many studies done on the mathematics teaching anxiety with the pre-service teachers (Levine, 1996; Peker, 2006, 2008; Peker and Halat, 2008). For example, Peker and Halat (2008) investigated the gender-related differences in pre-service elementary school teachers' teaching anxiety about mathematics. They found that there were no gender-related differences in mathematics teaching anxiety between pre-service male and female elementary school teachers. Levine (1996) stated that pre-service elementary school teachers usually experience anxiety for teaching mathematics and show feeling of mathematics anxiety. Furthermore, Peker (2006) found that there were several factors, such as content knowledge, attitudes towards mathematics, attitudes towards mathematics teaching and self confidence related to both mathematics anxiety and mathematics teaching anxiety.

Research indicated that abstract discussions regarding mathematical concepts increased the teaching anxiety of the pre-service elementary school teachers who had high level of anxiety for teaching mathematics, but using manipulative materials, getting familiar with developing creative teaching strategies for teaching mathematics and learning to design lesson plans in mathematical concepts reduced the teaching anxiety level of the pre-service elementary school teachers (Levine, 1996). Likewise, Sloan *et al*. (2002) reported that using both manipulative materials and hands on activities in the mathematics method courses may reduce math anxiety. According to Vinson (2001), pre-service teachers are better in understanding of mathematics concepts and procedures when they are presented in a concrete way.

The study focused on the effects of using technology on the pre-service elementary school teachers' teaching anxiety level in mathematics. In particular, the following question guided the study:

- Is there a difference, if any, with respect to mathematics teaching anxiety level between the pre-service elementary school teachers who were required to do WebQuest-based activities and their counterparts who were required to do spreadsheet activities?

MATERIALS AND METHODS

Methods of Inquiry: In the study the researchers followed the quasi-experimental statistical design procedure. With this procedure the control group was compared with the experimental group, but participants were not randomly selected and assigned to the groups (Creswell, 1994; McMillan, 2000). According to Creswell (1994), the nonequivalent (Pretest and Posttest) control group design model is a popular approach to quasi-experiments.

In this study, while the experimental group included students who were required to design their WebQuests, the control group included students who were required to do spreadsheet activities in the classroom. The experimental research method was chosen by the researchers because of the fact that it provides the best approach to investigating cause-and-effect relationships (McMillan, 2000). In the study pre-test and post-test were given to the participants before and after the instruction as an independent variable. The researchers examined the impacts of doing both spreadsheet and WebQuest activities on the pre-service elementary school teachers' teaching anxiety level in mathematics. The comparison of students' teaching anxiety levels was made in the study. Therefore, this experimental approach enabled the researchers to evaluate the effectiveness of developing both spreadsheet and WebQuest-based applications in mathematics classroom.

Participants: In this study, the researchers followed the convenience sampling procedure defined by McMillan (2000), where a group of participants is selected because

of availability. There were a total of 73 pre-service elementary school teachers, 35 in experimental group and 38 in control group, involved in this study. Twenty two of the participants in the experimental group were females and thirteen of them were males. Nineteen of the participants in the control group were females and nineteen of them were males. Participants in the study were pre-service elementary school teachers enrolled in mathematics teaching course at university located in central southwest part of Turkey.

Data instrument and scoring guide: The researchers gave the Mathematics Teaching Anxiety Scale (MATAS) to the participants in 10 min before and after the instruction. The MATAS developed by Peker (2006) is a Liker-type questionnaire including twenty three positive and negative items. The researchers made factor analysis that revealed four factors, content knowledge-10 items (factor loading ranging from 0.53 to 0.86), self-confidence-6 items (factor loading ranging from 0.57 to 0.76), attitude towards mathematics teaching-4 items (factor loading ranging from 0.61 to 0.70) and Teaching knowledge-3 items (factor loading ranging from 0.68 to 0.78). Reliability estimates of the MATAS obtained by using Cronbach's alpha measure for the total scale was 0.91 and for the each subscales were; 0.90 (content knowledge), 0.83 (self-confidence), 0.71 (attitude towards mathematics teaching) and 0.61 (teaching knowledge), respectively.

The objective of using this scale was to find out the mathematics teaching anxiety levels of the pre-service elementary school teachers. The followings are several statements from the MATAS so as to give some information about it; "I got anxious when it comes to the point of teaching some mathematical topics", "It is very easy for me to teach mathematics", "I like answering questions about the topic I am teaching", "Throughout my career as a teacher, i think i can make use of the different views and theories about teaching mathematics".

The highest point a person can make on the MATAS is 115 (23×5) and the lowest point is 23 (23×1). While calculating scores of the pre-service teachers' teaching anxiety in mathematics, the total points based on the criteria determined above at the 23-item scales are considered.

Procedure: The researchers conducted this study in a mathematics teaching course requiring; problem solving and writing based on major mathematical concepts at their levels, such as operations, fractions, numbers, measurements and so on, developing teaching methods and materials that are appropriate to elementary school students from 1st grade to 5th grade and learning how to teach certain topics in mathematics. These were the main tenets of the course offered to the students at Elementary School Teacher Education Program. In addition to these requirements, whereas the participants who were in the experimental group were required to design WebQuest-based applications as an individual project, the others who were in control group were required to develop spreadsheets activities. The study was conducted during the spring semester of 2008 and it took place seven weeks. Each group had 4 h of instruction in a week.

Analysis of the data: In the analysis of the data, first the researchers conducted the independent-samples t-test statistical procedure with $\alpha = 0.05$ on the pre-service elementary school teachers' pretest scores from the MATAS to determine any differences in regard to the teaching anxiety level between the experimental and control groups. This t-test procedure showed means score differences in terms of levels between the two groups. The lower teaching anxiety level was in favor of the experimental group. Then, scores from the MATAS were compared using one-way analysis of covariance (ANCOVA) with $\alpha = 0.05$, which is a variation of ANOVA, to adjust for pretest differences that existed between control and experimental groups. For instance, suppose in an experiment that one group has a mean value on the pretest of 15 and the other group has a pretest mean of 18. ANCOVA is used to adjust the posttest scores statistically to compensate for the 3-point difference between the two groups. This adjustment results in more accurate posttest comparisons. The pretest used for the adjustment is called the covariate (McMillan, 2000). In other words, because of the initial differences with reference to the participants' mathematical teaching anxiety levels between the groups, ANCOVA was used to analyze the quantitative data in the study. The pretest scores from the Mathematics Teaching Anxiety Scale served as the covariates in the analysis of participants' teaching anxiety level by WebQuests and spreadsheet activities. ANCOVA enabled the researchers to compare the teaching anxiety level of each group.

RESULTS

Table 1 shows the descriptive statistics for the pre-service elementary school teachers' mathematics teaching anxiety level based on the MATAS scores and indicates that there is a change in the participants' teaching anxiety levels between pre- and post-test scores for both groups. There was a decrease between the pre- and post-test scores in the teaching anxiety level of the participants in the experimental and control groups. The mean score of

Table 1: Descriptive statistics for the pre-service elementary school teachers' mathematics teaching anxiety

		Pre-test		Post-test		Post-test*	
Groups	N	M	SD	M	SD	M	SE
Experimental group	35	45.914	9.581	42.257	9.211	42.615[a]	1.085
Control group	38	46.947	8.427	46.737	8.284	46.407[a]	1.041
Total	73						

a: Covariates appearing in the model are evaluated at the following values: Pre-test = 46.452. *Estimated marginal means

Table 2: Summary of ANCOVA for pre-service elementary school teachers' mathematics teaching anxiety

Sources	Sum of squares	df	Mean square	F-statistic	p-value
Pre-test	2545.386	1	2545.386	61.896	0.000
Group	261.132	1	261.132	6.350	0.014*
Error	2878.668	70	41.124		
Total	150927.000	73			

$\alpha = 0.05$, *p = 0.014, *p<0.05

the experimental group on the pre-test (M = 45.914) was numerically lower than that of control group (M = 46.947). Likewise, the mean score of the participants in the experimental group on the post-test* (M = 42.615[a]) was numerically lower than that of control group (M = 46.407[a]) (Table 1).

Table 2, however, presents the analysis of covariance (ANCOVA) for both groups to the participants' teaching anxiety level and is based on the Mathematics Teaching Anxiety Scale. It demonstrates a significant main impact for the pre-service elementary school teachers who were required to design WebQuest-based applications, [$F(1, 73) = 6.35$; $p = 0.014 < \alpha = 0.05$]. In other words, the participants in the experimental group developed WebQuest-based applications had lower teaching anxiety level in mathematics than the ones who did spreadsheet activities in mathematics teaching course.

DISCUSSION

This study revealed that both developing WebQuest-based applications and doing spreadsheet activities reduced the teaching anxiety level of the pre-service elementary school teachers in mathematics. Schofield (1995) stated that using technology in teaching and learning has great effects on students' motivation, attitudes and achievements. This finding of the study supports the argument of Schofield (1995) because of the fact that the participants in the experimental group involved in this study used computer and several software programs and designed WebQuests that caused a significant decline in the pre-service teachers' teaching anxiety level in mathematics. However, on the other hand, the result of this study is not consistent with claim of Schofield (1995) because the pre-service elementary school teachers in the control group also used computer and did spreadsheet activities that had not a considerable effect on the teaching anxiety level of the pre-service teachers in mathematics.

According to the result of this study, although the participants in both groups had low level of teaching anxiety in mathematics, the mean score level of the experimental group was lower than that of control group. In other words, the pre-service elementary school teachers who were required to develop WebQuest-based activities indicated lower teaching anxiety level in mathematics than the ones who were required to do spreadsheet activities. This result is lined up with the several research findings by Halat (2007) and Halat and Jakubowski (2001). For example, Halat and Jakubowski (2001) stated that designing a WebQuest gave the pre-service middle and secondary mathematics teachers an opportunity to practice their mathematics knowledge in a different way, showed them how to adapt technology in their teaching and taught them how effectively the Internet and other programs could be used in the classrooms. They added, all groups provided positive responses to wanting to use WebQuests as a break from textbook and traditional ways of teaching. Moreover, Halat (2008a) found that the service teachers who developed WebQuests showed stronger motivational performance towards mathematics than the others who did not.

What would be the reasons behind the great impacts of designing WebQuests on the teaching anxiety level of the pre-service teachers in mathematics? Research has documented that the pre-service teachers demonstrated positive attitudes toward the use of computers, the interactive multimedia and web based resources in teaching mathematics (Taylor and Galligan, 2006; Yao Lin, 2008; Halat, 2008b). For instance, Yao Lin (2008) claimed that the interactive web sites could provide a rich environment for student learning activities. Using interactive web sites could be helpful for the students in the organization and representation of their data. Furthermore, Taylor and Galligan (2006) reported that using the interactive multimedia regarding mathematics with examples through animations and videos reduced the students' mathematics anxiety. Likewise, Rochowicz (1996) and Acelajado (2004) found that the use of technology in mathematics teaching and learning environment reduced students' mathematics anxiety. Therefore, WebQuests defined as an alternative teaching and learning technique in which students are actively involved in an activity or situations and use the internet as a resource. As stated earlier, it gives the pre-service teachers an opportunity to practice mathematics in a visual environment that might enhance students'

motivation towards mathematics and self-confidence in mathematics. In the current study, this may have caused the pre-service teachers to have a low teaching anxiety level in mathematics.

On the other hand, doing spreadsheet activities is more about learning and practicing mathematical topics or rules in comparison to designing WebQuests. Therefore, this might have contributed to the pre-service teachers' mathematics content and pedagogical content knowledge. But, if it was, then it could have caused a considerable decline in the teaching anxiety of the pre-service teachers in the control group.

According to Zakaria and Nordin (2008), when students' mathematics anxiety scores increase, their achievements scores decrease. Similarly, they reported that if students' mathematics anxiety scores increase, their motivation scores decrease. Indeed, Ryan and Pintrich (1997) and Dev (1998) claimed that there is a positive correlation between student achievement and motivation in mathematics. In this study, doing WebQuest-based activities in mathematics reduced the teaching anxiety level of the pre-service teachers more than that of others who did spreadsheet activities. Therefore, this implies that doing WebQuest-based activities may positively affect the students' motivation towards mathematics. However, this is not consistent with the reports of research Gottfried *et al*. (2001) claiming that there is a decline in students' motivation towards mathematics courses. Therefore, WebQuest-based activities either as a group project or a new instructional approach can be used in teaching and learning at college level (Halat, 2007). This supports the claims of Stipek (1998) and Middleton and Spanias (1999) stated that carefully structured instructional design including clear and meaningful task activities and level of difficulty had a great impact on students' achievement and motivation in mathematics because WebQuests includes well-designed and meaningful task activities in its structure.

In short, this study concluded that there was statistically significant difference found in regard to the teaching anxiety level in mathematics between the pre-service elementary school teachers who were required to design WebQuest-based activities and their counterparts who were required to do spreadsheet activities. This was in favor of the ones who did WebQuest-based activities in mathematics. In other words, doing WebQuest-based activities in mathematics teaching and learning can cause a decline in pre-service teachers teaching anxiety.

Implications and recommendations: The finding of this current study implies that doing WebQuest-based activities in a college level mathematics course may strongly cause a decline in the teaching anxiety levels of pre-service elementary school teachers in mathematics. This study also underlined the importance of use of technology in mathematics teaching and learning, which enhances student motivation and achievement in mathematics (Schofield, 1995; Yao Lin, 2008; Halat, 2008a). Furthermore, this supports the recommendation of NCTM (2000) stating that new educational theories and strategies be implemented in mathematics classrooms. According to Hardy (1998), successful technology adaptation requires careful planning and plenty of time. If the ones find time and carefully plan to work on this technique, they might successfully practice WebQuest in their teaching.

Limitations and future research: There is enough support to encourage the further study of doing WebQuest-based activities in teacher preparation programs. WebQuests, when done successfully, can be meaningful teaching strategies that utilize student use of technology in the classroom and can be a great factor that enhances students' attitudes towards mathematics and success in mathematics teaching and learning. This supports the claim of Freitas and Jameson (2006) stated that the ways in which technological developments can and do contribute to increased successful learning outcomes. Limitations in using WebQuests include the possibility of lack of access to the Internet, the time spent by the teacher to develop a WebQuest, finding reliable links for resources for the WebQuest and adapting scenario or story to the math topic.

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