INVESTIGATING TEACHERS' TRIGONOMETRY TEACHING EFFICACY

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The purpose of this paper is to share the process of investigating teachers' trigonometry teaching efficacy and categorizing them in terms of their efficacy levels. Firstly, Teacher Trigonometry Teaching Efficacy Scale (TTTES) was applied to sixteen teachers. Teachers generally scored the highest rank for their efficacy in the scale so researchers could not differentiate teachers. For further investigation, an interview was designed about their efficacy in which teachers talked about their experiences. Answers were studied using three indicators of self-efficacy - choices, effort, and thought patterns and emotions. Then teachers were categorized as having high and low trigonometry teaching efficacy. The categorization is used later for a larger study.

Keywords: Teacher efficacy, trigonometry teaching efficacy.

INTRODUCTION

Teachers' confidence level of their ability to teach-teacher efficacy has an important role in their teaching practises. Teachers with high teaching efficacy put more effort in teaching and use more diverse teaching strategies in class (Ghaith &Yaghi, 1997). The effective teaching methods may have positive effect on the learning of their students as well as students' desire to work on the subjects (Ashton, Webb, & Doda, 1983). So it is important to study teacher efficacy and its relation with other variables.

Bandura (1982) suggested social cognitive theory and the concept of self-efficacy. According to this theory teacher efficacy is defined as the level of belief a teacher has in his or her ability to affect student achievement. Tschannen-Moran, Woolfolk-Hoy and Hoy (1998) developed a model using Bandura's theory. This model emphasized the relationship between teacher efficacy and teaching experiences and it was widely used in literature.

The previous studies mainly investigated general teaching efficacy. However, the studies that investigate teaching efficacy for a specific topic such as trigonometry are rare in literature. In our study, we aimed to focus on trigonometry since it is one of the fundamental topics in high school curriculum with its relation to other topics such as complex numbers, derivatives etc. as well as its nature of including both algebra and geometry. However, it is found that students had difficulty in understanding some basic concepts of it and they had disinterest for the topic (Akkoc,2008; Durmus,2004). As teaching efficacy is related with teaching processes, students' learning and interest, it should be enlightening to study teachers' trigonometry

teaching efficacy to understand its relation with students' achievement and motivation which was the purpose of the larger study. In this paper, we will focus the discussion on the teacher efficacy with the purpose of sharing the process of categorizing teachers according to their trigonometry teaching efficacy.

TEACHER EFFICACY

Teacher efficacy has been defined as how competent a teacher feels in his or her ability to affect the performance of all students, no matter how unmotivated the students are or how difficult the teaching topic is (Tschannen-Moran et. al., 1998). In fact, a number of studies have concluded that teachers with high levels of efficacy differ significantly from teachers with low levels of efficacy. Teachers with high efficacy tend to have greater levels of planning and organization as well as being more enthusiastic to teach (Allinder, 1994). Teachers spend more time teaching in subject areas where their sense of efficacy is higher (Riggs & Enochs, 1990); whereas teachers tend to avoid subjects when efficacy is lower (Riggs, 1995). Specifically, high efficacy teachers demonstrate more effective teacher behaviors that lead to higher student achievement (Ashton et. al., 1983). So the concept is related with several variables and it is necessary to understand the construct and measure it effectively.

Many teacher efficacy instruments have been made in the last three decades to assist the research about teacher self-efficacy. In 1984, Gibson and Dembo created the Teacher Efficacy Scale (TES), and the scale includes items such as "when a student gets a better grade than he usually gets, it is usually because I found better ways of teaching" and "even a teacher with good teaching abilities may not reach many students." The measure uses a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). With the recognition that efficacy belief is context specific, researchers began developing scales that focused on specific content areas, such as Riggs and Enoch's (1990) Science Teaching Efficacy Belief Instrument (STEBI). The instrument changed the statements on the TES from a more general teaching focus to a specific science focus. For example, "I understand science concepts well enough to be effective in teaching elementary science."

These attempts to measure teacher efficacy were related with teaching in general areas such as science, personal teaching and classroom management. However, our aim was to investigate trigonometry teaching efficacy which is specific to a topic. In this case self-efficacy theory requires the type of assessment that is specified by a task to enhance the correspondence between self-efficacy and intended topic. So we adapted the Betz and Hackett's (1981) Mathematics Self-Efficacy Scale (MSES) to trigonometry, which is discussed in the method section.

We aimed to study trigonometry as it is one of the important topics in high school curriculum. It is a product of algebraic techniques, geometrical realities and trigonometric relationships. For most of the students in higher education, it is necessary to study trigonometry with its relation to other topics such as integral,

derivative. Understanding of its basic concepts and application to the geometry and algebra is important for students to learn other mathematics topic effectively.

However, studies have indicated that students have difficulty in understanding trigonometry (Akkoc, 2008) and they are not motivated to do it (Durmus, 2004). As teacher efficacy is one element that is related with student achievement and motivation, it should also be studied for such an important topic-trigonometry. However, there is limited research related with teachers' trigonometry teaching efficacy.

METHOD

As a part of a larger study we aimed to categorize 16 teachers according to their trigonometry teaching efficacy. For this purpose, Teacher Trigonometry Teaching Efficacy Scale (TTTES) was used but the results show that all 16 participants have high efficacy. For additional information on these teachers; we aim to improve method of studying teacher efficacy level with individual interviews. Among sixteen teachers, 13 of them voluntarily agreed to participate in individual interviews.

Sample

The sample of the larger study consisted of sixteen mathematics teachers (n=16) from various high schools in Istanbul. In our education system, the four-year secondary education is provided in two different types of schools, non-vocational and vocational. Non-vocational secondary education institutions comprise two types: General High School and Anatolian High School. Anatolian High Schools admit students with examination whereas General High Schools admit without examination. These institutions demonstrate some differences with respect to the number of students in classrooms, selection of teachers, conditions for admission, predominance of foreign language etc. All schools are required to apply the curriculum which is determined by the Turkish Ministry of Education (MEB).Teachers are obliged to prepare their lesson plans according to the objectives determined by MEB.

In our study, the schools were chosen from similar and close districts of Istanbul so that they would be similar in terms of type (general high school) and student profile (social economic status is not high) in order to control the effect of school variable which may be related with teacher efficacy (Moore & Esselman, 1992).

Among the teachers, four of them were male and 12 of them were female. Ten of them graduated from mathematics department, three of them graduated from mathematics education, 2 graduated from physics and 1 from chemistry department. Teachers with non-educational degrees were certified to teach after a short period of education. Teachers' years of experiences in teaching mathematics was high as majority of them have been teaching more than ten years. Four of them had more than 15 years, three of them had 10-15 years, six of them had 5-10 years and three of them had less than 3 years of experience.

Teachers Trigonometry Teaching Efficacy Scale (TTTES)

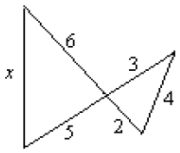
This scale was adapted by the researchers in order to measure the efficacy level of teachers in teaching trigonometry. Mathematics Self-Efficacy Scale (MSES) which was developed by Betz and Hackett (1981) was used as the primary model. Betz and Hackett (1981) developed the MSES to assess college students' mathematics self-efficacy with greater specificity than previous instruments. This instrument has been used widely in research (Zimmerman, 2000). The MSES has 52 items. Some college mathematics topics which were addressed in this instrument are such as algebra, calculus, economics, and statistics. Each item has a rating scale with 5 levels to show the confidence level of subjects to solve the problems. Subjects chose appropriate number which shows their confidence level to solve these problems, rather than finding the answer.

Since purpose of the present study was to measure self-efficacy on trigonometry teaching, the format of the scale was kept to be parallel with the MSES but the mathematics problems for the items were for trigonometry. This adaptation of the items was supported by the suggestions of Bandura (1997) to assess self-efficacy. According to Bandura, the items should be aligned with the task being assessed and the domain which is analyzed.

For the adaptation, we needed to consider the Turkish curriculum for trigonometry. In order to determine the questions of the test, the objectives determined by Ministry of Education (MEB) were used as guidelines. In the curriculum the trigonometry unit consists of six main sub topics which are

- Trigonometric Functions
- Graphs of Trigonometric Functions
- Inverse Trigonometric Functions
- Trigonometric Relations in a Triangle
- Addition Formulas
- Trigonometric Equations

So, the questions were developed according to cover all the sub-topics. There were 18 items in the test. There was at least one question related to each sub-topic. The items were adopted from problems in several textbooks (MEB, 2005; Altuntas, 2007). Some examples from the TTTES are presented in Figure1.

- Graph the function $f(x) = 3 \sin(2x)$.
- 

Find the x value in the above figure.
- $\tan\left(\arctan \frac{1}{2} + \operatorname{arccot} \frac{2}{3}\right) = ?$

Figure 1. Items from TTTES

Teachers did not solve the problems but they only rated their perception of confidence level to teach those problems. Each item has a rating scale with 5 levels ranging from 1 (I am not at all confident) to 5 (I am totally confident). For example, if they are totally confident to teach a problem they rated 5 but they rated 1 if they are not confident at all. The reader may see the whole test in Sarac (2012).

For this instrument, teachers generally marked the highest rank as their self-efficacy. There were 16 participants and 12 of them got 90 and the remaining four got more than 80 out of 90. While applying the instrument, teachers expressed that they felt to be tested about their qualities. Hence, it was possible that they may not reflect their actual confidence levels. In the previous study (Betz & Hackett, 1981) the similar measurement was done with college students and any problem weren't reported. However, in our study we could not categorize teachers according to their efficacy using TTTES.

Individual Interviews

When we did not reach our purpose with TTTES, we searched for another way to get detailed information about teacher efficacy and we decided to do individual interviews. Among the sixteen teachers, thirteen of them accepted to participate in an interview. Since teachers would not be comfortable talking about their efficacy of trigonometry teaching, in the interview this issue was studied through teachers responses for their experiences. The interview was semi-structured. There were leading questions:

1) Can you talk about your teaching methods for trigonometry?
2) Can you talk about your experiences related with teaching trigonometry in this year? Positive/Negative
3) Can you talk about your experiences related with teaching trigonometry in previous years? Positive/ Negative

During the interview, teachers talked about their teaching trigonometry experiences and their teaching methods. They also shared the problems they encountered and the

way they tried to solve those problems. In order to study their efficacy, we asked them about their teaching experiences since ones' experience related to a task is one of the major sources and the outcome of the self-efficacy (Bandura, 1997). Also, the outcome gives clues of one's self-efficacy. Furthermore, as Philippou and Christou (1998) point out, "teachers' formative experiences in mathematics emerge as key players in the process of teaching since what they do in the classroom reflects their own thoughts and beliefs" (p. 191).

Interviews lasted 40- 45 minutes. They were conducted and analyzed in Turkish but for the writing purposes, the researchers translated them into English in this article. The interviews were audio-taped and transcribed. To be able to categorize teachers as low and high efficacy in teaching trigonometry, three indicators were utilized. These indicators were based on Bandura's self-efficacy theory and previous studies related with the features of high and low self-efficacy people (Pajares, 1996). The indicators and their use for categorization are explained in detail as follows:

Choices: People who have high self-efficacy engage in the activities more willingly and they tend to set higher goals to achieve. On the other hand, people with low self-efficacy tend to set incomplete goals and they feel incompetent (Bandura, 1997). Some teachers reported that they really liked teaching trigonometry and want to teach trigonometry (they were coded as 1 for this indicator as willingly engage in the activity) while some stated teaching trigonometry to students is more difficult than other subject (they were coded as 0 for this indicator as they were not willingly engage in the activity).

> Teacher A: I really like to teach trigonometry. It is a wonderful subject, since I teach it by forming connections with analytic geometry. I teach it by helping students to connect it to the triangles and unit circle. (Engage willingly and set high goals. Choices indicator is present)
>
> Teacher B: It is difficult to teach trigonometry because students do not have the necessary pre knowledge. It is so long that students get easily bored and once they get lost, they cannot continue. I am not able to help all of them. (Do not set high goals and do not wish to involve in teaching trigonometry. Choices indicator is not present.)

Effort: People with high self-efficacy put more effort on the job, they work harder. They show more self-regulated behaviour and use more effective strategies (Bong, 1997). They believe in themselves whatever the situation is. They attribute the success or failure to themselves while low self-efficacy people blame other factors such as crowded classrooms, intense curriculum (Rotter, 1966). Some teachers in the interview stated that they try hard to teach trigonometry and to overcome the difficulty of lack of previous knowledge (they were coded as 1 for this indicator as they put more effort) while some stating that they cannot do something to teach the ones who are not good at mathematics and unmotivated to learn (they were coded as 0 for this indicator as they were not try to get over difficulties).

Teacher C: We strived hard to teach trigonometry since it is a very important subject. We tried to teach firstly the necessary pre knowledge. Also, I gave homework to students to not let them get away from the topic and help them learn all the parts of it well. I talked individually with the students who are not so good at the subject and recommended them some extra works to close the gap. (Put more effort and strive hard to teach. Effort indicator is present.)

Teacher D: It is a difficult subject. Students' levels are low. It is necessary to complete their missing previous knowledge and to teach it at low level. However, it was not possible to give all the previous knowledge because when I go back, the subject is messed up and I cannot build it up. (Do not strive hard for the students who do not have the previous knowledge. Effort indicator is not present.)

Thought Patterns and Emotions: People with high self-efficacy are more comfortable and they are less anxious (Pintrich&De Groot,1990). While talking about their experiences they use less negative words (Bandura,1997) while low self-efficacy people concentrate on difficulties and use more negative words about their experiences. In this study, some teachers talked more on difficulties and blame students (they were coded as 0 for this indicator) while some concentrated on their efforts and joy in teaching trigonometry (they were coded as 1 for this indicator).

Teacher E: This year it was good for me to observe that I can teach students some necessary knowledge in trigonometry. Also, I feel successful in that I can help them to study in 80 per cent. If I can help them to change their negative emotions about trigonometry, the remaining part becomes nice to teach. (Do not concentrate on difficulties and do not use negative words. She says that it is good to observe students learn. Thought Patterns and Emotions indicator is present.)

Teacher F: Teaching those [low achieving] students was very frustrated for me since I could not get any sign of learning from them. (Concentrate on difficulties, use negative words. Thought Patterns and Emotions indicator is not present.)

Teachers' answers to interview questions were evaluated by giving code for each indicator (0 or 1). The teachers who showed the features of the indicator were coded as 1 and the ones who did not show the features were coded as 0. With the addition of the points for three indicators, the final score for each teacher were calculated. The ones with 2 or 3 were categorized as having high trigonometry teaching efficacy and the ones with 0 or 1 were categorized as having low trigonometry teaching efficacy. These coding and categorization of the teachers according to their interviews was checked by a mathematics education expert.

Among the 13 teachers, six teachers got 0 or 1 and were categorized as having low trigonometry teaching efficacy whereas 7 teachers get 2 or 3 and they were

categorized as having high trigonometry teaching efficacy. Table 1 presents the scores according to teachers. Pseudonyms were used for each teacher.

Teacher	Choices	Effort	Thought Patterns and Emotions	Total
Oyku	1	1	1	3
Dilan	1	1	1	3
Cigdem	1	1	0	2
Hulya	0	1	1	2
Fahri	1	1	0	2
Kerem	1	0	1	2
Ozge	0	1	1	2
Hasan	1	0	0	1
Gaye	0	1	0	1
Ayca	0	0	0	0
Nermin	0	0	0	0
Hale	0	0	0	0
Melisa	0	0	0	0

Table1. Trigonometry Teaching Scores for the Indicators

The categorization of teachers was used in the larger study (Sarac, 2012). In that study, we investigated the trigonometry self-efficacy of the teachers' students. The students were grouped according to their teachers' efficacy level and the groups' self-efficacy was compared. Significant difference was found between two groups of students in terms of their trigonometry self-efficacy.

DISCUSSION

In this article we aimed to share the process of categorizing teachers according to their trigonometry teaching efficacy. Firstly, trigonometry teaching efficacy was attempted to be studied using TTTES in which teachers were asked about their confidence level to teach trigonometry for a given problem. However, we could not differentiate the teachers since teachers ranked the highest score for their trigonometry teaching efficacy for almost all questions. So we decided to get further information to study teachers' efficacy by analyzing interview data of teachers.

In these interviews they were not asked directly about their confidence level to teach trigonometry. Instead they were asked to share their teaching methods and teaching process, assuming that teaching experiences were the major indicators for one's teaching efficacy. From their expressions, we got clues about their interest in teaching trigonometry as well as their feelings related with the teaching process. For instance, some teachers concentrated on the difficulties expressing negative feelings such as frustration of not being able to teach all students while some were on the more positive side expressing the enjoyment to teach all students. Also, teachers mentioned about their efforts to make students learn better while they were talking about their teaching methods. Some teachers said they strived hard to teach all students and made additional studies with the students who did not learn well. On the other hand, some of them blamed the school conditions and the level of students, stating they could not teach all students.

Teacher efficacy can be studied using the mentioned indicators- choices, effort, and thought patterns and emotions. This paper proposes a method for studying teacher efficacy which can be applied for other specific topics. Using the findings of these interviews, TTTES can be improved with addition of items targeting the indicators. Also, some open ended questions might be included to get detailed information related with teaching processes. Furthermore, in this study we used binary scale for the indicators since our purpose was categorizing teachers in two groups. However, differentiated scales can be used for the efficacy levels for other studies.

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