Effect of Self-Evaluation on Pre-service Mathematics Teachers' Self-Efficacy in Language of Mathematics[1][2]

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Mathematics is a universal language and mathematics teachers are responsible for teaching this language. However, teachers generally ignore knowledge and skills of mathematical language and this may be explained by Bandura's (1997) self-efficacy theory (Gray, 2004). The aim of this study was to investigate the effect of self-evaluation of pre-service elementary mathematics teachers on their self-efficacies with regard to language of mathematics by using the mixed method sequential explanatory design. The data was obtained with the developed instrument quantitatively in the first phase and qualitatively in the second phase. The results of the first phase indicated that there was no significant difference between pretest and posttest self-efficacy scores. On the other hand, the results of the second phase indicated that participants perceived the language of mathematics as using native language or using pedagogical approaches and they weren't aware of the responsibility of teaching the language of mathematics besides mathematical concepts.

Keywords: Pre-service mathematics teachers, Teachers' self-efficacy, Language of mathematics, Self-evaluation, Teaching the language of mathematics

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Introduction

Mathematics can be defined as a universal language. Many countries have started to emphasize teaching the language of mathematics in their teaching programs and standards. In this regard, National Council of Teachers of Mathematics (NCTM) emphasizes participants' communication in mathematical language beginning from the early ages (NCTM, 2000). Although mathematics teachers' responsibilities for developing mathematics language competencies are frequently emphasized (e.g. Owens, 2006; Schleppegrell, 2007, Zazkis, 2000), it is claimed that teachers generally focus only on mathematical concepts while they ignore mathematical language knowledge and skills in the classroom (Gray, 2004). According to Gray (2004), Bandura's self-efficacy theory is a possible explanation for such neglect of mathematical language. On the other hand, previous performance was specified as one of the most influential sources of efficacy (Bandura, 1997) and self-evaluation was labeled as an important tool for self-improvement of the teachers (Airasian & Gullickson, 1997; Ross & Bruce, 2007). In the light of this rundown, the aim of the current study was to investigate the effect of self-evaluation of pre-service elementary mathematics teachers on their self-efficacies with regard to language of mathematics.

Background Research

Mathematics can be defined as a universal language with its own language system containing special vocabulary, syntactical and rhetorical structure. It is widely agreed that students should gain the language of mathematics skills as well as mathematical concepts in order to have competency and success in mathematics (Pimm, 1987; Schleppegrell, 2007, Zazkis, 2000). In this context, Jamison (2000) concluded that as a result of explicit explanation about the syntactical and rhetorical structure of language of mathematics, participants could learn

the rules of language of mathematics and use them as tools to understand abstract mathematical concepts.

In literature, mathematics teachers' responsibilities about developing mathematics language competencies are emphasized (e.g. Owens, 2006; Schleppegrell, 2007, Zazkis, 2000). Beside the importance of teaching the language of mathematics, Gray (2004) claim that teachers generally focus on only mathematical concepts while they ignore mathematical language knowledge and skills in the classroom since they expect participants to learn language of mathematics skills through exposure. Gray (2004) obtained that teachers are either unaware of how to teach the language of mathematics or they may not believe that they can implement such language training in their mathematics classrooms. According to Gray (2004), Bandura's self-efficacy theory is a possible explanation for such neglect of mathematical language. In detail, Gray (2004) explained that if a teacher does not believe that she can teach a mathematics topic successfully, she will not choose this topic to teach and probably she will not be able to. In this context, Gray (2004) designed Language of Mathematics Teacher Efficacy Scale (LoMTES), to measure teacher' self-efficacy about teaching language of mathematics.

Bandura defined self-efficacy as the "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 3). As Bandura noted that self-efficacy relates to one's belief in one's capability to perform a task, it is important to point out that self-efficacy is concerned with judgments of personal capabilities. The skills that one have do not matter. What matters is what people think they can do with the skills they have in different circumstances. Bandura emphasized that previous performance was one of the most influential source of efficacy (Bandura, 1997). Consistent with this idea, Hall and Ponton (2005) noted that experiences producing positive outcomes in mathematics increased math self-efficacy and experiences producing negative outcomes decreased it.

Similarly, it is reported that when students perform tasks successfully and come closer to obtaining a goal, their self-efficacy is enhanced (Schunk, Pintrich, & Meece, 2008) and successful learning experiences contribute to greater self-efficacy (Gist & Mitchell, 1992). As Torkzadeh and Dyke (2001) indicated that self-efficacy is a dynamic construct that changes over time as new information and experiences are acquired.

With regard to the development of teachers' beliefs about ability to teach, the results of the research studies verified that the reflection had a positive effect on teachers (e.g. Bohen, 2000). Ross and McDougall (2003) concluded that teacher self-evaluation contributes to the development of beliefs about their ability to do the job. Self-evaluation that is questioning, reflecting on, and interpreting of teachers' own practices is a powerful tool for self-improvement (Airasian & Gullickson, 1997; Ross & Bruce, 2007). Eckart and Gibson (1993) indicated that when teachers are allowed to be their own critics, they seek strategies for continued development and set achievable objectives for improving their teaching skills. Researches have displayed that self-evaluation and reflection promote teacher learning and improve professional development (Bohen, 2000; Finn, 2002; Frederiksen, Sipusic, Sherin, & Wolfe, 1998; Roth & Chen, 2007; Sherin & van Es, 2005). Based on the positive effects of self-evaluation on teacher professional development, many researchers have suggested increasing the amount of self-evaluation of teachers. The reason for this suggestion is not only cognitive but also motivational. Motivation theorists suggest that self-evaluation contributes to feelings of control over one's own learning, of choice and of agency, and of self-worth (Covington, 1992).

The literature review revealing the impact of language of mathematics in understanding the mathematical concepts, the ignorance of mathematics teachers in teaching this language and their tendency to teach skills related to language of mathematics through exposure provides support for the significance of language of mathematics from the view of mathematics

teachers education programs. It is quite apparent that training mathematics pre-service teachers with regard to teaching language of mathematics and raising their awareness on the importance of language of mathematics is considerably important. With this regard, one of the researchers has given an elective course of language of mathematics for the middle school pre-service mathematics teachers at a faculty of education. In this sense, the aim of this course is to raise pre-service mathematics teachers' awareness on the importance of language of mathematics and on the way of teaching the language of mathematics. In literature, the importance and the necessity of such courses on language of mathematics have been approved and emphasized. For instance, Esty (2004) has developed a language of mathematics course for the first grade of colleges and published a textbook for this course.

In this study, it is aimed to investigate the effect of self-evaluation of middle school pre-service mathematics teachers on their perceived self-efficacies with regard to using and teaching language of mathematics. The research was carried out in the context of the language of mathematics course that was given by one of the researchers. Although some research studies were conducted related to students' and mathematics teachers' use of language of mathematics, this study was the first study handling the issue of language of mathematics from the views of pre-service mathematics teachers' self-efficacies and self-evaluation process. It is strongly believed that this study would add an important contribution to the area of mathematics teacher education.

Methodology

The mixed method that provides more comprehensive evidence than either quantitative or qualitative research alone (Creswell & Plano Clark, 2011) was used in this study. Qualitative research makes up weaknesses of quantitative research, which is weak in understanding the context or setting of people talks (Creswell & Plano Clark, 2011). On the other hand, research

design of this study is sequential explanatory design (Creswell & Plano Clark, 2011). There are two distinct phases in the mixed methods sequential explanatory design (Creswell, Plano Clark, Gutman, & Hanson, 2003). In the first phase quantitative data are collected and analyzed, and in the second phase qualitative data are collected and analyzed to help explain, or elaborate the quantitative results obtained in the first phase. Analysis of the qualitative data refines and explains results of quantitative data by exploring participants' views in more depth (Creswell, 2003; Rossman & Wilson, 1985; Tashakkori & Teddlie, 1998). Moreover, this design can also be used to form groups based on quantitative results and to guide purposeful sampling for a qualitative phase (Creswell, et al., 2003; Tashakkori & Teddlie, 1998). In the first phase of the sequential explanatory design study, the effect of self-evaluation of middle school pre-service mathematics teachers on their perceived self-efficacies with regard to using and teaching language of mathematics was investigated by using one-group pre-test – post-test design (Fraenkel & Wallen, 1996). The data of the first phase were collected quantitatively by using Teacher Self-Efficacy Scale in Language of Mathematics (TSESLoM). The researchers prior to the main study developed this instrument. In the second phase of the study, the data was obtained from participants' reports and clinical interviews qualitatively to explain and elaborate the nature of the effect of self-evaluation of middle school pre-service mathematics teachers on their perceived self-efficacies in more detail. Participants of the second phase were chosen with purposeful sampling method based on the results of the first phase. In this way, it is expected that the combination of two phases of the mixed method design may provide broad and rich information as to whether there is an effect or not, the reasons and nature for this effect, or when and under which conditions this effect is valid. Beyond these, it is also anticipated that we may obtain valuable and considerable information with regard to the participants' self-efficacies in the language of mathematics and

perceptions of language of mathematics as well. The research process is detailed in the following section.

The Language of Mathematics Course

The research was carried out in the context of the language of mathematics course that was an elective course offered by one of the researchers. As mentioned before, the aim of this course was to raise pre-service mathematics teachers' awareness on the importance of language of mathematics and on the way of teaching the language of mathematics. Additionally, it was intended that pre-service teachers should comprehend mathematics as a language and they should be aware of the importance of this language and their responsibilities in teaching this language. Throughout the course, it was stressed that there are no native speakers of the language of mathematics and it requires the support of a native language. More importantly, it was emphasized that skills of using the language of mathematics develop throughout the process of learning mathematical concepts simultaneously. In this context, the responsibilities of mathematics teachers about developing their students' mathematics language skills were discussed. They were strongly recommended to use the language of mathematics efficiently during their instruction, to ask their students to read and write the mathematical sentences, symbols, and so on by presenting various reading and writing practices. Knowledge with regard to the structure and teaching of the language of mathematics was given through the first four weeks of the course. Throughout the course, characteristics of the language of mathematics, which has its own vocabulary, grammar, syntax, conventions and sentence structure were featured with various reading and writing examples in the areas of algebra, sets, functions, and logic. Two sample practices presented during the course were as follows;

Example 1: The equation "$2x + 4 = 9$" is a mathematical sentence. How would you pronounce this sentence aloud?

Focus points related to language of mathematics:

- This sentence may be pronounced as "two x plus four is equal to nine"
- The verb of this sentence is "equals"
- The subject of this sentence is "x" that is a number.
- This sentence may also pronounced as "when we add four to two times of a number "x" we obtain 9" by giving comprehension.
- This sentence also indicates a mathematical equation. In this context, this sentence refers the operations and the order of these operations to solve the equation. This proves the richness of the language of mathematics.
- An English, a French or a Japanese comprehend the same meaning from this sentence, although they pronounce this sentence differently in their native languages.

Example 2: Can you write the following sentence in the language of mathematics?

"If you add two real numbers in either order you get the same result."

Points related to language of mathematics:

- The sentence can be rewritten in the language of mathematics as a conditional proposition either with the conjunction "if" or with the use of universal quantifier;
    - "$a, b \in \mathbb{R} \Rightarrow a$+b=b+a"
    - "For each $a, b \in \mathbb{R}$, a+b=b+a"
- The essence of this sentence is a property in mathematics that "commutative property of addition."

- Mathematical symbols are clear, precise and universal to convey the mathematical thoughts.

- The sentence in your native language includes 14 words. However, by using just a couple of mathematical symbols you can convey the same meaning.

The Research Process

At the end of the first four weeks of the course, TSESLoM was administered as a pretest and afterwards the micro teaching technique was carried out. In microteaching, pre-service teachers taught a middle school level mathematics subject they had selected. They were required to prepare their teaching presentations considering using and teaching language of mathematics. Teaching presentations of the pre-service teachers were recorded by video camera. Their own presentation records were given to them together with open-ended questions prepared to guide pre-service teachers' self-evaluation process. Pre-service teachers were asked to evaluate their teaching presentations by watching video records in the context of questions given formerly and also they were asked to report their self-evaluations (Appendix 1). After pre-service teachers evaluated themselves, TSESLoM was reapplied as a posttest. The data obtained from administration of the instrument as a pretest and a posttest were analyzed and compared by using paired samples t-tests to investigate the effect of self-evaluation on pre-service teachers' perceived self-efficacies. Finally, participants of the second phase were selected by using purposively sampling method based on the obtained results.

The second phase of the sequential explanatory design study included analyses of selected participants' self-evaluation reports and implementation of clinical interviews with them. Self-evaluation reports were analyzed by using document analysis method (Cresswell, 2003). The interviews were conducted by the second researcher who was not the instructor of the

language of mathematics course in order to prevent biased responses favoring the effect of the course. The clinical interviews were conducted by showing both pretest and posttest questionnaire sheets to the participants. The participants were reminded the responses given by themselves in pretest and posttest application for each item. In this sense, the reasons of their responses and changes in their responses if there was any change were questioned. Moreover, the effect of self-evaluation on participants' self-efficacy was requestioned in the context of the each item in the interview. In the data analyses process, both the transcribed records of the interviews and the self-evaluation reports were coded by the two researchers independently. The reliability rates were found as 92% and 90% for the interview records and self-evaluation reports, respectively (Miles & Huberman, 1994).

Development of the Instrument

A comprehensive literature review indicated that there was no instrument measuring the self-efficacy perceptions of the pre-service teachers with regard to using and teaching language of mathematics, therefore it was decided to develop an instrument named as Teacher Self-Efficacy Scale in Language of Mathematics (TSESLoM). The development process began with adaptation of Language of Mathematics Teacher Efficacy Scale (LoMTES) developed by Gray (2004). The 14 items of this scale were adapted from English into Turkish separately by the researchers who are good at the language of English. One of the researchers has been conducting the course of "Language of Mathematics" at both undergraduate and graduate level for seven years. Afterwards, to make the instrument more comprehensive and to add different perspectives to the language of mathematics seven related items were taken from self-efficacy scale developed by Özgen and Bindak (2008) to measure the self-efficacy of pre-service teachers related to mathematics literacy. Afterwards the complements considering either using or teaching language of mathematics for the possible items were written by the researchers. For instance, for the item "I am able to teach my students to read and write

mathematical symbols," a new complement item was written such as "I am able to read and write mathematical symbols". While writing out the items, the use of the language of mathematics symbolically was distinguished from the use of the language of mathematics with the support of native language. Additionally, in one of the items of the scale the definition of "informal language" was given as using native language. As a result the number of items increased to 28 at the end of this step. Two experts including two associate professors from the department of mathematics education and two doctorate students who had experience in the language of mathematics determined the content validity of the 28 items. The experts were asked to evaluate relevance, clarity, simplicity, and ambiguity of each item. The researchers considered the relevant suggestions of the experts and the doctorate students and revised the items in this respect. In the next step, the total of 28 items was pilot tested during 2011-2012 academic year of fall semester in order to identify and select the best items for the final version of the self-efficacy instrument for using and teaching language of mathematics. The 28-item self-efficacy instrument was administered to 151 middle school pre-service mathematics teachers (7.9% third semester students, 50% fifth semester students, 41.1% seventh semester students) by the researchers in the classroom environment. The results of the item response analysis and the explanatory factor analysis indicated that the final version of the self-efficacy instrument included 17 items with a three-factor structure (Appendix 2). These factors together with sample items are as follows:

1. Teaching language of mathematics (TLoM) (Appendix 2 – Item 10-17): Sample item "I am able to explain mathematical symbols in many different ways in teaching them"

2. Using specific language of mathematics (USLoM) (Appendix 2 – Item 5-9): Sample item: "I am able to read and write mathematical symbols"

3. Using general language of mathematics (UGLoM) (Appendix 2 – Item 1-4): Sample item: "I am able to use language of mathematics in expressing mathematical ideas"

The final version of TSESLoM (17-item) was administered to a new sample including 304 pre-service mathematics teachers (22% sophomores, 49% juniors, 29% seniors – 39% males, 61% females) to obtain evidence for construct validity. Construct validity was supported by confirmatory factor analysis (CFA) using LISREL 8 (Jöreskog & Sörbom, 1993). The results of the CFA indicated good fit for three-factor model with respect to the assessment criteria (χ^2 = 280.01, df = 101, χ^2/df= 2.77, RMR= 0.05, GFI= .93, AGFI= .92, RMSEA = .05 and CFI = .92) (Schreiber, Stage, King, Nora, & Barlow, 2006) (Appendix 3). The maximum likelihood estimations were found to be between .47 and .79 and all t values were significant at $p<.05$. Evidence for discriminant validity was provided by comparing the fit of three-factor model of TSESLoM against the one-factor model of TSESLoM. The reliability analysis yielded sufficient Cronbach alpha coefficients both for the total scale and the three factors of the scale. The total reliability of TSESLoM with 17 items in the pilot study was .88 as indicated by the Cronbach alpha coefficient. Moreover the Cronbach alpha coefficients for the three factors were .81, .80, and .81 for the first (TLoM), second (USLoM), and third (UGLoM) factors, respectively.

Participants

In the one-group pre-test – post-test design study, TSESLoM was administered to 23 elementary mathematics pre-service teachers (78% females, 22% males) attending the language of mathematics elective course offered in the program of elementary mathematics education at a state university in Turkey. Most of the pre-service teachers attending the course were third semester students, one of them was seventh semester student, and two of them were fifth semester students.

Second phase of the study included eight pre-service teachers who were purposively selected based on the responses of pre-service teachers to TSESLoM administered as both pretest and posttest. Based upon the changes between the two administrations similar response patterns across the factors (e.g. the score of TLoM is increasing, the scores of USLoM is decreasing, etc.) were tried to be found among the pre-service mathematics teachers. As a result, eight groups were constructed and one pre-service teacher was selected randomly from each group to represent the group properties. All selected pre-service teachers were invited for clinical interviews and the interviews were conducted on a voluntary basis. In the second phase, both the transcripts of the clinical interviews and these participants' self-evaluation reports were analyzed as qualitative data. The word of "participants" will refer to the eight pre-service mathematics teachers selected for the clinical interviews from now on throughout the paper.

Results

The results of the first phase designed as one-group pre-test – post-test design indicated that there was no significant difference between pretest and posttest self-efficacy scores of the pre-service teachers. In other words, self-evaluation of pre-service teachers had no effect on their perceived self-efficacies measured by TSESLoM. On the other hand, the results of the second phase displayed that participants' awareness with regard to importance of using and teaching of language of mathematics raised by the course and the self-evaluation activity. Moreover, one of the findings that all of the participants except one had various perceptions related to language of mathematics different than expected deserves significant attention. One of these different perceptions was *using pedagogical approaches* whereas the other one was *using native language*. The participants who possessed either of these perceptions did not reflect even a little evidence that they perceived the language of mathematics as a language having specific terminology and a well-structured syntax. While they were both evaluating themselves and responding the questions related to language of mathematics, they neither talk

nor exemplify about the processes or the activities pointing to the nature or structure of the language of mathematics such as expressing mathematical ideas, writing mathematical symbols and words, reading and writing mathematical symbols, expressions, representations, writing mathematical definitions, drawing graphs, explaining mathematical symbols, transforming informal language to formal and so on. Some of the participants answered the questions related to language of mathematics considering mathematics teaching activities and practices in general, such as posing questions to students, telling the subject, using the board orderly, assessing students' learning, making eye contact with the students, exemplifying or setting the place to stand in the classroom. For this reason, such participants were identified as having the perception of *using pedagogical approaches* implying that they perceived using or teaching the language of mathematics as using general teaching practices to teach mathematics. On the other hand, other participants focused dominantly on using not the language of mathematics but written and oral native language such as expressing what is thought, writing and speaking comprehensibly, speaking pausingly, or forgetting the words and so on while they were evaluating themselves or responding the questions related to language of mathematics. In consequence, these participants were identified as having the perception of *using native language* implying that they perceived using or teaching the language of mathematics as using written and oral native language in their teaching practices. Two other findings of the second phase were participants' different perceptions related to their status in responding TSESLoM items; as either a teacher or an undergraduate student and there was an effect of self-evaluation on their self-efficacies. However this effect could not be reflected by the scale. When the results of both phases were combined, the results of the second phase shed light on the statistically non-significant effect of pre-service teachers' self-evaluation on their perceived self-efficacies. These results acting individually or together

may be the reason/ reasons of unobservable effect. The detailed explanations of the results were presented under following sections.

Results of the First Phase

The differences between the pre-test and post-test scores were analyzed by using paired t-test in terms of overall scores and scores of three factors evaluate whether pre-service mathematics teachers' self-efficacy scores changed with respect to self-evaluation. The results of the paired samples t-test indicated that there were no statistically mean differences between pre and post administrations on TSESLoM ($t = -.36$, $p > .001$), TLoM ($t=.00$, $p > .001$), USLoM ($t = .23$, $p > .001$), and UGLoM ($t = -1.35$, $p > .001$) scores. These results indicated that pre-service mathematics teachers' self-efficacies in using and teaching language of mathematics did not change with the effect of self-evaluation process.

Table 1

The Results of Paired Samples t-test

	Mean	*SD*	*Pre*	*Post*	*t*	*p*
preTSESLoM-postTSESLoM	-.39	5.26	49.74	50.13	-.36	4.86
preTLoM-postTLoM	.00	3.25	23.22	23.22	.00	2.88
preUSLoM-postUSLoM	.08	1.83	15.17	15.09	.23	1.70
preUGLoM-postUGLoM	-.48	1.70	11.35	11.83	-1.35	1.50

Results of the Second Phase

The results of the analysis of self evaluation reports indicated that half of the participants mentioned about the importance with regard to correct usage of language of mathematics and teaching this language in mathematics teaching in their reports. Moreover, they indicated that

they would teach considering these issues hereafter. By this way, they put forward their awareness related to the importance of language of mathematics in mathematics teaching in their reports. However, they did not make an evaluation. That is, they were not able to use their awareness and knowledge to evaluate themselves with respect to language of mathematics. On the other hand, other half of the participants demonstrated their perceptions related to language of mathematics in their self-evaluation reports by evaluating themselves from using pedagogical approaches or using native language while they were teaching the mathematics subject. In other respects, four of the participants stressed the importance of language of mathematics course and the contribution of this course to themselves. Consequently, self-evaluation reports displayed that language of mathematics course and self-evaluation included in the course process provide them awareness and knowledge related to language of mathematics. However, it was seen that participants could not use this knowledge while they were evaluating themselves with respect to using and teaching language of mathematics.

The results of the analysis of clinical interviews confirmed the results obtained from participants' self-evaluation reports at two points; appreciation of language of mathematics course and participants' perceptions of language of mathematics. Additionally, it was seen that the number of participants who appreciated their acquisitions by emphasizing the importance and necessity of the language of mathematics course increased by the data obtained from clinical interviews. Hereby, the conclusion that participants developed positive attitude towards the language of mathematics course was reached. The following excerption from the clinical interview is a good example for this conclusion;

P2: I would not want to be a mathematics teacher. When we took this course, the things we learned and we made in this course impressed me. But now, I want to be a teacher.

Similarly, in the clinical interview P8 reflected her positive attitude related to the course by referring her realization with respect to importance of language of mathematics as follows;

P8: Actually, I did not realize this issue before. I am at the 4th grade, but I did not think that if a verbal expression is given to me, how I can express this by using the language of mathematics. I did not concentrate on this issue before. But now, I realize the importance of the language of mathematics.

Another point that clinical interviews confirm the results of self-evaluation reports was related to participants' perceptions of language of mathematics. Although participants possessed these two perceptions time to time, each participant reflected one of the perceptions dominantly. Moreover, the dominant perceptions of participants were generally consistent in self-evaluation reports and clinical interviews. Only one of the participants reflected that she evaluated herself from the perspective of using pedagogical approaches whereas she responded the items of TSESLoM from the perspective of using native language. In the interviews, it was observed that three of the participants (P1, P2, and P6) perceived language of mathematics as using pedagogical approaches whereas four of them (P3, P4, P5, and P7) perceived the language of mathematics as using native language while they were responding the items of TSESLoM.

One of the participants who dominantly possessed the perspective of using pedagogical approaches was P1. When the changes of her ideas were questioned after she evaluated herself, her response was related to using pedagogical approaches, given as follows;

P1: First of all, I could have posed questions to the students to test whether they learned. I could have asked them to write on the board or I could have controlled their notebooks. I thought that my contribution to the students was not enough.

P2 was another participant possessing the perception of using pedagogical approaches. Participant P2 found herself deficient from her perspective and when the researcher questioned her deficiency especially with respect to language of mathematics, she responded as follows;

P2: Yes, I should also develop myself at language of mathematics because the students may misunderstand our expressions. If I teach one thing inaccurately, the student may continue with this wrong knowledge up to the university. Since we construct the basic knowledge of the students, I should develop myself on this topic.

The other perspective for the language of mathematics was using native language. For instance, at the outset of the interview when the researcher asked general ideas of P5 with respect to the language of mathematics as a pre-service teacher, she only focused on using written and oral native language as given in the following excerption;

R: What did you think when you evaluated yourself as a pre-service teacher in terms of the language of mathematics?

P5: Well, I thought that I was better in writing ... verbally ... that is I thought that my expressions were not exact and clear.

R: Well, how did your ideas change depending on your self-evaluation?

P5: I understood that I should use the language in the way that children can understand when I am using the expressions.

The perspective of P7 was related to speaking for the language of mathematics. As given in the following excerption she found herself better than she expected in her own perspective.

R: In your self-evaluation process, what did you think about yourself?

P7: Well, actually, I had been prejudiced, I had thought that I dogmatized the sentences, I did not speak fluently, I did not build complete sentences, I did not build direct sentences however, when I watched myself I saw that I spoke normal. I realized this.

Another finding was participants' different perceptions related to their status in responding TSESLoM items. Although pre-service teachers were warned to respond the items of TSESLoM from a view of mathematics teacher, three of the participants displayed that they responded the items from a view of an undergraduate student and they evaluated the items in the context of their undergraduate mathematics courses. By this way, it was seen that they evaluated their skills referred in the items of TSESLoM in the context of higher mathematics. The expressions of P2 and P4 may be given as examples for this result.

R: For the item "I am able to use the language of mathematics in proving" you said "disagree" in the first implementation but then after you watched and evaluated your presentation, you said "agree" in the second implementation. What was effective in this change?

P2: In our courses we prove you know. For instance, in our exams I cannot do this. When I take bad marks I think that I cannot do this. For this reason, I said "disagree". In the presentation, for instruction of division, I saw that I could validate the operation of division so I said "agree".

Similarly P4 referred the graphs she learned in her undergraduate courses.

R: For the item "I am able draw any graphs" you said "agree" in the first implementation but you said "disagree" in the second implementation.

P4: It changes from graph to graph. I did not mention about elementary level, I may have difficulty in drawing graphs we are learning currently. For instance a more difficult graph may be.

As the interview was progressing, participant P4 put into words her point of view clearly.

R: For the item "I am able to read and write the mathematical symbols", it stayed the same.

P4: Initially, when I saw mathematical symbols I thought the symbols we saw in algebra and calculus. Actually the symbols those I will teach are simpler forms of those. In the first administration I though the mathematical symbols I saw in our courses whereas in the second administration I thought the symbols those I will teach.

Another significant finding was that there was an effect of self-evaluation on some of the participants' self-efficacies. However this effect could not be reflected by the scale. For instance, when the changes in ideas of P5 were questioned with respect to self-evaluation, P5 emphasized this change as realizing the necessity to improve her as given in the following;

P5: I understood that I should improve myself. I saw that I could not tell what I thought. Therefore, I need some improvement from this point of view.

In contrast to P5, P6 emphasized the change as feeling encouragement when her ideas were questioned with respect to the effect of self-evaluation as follows;

P6: I was thinking that mathematics was a mysterious thing. But I saw that I could do, I could draw, I could write when I wrote something related to mathematics. Teaching presentation encouraged me. I could do, I could write. I watched the video record again and again while I was evaluating myself. The video record was very good.

Similarly, P8 reflected the positive effect of self-evaluation in detecting her mistake as given in the following;

P8: While I was watching myself, I saw a serious mistake. By this way, I saw that what I thought, what I said even what I wrote may be so different from each other. So I realized that all these should be in harmony.

As mentioned before, besides these reflections on the effect of self-evaluations on participants' ideas and beliefs, some of the participants clearly indicated that self-evaluation caused some changes in their self-efficacies however; they could not reflect this change in the scaling of the questionnaire items and thus they selected the same choice. The following excerptions reflect the ideas of P5 in this issue;

R: There was decline in your self-efficacy not in teaching but in verifying your mathematical ideas and drawing graphs. Did self-evaluation change your perceived self-efficacy in other topics?

P5: In certain interval it was more close to "agree". Eventually it changed. For instance, it remained between "agree" and "disagree" but as a result I selected "disagree". It might come on to "agree" but nevertheless, it was around "disagree".

Similarly, the response of P8 was a good example for pointing out that the scales of questionnaire items might not reflect the minor changes in the situations. P8 selected the choice "agree" for being able to use the language of mathematics in expressing mathematical ideas in both before and after the self-evaluation. When the researcher questioned whether or not there was a change in her ideas with regard to issue;

P8: According to me, my ability of using language of mathematics increased however, it was not completely. Thus, my response stayed in "agree". For instance, if there were responses of

percentages in here, if 60 percent represented the situations those I could not achieve, this would have decreased to 40 percent. But, the amount of 60 percent would not be zero percent, I want to mention this.

Besides all these findings, one of the participants came into prominence by the characteristics of possessing the perception of language of mathematics as expected. On the other side, this participant emphasizing the importance of language of mathematics, teaching this language and the language of mathematics course was distinguished from other participants by her acquisition in language of mathematics and teaching this language. For instance, P8 defined her awareness that she acquired during the language of mathematics course and self-evaluation process as entering a new world and she told the followings;

P8: As I mentioned before, I had had little awareness. I have entered a new world. I have never entered this world before. Thus, there are many things to discover especially in this world. Actually, I had mathematical ideas, but I did not think that using language of mathematics was necessary for verifying these mathematical ideas in the first implementation. But, in the second implementation I thought this issue and I realized that I should progress more.

In addition to reflect the effects of the course and the self-evaluation, this pre-service teacher also used some statements directly referring the positive effects of the self-evaluation.

P8: Here I caught a good increase.

R: Yes you said "disagree" in the first administration and then you said "completely disagree" in the second administration.

P8: Especially, I like telling the meanings of these words by giving daily life examples very much. I felt that self-evaluation increased my self-efficacy with respect this issue. Because I

saw that I could relate easily when I used the language of mathematics better. Thus I said "completely disagree". I decided this especially after I evaluated my presentation.

She also put forward the effects of self-evaluation with respect to possible effects of it in her professional life clearly. Moreover she expressed her deficiencies those should be eliminated.

P8: When I was looking at myself, I realized that I had used a sentence unawares. I had said that "the multiplication of positive and positive is positive". I saw that I had said "The multiplication of two number possessing same signs is positive" afterwards. I had not wanted to make student to imagine the first sentence as I had said unawares. I saw how much difference there might be between what I thought and what I said. It is very important that what I think and what I say are the same. I am going to pay particular attention on how I want to express but how I am expressing.

As it was understood from the excerptions given above, P8 who perceived the language of mathematics as a language having its own terminology put forward clearly that she had the responsibility to teach this language in the future.

Eventually, it can be asserted that the results of the second phase clarified the results obtained from comparison of pre-test and post-test scores statistically, by coming up with reasonable justifications. As it was seen in the elaborative examples, participants did not perceive the items as expected for two reasons; perceptions of language of mathematics and not being able to respond the items from the view of mathematics teacher. On the contrary to quantitative results obtained in the first phase of the study, even the participants responded the questions in the clinical interviews from their perspectives they displayed that self-evaluation had an effect on their self-efficacy perceptions.

Discussion and Conclusion

The results of the first phase revealed that pre-service teachers' perceived self-efficacies in using and teaching language of mathematics did not change by the effect of self-evaluation quantitatively. However, the results of the second phase not only shed light on the results of the first phase by providing rich data, but also guided us to propose valuable justifications for the non-significant effect. It was concluded that the results of the second phase might be the reason for the non-significant effect of the self evaluation. This situation puts forward the necessity of using mixed method design in which both quantitative and qualitative methods support each other (Creswell, 2003; Rossman & Wilson, 1985; Tashakkori & Teddlie, 1998).

One of the reasons for the non-significant effect of self-evaluation might be participants' perceptions related to language of mathematics; *using pedagogical approaches* or *using native language*. The results indicated that they evaluated themselves from their own views and they did not reflect that they possessed the knowledge and skills in the language of mathematics. Moreover, they were unaware of that their perceptions and knowledge were different from the language of mathematics covered in the course. In this situation, it was concluded that researchers' assertions related to positive effects of self-evaluation on self-efficacy perceptions of teachers (Bohen, 2000; Ross & McDougall, 2003) depended on being able to carry out the self-evaluation in the expected context. In other words, the context of the self-evaluation should be perceived as expected by the teachers in order to obtain valid and reliable results for the effect of self-evaluation. From this point of view, it was concluded that if these pre-service teachers had possessed sufficient skills and knowledge in the language of mathematics and had evaluated themselves in this context, self-evaluation might have had positive effects on their self-efficacies as Bohen (2000) and Ross and McDougall (2003) put forward.

Two important issues related to perceptions of *using pedagogical approaches* and *using native language* should be clarified. The first issue is that this result was not an expected result. When this result was obtained, the related literature was reviewed in order to have knowledge whether there were different perceptions of mathematics teachers related to the language of mathematics. However, there was no related literature explaining this issue. Actually, we tried to present their own perceptions as they were. We were in endeavor of neither comparing to nor measure against ours. The second issue which was related to the perception of *using native language* should be clarified. Relative to this perception, a doubt may come to mind that this perception may be the result of the particular phrasing of the self-evaluation questions and the items. However, it was thought that, the distinction of symbolic use of the language of mathematics in the wording of both self-evaluation questions and items of the scale may provide a strong support not to give rise to a such a doubt.

Different views of the participants with regard to the level of mathematics may be another reason the non-significant effect of self-evaluation. As the qualitative analyses revealed, some of the participants evaluated their self-efficacies in the context of undergraduate mathematics in the pre-test whereas in the context of elementary mathematics in the post-test. According to Bandura (1997), efficacy beliefs depend on the situation or context relative to the action or task to be performed. From Bandura's (1997) point of view, the pre-test and post-test self-efficacies of these teachers may differentiate owing to the context of mathematics level. As a conclusion, this differentiation may probably suppress the effect of self-evaluation on self-efficacies of the participants.

Another point deserving significant attention was that it was not so easy and straightforward to make pre-service mathematics teachers to perceive, appreciate, or to be aware of the language of mathematics. This study shows that it is not very easy to construct expected perceptions of the language of mathematics in pre-service teachers' minds although they have

taken many mathematics courses beginning from their early ages. The instructor of the course gave valuable information with regard to nature, structure, and rules of the language of mathematic, stressed the importance of using and teaching the language of mathematics in expressing mathematical ideas precisely. She also gave many examples with regard to writing and reading the mathematical sentences. However, only half of the participants reflected the importance of language of mathematics and teaching this language in mathematics education and most of them had different perceptions related to language of mathematics. It is thought that these participants probably have not been exposed to writing and reading activities while they were learning mathematical concepts. At this point, engaging these pre-service mathematics teachers with writing and reading practices in mathematics focusing on the structure and properties of the language of mathematics was not enough for them to internalize the language of mathematics. Therefore, it is seen that many countries have started to emphasize teaching language of mathematics in their teaching programs and standards (NCTM, 2000) and it is emphasized that mathematics teachers need to know to teach the language of mathematics by connecting conceptual structure of mathematical knowledge (Owens, 2006). Consequently, the results of the current study provided evidence for necessity of stressing the language of mathematics in all of the mathematics courses from the very beginning.

Indeed, we did not have such an aim as investigating the effect of the course on pre-service teachers' self-efficacy perceptions. In our study, the course was only a vehicle and it established an environment to conduct the study. We admit that, it is very meaningful that the questions "what do the results say about the course?" or "is this course useless or unnecessary?" come to mind. According to us, these results say that the course could not be helpful to pre-service teachers in providing a substantial basis to evaluate themselves with regard to using and teaching the language of mathematics during their own instruction. As it

is indicated in literature, the development of the language of mathematics skills takes place simultaneously with the conceptual development. Therefore, the major aim of the course was to raise pre-service mathematics teachers' awareness on the importance of language of mathematics and on the ways of teaching the language of mathematics rather than developing their mathematics language skills. Consequently, this course could be able to provide an awareness of the language of mathematics for some of the pre-service teachers only at the beginner level. As to the second question, it should be noted that some of the pre-service teachers could able to gain awareness with regard to importance of the language of mathematics and teaching of this language within the context of the course. However, since they have not come across such writing and reading practices in their mathematics courses and they do not look mathematics from the "language" point of view, their perceptions related to the language of mathematics are at the beginner level. If we liken these pre-service teachers' perceptions to a toddler, then the result is not surprising. In this regard, it would be injustice to say, "This course is useless or unnecessary." Additionally one of the participants who came into prominence by the characteristics of possessing the perception of language of mathematics as expected put forth the significant contribution of the course clearly. Then it makes sense to say that this course may be more helpful for pre-service teachers who are more equipped with mathematical knowledge and skills.

Appendix 1

Self-evaluation Questions

Please answer the following questions considering your teaching presentation and think of the questions from the perspective of a mathematics teacher who is always teaching in this style.

1. Do you think that you used the appropriate language of mathematics related to the concept you made related instruction? Why?
2. Is the language of mathematics you used appropriate to your students' grade? Explain.
3. Is native language you used clear enough? Explain.
4. Does the language of mathematics you used reflect your mathematical ideas exactly and accurately? Do you have any deficiency? Please explain by exemplifying.
5. Are your verbal sentences in language of mathematics complete? Do you have any deficiency? Please explain by exemplifying.
6. Are there any deficiency and mistake in your written expressions in writing mathematical symbols and words? Please explain by exemplifying.
7. Do you think that you used verbal expressions of symbols and mathematical representations accurately? Please explain by exemplifying.
8. Do you think that you gave the necessary mathematical definitions in your presentation? Please explain.
9. Are the definitions you gave in your presentation accord with the form of formal mathematical definition? Why? Please explain.
10. What is the knowledge of mathematical representation (if there is any) within the mathematics subject you taught? Do you think that students can acquire this knowledge by such an instruction? Why? If you think that they can acquire this knowledge, how do you do that?
11. Did you contribute to development of the use of mathematical representations? How?
12. Do you think that such an instruction can make students to acquire the relationship between conceptual knowledge and symbolic representation for the meaningful understanding of representations in mathematical concepts? Why? If you think that they can acquire this relationship, how do you do this?
13. Did you relate abstract concepts you used in your presentation (if there is any) to concrete situations? How? Please explain.

Students' communication skills in the language of mathematics should improve in instruction processes of mathematical concepts throughout their mathematics learning experiences. Therefore, this responsibility belongs to mathematics teachers. Please answer the following questions considering this expression.

14. Do you think that you contributed to the development of students' reading in the language of mathematics? If your response is "yes" how did you contribute? Please explain.
15. Do you think that you contributed to the development of students' writing in the language of mathematics? If your response is "yes" how did you contribute? Please explain.
16. Do you think that you contributed to your students for being able to express their mathematical ideas in the language of mathematics clearly and comprehensibly? If your response is "yes" how did you contribute? Please explain.

Appendix 2

Teacher Self Efficacy Scale for the Language of Mathematics

GENERAL DESCRIPTIONS

In this scale you will find sentences with regard to your self-efficacy of the language of mathematics. These sentences were written for inquiring your own ideas. Please read each item carefully and give respond to each one honestly. It is very important to express your own feelings and not to omit any item for the results of the study.

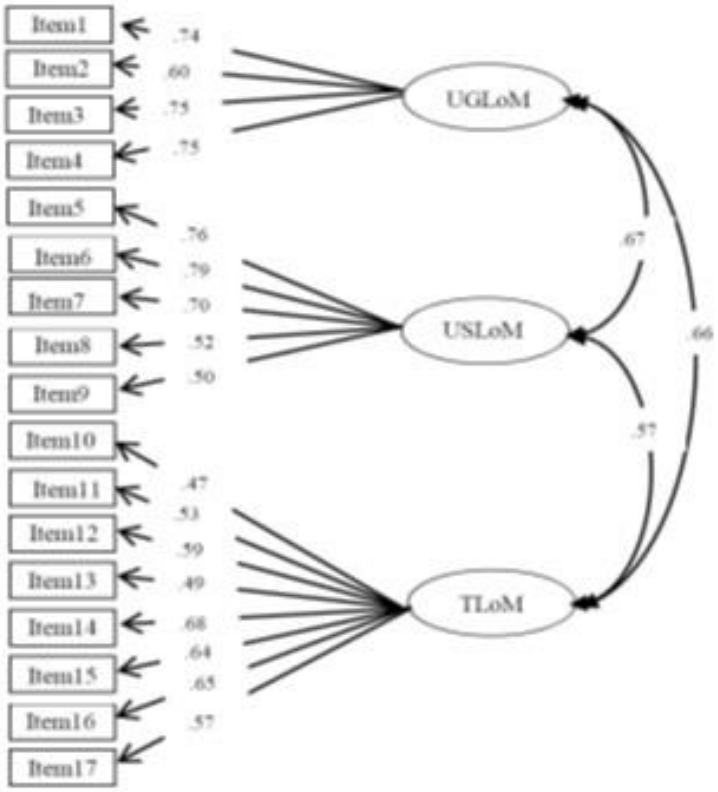
Thank you for your attendance

Explanation: Please identify that to what extent you agree with the expressions by circling the appropriate choice. When you are evaluating the items please consider only your own ability not what you are doing or will do.

		Completely Disagree	**Disagree**	**Agree**	**Completely Agree**
1	I am able to use the language of mathematics in expressing mathematical ideas.	a	b	c	d
2	I am able to use the language of mathematics effectively in making proofs.	a	b	c	d
3	I am able to express a statement by the language of mathematics.	a	b	c	d
4	I have difficulty with using the language of mathematics in expressing mathematical concepts.	a	b	c	d
5	I am able to read and write mathematical symbols.	a	b	c	d
6	I am able to use mathematical words appropriately.	a	b	c	d
7	I am able to draw intended kind graphs.	a	b	c	d
8	I am able to reach to solution by drawing graphs in solving some problems.	a	b	c	d
9	I am able to find appropriate ways to justify my mathematical ideas.	a	b	c	d
10	I have difficulty in using formal and informal language by appropriately relating in teaching mathematical concepts. (Informal language: Introducing a concept by using native language. Formal language: The language of mathematics used appropriate to mathematics terminology)	a	b	c	d
11	I have difficulty with developing students' awareness with regard to that the language of mathematics provides different solution ways for the problems by its rich terminology.	a	b	c	d
12	I have difficulty in teaching to my students the meanings and use of mathematical words with different perspectives.	a	b	c	d
13	I am able to teach to my students to connect equations to something concrete instead of just letting equations be abstract.	a	b	c	d
14	I am able to explain mathematical symbols in many different ways in teaching them.	a	b	c	d
15	I have difficulty in giving lots of examples while I am teaching mathematical words.	a	b	c	d
16	I have difficulty in modeling diagrams such that students can understand them.	a	b	c	d
17	I have difficulty in teaching appropriate ways for my students to justify their mathematical ideas.	a	b	c	d

Appendix 3

Standardized coefficients for the three-factor model of TSESLoM



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