Research Article doi: 10.12973/ijem.5.3.451

International Journal of Educational Methodology
Volume 5, Issue 3, 451 - 463.
ISSN: 2469-9632
http://www.ijem.com/

The Impact of Instructional Technology and Material Design Course on Pre-service Teachers

Selcen Calik-Uzun
Artvin Coruh University, TURKEY

Umit Kul*
Artvin Coruh University, TURKEY

Sedef Celik
Artvin Coruh University, TURKEY

Received: June 11, 2018▪ Revised: July 27, 2019▪ Accepted: August 10, 2019

Abstract: The purpose of this study is to evaluate the effects of Instructional Technologies and Material Design (ITMD) course on pre-service mathematics teachers' attitudes, efficacy beliefs about using concrete materials, and their opinions regarding the material preparation process. A total of 73 pre-service teachers were participated in this study. The scale developed by Bakkaloglu was used to determine efficacy beliefs of pre-service teachers about using concrete materials, and the attitudes scale developed by Cetin, Bagceci, Kinay and Simsek was used to determine the attitudes towards ITMD course. A written form was also used to reveal the opinions of pre-service teachers regarding the material preparation process. The qualitative data collected from 16 pre-service teachers was analyzed with the MAXQDA. Using content analysis, codes and themes were created separately by the researchers and analyzed through several iterations. As a result of this study, positive changes were found in the attitudes and efficacy beliefs of pre-service teachers. The results obtained from the opinions of the pre-service teachers support this positive change. In other words, it is possible to argue that the attitudes of pre-service teachers towards the material development process changed positively with the positive change in the efficacy beliefs about preparing materials after taking the ITMD course.

Keywords: *ITMD course, attitude, beliefs, concrete materials, pre-service mathematics teacher.*

To cite this article: Calik-Uzun, S., Kul, U., & Celik, S. (2019). The impact of instructional technology and material design course on pre-service teachers. *International Journal of Educational Methodology*, *5*(3), 451-463. https://doi.org/10.12973/ijem.5.3.451

Introduction

Nowadays, the rapid development of digital technology in all areas of life has become an expected situation. Naturally, it is essential for educational activities to include technological materials and its applications in mathematics education (Kul, Aksu, & Birisci, 2019). Learning environments have always kept their door open for technological support. Today, one of the educational goals is not only to raise individuals who can think critically, but also to educate them as individuals who question, are open to innovations, and can solve problems (National Council of Teachers of Mathematics [NCTM], 2000). For this reason, programs and activities must be planned and applied to develop necessary skills and behaviors of students (Ministry of National Education [MoNE], 2018). In mathematics education, learning settings that employ different teaching materials like symbols, concrete objects, pictures and diagrams are gaining importance in the concretization of concepts and relationships (Clements & McMillen, 1996; Lesh, Post, & Behr, 1987). It was often reported that using concrete material is an effective way to increase the mathematics achievement (Sherman & Bisanz, 2009; Kul, Celik, & Aksu, 2018). It was stated that the use of concrete materials in education makes it easier for students to learn mathematical concepts (Boggan, Harper, & Whitmire, 2010; Carbonneau, Marley, & Selig, 2013), makes conceptual learning possible (Dienes, 1973), ensures opportunities for permanent learning (Cass, Cates, Smith, & Jackson, 2003; Martin & Schwartz, 2005), increases individual critical thinking skills (Apperson, Laws, & Scepansky, 2006), provides opportunities for problem solving (Kelly, 2006), and contributes to the development of positive attitudes towards learning (Aydogdu-Iskenderoglu & Taskin, 2015; Kelly, 2006; Yetkin-Ozdemir, 2008; Aydin-Unal & Ipek, 2009).

Recently, student-centered approaches have been adopted, it has been reported that teachers should use instructional materials effectively in learning settings when supporting the integration of materials into learning settings (Gurbuz, 2010; Kul, 2018). As using different kinds of tools and materials, especially at elementary level, helps to deal with mathematical experiences from simple to difficult ones, and from the concrete ones to abstract ones (MoNE, 2018). It

*Correspondence:
Umit Kul, Artvin Coruh University, Turkey. ✉umitkul@artvin.edu.tr

has been often reported that learning settings must be improved and enhanced with educational materials to increase the mathematics achievement and competitiveness of the program acquisitions (Kelly, 2006; Yildirim, Ozgurluk, Parlak, Gonen & Polat, 2016). In this respect, it has also been emphasized that developing and changing technology offers new opportunities for learning settings in the contemporary curricula, and teachers have been requested to use teaching materials in their courses (MoNE, 2018).

In application principles of the mathematics curriculum, it was emphasized that concrete materials must be used as much as possible when teaching new concepts (Bulut, 2004), and that these materials might be obtained through number cards, buttons, beads, beans, and simple daily materials (Bozkurt & Akalin, 2010). Erbas et al. (2014) reported that the use of concrete materials was considered as the first step in mathematical thinking skill development as the development in students started from concrete ones to abstract ones; and therefore, decimal base blocks, unit cubes, pattern blocks, the symmetry mirror, fraction sets, fraction cards, and geometric strips are used in teaching mathematics. Similarly, NCTM released a report in 2000 recommending that students must have access to educational materials to improve their mathematical understanding, since using educational materials in learning and teaching processes contributes to the development of the psychomotor skills of students. To realize the purpose of using concrete teaching materials, students must explore the relationship between materials, concepts and symbolic representations (Yetkin-Ozdemir, 2008). Otherwise, students will be able to see the materials as toys by concentrating only on their usage without understanding the purpose of them (Moyer, 2001). For this reason, it is very important that teachers guide their students in an appropriate manner when using concrete materials (Guven, 2006). In addition to this, the necessary professional competencies must be acquired in advance to cover the needs of students and to increase the quality of learning settings. For this reason, it is important for pre-service teachers to know and use teaching materials in an effective way.

In this respect, the ITMD course has become compulsory in all teacher education programs. The Higher Education Council (HEC) has recently revised this course and divided it into two different courses as Instructional Technologies (compulsory) and Material Design in Mathematics Teaching (elective) (Higher Education Council [HEC], 2018) as of 2018-2019. In the scope of this course, pre-service teachers are received to grade information technology, and on their theoretical approaches, new orientations in these approaches, design, development and evaluation process of materials in this field. After pre-service teachers have taken this course, they are expected to have the ability to know and use various educational materials, and also to design or update materials that will be used in their classes when they become teachers (Acer, 2011; Gunduz & Odabasi, 2004). These qualifications that will be acquired by pre-service teachers will contribute to proper utilization of teaching materials in their future classes.

Piskin-Tunc, Durmus and Akkaya (2012) reported that the self-efficacy beliefs of pre-service teachers in using materials affected how they created and applied activities in classes. Self-efficacy may be described as the perception of organizing and applying the skills that are needed to produce the targeted and desired outcomes (Bandura, 1997; Skaalvik & Skaalvik, 2010). Teacher efficacy is described as a teacher's beliefs regarding her ability elicit positive learning outcome (Isiksal, 2010). For this reason, the perception of a person about his/her abilities to perform a task will increase the probability of a successful task because the behaviors of people are frequently directed by self-efficacy perceptions (Pajares, 1992). Although self-efficacy has effects on the thinking, sensitivity, motivation and behaviors of an individual, the knowledge and skills of teachers and what they can do in the classroom may be determined in advance (Pajares, 1992). It is expected that each teacher and pre-service teacher will have a strong self-efficacy to demonstrate his/her competences in the teaching process (Umay, 2001). Knowledge, attitude, skills and behavior that are acquired with the ITMD courses will contribute to teachers in becoming more effective in teaching-learning processes (Gunes & Aydogdu-Iskenderoglu, 2014; Karatas & Yapici, 2006). Uzunoz, Aktepe and Gunduz (2017) reported in their study that the ITMD course provided professional acquisitions to pre-service teachers in many different dimensions. Saka and Saka (2005) reported that ITMD courses greatly improved the ability of prospective teachers in using teaching tools. Another study reported that ITMD courses were one of the important courses that increase the efficacy beliefs of pre-service teachers (Bakac & Ozen, 2016). Knowing the efficacy beliefs of pre-service teachers on proficiency in using materials is very important in shaping in-class organizations in the professional lives of pre-service teachers (Bakkaloglu, 2007). It is expected that teachers have competent knowledge on this subject and their efficacy perceptions are high.

When the literature was examined in this respect, there are many studies relevant to ITMD courses (Uzunoz, Aktepe, & Gunduz, 2017). For example, it was determined that ITMD courses were associated with attitudes (Bakac & Ozen, 2016; Cetin, Bahceci, Kinay, & Simsek, 2011; Gunes & Iskenderoglu, 2014), anxiety (Cabi & Ergun, 2016), creative thinking skills (Bakac & Ozen, 2016; Cenberci & Yavuz, 2018), and self-efficacy perceptions (Aydogdu-Iskenderoglu, Turk & Iskenderoglu, 2016; Piskin-Tunc, Durmus, & Akkaya, 2012, Uribe-Florez & Wilkins, 2010, cited by Gokmen, Budak, & Ertekin, 2016). However, to the best of our knowledge, there is no mixed research about the effect of ITMD course on the pre-service mathematics teachers' attitudes and efficacy beliefs about the use of concrete materials. Since the attitudes of pre-service teachers towards ITMD courses will guide the use of materials in their professional lives, efficacy beliefs and attitudes were examined together in this study. The present study was designed to examine the effects of ITMD on the attitudes and efficacy beliefs of pre-service teachers about concrete material use, and to

determine the thoughts of pre-service teachers on material development processes. For this purpose, the answers for the following questions were investigated:

1. How is the effect of the ITMD course on the efficacy beliefs of pre-service teachers about using concrete materials?
2. How is the effect of the ITMD course on the attitudes of pre-service teachers?
3. What are the opinions of pre-service teachers about the material development process?

Methodology

Research Design

In this study, the mixed method was used. In the quantitative part of the study, the pre-test post-test control group design was used. The experimental design explores a cause and effect relationship, in other words, the effects of one variable on other variables (Buyukozturk, 2007). In this context, since the pre-service teachers in the experimental and control groups continued their education processes, no random assignment was made among the pre-service teachers in the formation of the control and experimental groups. A total of 73 pre-service teachers participated in the study, with 37 pre-service teachers in the Control Group, and 36 pre-service teachers in the experimental group in a faculty of education. Semi-structured interviews were conducted with 16 participants. These students were chosen on a voluntary basis.

Data Collection

A 5-point Likert-type scale that was developed by Bakkaloglu (2007) was employed in the study to determine the efficacy beliefs of pre-service mathematics teachers about using concrete materials in mathematics teaching. This scale consisted of two dimensions as *Teaching Efficacy* and *Expectations from Material Use*, and has 15 items. Bakkaloglu (2007) found the Cronbach alpha coefficient of the dimensions of this scale as 0.79 and 0.81. In addition, the Cronbach alpha coefficient was also calculated for reliability in this study, which was found as 0.74 for the pre-efficacy beliefs scores in using concrete material in mathematics courses; and it was 0.79 for the post-efficacy beliefs scores. Attitudes towards ITMD course scale was developed by Cetin, Bagceci, Kinay and Simsek (2013) and was used in the present study. The questionnaire consisted of 38 items and was in the 5-point Likert type. It consisted of three dimensions: *Utility*, *Pleasure*, and *Denial*. Cetin, Bagceci, Kinay and Simsek (2013) conducted a study with pre-service teachers who received ITMD courses and found that the Cronbach alpha of the whole scale was 0.95. In addition, for reliability purposes, the Cronbach alpha was calculated for the two scales that were used in this study. The Cronbach alpha was 0.84 for the pre-attitude scores for the educational technologies material courses, and was 0.93 for post-attitude scores for ITMD course. In addition to the quantitative data collection tools that were used in the study to determine the efficacy beliefs and attitudes of middle school pre-service mathematics teachers in using concrete materials in ITMD courses, the pre-service teachers in the experimental group were also interviewed with written forms. Before the written form was applied to the pre-service teachers, a pre-interview was made with four pre-service teachers; and it was confirmed whether the questions were understood. The written form was finalized with the pre-service teachers with whom pre-interviews were made and after expert opinions were received. Two questions were asked to the pre-service teachers about material development processes, and their responds were received in writing form in order to obtain in-depth opinions from pre-service teachers simultaneously.

Implementation Process

In the present study, in which the efficacy beliefs of the ITMD courses was examined, efficacy beliefs and attitudes of pre-service teachers towards using concrete materials were determined before the ITMD course. In this respect, two scales were employed to determine the self-efficacy beliefs and attitudes of the pre-service teachers studying at first year and second year on using concrete materials. Then, course content was conducted by a faculty member in the field of mathematics education with the second year of pre-service teachers and ITMD courses in line with the course content defined by the HEC.

In the scope of the course, the development of concrete materials was considered as well as the development of web-based materials. When the ITMD courses ended, two scales were applied to the pre-service teachers to determine their efficacy beliefs and attitudes. Finally, a written form was employed to obtain their views on material preparation process.

Analyzing of Data

Firstly, the normal distribution hypotheses of the data were examined in the analysis of the quantitative data obtained in the study. The skewness and kurtosis coefficients were calculated as 0.28 and 0.55, respectively. In addition, as a result of the Kolmogorov-Smirnov and Shapiro-Wilk analyses of normality tests, it was determined that the p values were greater than 0.05 (p1=0.12; p2=0.52; p3=0.11; p4=0.93). In this respect, parametric tests were employed to analyze the data. In addition, the SPSS was used for the analysis of the data that were obtained from the scales and personal information forms. The significance level was taken as .05. Before the ITMD courses, the Independent t-test was employed to determine whether the efficacy beliefs and attitudes of pre-service teachers towards material development differed at a significant level according to grades.

After these analyzes, the ANOVA Analysis was made to determine the beliefs of the pre-service teachers for material development and attitudes towards the courses. After the ITMD courses, the Independent ***t***-test was used to determine whether the efficacy beliefs and attitudes of the pre-service teachers changed according to grades to test the effectiveness of the ITMD courses; and the dependent *t*-test was used to compare the efficacy beliefs and attitudes in terms of the grades.

The qualitative data obtained from the written documents that were made with the pre-service teachers were analyzed using MAXQDA. The authors of the study were involved actively in the analysis process. Firstly, researchers analyzed the data separately, and then defined themes and codes. Then, they came together and prepared a spreadsheet based on the themes and codes that were created; and updated the codes and themes by discussing the mismatched codes. It was decided that some of the independent codings that the researchers had created from each other were discussed and they were combined. For example, the pre-service teachers' concerns about material development and codes such as the contribution of material development to mathematics learning and teaching process were evaluated in the attitude category. Similarly, other codes are rearranged. The analysis process continued until the researchers reached consensus.

Findings

Findings on the efficacy beliefs and of pre-service teachers about concrete materials and their attitudes towards ITMD course according to grades

To respond two research questions, the Independent *t*-test results showed that whether the attitudes towards ITMD and efficacy beliefs about using concrete materials courses vary according to the results obtained from the data are presented in Table 1.

Table 1.The Independent t-test results of the pre-service teachers according to pre-efficacy and pre-attitude scores in the control and experimental group.

Measurement	Group	N	M	SD	t	df	p
Pre-efficacy	Control	37	50.67	4.54	-2.26	71	.026
	Experimental	36	53.77	6.92			
Pre-attitude	Control	37	110.77	8.26	3.51	71	.001
	Experimental	36	118.97	11.59			

When Table 1 is examined, there were no significant differences in the efficacy beliefs of pre-service teachers about using concrete materials in mathematics education ($p>0.01$). It is also observed that there were significant differences in their attitudes towards ITMD ($p<0.01$).

Table 2. ANCOVA corrected scores for post-efficacy beliefs about concrete materials according to pre-efficacy beliefs scores.

Variance Source Corrected Model	Sum of Squares	df	Sum of Squares	F	Partial η^2
Corrected Model	2165.79	2	1082.89	72.40**	.67
Intercept	1323.34	1	1323.34	88.48**	.55
Pre-efficacy	252.97	1	252.97	16.91**	.19
Class	1451.38	1	1451.38	97.04**	.58
Error	1046.94	70	14.95		
Total	229238.00	73			
Corrected Total	3212.74	72			

Note. $^{**}p < .01$

According to Table 2, when the effect of pre-efficacy beliefs of pre-service teachers about using concrete material was examined, it was seen that there was a difference in pre-service teachers' post efficacy beliefs [$F_{(1-70)} = 97.04$, $p < 0.01$]. In addition, when evaluated in terms of effect size, it can be mentioned that there is a large effect, ($\eta_p^2 = .58$).

Table 3. ANCOVA corrected scores for post-attitudes about using concrete material according to pre-attitude scores

Variance Source Corrected Model	Sum of Squares	df	Average of Squares	F	Partial η^2
Corrected Model	13189.108	2	6594.554	77.263**	.69
Intercept	2659.720	1	2659.720	31.162**	.31
Pre-attitude	1660.001	1	1660.001	19.449**	.22
Class	6956.153	1	6956.153	81.500**	.54
Error	5974.645	70	85.352		
Total	1165546.000	73			
Corrected Total	19163.753	72			

Note. $^{**}p< .01$

According to Table 3, when the effect of pre-service teacher's pre-attitudes towards using concrete material is examined, it is seen that there was a difference in pre-service teachers' post-attitudes. [$F_{(1-70)}$ = 81.500, p < 0.01]. In addition, when evaluated in terms of effect size, it can be mentioned that there is a large effect, (η_p^2 = .54).

Table 4.Independent t-Test results of the post-efficacy beliefs and post-attitude scores of the pre-service teachers in terms of the control and study groups

Measurement	Group	N	M	SD	t	df	p	Cohen *d*
Post efficacy	Control	37	50.59	3.49	-10.22	71	.001	2.39
	Experimental	36	60.83	4.95				
Post-attitude	Control	37	112.91	10.31	-10.35	71	.001	2.42
	Experimental	36	138.05	10.42				

Examining Table 4, it is possible to argue that there are significant changes in efficacy beliefs of pre-service teachers about using concrete materials after receiving ITMD course [$t_{(71)}$ = -10.22, *p*<.001, *d* = 2.39]. In other words, there were significant and large differences in the efficacy beliefs of pre-service teachers in using concrete materials in favour of the second year pre-service teachers ($x_{control}$=50.59; $x_{experimental}$=60.83).

Similarly, it is possible to argue that there are significant changes in the attitudes of the pre-service teachers towards educational technologies and materials after receiving the ITMD course [$t_{(71)}$ = -10.35, *p*< .001, *d* = 2.42]. In other words, there are significant and large differences in the attitudes of pre-service teachers in favour of the experimental group ($M_{control}$=112.91; $x_{experimental}$=138.05).

Table 5. The dependent t-Test result of the score of the control and experimental group

Group	Measurement		N	*M*	SD	t	df	p
Control	Efficacy	Pre-efficacy	37	50. 67	4.54	.110	36	0.91
		Post-efficacy	37	50.59	3.49			
	Attitude	Pre-attitude	37	110. 70	8.26	-1.81	36	0.07
		Post-attitude	37	112.91	10.31			
Experimental	Efficacy	Pre-efficacy	36	53.77	6.92	-6.61	35	0.001
		Post-efficacy	36	60.83	4.95			
	Attitude	Pre-attitude	36	118.97	11.59	-8.80	35	0.001
		Post-attitude	36	138.05	10.42			

When Table 5 is examined it is seen that there are no significant differences in the pre- and post- efficacy beliefs of the first year pre-service teachers (Control Group) about using concrete materials (p>0.01). In addition, there are no significant differences in the attitudes of pre-service teachers (p>0.01).

Furthermore, there was an increase in the pre-and post- efficacy beliefs scores of the second year pre-service teachers (i.e. Experimental Group) after receiving ITMD course ($x_{pre\text{-}efficacy}$=53.77; $x_{post\text{-}efficacy}$=60.83). Moreover, a significant difference was also detected between the pre-efficacy and post-efficacy beliefs of pre-service teachers(p<0.01).Similarly, an increase was detected between the attitudes towards course of the second year pre-service teachers after ITMD ($x_{pre\text{-}attitude}$=118.59; $x_{post\text{-}attitude}$=138.05). There was also a significant difference between the attitudes of the pre-service teachers studying in the second year and their attitudes towards ITMD course (p<0.01).

In the light of the above findings, it is possible to argue that the efficacy beliefs of the pre-service teachers about using concrete material in mathematics teaching and the attitudes towards ITMD courses changed after they received the ITDM course.

Findings obtained from the perceptions of the pre-service teachers on the material development process

The hierarchical map was revealed through the analysis of the opinions obtained from the pre-service teachers on the material preparation process which is given in figure 2. As seen on the map, the viewpoints of the pre-service teachers on the material preparation process were classified under four themes as *Attitude*, *Competence*, *Incompetence*, *Suggestion* and *Criticism*. Although the pre-service teachers who considered themselves competent in material development encoded their viewpoints on their proficiencies under the headings of *Material Development*, *Material Use* and *Technological Interest*; those who thought that they could develop materials grounded their ideas on the *effects of the practices and information made in the process* and on the *positive change in their beliefs in preparing materials over time*. It is possible to argue that the attitudes of the pre-service teachers in the material development process differed positively as well as negatively. The negative viewpoints about this process, such as it being *time-consuming*, *preparation of materials in a way that is specific to the subject*, *anxiety for not being able to do* from the beginning of the process, *preparing materials that are not specific*, the difficulties in the *thinking and research stage* of the process, and how the materials are prepared.

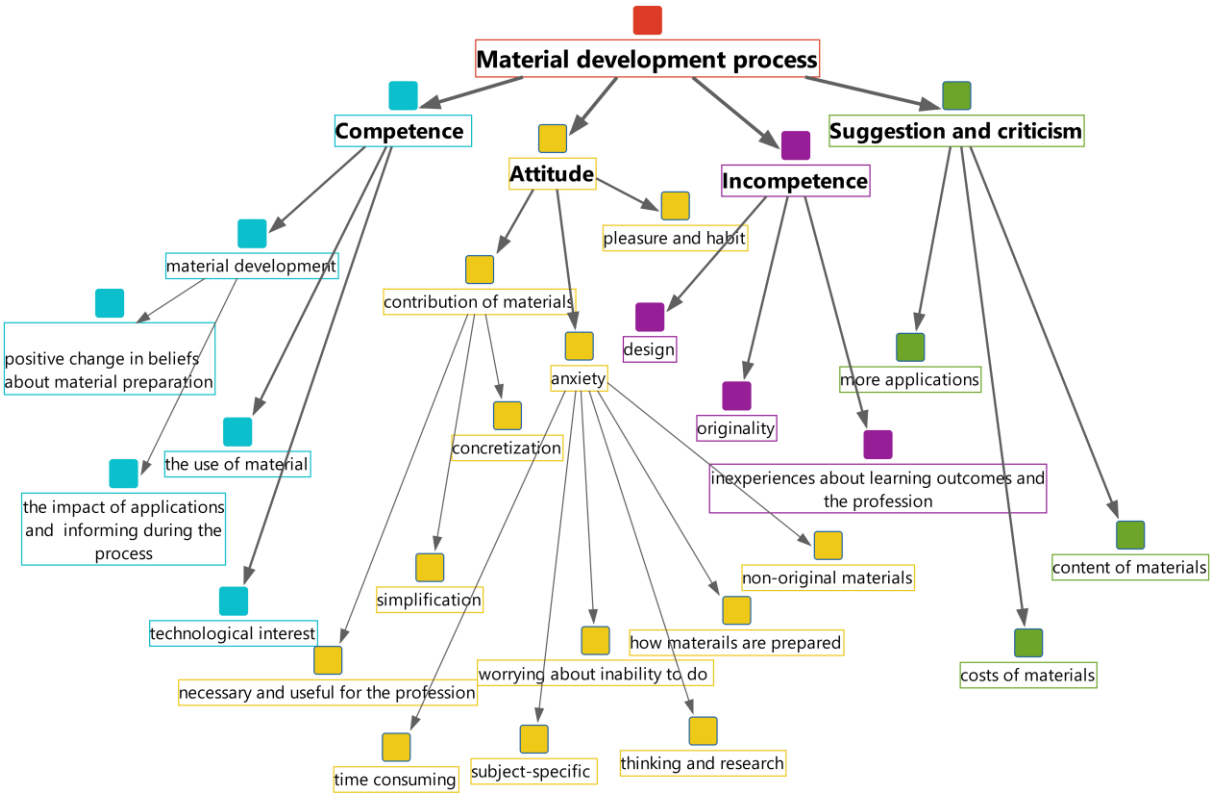

Figure 1. Hierarchical map showing the viewpoints of pre-service teachers on material development process.

Conversely, pre-service teachers who were aware of the contribution of materials including simplification and concretization in the learning processes, have positive attitudes towards the idea because they believe that this process is *necessary and useful* for their professions. The process might be enjoyable and create a habit, and the thoughts were encoded as a *pleasure-habit* which is another positive attitude indicator. The incompetence theme was created by the pre-service teacher who considered themselves to be incompetent in developing materials. The pre-service teacher associated these insufficiencies they faced during the design stage of the material development process with their inability to add *originality* to their materials, and with their *inexperience about the acquisitions and occupations*. Critical statements and suggestions of the candidates on the *costs of the materials and their contents* and their suggestions about *doing more practice* in the process constituted the *criticism and suggestion* theme. These themes and codes that are given above are summarized in detail in this section with quotations from the pre-service teachers.

Table 6. The themes and codes obtained from the viewpoints of the pre-service teachers on material preparation process

Theme	Codes And Sub-Codes		Pre-service Teacher
Attitude	Anxiety	Anxiety for not being able to do	S8, S13
		Preparing materials specific to the subject	S2, S4, S7
		Preparation process being too time-consuming	S11, S15
		Making of the materials that are not specific	S2, S16
		How materials are prepared	S4, S12
	Pleasure-habit		S7, S15
	Belief in the contribution of the material	Necessary and beneficial for the profession	S1, S2, S3, S4, S6, S7, S9, S10, S11, S12, S13, S16
		Simplifying	S8
		Concretization	S4, S5, S8, S9, S10
Competence	Using materials		S2, S5, S7, S10, S11, S12
	Developing materials		S1, S2, S7, S11, S14, S15
		The effect of the applications and information during the process	S3, S4, S6, S9, S12, S13
		Positive change in material preparation belief	S8, S9, S13
	Technological interest		S4, S9, S16

Table 6.Continued

Theme	Codes And Sub-Codes	Pre-service Teacher
Incompetence	Design	S5,
	Specificity	S5, S10, S15, S16
	Inexperience about the acquisitions and the profession	S5
Criticisms and recommendations	Contents of the material	S4, S12
	Cost of the materials	S8, S12
	More practice	S5

It is possible to argue that the anxiety of the pre-service teachers about the material preparation process, associated these anxieties with the necessity of preparing materials, *not being able to do, the necessity for materials being prepared specific to subjects*, the process being too time-consuming, and the inability to prepare original materials and the worries on how to prepare materials. The S8 candidate, who had the initial anxiety of not being able to do, said "*When I first took the lesson, I thought I could not do it"*, and similarly, S13 said "*At the beginning, I was afraid of not being able to prepare the material*". S8 also stated that s/he had anxiety for the probability of not preparing the material in an original way, and said "*I was scared that the material would not be specific to the subject*". S4 said "*Some acquisitions were not suitable for material development; however, many materials can be prepared and used for some acquisitions*".

S7 expressed his/her anxiety for the process as "*I was anxious that the required material cannot be prepared for any subject*". S15, who was one of the two students who stated that the process took time said "*The material preparation stage or the development stage takes time"*, and S11 said" *I have no doubt that I am going to prepare and use materials in due form if I have time in the future*".

One of the concerns of the pre-service teachers on the process was determined as the anxiety of developing original materials. S2 said *…but the bad aspect is that the materials that are prepared in the courses is not usually original, which is, of course normal; however, it makes us worried*". S16 said "*But I was a little anxious about preparing concrete materials since it was difficult for me to find original concrete materials*". Another theme that was under the anxiety of students theme was the way material was prepared. Two students stated that materials were prepared by carpenters rather than teacher candidates, which did not fit the purpose of the process. S4 said "*In the concrete material preparation, I noticed that my friends had a carpenter or an advisor to prepare materials. As a matter of fact, it is important that materials are durable and also they are easily designed and produced, easily available, and must be in a condition that reflects the point we emphasize."*

The students who were coded as S7 and S15 and who expressed positive attitudes, indicated that they enjoyed the material development process and that the process became a passion as they saw the products. These viewpoints constituted the *pleasure-habit* code. About the process, S7 said "*To make it really beneficial for students, it is necessary to consider what is missing and then to work hard and work with devotion. As long as these are realized, it can even become a passion to develop new materials*", similarly, S15 said "*… I enjoy the work as I do more, and this is gradually increasing"*.

Another code causing students to develop positive attitudes towards the process is their belief in the contribution of materials to learning. When considered in terms of all sub-codes, it is seen that all pre-service teachers have this positive opinion. The students think that the materials are necessary and useful for their professions; and when they use them these materials it contributed to simplifying and concretizing the subjects. S11, who thought that materials are necessary for their profession, said "*I believe that using materials is necessary for understanding and teaching mathematics*". S12, on the other hand, said "*The importance of materials is very important for students to love and understand the lesson*". S9 said "*The teacher must draw the attention of students both with abstract and concrete materials; and make the course become easy and understandable*". The common idea of all pre-service teachers was that the material development process, which is necessary and beneficial for the profession, was explained in the course, the ITMD course must be received by all teacher candidates, and they will definitely recommend this course to friends in lower grades.

The pre-service teachers think that another contribution of materials was that they simplified the courses. S8 said "*…. I saw that the abstract subjects and concepts became more concrete and simplified with materials that I made on my own and we made together with my friends*".

Similarly, another code that was formed by the opinion of pre-service teachers on materials concretizing the courses was concretization. The pre-service teachers, who emphasized the importance of using materials, expressed their positive viewpoints about the material design process, which allowed them to think more on how to concretize the mathematics course that had abstract features, and enabled them to look for ways and methods. S5 said, "*The concretization of courses that are not liked by students, like mathematics and others, is difficult to understand, because*

being abstract plays an important role in teaching the courses. And this process is necessary for us in developing materials as a guide in concretizing subjects and attracting the attention of the students".

Another theme that was based on the analysis of the viewpoints of students was *sufficiency*, which consisted of "*material preparation*", "*material handling*" and "*technological interest*" codes. Some of the students considered themselves to be competent in preparing materials (S1, S2, S3, S4, S6, S7, S9, S11, S12, S13, S14, S15); however, others considered themselves to be sufficient in using materials (S2, S5, S7, S10, S11, S12). Although it was not specifically asked to the students "*Do you consider yourself competent in using materials?*", these students needed to indicate that they were competent especially in using materials. As seen in Table 6, four students (S2, S7, S11, and S12) stated that they considered themselves to be competent in both preparing and using materials. Some students (S3, S4, S6, S9, S12, S13), who considered themselves to be competent in preparing materials, stated that these competencies developed through the ITMD course.

It was noticed that the expression "*after receiving this course*" in the statements of all students was common. In this respect, S6 said, "*Because I think that I have learned enough information from the materials of both myself and my friends after receiving this course*". S9 said, "*I consider myself competent in creating concrete and abstract materials and develop existing materials after receiving this course. Because, I tried to find the answers to questions like 'How must the material be both technically and practically? How must courses be taught by using materials? I believe that I will apply what I learned in these courses in my teaching life*". S12 said, "*After receiving this course, I am very capable of using and developing materials, and I can use both computer and concrete materials in an efficient manner*". This similar statement reflects the common ideas of students on the contribution of information that was provided in the material development process to the competencies of students.

Another code that enabled the students to develop the idea that they were competent may be claimed to be the change of their beliefs about the material development process. S8 expressed his/her opinions at the beginning and at the end of the process as "*When I first received the course, I thought I could not do it. Then I saw the different materials that were made by my friends, and found their missing parts, and started to produce new ideas. I think I can present ideas about a material for an acquisition in mathematics with my current knowledge.* S9 said "*When I first learned that we would receive this course, I thought we would design materials with my classmates without researching for the contents of the course. Then, I was having difficulties when I came to the first classes because I started to feel bored as I was not competent in technology, and we were informed about making and using materials in the first weeks. However, later, I started to feel interested in the course because the internet sites we used started to attract my attention*".

Some student teachers said that there were significant improvements in their technological interests at the end of the process; and they found especially this part of the process very productive. On this subject, S9 expressed his/her opinion as; "*When I first learned that we would receive this course, I thought we would design materials with my classmates without researching the contents, and we would do it in the class. Then, I had difficulties in coming to the first classes because I started to become bored as I was not competent in technology and we were informed about making and using materials in the first weeks. However, I started to become interested in the course because the web sites we used started to attract my attention in the future."*The opinions expressed by the students who did not think they were competent in material development constituted the theme of *Insufficiency*. The expressions that make up this theme were coded as *Design*, *Originality* and *Inexperience* about the acquisitions and the profession. One of the students who stated that s/he was inadequate said that S5 did not consider himself/herself competent because s/he had difficulty in the design process, and S10 stated that the difficulty of preparing an original material was "*I think I was competent to use it, but I do not think that I am competent because it is a highly demanding and labour-intensive stage*". S16 said, "*I consider myself incompetent in developing original concrete materials*". S5, who linked the reason for his/her incompetence to the acquisitions and lack of experimental experience about the profession, said, "*I do not consider myself competent in material development. The main reason for this is that I do not master the acquisitions and because I did not have teachers in secondary and high school with materials, I am inadequate and experimental about how to embody the issues.*"

Although not in the interview questions, some students made some criticisms and suggestions for the process. S12 criticizes the cost and content of materials and said "*I think this course is very important for a pre-service teacher, because materials are important for students to love and understand the course. For this reason, all pre-service teachers must receive this course with interest. However, if I am to criticize this subject, concrete materials must be realistic I think. Now, we organize the carpenter or the furniture shop to produce the materials and spend too much money on them, but when we become actual teachers, we will need sound materials. I think students must be asked to develop such materials*". When the criticism of the student coded as S5 was considered, it is possible to say that it was about the application stage; "*…but this course has been mostly about theoretical knowledge, and I think my theoretical knowledge is not adequate because it is boring and difficult for us to listen for a long time. Practical courses, on the other hand, are very funny. I think they are very successful in teaching the use of new programs we might use in the future. Because we are active in these classes, and learn easily as we learn things by doing.*"

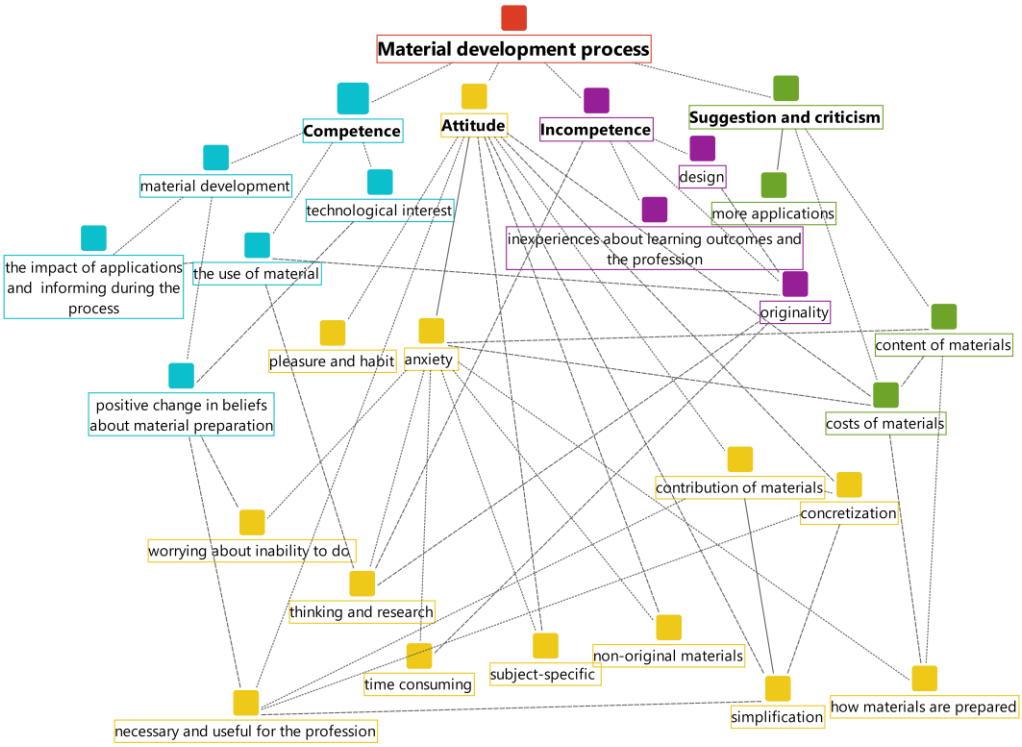

Figure 2. Relational map of the viewpoints of pre-service teachers on material development process

When the relational map that was obtained from the analysis of the viewpoints of the pre-service teachers on the material development process were examined, it is possible to argue that the attitudes and adequacies of the pre-service teachers about material preparation processes changed positively with the effect of the applications and information throughout the process, in other words, after the ITMD course.

It is also possible to argue that the pre-service teachers who had the anxiety for not being able to perform the expected outcomes developed positive attitudes made them develop positive attitudes towards the process with the help of the applications throughout the study. The anxiety of the pre-service teachers about preparing specific materials guide them to think that they are adequate in using the incompetent and ready-made materials and also cause that they think that they are inadequate in developing materials due to the challenges brought by the thinking and research stages of the process. In other words, it is possible to argue that the pre-service teachers who expressed that they were inadequate in preparing materials trusted in themselves for using them. It is possible to claim that how the pre-service teachers prepare materials, the contents and their costs make them feel anxious about the process.

Discussion

The aim of this study is to evaluate the effects of ITMD course on pre-service teachers. In this context, the effects of ITMD course on the attitudes of pre-service mathematics teachers and their efficacy beliefs about using concrete materials were examined and the opinions of pre-service teachers regarding the material preparation process also were examined. As a result of the study, it was determined that there are statistically significant and large differences in the efficacy beliefs of middle school pre-service teachers about using concrete material in mathematics teaching and their attitudes towards the ITMD course. The results obtained from the opinions of the pre-service teachers support this positive change.

It was found that this course affected positively the efficacy beliefs of pre-service mathematics teachers regarding using concrete materials in mathematics education. The finding showed that the efficacy beliefs of the pre-service teachers who received the ITMD course were high. This finding is consistent with the results of similar studies reported in the literature review (Aydogdu-Iskenderoglu, Turk, & Iskenderoglu, 2016; Bakac & Ozen, 2016; Bakkaloglu, 2007; Gokmen, Budak, & Ertekin, 2016; Unlu, 2018). For example, according to the results of the study that was conducted by Gokmen, Budak and Ertekin (2016), the efficacy beliefs of elementary teachers about being competent in using materials were high. Similarly, the pre-service teachers who received the ITMD courses stated that their competences about cognitive and affective domains were high (Guven, 2006).The fact that efficacy beliefs for using concrete materials in mathematics teaching is high and positive shows that pre-service teachers find themselves adequate to use concrete materials in mathematics teaching and they think that they will achieve positive results. The main reason for this is that engagements with course activities within the ITMD course provided an opportunity to develop pre-service teachers' professional experiences.

The result of the present study also showed that the ITMD course positively increased the attitudes of the middle school mathematics pre-service teachers towards the ITMD course. In this respect, the present study produced findings which agree with the findings of the preceding work in the literature (Bakac & Ozen, 2016; Johson, & Howell, 2005). According to this result, it may be argued that the activities that are carried out during the course increased the interest of the pre-service teachers towards the ITMD course, and also affected it in a positive way.

When the relation map obtained from the analysis of the viewpoints of the pre-service teachers on material development process (see figure 2) is considered, it is possible to argue that the attitudes and competencies of the pre-service teachers in the material development process changed positively with the effect of the applications and information provided in the process, in other words, after the ITMD course. This situation explains the significant differences detected between the pre- and post-attitudes towards the course. This result is similar to that reported by Gunes and Iskenderoglu (2014) and Unlu (2017) in their studies. It is possible to argue that the pre-service teachers had the anxiety for not being able to do at the beginning of the process, and later, thanks to the activities carried out in the process, the beliefs that the materials will be necessary and useful for their profession enabled them to develop positive attitudes about the process.

The anxieties of the pre-service teachers about preparing original materials, the difficulties brought by the thinking and research stage of the process, and inadequacy in developing materials made them adopt the idea that they were insufficient in developing materials but competent to use ready-made materials. In other words, it is possible to argue that the pre-service teachers who stated that they were incompetent in preparing materials have confidence in using materials. The fact that the thoughts of the pre-service teachers about how the materials were prepared, contents and costs caused them to be anxious about the process was also among the findings of the study.

It is known that teaching materials concretize abstract concepts facilitating understanding and learning by simplifying contents. It may be argued that pre-service teachers, who develop positive attitudes about material preparation process, share the same idea. The pre-service teachers, who expressed the contribution of materials to learning processed with an emphasis on concretization and simplification, thought that materials would be necessary and useful for their professions. In another study that supported this viewpoint, it was determined that teachers described the materials as objects embodying abstract concepts, facilitating understanding, and enabling students to consider mathematical concepts, and providing practicality and visuality for teaching activities (Ciftci, Yildiz, & Bozkurt, 2015).

On the other hand, it is possible to argue that the learning of web-based and concrete materials together was effective in changing the attitudes of the pre-service teachers after receiving the ITMD course. As it may be seen in the relational map that was obtained from the analysis of the viewpoints of the pre-service teachers on material development process (see figure 2), the ideas of the pre-service teachers that were encoded with the title of “technological interest” were related to the change in their beliefs in material preparation. It is possible to argue that the technology-supported applications pre-service teachers received in the contents of the ITMD course positively affected their efficacy beliefs and attitudes in the process.

Conclusion and Suggestions

The Instructional Technologies and Material Design courses ensures that the basic competence of pre-service teachers, which is to enable students to produce materials and to use them in the most effective way to help them learn effectively, wherever they under any circumstances even under unfavourable conditions, is acquired by pre-service teachers and help them to produce materials and use them effectively. In this context, the criticisms of pre-service teachers focus on the contents of the materials. The criticism of the pre-service teachers is that the materials are usually made by carpenters and cost more. In order to resolve this, fully equipped workshops may be opened to the use of pre-service teachers in educational faculties. In order to provide a more effective and functional course of ITMD in faculties, the content of the course should be revised. Thus, it should be ensured that pre-service teachers are better equipped in planning, preparation, implementation and evaluation of instructional material. In addition, in order to use the materials prepared by pre-service teachers in classrooms, cooperation with school should be provided. In this way, it should be ensured that the pre-service teachers would realize the missing and inappropriate aspects of the material.

It is thought that elective lesson of Material Design in Mathematics Teaching should be compulsory in teacher education program in order for pre-service teachers to develop positive attitudes towards using material. It is also suggested that it would be suitable for pre-service teachers to prepare teaching materials for their own major by using applications such as computer-based education, web-based education, e-diary, e-portfolio in order to develop a higher efficacy beliefs about ITMD course.

It is considered that increasing the number of qualitative studies that reflect the viewpoints of pre-service teachers as well as quantitative study designs to determine whether the course is conducted effectively, will contribute to more effective processing of this course. It must be ensured that pre-service teachers are encouraged to design, develop and apply various materials that are specific to this field for teaching at schools in the scope of teaching practice. In this way, it can be ensured that the self-efficacy of pre-service teachers on using materials can be determined by defining which materials are efficient and inefficient in which subjects in mathematics lessons.

References

Acer, D. (2011). A study on the viewpoints of preschool pre-service teachers on design of instructional materials course. *Elementary Education Online, 10*(2), 421-429.

Apperson, J. M., Laws, E. L., & Scepansky, J. A. (2006). The impact of presentation graphics on students' experience in the classroom.*Computers and Education*, *47*(1), 116-126.

Aydin-Unal, Z., & Ipek, A. S. (2009). Gercekci Matematik Egitiminin Ilkogretim 7.Sinif Ogrencilerinin Tam Sayilarla Carpma Konusundaki Basarilarina Etkisi [The effect of realistic mathematics education on 7th grade students' achievements in multiplication of integers]. *Education and Science, 34*(152), 60-70.

Aydogdu-Iskenderoglu, T., & Taskin, D. (2015). Ilkogretim matematik ogretmeniadaylarinin ozel ogretim yontemleri dersinde somut materyalleri secme ve kullanma nedenleri [Reasons of pre-service elementary mathematics teachers' selecting and using concrete manipulatives in special teaching methods course]. *Journal of Ziya Gokalp Faculty of Education,* (25), 215-237. http://dx.doi.org/10.14582/DUZGEF.635

Aydogdu-Iskenderoglu, T., Turk, T., & Iskenderoglu, M. (2016). Ilkogretim matematik ogretmeni adaylarinin somut materyalleri tanima-kullanma durumlari ve matematik ogretiminde kullanmalarina yonelik oz-yeterlikleri [Pre-service elementary mathematics teachers' awareness of ability to use concrete materials and their self-efficacy in the usage thereof in mathematics education]. *Mehmet Akif Ersoy University Journal of Education Faculty,* (39), 1-15.

Bakac, E., & Ozen, R. (2016). Ogretmen adaylarinin ogretim teknolojileri ve materyal tasarimi dersine yonelik tutumlari, yaraticilik algilari ve oz-yeterlik inanclari arasindaki iliski [The relationship between preservice teachers' attitudes towards instructional technology and material design course, creativity perceptions and self-efficacy beliefs]. *Journal of Abant Izzet Baysal University Faculty of Education, 16*(1), 41- 61.

Bakkaloglu, E. (2007). *Preservice elementary mathematics teachers' efficacy beliefs about using manipulatives in teaching mathematics* (Unpublished master's thesis). Middle East Technical University, Ankara, Turkey.

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

Boggan, M., Harper, S., & Whitmire, A. (2010). Using manipulatives to teach elementary mathematics. *Journal of Instructional Pedagogies, 3*(1), 1–6.

Bozkurt, A. & Akalin, S. (2010). Matematik ogretiminde material gelistirmenin ve kullaniminin yeri, onemi ve bu konuda ogretmenin rolu [The importance of material development and use in mathematics education and the role of the teacher]. *Dumlupinar University Journal of Education, (27)*, 47-56.

Bulut, S. (2004). *Ilkogretim programi yeni yaklasimlar matematik (1-5 sinif)* [Elementary curriculum new approaches mathematics 1-5 grade]. Ankara, Turkey: Ministry of National Education Publications.

Buyukozturk, S. (2007). *Sosyal bilimler icin very analizi el kitabi* [A booklet of data analysis for social sciences]. Ankara, Turkey: PegemA.

Cabi, E., & Ergun, E. (2016). Ogretmen adaylarinin egitim teknolojilerinin kullanimina yonelik kaygilari uzerine boylamsal bir calisma [The impact of instructional technologies and material development course on the pre-service teachers' concern about using educational technologies]. *Baskent University Journal of Education*, *3*(1), 37-43.

Carbonneau, K. J., Marley, S. C., & Selig, J. P. (2013). A meta-analysis of the efficacy of teaching mathematics with concrete manipulatives. *Journal of Educational Psychology*, *105*(2), 380-400. https://doi.org/10.1037/a0031084.

Cass, M., Cates, D., Smith, M., & Jackson, C. (2003). Effects of manipulative instruction on solving area and perimeter problems by students with learning disabilities. *Learning Disabilities Research & Practice, 18*(2), 112-12.

Cenberci, S., &Yavuz, A. (2018). The correlation between the creative thinking tendency of mathematics pre-service teachers and their attitudes towards instructional technologies and material design lesson. *World Journal of Education, 8*(3), 95-106.

Cetin, B., Bagceci, B., Kinay, I., & Simsek, O. (2013). Ogretim teknolojileri ve material tasarimi dersine yonelik tutum olceginin(OTMTDYTO) gelistirilmesi: Gecerlik ve guvenirlik calismasi [Development of attitudes towards instructional technologies and material development course scale (ATITMDCS): a study of validity and reliability]. *The Journal of Academic Social Science Studies, 6*(2), 697-713.

Ciftci K., Yildiz P., & Bozkurt E. (2015). Ortaokul matematik ogretmenlerinin material kullanimina iliskin gorusleri [Middle school mathematics teachers' opinions about using material]. *Journal of Educational Policy Analysis, 4*(1), 79-89.

Clements, D. H., & McMillen, S. (1996). Rethinking concrete manipulatives. *Teaching Children Mathematics, 2*(5), 270-279.

Dienes, Z. P. (1973). *Mathematics through the senses, games, dance, and art.* Windsor, UK: The National Foundation for Educational Research Publishing Company Ltd.

Erbas, A. K., Kertil, M., Cetinkaya, B., Cakiroglu, E., Alacaci, C., & Bas, S. (2014). Mathematical modeling in mathematics education: Basic concepts and different approaches. *Educational Sciences: Theory & Practice, 14*(4), 1-21.

Gokmen, A., Budak, A., & Ertekin, E. (2016). Ilkogretim ogretmenlerinin matematik ogretiminde somut materyal kullanmaya yonelik inanclari ve sonuc beklentileri [Elementary teachers' beliefs about using manipulatives and outcome expectations in teaching mathematics]. *Kastamonu Education Journal, 24*(3), 1213-1228.

Gunduz, S., & Odabasi, F. (2004). Bilgi caginda ogretmen adaylarinin egitiminde Ogretim Teknolojileri ve Materyal Gelistirme dersinin onemi [The importance of instructional technologies and material development course at pre-service teacher education in information age]. *The Turkish Online Journal of Educational Technology, 3*(1), 43-48.

Gunes G., & Iskenderoglu T. A. (2014). Ilkogretim matematik ogretmeni adaylarinin ogretim teknolojileri ve material tasarimi dersine yonelik yaklasimlari [Attitudes of pre-service primary school mathematics teachers towards instructional technologies and material design lesson]. *Journal of Gazi University Faculty of Education, 34*(3), 469-488.

Gurbuz, R. (2010). The effect of activity-based instruction on conceptual development of seventh grade students in probability. *International Journal of Mathematical Education in Science and Technology*, *41*(6), 743–767.

Guven, S. (2006). Ogretimteknolojilerivemateryalgelistirmedersininkazandirdigiyeterlikleryonundendegerlendirilmesi [The evaluation of teaching technologies and materials development course in terms of competencies it provides]. *Turkish Journal of Educational Sciences, 4*(2), 165-179.

Higher Education Council. (2018). Ogretmen Yetistirme Lisans Programlari, Egitim-Ogretim Dairesi Baskanligi [Teacher education programs, Department for teaching and learning]. Retrieved from https://www.yok.gov.tr/kurumsal/idari-birimler/egitim-ogretim-dairesi/yeni-ogretmen-yetistirme-lisans-programlari.

Johson, G., & Howell, A. (2005). Attitude toward instructional technology following required versus optional webct usage. *Journal of Technology and Teacher Education, 13*(4), 643-654.

Isiksal, M. (2010). The relationship among mathematics teaching efficacy, math anxiety and mathematical self-concept. The case of Turkish pre-service elementary teachers. *The Asia-Pacific Education Researcher*, *19*, 501-514.

Karatas, S., & Yapici, M. (2006). Ogretim teknolojileri ve material gelistirme dersinin islenisi ve uygulama ornekleri [The process and application samples of teaching technologies and material development]. *Afyon Kocatepe University Journal of Social Sciences, 8*(2), 311-325.

Kelly, A. C. (2006). Using manipulatives in mathematical problem solving: a performance- based analysis. *The Montana Mathematics Enthusiast, 3*(2), 184-193.

Kul, U. (2018). Influences of technology integrated professional development course on mathematics teachers. *European Journal of Educational Research, 7*(2), 233-243. https://doi.org/10.12973/eu-jer.7.2.233

Kul, U., Aksu, Z., & Birisci, S. (2019). The relationship between technological pedagogical content knowledge and Web 2.0 self-efficacy beliefs. *International Online Journal of Educational Sciences, 11*(1), 198-213.

Kul, U., Celik, S., & Aksu, Z. (2018). The impact of educational material use on mathematics achievement: A meta-analysis. *International Journal of Instruction*, *11*(4), 303-324.

Lesh, R., Post, T., & Behr, M. (1987). *Representations and translations among representations in mathematics learning and problem solving*. In C. Janvier (Ed.), Problems of representation in the teaching and learning of mathematics (pp. 33-40). New Jersey, NJ: Lawrence Erlbaum Associates.

Martin, T., & Schwartz, D. L. (2005). Physically distributed learning: Adapting and reinterpreting physical environments in the development of fraction concepts. *Cognitive Science, 29*(4), 587-625.

Ministry of National Education. (2018). *1-8 Matematik dersi ogretim programi* [1-8 Grade Mathematics curriculum]. Ankara, Turkey: MEB.

Moyer, P. S. (2001). Are we having fun yet? How teachers use manipulatives to teach mathematics. *Educational Studies in Mathematics, 47*(2), 175-197.

National Council of Teachers of Mathematics. (2000). *Principles and Standards for School Mathematics.* Reston, VA: National Council of Teachers of Mathematics.

Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research, 62*(3), 307-332.

Piskin-Tunc, M., Durmus, S., & Akkaya, R. (2012). Ilkogretim matematik ogretmen adaylarinin matematik ogretiminde somut materyalleri ve sanal ogrenme nesnelerini kullanma yeterlikleri [Competence of elementary mathematics pre-service teachers to use concrete materials and virtual learning objects in mathematics teaching]. *Journal of Mathematics Education, 1*(1), 13-20.

Saka, A. Z., & Saka, A. (2005). Ogretmen adaylarinin ogretim teknolojileri ve material gelistirme dersinde mesleki becerilerini gelistirme duzeyi: Sakarya ornegi [The level of pre-service teachers' professional skills development in instructional technologies and material development course: The case of Sakarya]. *Journal of Sakarya University Faculty of Education,* (10), 81-177.

Sherman, J., & Bisanz, J. (2009). Equivalence in symbolic and nonsymbolic contexts: Benefits of solving problems with manipulatives. *Journal of Educational Psychology*, *101*(1), 88-100.

Skaalvik, E. M., & Skaalvik, S. (2010). Teacher self-efficacy and teacher burn put: A study of relations. *Teaching and Teacher Education, 26*(4), 1059-1069.

Umay, A. (2001). Effect of primary school mathematics teacher's program on mathematics self-efficacy perception. *Journal of Qafqaz University, 8*(1), 1-8.

Unlu, M. (2017). Pre-service mathematics teachers' views about using instructional materials in mathematics lessons. *Journal of Theory and Practice in Education, 13*(1), 10-34.

Unlu, M. (2018). Effect of micro-teaching practices with concrete models on pre-service mathematics teachers' self-efficacy beliefs about using concrete models. *Universal Journal of Educational Research, 6(*1), 68-82.

Uzunoz, A., Aktepe, V., & Gunduz, M. (2017). Ogretim teknolojileri ve material tasarimi dersinin, mesleki acidan kazandirdiklarina iliskin ogretmen adaylarinin gorusleri: Nitel bir calisma [Candidate teachers' views on professional achievements in instructional technologies and material design a qualitative study]. *Journal of Qualitative Research in Education, 5*(3), 317-339.

Yetkin-Ozdemir, E. (2008). Sinif ogretmeni adaylarinin matematik ogretiminde materyal kullanimina iliskin bilissel becerileri [Prospective elementary teachers' cognitive skills on using manipulatives in teaching mathematics]. *Hacettepe University Journal of Education,* 35*(35)*, 362-373.

Yildirim, A., Ozgurluk, B., Parlak, B., Gonen, E., & Polat, M. (2016). *TIMSS 2015 Ulusal matematik ve fen bilimleri on raporu 4. ve 8. Siniflar* [TIMSS 2015 National Mathematics and Science preliminary report 4th and 8th grades]. Retrieved from https://odsgm.meb.gov.tr/meb_iys_dosyalar/2017_06/23161945_timss_2015_on_raporu.pdf