VIRTUAL OR PHYSICAL: In-service and Pre-Service Teacher's Beliefs and Preferences on Manipulatives

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ABSTRACT

Although the use of physical manipulatives, which have been emphasized to use in preschool education program and primary and secondary mathematics curriculum, in classroom environments is old, it is very new to use virtual manipulatives in classroom environments. The selection, preparation, and the integration to learning environments of both types of manipulatives are the most basic duties of teachers. However, the experiences, of using the physical and virtual manipulatives in course environments, of teachers and pre-service teachers are influenced by beliefs about the nature, teaching and learning of mathematics. The aim of this study is to determine and compare the beliefs of teachers and pre-service teachers in different branches for the use of virtual and physical manipulatives in mathematics education. For this purpose, 148 teachers, in the provinces of Trabzon, Kars and Gümüşhane, and 228 pre-service teachers, in the Education Faculties of Karadeniz Technical University and Kafkas University, have been applied two types of scales and interviews have been conducted with 40 teachers and pre-service teachers selected from that sample. Frequencies, percentages and arithmetic averages have been used to analyze the data. As a result, the majority of teachers and pre-service teachers have been identified to carry positive beliefs for the use of virtual and physical manipulatives in mathematics education and they have expressed that they desire to use both types of manipulatives more in the future.

Keywords: **Mathematics education, belief, virtual and physical manipulatives, teachers and pre-service teachers.**

INTRODUCTION

Manipulatives are defined as "*objects that appeal to several senses and that can be touched, moved about, rearranged, and otherwise handled by children*" (Kennedy, 1986; p. 6). Stein & Bovalino (2001) has said that manipulative are one of the ways to make mathematics learning more expressive for students.

Moyer (2001) has pointed out that manipulatives are materials constructed to symbolize explicitly and concretely abstract mathematical ideas. Similarly, Gagnon & Maccini (2001) identified manipulative as objects that students physically handle to symbolize mathematical concepts and relationships.

Thus, Moyer (2001) and Moyer & Jones (2004) have underlined that both virtual and physical manipulatives support the understanding of the learners.

The researches by Marzano (1998) and Sowell (1989) have supported that Physical Manipulative (PMs) are basic tool for mathematical teaching. McNeil & Jarvin (2007) have identified that PMs are tangible objects which students use to discover mathematical concepts via visual and tactile senses of them. NTCM (2000) has declared that PMs which include an echelon of items such as tangrams, number cubes, 3-D models, and etc. are objects to be processed and arranged by students and teachers that are used to convey intangible ideas or notions by modeling or representing their ideas perceptibly. Clement (1999) have discussed that PMs are helpful for students to construct, reinforce and connect several representations of mathematical ideas that are meaningful for the learner, encourage control and elasticity to the learner. In addition, PMs include mathematical tools, designed especially for this aim, such as objects and pictures, which embody abstract mathematical concepts, and real life objects (Van de Walle, 2007). However, these manipulatives are adopted as objects that can be touched and moved about (Hacıömeroğlu & Apaydın, 2009). PMs are objects that help in understanding the mathematical conceptions more explicitly and concretely (Moyer, 2001). The use of PMs helps students to understand the concepts more easily by providing the expression of the mathematical concepts concretely (Bulut, Çölekoğlu, Seçil, Yıldırım &Yıldız, 2002) and encourages students to think by themselves, and submits various opportunities to students for problem solving, and increases the self-confidence of the students, and provides them the possibility to make their own decisions. In addition, PMs provide the opportunity to students to enrich their visions together with their peers (Kamii & Lewis, 1990; Özdemir, 2008; Williams & Kamii, 1986).

Recent developments for information and communication technologies submit many new opportunities that are augmenter for the comprehending levels of students in learning and teaching processes by providing the mathematical concepts to be embodied and interrogated. Especially in courses such as mathematics where abstract concepts and relationships are discussed, developing computer software referred as "Virtual Manipulatives (VMs)", in substantiating these concepts and relationships, becomes important (Karakırık, 2008).

VMs are assumed to be helpful in developing the abilities, to understand better the concepts, to make comments on concepts and to use concepts in problem solving, of the students in pre-school and primary school period when mathematical concepts are supposed to be at the level of concrete perception via embodying by modeling in computer environment (Durmuş & Karakırık, 2006). In this regard, VMs are practical materials that are offered as interactive tools that interact with in an imaginary environment and click and drag to move the materials into intended locations. Besides, VMs are frequently active visual/pictorial copies of PMs. In their study, Moyer, Bolvard & Spikell (2002, p. 373) have described that "*an imaginary manipulative is best determined as an interactive, Web-based visual symbolization of an active object that provides opportunities for building mathematical knowledge. Now, VMs are simulated on tangible manipulatives usually utilized in schools… Nevertheless, their ability to be utilized internationally- that is, to permit the user to prosecute and control the physical actions of these objects- compounded with the opportunities that they provide to explore and build mathematical principles and relationships, differentiates them as VMs***". Lots of studies have corroborated the sensed profits of VMs. Clements & McMillen (1996), Heath (2002), and Moyer & Bolvard (2002) have concluded that one of the most important profits is their availability online.**

It has been pointed out in the study of Moyer et al (2002, p. 375) that "... ***accessing many VMs on the web is advantageous, thereby it allows online schools to access freely, busy teachers and students, who have limited time to use these sites during class, to reach them permanently"*****.**

Moreover, VMs are skillful in doing things that are almost impossible with PMs, pencil and paper, or other tool (Clements, 2002; Clements & McMillen, 1996; Crawford & Brown, 2003; Forster, 2000). Additionally, as VMs ensure students with abrupt, amendatory feedback, this ability makes VMs appropriate to interrogate-based learning and problem solving (Clements & McMillen, 1996; Crawford & Brown, 2003; Durmuş & Karakırık, 2006; Suh & Moyer, 2005). Diverse pedagogical utilities of VMs enable to ensure multiple submissions of a single concept simultaneously (Clements & McMillen, 1996; Heath, 2002; Moyer & Bolvard, 2002; Suh &Moyer, 2005).

There are a number of reasons, affecting to the integration of manipulatives to mathematics classes, originated from teacher, student, environment and administration (Baki, 2000; Forgazs & Prince, 2001). Reasons, originated from teacher, can be arrayed as accessibility for suitable teaching materials, technical support, and information how the technology will be integrated to mathematical education, that computer-aided education becomes a need, experiences of teachers, attitudes and beliefs of teachers and so on (Fine & Fleener, 1994; Forgazs & Prince, 2001; Manoucherhri, 1999; Simonsen & Dick, 1997; Walen, Williams & Garner, 2003).

However, teachers' beliefs are considered as the most important reason (Simonsen & Dick, 1997). Beliefs are individualistic comprehensions, guiding their actions, of the individuals that they consciously or unconsciously have. According to Ernest, comprehensions, values, ideology, tendencies of the individual are components which generate the belief (Ernest, 1989). Thompson (1984) has put forth that the beliefs, which they consciously or unconsciously have, points of view and choices of mathematics teachers have an important role in shaping the behaviors during the period of education.

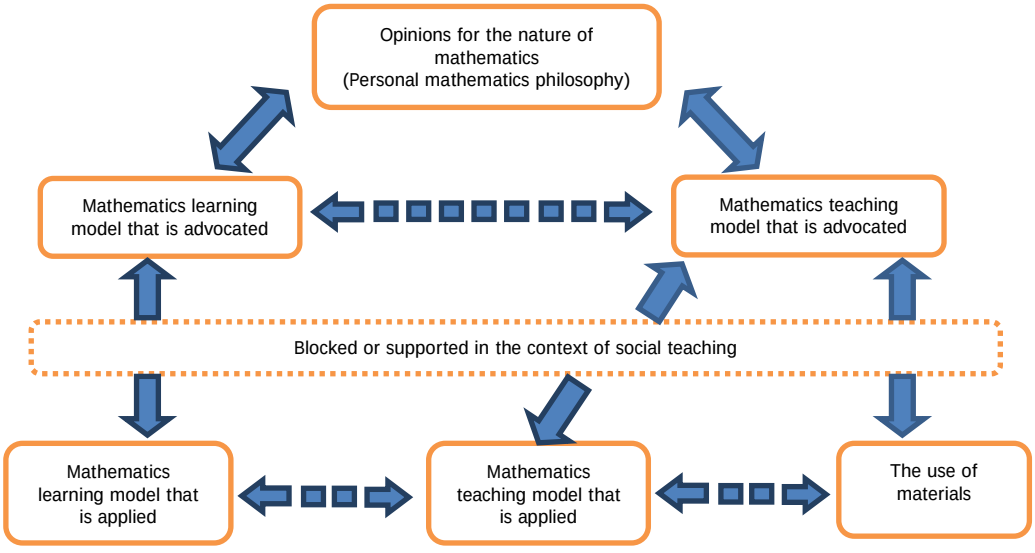


Figure: 1
Relationships between beliefs and effects of the beliefs on practices (Ernest, 1991)

Ernest (1991) handles the beliefs of mathematics teachers under three main titles: opinions or insights about the nature of mathematics, beliefs about the nature of teaching mathematics, beliefs about learning of mathematics. The belief that teacher has about the teaching of mathematics shapes the understanding of the teacher about his role in the class. As a result of his belief, teacher may adopt didactic, descriptive or facilitator roles (Ernest, 1991). However, belief of the teacher about mathematics learning is the key of a student-centered education approach. Model for relationships between beliefs and relationships on instructional practices of Ernest has been shown in Figure: 1.

As you see in the figure, beliefs of the teachers about the nature, teaching and learning of mathematics are arbiter of their in-classroom practices and use of manipulatives.

Consequently, experiences of teachers and pre-service teachers to use of VMs and PMs in the classroom are affected by these beliefs as well. By the help of this study, it has been aimed to define and compare the beliefs, of pre-school, classroom, primary mathematics and secondary mathematics teachers and pre-service teachers, for the use of VMs and PMs in mathematics education.

METHOD

Sample

Sample of the study consists of teachers, who have worked in the provinces of Trabzon, Kars and Gümüşhane in the academic years of 2009-2010 and 2010-2011, and pre-service teachers, who attend in the Education Faculties of Karadeniz Technical University and Kafkas University.

The scales have been administered to 148 teachers and 228 pre-service teachers for the purpose of the study. Later, interviews have been conducted with 40 teachers and pre-service teachers who were homogeneously selected based on a voluntary basis and as a result of informal interviews, but interviews, that belong to 16 teachers and pre-service teachers, have been assessed in the study.

Distribution of these teachers and pre-service teachers according to branches and data collecting tools has been presented in Table: 1.

Table: 1
Distribution of these teachers and pre-service teachers

Instruments	Scales		Interviews	
Branches	Pre-service Teachers (PTs)	Teachers (Ts)	Pre-service Teachers (PTs)	Teachers (Ts)
Pre-school	42	35	PT_1, PT_2, PT_3	T_1, T_2, T_3
Classroom(Elementary)	92	54	PT_4, PT_5, PT_6	T_4, T_5, T_6
Primary Mathematics	52	32	PT_7, PT_8, PT_9	T_7, T_8, T_9
Secondary Mathematics	42	27	PT_{10}, PT_{11}, PT_{12}	T_{10}, T_{11}, T_{12}
Total	228	148	12	12

Process

VMs that have been used in the study are the manipulatives that were submitted in the website of NVLM (National Library of Virtual Manipulatives-http://nvlm.usu.edu); PMs are materials from kindergartens, elementary schools, primary and secondary schools and, designed and bought by the researcher. Some of these VMs and PMs have been given in Figure: 2.

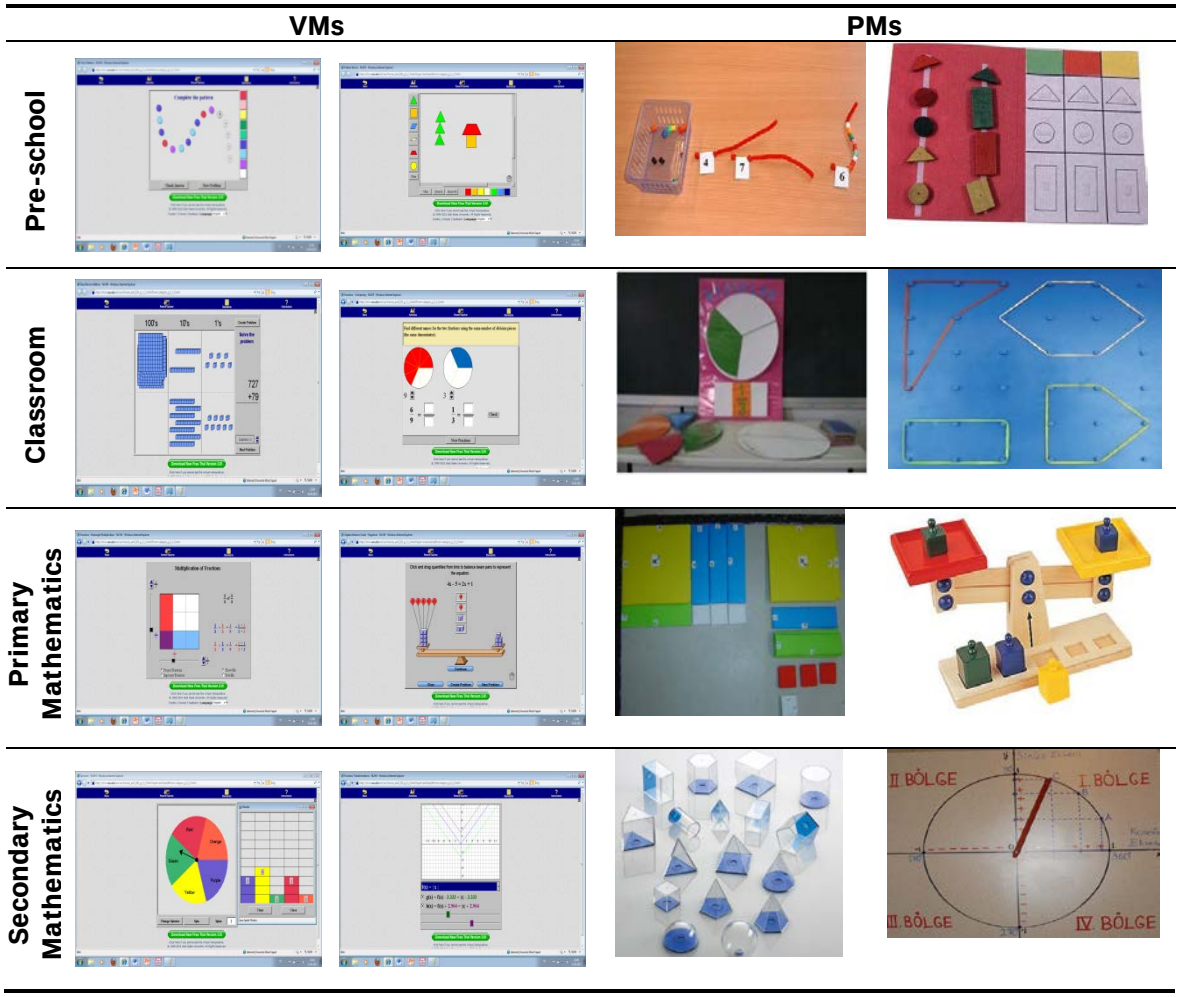


Figure: 2
Some VMs and PMs that have been used by teachers and pre-service teachers

Pre-service teachers have used the both manipulatives, which were chosen or prepared, in the courses of Material Development, Mathematics Education, Mathematics Teaching and Special Teaching Methods; teachers have used them in the courses of Mathematics and in leisure times.

Pre-service teachers have received theoretical information on material development in the first three weeks of Material Development course; and they have developed PMs on learning areas, mentioned above, in next weeks. Later, pre-service teachers have used those PMs in related learning areas of the courses of Mathematics Education, Mathematics Teaching and Special Teaching Methods.

In addition, pre-service teachers have been taken to computer lab in the fourth and fifth weeks of the course of Material Development in order to that they can recognize computer-aided teaching materials. Pre-service teachers have been introduced websites such as NVLM (National Library of VirtualManipulatives- http://nvlm.usu.edu),RainforestsMath http://www.rainforestsmaths.com), Illuminations (http://illuminations.ntcm.org), Vitamin (http://vitaminegitim.com), and Learning Objects (http://ogrenme nesneleri.com) and they have been asked to examine and use the VMs in the website of NVLM, which is especially shown as one of the best websites in the world and can be easily reached and used online.

However, PMs, which were developed by pre-service teachers in the course of Material Development, and were bought by the researcher and were available in schools, have been provided to be used by teachers in math classes for one semester. But, these instructions below have been respectively followed for the use of VMs by teachers: The names of the websites, mentioned above, have been distributed to the teachers in the first week of the term, they have been asked to examine these websites and a rendezvous has been done for one week later. In the second week, NVLM website has been introduced as online to teachers in computer labs by visiting their schools and they have been asked to examine the VMs especially suitable for their own branches. In addition, they have been asked to choose ten manipulatives from NVLM website for that they will use in their next math classes. In subsequent weeks, they have been provided to utilize these manipulatives as online for eight lessons in computer lab under the supervision of researcher. Towards the end of the term, scales have been implemented in order to determine the beliefs of teachers and pre-service teachers for the use of VMs and PMs in mathematics education and, interviews have been conducted with teachers and pre-service teachers, who were chosen.

Instruments

The beliefs of teachers and pre-service teachers can be classified as beliefs related to the nature of the mathematics, teaching mathematics and learning mathematics (Ernest, 1991). In the literature, scales, which were developed for determining the beliefs of mathematics teachers, have been seen to be designed basing these three components (Çakıroğlu, Güven & Akkan, 2008). On the other hand, the scale, which was developed in the study, has been formed on two components; evaluation of these beliefs has been handled for the environments which contain VMs and PMs. Assessment tools are prepared as theoretical form-experimental form or solely theoretical form in the period of scale development (Yurdagül, 2005).

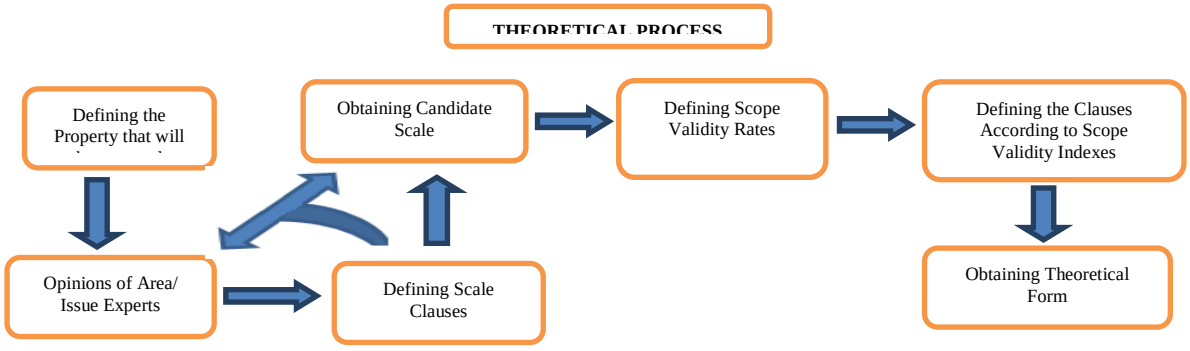


Figure: 3
Theoretical form that is used in the period of scale development

It has been benefited from theoretical form in accordance with expert opinions during scale development process in the study where there is no experimentation. Schematic explanation of the theoretical form, which was used in the period of scale development, has been expressed as follows by Yurdagül (2005) in Figure: 3

In this context, scales, which were developed in order to determine the beliefs of teachers in the literature for mathematics education and sources, have been examined after determining the property that will be assessed (Albirin, 2006; Çakıroğlu, Güven and Akkan, 2008; Stipek, Givvin & Salmon, 2001; Wu, Hsu & Wang, 2007). After this survey, interviews have been conducted by two expert faculty members, who serve in the Fatih Faculty of Education-Karadeniz Technical University and, have studies on computer-aided mathematics teaching and the beliefs of teachers, about the content, that is needed to have, of "Belief Scale of Teacher and Pre-service Teacher for The Use of VMs and PMs in Mathematics Education". After these interviews, researchers have determined the scale items. A support has been taken from Turkish Education Department of the same faculty during the lettering this 42-items candidate scale. Next step for theoretical process is defining content validity rates. Lawshe technique has been benefited in the process of defining content validity rates. This technique includes six steps (Yurdagül, 2005): 1) Forming the group of field experts, 2) Preparing the candidate scale forms, 3) Evaluating the opinions of experts, 4) Obtaining the content validity rates for items, 5) Obtaining the content validity indexes for scale, 6) Forming the final form according to the criteria of content validity rates/indexes. In this context, implementations below have been done in the process of developing the scale;

1. Field experts group of this study has included 6 faculty members –who are serving for the Faculties of Education in Kafkas University and Karadeniz Technical University and, have enough accoutrement and knowledge in the field- and 8 postgraduates –who do doctorate in the mathematics education field in the same universities, did their master's degree in the field of mathematics education and, directed their searches to mathematics teacher education.

2. 42-items candidate scale forms, which were previously prepared in accordance with expert opinions and literature, have been rearranged about to be presented to experts. In this context, experts; have been asked to state what kind of arrangements should be done in the clause so as to that target group can better understand the clause: The final forms for the items have been done by the help of the arrangements that were done by the experts. Have been asked to state whether the clause can take place in the factor that was previously determined or not: For that, the experts have been asked to put (+) for yes and (-) for no. As a result of the evaluations of the experts, it has been identified that all of 42 items can take place in the factors, which were previously determined. Have been asked to state whether the clause can represent the feature that will be assessed: For that, each clause of the scale, which was prepared for experts, has been gradated as "Necessary", "Beneficial but insufficient" and "Unnecessary", and, experts have been asked to gradate for each of the items.

3. After collecting the forms from the experts, the answers of the experts have been incorporated in only one form. The incorporation of experts' opinions is to show totally how many experts have given approval for possible answers of each clause.

4. In the next step of Lawshe technique, content validity rates for each clause have been determined. Content validity rates are connoted by 1 minus of the ratio to half of expert number who determines "Necessary" opinion for each clause to the total number of experts who makes statement for the clause (Baykal, 1994). Minimum value of content validity rates in alpha for 14 experts= 0, 05 significance level has been stated as 0, 51 by Veneziano & Hooper (1997). As content validity rates of 8 items are smaller than 0, 51 value in the scale that was designed as 42 items, they have been omitted from the scale.

5. After obtaining content validity rates and omitting 8 items from the scale, content validity indexes have been obtained by taking arithmetic averages of content validity rates of items in each part. As content validity rates- which have been obtained for each part- are bigger than 0, 51 value that was determined for 14 experts, it has been concluded that content validity of "Belief Scale of Teacher and Pre-service Teacher for The Use of VMs and PMs in Mathematics Education" is statistically significant. After this process, final version of "Belief Scale of Teacher and Pre-service Teacher for The Use of VMs and PMs in Mathematics Education" has been obtained. In addition, Croncbach Alpha value for all of the scale has been calculated as 0, 81 by using the data that were obtained at the end of the implementation. Sub-sections in 5-option Likert type scale have been given below:

- **1st Part: In this part where there are beliefs for learning mathematics, there are 22 items for determining the effect of VMs and PMs on learning mathematics.**
- **2nd Part: This part, where beliefs for the use of VMs and PMs in teaching mathematics are handled, consists of 10 items.**

Also, *"Preference Scale"*, which has been prepared literature-assisted and has consisted of 9 questions, has been prepared for searching types of manipulatives that teachers and pre-service teachers have preferred (Drickey, 2000; Suh, 2005). Items of preference scale have been given below in Table: 2.

Table: 2
Items related to preference scale

	Items of preference scale
1	I want to use these manipulatives much more in the future
2	Teaching mathematics by the help of these manipulatives is a good method
3	Understanding how these manipulatives work is enjoyable
4	Using these manipulatives is boring
5	Dealing related problem by using these manipulatives resembles doing puzzles
6	I want to have much more time to use types of these manipulatives
7	Learning and teaching by using these manipulatives is interesting and amusing
8	I can make activities do easily by using these manipulatives
9	These manipulatives cause me feel irritated and insecure

However, 40 teachers and pre-service teachers have been asked two interviews questions (1. Which manipulatives do you think are more suitable for mathematics education? Explain the reason, 2. Explain with the reasons how VMs and PMs will help you in mathematics education) in order to search manipulatives that they have preferred and reasons to prefer these manipulatives.

Data Analysis

Frequencies and percentages of the answers that teachers and pre-service teachers gave to scale items have been primarily calculated in this study, which aims to examine the beliefs of teachers and pre-service teachers for the use of VMs and PMs in mathematics courses. In transferring items in data collection tool to computer, responses to the five Likert expressions have been scored as "Strongly Agree (SA), 5", "Agree (A), 4", "Partly Agree (PA), 3", "Disagree (D),2", "Strongly Disagree (SD),1". By the help of scores to responses, arithmetical average of each clause has been calculated and commented. In addition, 16 has been chosen from dialogues those were obtained from interviews with 40 teachers and pre-service teachers and, it has been directly given place in the part of findings to citations from these dialogues in terms of submitting a descriptive and realist picture to reader and giving an opportunity of making their own comments.

RESULTS

In this part, findings, related to the beliefs of mathematics teachers and pre-service teachers in different branches for the use of VMs and PMs in mathematics education, have been respectively presented.

Table: 3

Arithmetical average values including answers to above mentioned items

	Pre-school				Classroom				Primary Mathematics				Secondary Mathematics			
	PTs		Ts		PTs		Ts		PTs		Ts		PTs		Ts	
Scale Iems	X_{PM}	X_{VM}	X_{PM}	X_{VM}	X_{PM}	X_{VM}	X_{PM}	X_{VM}	X_{PM}	X_{VM}	X_{PM}	X_{VM}	X_{PM}	X_{VM}	X_{PM}	X_{VM}
I have previous information about these kinds of manipulatives	3,53	1,01	3,77	1,12	2,79	1,07	3,45	1,17	2,98	1,06	3,32	1,21	2,92	1,12	3,23	1,24
I have used these kinds of manipulatives	2,04	0,87	2,23	0,83	1,86	0,87	2,13	0,98	1,55	1,01	1,98	1,05	1,42	1,08	2,37	1,13
I want to use these kinds of manipulatives again and again	4,46	4,53	4,43	4,39	4,53	4,57	4,55	4,63	4,43	4,55	4,35	4,53	4,23	4,68	4,33	4,75

But before going on the scale items about learning and teaching, findings- which were obtained from two items for determining whether teachers and pre-service teachers previously had information about VMs and PMs or not and, whether they previously used those manipulatives or not- have been examined in the items that were submitted to the sample. Arithmetical average values including answers to these items have been given in Table: 3

By teachers and pre-service teachers indicate that they have used PMs much more than VMs and they have had much more information about PMs, arithmetical averages of teachers in four different branches are more than pre-service teachers. Then, teachers who are more experienced and have more knowledge about manipulatives have mostly used PMs and VMs. Also, both of teachers and pre-service teachers (except pre-school teachers) have expressed that they used VMs less in comparison with PMs and they want to use VMs much more in the future.

Table: 4
Arithmetical average values of answers to 22 items

		Pre-school				Classroom				Primary Mathematics				Secondary Mathematics			
		PTs				PTs		Ts		PTs		Ts		PTs		Ts	
	Learning Mathematics	X_{PM}	X_{VM}	X_{PM}	X_{VM}	X_{PM}	X_{VM}	X_{PM}	X_{VM}	X_{PM}	X_{VM}	X_{PM}	/M	X_{PM}	X_{VM}	X_{PM}	X_{VM}
1	Manipulatives prompt students to memorization	2,53	2,85	2,33	2,95	2,45	2,87	2,23	2,63	2,18	2,52	2,08	38	2,08	2,33	2,03	2,28
2	Manipulatives support students to learn for their individual needs	4,18	4,03	4,23	4,05	4,05	3,98	4,11	4,03	3,98	3,85	4,01	88	3,88	4,01	3,98	4,08
3	Students improve their mathematical skills by the help of manipulatives	4,02	4,20	4,06	3,98	4,08	4,13	4,18	4,22	4,08	4,18	4,12	32	4,03	4,29	4,18	4,57
4	Manipulatives prompt students to searching	4,02	4,08	4,05	4,13	3,95	4,08	4,04	4,13	4,04	4,18	4,15	38	4,03	4,28	4,08	4,43
5	Manipulatives affect students' attitudes for mathematics positively	4,08	4,02	4,14	4,08	3,67	3,73	4,23	4,34	4,08	4,18	4,28	45	4,05	4,35	4,12	4,47
6	Manipulatives help students construct new mathematical information	3,93	3,96	4,13	3,33	3,74	4,02	3,99	4,2	4	4,08	4,20	4,18	38	4,03	4,38	4,12	4,43
7	Manipulatives increase students' communication power of mathematics	4,14	4,09	4,17	3,54	3,38	3,07	3,45	3,41	3,64	3,54	3,77	65	3,56	3,78	3,65	3,82
8	Manipulatives damp down students' abilities of mindly processing	2,47	3,04	2,67	3,60	2,54	3,17	2,40	2,47	2,48	2,68	2,37	40	2,35	2,37	2,23	2,28
9	Manipulatives allow mathematical reasoning	4,20	4,30	4,17	4,04	3,78	3,85	4,27	4,36	3,90	4,05	4,28	38	,12	,28	4,18	4,43
10	Manipulatives support the use of mathematical language	3,80	4,02	4,07	3,87	3,94	4,03	3,98	4,07	3,93	4,08	4,13	23	,08	,23	4,13	4,38

11	Manipulatives help students understand concepts better	4,14	4,11	4,13	3,87	4,06	4,11	4,13	4,18	4,01	4,18	4,11	20	,13	,33	4,15	4,43
12	Manipulatives allow information be constructed by student	3,98	4,09	3,85	3,67	3,70	3,78	3,93	4,03	3,93	4,04	4,14	23	,03	,23	4,08	4,28
13	Manipulatives provide students to discover mathematical relationships by increasing their curiosity	4,20	4,25	4,28	4,12	3,84	4,02	4,08	4,24	4,11	4,28	4,24	37	08	,38	4,13	4,56
14	Manipulatives are useful for students in different levels of education	3,72	3,85	3,87	3,95	3,89	3,98	4,05	4,13	4,12	4,24	4,18	28	08	,38	4,13	4,48
15	Manipulatives provide the development of problem solving skills of students	4,11	4,25	4,04	3,92	4,12	4,17	4,15	4,20	4,13	4,17	4,17	28	98	,23	4,05	4,36
16	Manipulatives help students construct different problems	4,13	4,24	4,09	4,01	3,75	3,84	4,04	4,23	3,98	4,07	4,11	27	18	,28	4,23	4,33
17	Manipulatives provide feedback	3,52	3,61	3,41	3,49	3,25	3,48	3,43	3,65	3,75	3,88	3,95	11	86	,13	3,97	4,28
18	I believe in that manipulatives will increase the successes of students	3,66	3,72	3,58	3,39	3,66	3,72	3,75	3,99	3,93	4,04	4,11	20	96	,23	4,05	4,33
19	By using manipulatives, errors of students can be easily corrected	3,48	3,72	3,77	3,46	3,90	3,98	3,95	4,07	3,93	4,01	4,03	11	95	,15	3,98	4,23
20	Learning environments including manipulatives do not allow interaction between students	2,34	3,18	2,88	3,15	2,98	3,32	2,76	3,15	2,93	3,08	2,47	11	76	,35	2,98	3,55
21	Manipulatives are more useful for lower level students	4,14	4,09	4,17	3,54	3,38	3,07	3,45	3,41	3,64	3,54	3,77	65	78	3,75	3,86	3,81
22	I do not think that manipulatives are suitable for collaborative learning	2,41	3,01	2,78	2,84	2,85	3,21	2,64	3,01	2,91	2,9	2,61	,01	2,56	3,18	2,68	3,23

There are total 22 items about this part (beliefs of teachers and pre-service teachers about purposeful use of mathematics learning of VMs and PMs). Arithmetical average values of answers to scale items of teachers and pre-service teachers in different branches have been given in Table: 4

When Table: 5 is analyzed, arithmetical average values about VMs are slightly higher whereas arithmetical average values of teachers and pre-service teachers in four different branches about the scale clause *"Manipulatives prompt students to memorization"* are close and close values to average value (values between X_{PM}=2,03-2,53 and values between X_{VM}=2,88-2,95). While arithmetical average values in scale items *"Manipulatives allow mathematical reasoning* and *Manipulatives support the use of mathematical language"* are in favor of VMs except pre-school teachers, arithmetical average values in the clause *"Manipulatives help students understand concepts better"* are in favor of PMs except classroom, primary and secondary mathematics teachers and pre-service teachers (X_{PM} = 4,14 > X_{VM} = 4,11; X_{PM} = 4,13 > X_{VM} = 3,87). Besides all teachers and pre-service teachers have indicated that both types of manipulatives would be effective in *"construction of the information by the student"*, pre-school pre-service teachers (X_{VM}=4,09> X_{PM}=3,98), classroom, primary and secondary mathematics teachers and pre-service teachers (X_{VM}=3,78> X_{PM}= 3,70; X_{VM}=4,03> X_{PM}=3,93; X_{VM}=4,04> X_{PM}=3,93; X_{VM}=4,23> X_{PM}=4,14; X_{VM}=4,23> X_{PM}= 4,03; X_{VM}=4,28 > X_{PM} =4,08) have stated that VMs would be more effective and, pre-school teachers (X_{PM}=3,85> X_{VM}=3,67) have stated that PMs would be more effective. Similarly, arithmetical average values of teachers and pre-service teachers (except pre-school teachers (X_{PM}=4, 28> X_{VM}=4, 12), who have expressed that VMs would provide students to explore mathematical relationships by increasing students' curiosity, are higher.

Arithmetical average values in the scale items of *"Manipulatives help students construct different problems, I believe in that manipulatives will increase the successes of students, Manipulatives provide the development of problem solving skills of students, By using manipulatives, errors of students can be easily corrected"* are in favor of VMs except again pre-school teachers. Teachers and pre-service teachers in four different branches have expressed that PMs would be more effective for lower level students, but that VMs would be more beneficial and effective in providing feedback and for students who are in different learning level. In addition, all teachers and pre-service teachers have stated that VMs would have negative influence on collaborative learning and relationship between students as against PMs. Whilst arithmetical average values in the scale items of *"Manipulatives help students construct new mathematical information, Students improve their mathematical skills by the help of manipulatives"* are in favor of VMs except pre-school teachers (X_{PM} = 4,13> X_{VM}=3,33; X_{PM}=4,06> X_{VM}=3,98), arithmetical average values in the scale clause of *"Manipulatives affect students' attitudes for mathematics positively"* are in favor of VMs except pre-school teachers and pre-service teachers (X_{PM}=4,14> X_{VM}=4,08; X_{PM}=4,08> X_{VM}=4,02).

Arithmetical average values of teachers and pre-service teachers in four different branches, who believe that VMs will damp down abilities of processing by mind of students in comparison with PMs, are higher. In contrast, as they believe that PMs will be more supportive to the learning of students for individual needs than VMs, arithmetical average values of teachers and pre-service teachers in four different branches are higher.

There are 10 items related to this part in the scale (beliefs of teachers and pre-service teachers about purposeful use of mathematics teaching of VMs and PMs). Arithmetical average values of answers to scale items of teachers and pre-service teachers in different branches have been given in Table: 5.

Table: 5

Arithmetical average values of answers to 10 items

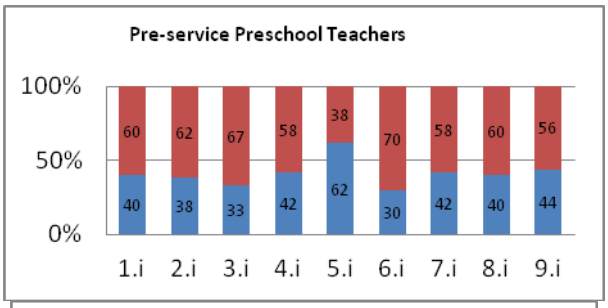
		Pre-school				Classroom			Primary Mathematics				Secondary Mathematics			
		PTs		Ts		PTs		Ts	PTs		Ts		PTs		Ts	
	Teaching Mathematics	X_{PM}	X_{VM}	X_{PM}	X_{VM}	X_{PM}	X_{VM}	$X_{PM}X_{VM}$	X_{PM}	X_{VM}	X_{PM}	X_{VM}	X_{PM}	X_{VM}	X_{PM}	X_{VM}
1	Manipulatives inhibit me to communicate with students one to one	2,93	3,03	2,73	3,08	2,83	3,11	2,73,08	2,85	3,03	2,65	2,98	2,89	2,93	2,81	2,85
2	I can better design group-work with manipulatives	3,85	3,78	3,98	3,64	3,83	3,75	3,93,78	3,81	3,73	3,87	3,77	3,77	3,75	3,81	3,78
3	Manipulatives provide me to teach by visualing mathematical relationships	4,23	4,15	4,33	4,13	4,22	4,15	4,24,18	4,18	4,15	4,11	4,08	4,11	4,18	4,13	4,25
4	Manipulatives provide me to save up time from long calculations	3,62	3,84	3,67	3,75	3,43	3,79	3,43,83	3,47	3,81	3,55	3,82	3,52	3,98	3,42	4,03
5	I think I can better teach mathematical concepts with manipulatives	4,09	4,11	4,11	3,89	3,83	3,89	4,04,11	3,96	4,08	4,05	4,18	4,03	4,23	4,05	4,28
6	Manipulatives help me design problems for daily life	4,16	4,07	4,21	3,80	3,97	3,89	4,14,09	3,98	3,95	4,15	4,13	4,05	4,01	4,08	4,05
7	Using manipulatives in mathematics class provides courses to be funnier	3,93	3,96	4,03	3,87	3,94	4,01	3,94,05	4,08	4,20	4,18	4,35	4,12	4,28	4,15	4,45
8	It may be time-consuming to design class environments including manipulatives	3,35	3,43	3,28	3,37	3,38	3,41	3,33,35	3,25	3,28	3,21	3,23	3,33	3,35	3,31	3,37

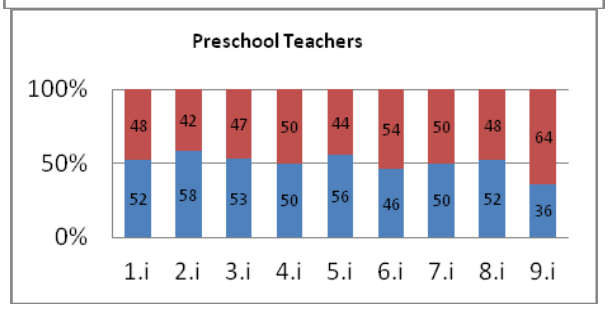
9	I think it is hard to assess the students in courses including manipulatives	3,51	3,55	3,53	3,55	3,58	3,61	3,63,68	3,44	3,51	3,39	3,48	3,31	3,33	3,28	3,35

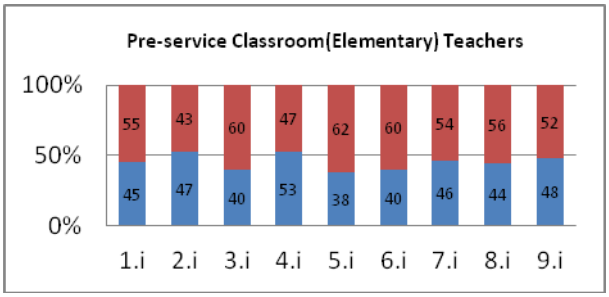
10	Manipulatives provide me to organize the mathematics course better	3,75	3,73	3,78	3,65	3,63	3,68	3,73	3,83	3,73	3,83	3,83	3,95	3,78	3,93	3,73	3,98

Arithmetical average values about VMs of teachers and pre-service teachers in four different branches about the scale clause of *"Manipulatives inhibit me to communicate with students one to one"* are higher. Teachers and pre-service teachers in four different branches have stated that PMs would be more effective in designing group-work than VMs, but that VMs would be more effective in saving time from calculations. Except pre-school teachers (X_{PM} = 4, 11 > X_{VM} = 3, 89), other teachers and pre-service teachers have stated that they could teach mathematical concepts better with VMs and that VMs would make mathematics courses funnier. Whilst all of teachers and pre-service teachers believe that PMs will be more effective in designing problems for daily life, they believe that designing course environment including VMs will take time. Arithmetical average values in other groups except pre-school teachers and pre-service teachers (X_{PM}=3,75> X_{VM}=3,73; X_{PM}=3,78> X_{VM}=3,65) in the scale clause of *"Manipulatives provide me to organize the mathematics course better"* are in favor of VMs. Participants except secondary mathematics teachers and pre-service teachers (X_{VM}=4,18> X_{PM}=4,11; X_{VM}=4,25> X_{PM}=4,13) have stated that PMs would be more effective in teaching mathematical relationships by visualization. Arithmetical average values for VMs of all teachers and pre-service teachers about the scale clause of "*I think it is hard to assess the students in courses including manipulatives*" are higher than PMs.

Percentage values to answers to preference scale of teachers and pre-service teachers using VMs and PMs have been given in figures below and then comparisons between groups have been done.







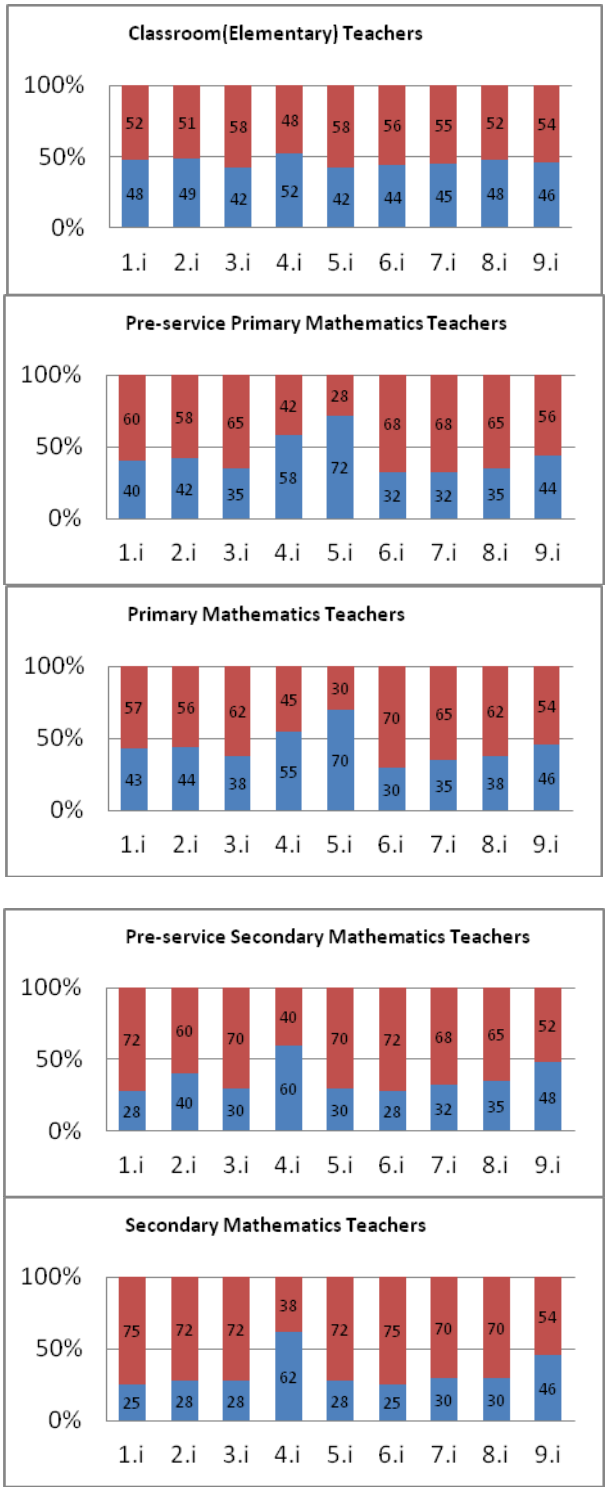


Figure: 4
Percentage values and column graphic of the preference scale

When graphics above are examined, all teachers and pre-service teachers except pre-school teachers are seen to have chosen VMs in all items of preference questionnaire. For example, except pre-school teachers, all teachers and pre-service teachers find PMs more boring than VMs and feel irritated and insecure while using PMs. In addition, when percentage values about the items of *"Dealing related problem by using these manipulatives resembles doing puzzles, I want to have much more time to use types of these manipulatives, Learning and teaching by using these manipulatives is interesting and amusing"* are examined, all teachers and pre-service teachers except pre-school teachers are seen to have had preference for VMs. However, when graphics of classroom teachers and pre-service teachers are examined, it is seen that their preference percentages are slightly in favor of VMs and very close values. When graphics of secondary mathematics teachers and pre-service teachers are examined, it is seen that their preference percentages are in favor of VMs and far values in comparison with other fields.

Furthermore, findings, which have been obtained from the interviews conducted for determining the preference of manipulatives and reasons of preference of 16 teachers and pre-service teachers, are supportive to the data that were obtained from the scales. Some dialogues of these teachers and pre-service teachers have been presented below Table 7.

Table: 6
Some dialogues of these teachers and pre-service teachers

Those who prefer VMs
PT_1*: VMs support the mental development and problem solving skill much more. VMs are more important as they have include visual communication, problem producing by different ways, repeatability, being funny, ease of use, having visual objects and, most important ones, exploring and learning by own facility. PMs are less convenient.*
T_1*: Visually is more important for child in pre-school period. However, as VMs are colorful, visual, conspicuous, funnier and memorable, they will be more beneficial. Especially, VMs can be always reached in web environment. In addition, it provides time-saving for teachers. Teachers do not have enough time in preparing their own PMs.*
PT_5*: I think VMs will be more useful. Since, children may be bored by PMs as they have less features such as animation, vocalization-that is, learning the information by auditory and visual ways-, trial and error, error correction and feedback. That is, PMs are not convenient as VMs.*
T_4*: When we particularly think the number of students in the classes, it may be hard to provide PMs for each student, but VMs can be easily obtained. PMs can be more beneficial for individual works. I prefer VMs much more since they take place in the education of the future. Since, many different examples can be solved by VMs, that is; children have many different experiences. In addition, many students work with VMs while few students simultaneously work with PMs.*
PT_7*: I prefer VMs as they are going to take much more place in future education. Because, many different examples can be solved, that is; they submit students many different experiences. In addition, many students work with VMs at the same time while few students simultaneously work with PMs.*
T_8*: I prefer VMs rather than PMs. Students and teachers can easily use VMs in their own computers and teachers can easily assess the products of students. Students can often study and make reinforcements by VMs about subjects that they have difficulty. Also, computer can motivate students.*
PT_{10}*: I prefer VMs more. Because, PMs are not useful as VMs. especially, the use of VMs is easy and fun. In addition, it can be controlled by VMs if the answers of students are right or wrong. Besides, I think VMs will help students better comprehend the mathematical concepts.*
T_{11}*: I prefer VMs. Since, these manipulatives are always accessible on the web. Also, they allow us to store and save the movements of the users. PMs do not have such features. In addition, they allow teachers to save time. Teachers do not have enough time to prepare their own PMs. Anyway, making transactions by VMs takes less time, it takes more time by PMs*
Those who prefer PMs

PT_3*: PMs are more suitable. Because; they are more simple and easily movable. You touch after all. In addition, as it is hard to have classroom management in a class including computers, it is hard to control children while they are studying with VMs. Also, 4-6 aged children do not have abstract thinking skill. It is important to make concrete the mathematical concepts. For this reason, both may be beneficial. But, PMs are more beneficial as they are more concrete. Because, the more there is a stimulating environment, the more learning of the child is enriched. That is, children can better understand and comprehend by seeing, touching and feeling with VMs. Usage of VMs propels students and teachers to*

laziness.
T_2: *I do not line up with that child is introduced with virtual environment in pre-school period. I think that children who study with PMs will be more social. Since, the child who sits at computer is asocial. Also, PMs are closer to the applications in daily life and you can comfortably see and touch their pieces and you can easily watch all the applications on them. It is not possible on VMs, even; sometimes you have to think abstract.*
PT_6*: Children enjoy mathematical concepts which they learn by having fun. PMs especially help students learn by touching, doing and living. Both types of material are effective in developing skills of classifying, sorting, matching, reason-result relationship and problem solving. I think PMs are not suitable for the level of the children.*
T_6*: I think PMs are more suitable for students. As they are more simple, easily movable and appealing to sensory organs, learning is more permanent. You touch after all. As it is hard to have classroom management in a computerized-class, it is hard to control students while they are studying with VMs. But, controlling the students is easy in PMs. I do not think that PMs will be useful in pre-school periods.*
PT_8*: PMs are much more important as they are visual and concrete. VMs can be sometimes used but in under the supervision of the teacher.*
T_9*: Both are important for me. I think that students who use PMs do not need to take too much teacher support. However, I am opposed to using VMs without a teacher or adult supervision.*
TC_{12}*: I think PMs are more suitable for students. Since, they are simpler and easily movable. You touch after all. As it will be hard to have classroom management in a computerized-class environment, it is hard to control students while they are studying with VMs. But, controlling the students is easy in PMs.*
T_{12}*: In fact, the pen and the paper are the important ones. I am against the computer. Therefore, I prefer PMs. Since; these manipulatives are close to real life applications. In addition, you can easily see and watch the pieces of manipulatives, and you can easily watch all the applications on PMs. But, this is not possible with VMs, even; you have to think abstract. Therefore, I think PMs will definitely more beneficial both in primary and secondary education.*

CONCLUSION AND DISCUSSION

Although teachers and pre-service teachers generally state that they have used PMs more than VMs and that they have had much more information about PMs, the number of teachers who state that they have used PMs much more than VMs is higher than the number of pre-service teachers. Then, teachers who are more experienced and have much more knowledge about manipulatives have used PMs and VMs much more. In their study which Akkaya, Durmuş & Tunç (2012) examined the situations of pre-service teachers of primary mathematics that they could use VMs and PMs throughout their education process, they have expressed that 33 percent of primary pre-service teachers had information about VMs and only 14 percent of them could use the manipulatives. In addition, they have expressed that 45 percent of pre-service teachers had information about PMs and 22 percent of them used PMs. The result obtained from the study of Akkaya, Durmuş & Tunç (2012) is consistent to the result that has been obtained from primary mathematics pre-service teachers in this study. Also, both of teachers and pre-service teachers (except pre-school teachers) have expressed that they used VMs less in comparison with PMs and they want to use VMs much more in the future. These obtained results show parallelism with the results obtained from the belief scale.

In addition, when percentage values -in the clause of *"I want to use these manipulatives much more in the future"* of the preference scale- are taken into consideration, the most of teachers and pre-service teachers in other branches except pre-school teachers have expressed that they desire to use VMs much more in the future.

It has been identified that the majority of both teachers and pre-service teachers carry positive beliefs for the use of VMs and PMs in mathematics education.

While the most of pre-school teachers have belief that PMs will be more suitable for mathematics education, the most of other teachers and pre-service teachers have the belief that VMs will be more effective. Pre-school pre-service teachers, in comparison with pre-school teachers, have the belief that VMs will be able to be more effective in mathematics education. This result may be related to the result that pre-service teachers significantly use information technologies by a high level in comparison with teachers (Seferoğlu, Akbıyık &Bulut, 2008).

Arithmetical average values for PMs and arithmetical average values for VMs of classroom teachers and pre-service teachers are close values in comparison with the arithmetical average values of teachers and pre-service teachers in other branches. Classroom teachers and pre-service teachers think that PMs and VMs will have almost the same affect in mathematics education and they stand an equal distance to the use of both VMs and PMs. Although classroom teachers and pre-service teachers slightly have the belief that VMs will be able to be effective, these teachers and pre-service teachers conclude that first stage students of primary school consider that real articles and models (PMs), which they see and handle, are more meaningful for them (Yolcu & Kurtuluş, 2010). Similarly, secondary mathematics teachers and pre-service teachers think that VMs will be more effective than PMs as primary and secondary mathematics teachers and pre-service teachers believe that VMs will be more effective in mathematics education. The most of teachers and pre-service teachers in four different branches have the idea that VMs will prompt students to memorization in comparison with PMs. But, it has been realized a decrease in the belief that VMs will prompt students to memorization as grade levels, of which teachers and pre-service teachers give courses, proceed. In addition, the number of teachers and pre-service teachers in four different branches, who believe that VMs will damp down the students' skills of mental operating in comparison with PMs, is higher. Whilst the number of pre-school teachers and pre-service teachers -who believe that VMs will damp down the students' skills of mental operating- is higher than the number of classroom teachers and pre-service teachers, the number of primary mathematics teachers and pre-service teachers is less than the number of classroom teachers and pre-service teachers. This case has shown that teachers and pre-service teachers did not believe that manipulatives would prompt students to memorization and damp down their skills of mental operating, but that there were teachers and pre-service teachers who believed that VMs would prompt students to memorization and damp down their skills of mental operating, as well.

Cakıroglu, Güven & Akkan (2008) have stated that a certain part of mathematics teachers did not have positive belief for the use of computer in mathematics education, and had anxiety for that using computer in courses would prompt students to memorization and damp down their skills of mental operating. The result obtained shows parallelism with this result. Ian (2006) have pointed out that developing and using materials in annihilating the memorization, which damps down the creativity of students, would be useful. Whilst the most of pre-school, classroom and primary mathematics teachers and pre-service teachers believe that PMs will support much more students' learning for their individual needs in comparison with VMs, secondary mathematics teachers and pre-service teachers slightly believe that VMs will support much more students' learning for their individual needs in comparison with PMs. In addition, teachers -in comparison with pre-service teachers- have stated that both kinds of manipulatives will be more supportive to students' learning for their individual needs.

This can be derived from that teachers are in interaction much more with students and work in real classroom environment. While teachers and pre-service teachers in four groups believe that both PMs and VMs will develop the mathematical skills of students, the majority of teachers and pre-service teachers believe that VMs will be more effective in developing the mathematical skills of the students. But, pre-school teachers have stated that PMs will slightly be more effective in developing the mathematical skills.

In addition, as grade levels (of which teachers and pre-service teachers will give courses) proceed, their beliefs for VMs increase. While arithmetical average values of all teachers and pre-service teachers who state that both types of manipulatives prompt students to researching are higher values than the average, the most of teachers and pre-service teachers have stated that VMs would prompt students to searching much more than PMs. But, when arithmetical values of teachers and pre-service teachers in four different branches are examined, differences between the arithmetical average values of secondary mathematics teachers and pre-service teachers are less –the same as in this clause like in the second and third items of the scale- than teachers and pre-service teachers in other branches. Besides that, the number of secondary mathematics teachers and pre-service teachers who believe that VMs will allow students to explore mathematical relationships by increasing curiosity is higher than the number of teachers and pre-service teachers in other branches.

The reason to this result: those different concepts with VMs are submitted in different forms, that they include many activities and activities are renewable, the idea that it would increase the curiosity, which is a behavior that prompts students to searching and learning, may have affected the teachers and pre-service teachers. Except pre-school teachers, the most of other teachers and pre-service teachers have stated that VMs will make a positive effect on the motivation of students.

The differences -between arithmetical average values of classroom, primary and secondary mathematics teachers and pre-service teachers who believe that VMs will be more effective than PMs in constructing new mathematical information- are less than the difference between the arithmetical average values of pre-school pre-service teachers. But, pre-school teachers believe that PMs will be more effective than VMs in constructing new mathematical information.

Although teachers and pre-service teaches in four different branches whose arithmetical average values are over the average value have stated that both types of manipulatives will be effective in *"constructing the information by the student"*, pre-school pre-service teachers, classroom, primary and secondary mathematics teachers and pre-service teachers have indicated that VMs will be more effective and, pre-school teachers have indicated that PMs will be more effective. Similarly, –except pre-school teachers- teachers and pre-service teachers who believe that VMs will allow students to explore the mathematical relationships by increasing students' curiosity are more. Except pre-school teachers, other teachers and pre-service teachers believe that VMs will help students develop their problem solving skills, and that they will further increase the success of students and that they will further contribute to that they will be able to correct the errors of the students. The opinions of pre-school teachers are important to provide to integrate technology to the pre-school education environments and it is known that positive opinions are highly effective in their decisions to use technology in their classes (Sime & Priestly, 2005).

In this context, the reasons, why pre-school teachers do not open up to the use of technological VMs, may be related to that some of the teachers with different experiences do not have previous computer experience and that teachers have a traditional understanding in terms of adopting and using the innovations. However, Arı & Bayhan (2002) have indicated that computer-aided education could be started in the period of pre-school due to that it was a period where interest and curiosity, which were the factors that made the learning easy, were intense. Whilst the most of teachers and pre-service teachers in the branches of pre-school, classroom and primary mathematics believe that PMs will be able to develop the power of mathematical communication of students much more than VMs, secondary mathematics teachers and pre-service teachers believe that VMs will be able to develop the power of mathematical communication of students much more than PMs. This case may be related to that teachers and pre-service teachers consider the situations of high school students. The most of teachers and pre-service teachers generally believe that VMs give opportunity to mathematical reasoning much more than PMs and have the belief of that they support the use of mathematical language much more than PMs. But, teachers and pre-service teachers of classroom, primary mathematics and secondary mathematics have the belief of that VMs will be more effective while pre-school teachers and pre-service teachers have the belief of that students will understand better the concepts by the help of PMs. Although pre-school pre-service teachers generally advocate - in scale items- the opinion of those VMs will be more effective in mathematics education, they have stated that PMs will be more useful for students to understand the concepts better.

The branch, which has the highest arithmetical average value between teachers and pre-service teachers in four different branches who believe that VMs will be more useful than PMs for the students in different levels of learning, is secondary mathematics teachers and pre-service teachers. The most of teachers and pre-service teachers in four different branches have indicated that PMs will be more effective for lower-leveled students, but they have stated that VMs will be more effective in ensuring feedback. The most of teachers and pre-service teachers in different branches have indicated that VMs will have negative effects on collaborative learning and communication between students in comparison with PMs. Then, it is a clear indication that teachers and pre-service teachers, who have this belief, could not have pedagogically loaded a role to computer due to that they have approved computer for individual usage.

However, it has been identified that both teachers and pre-service teachers have had positive beliefs for the use of PMs and VMs in mathematics education. Pre-school pre-service teachers have the belief of that VMs will be more effective in teaching of mathematics in comparison with pre-school teachers. This may be related to that pre-service teachers significantly use the information technologies at higher levels in comparison with teachers. Classroom teachers and pre-service teachers believe that PMs and VMs will have almost the same effect in mathematics education. Although primary and secondary mathematics teachers and pre-service teachers believe that VMs will be more effective in teaching of mathematics, secondary mathematics teachers and pre-service teachers believe that VMs will be more effective in teaching of mathematics in comparison with other three branches. The most of teachers and pre-service teachers in four different branches believe that VMs inhibit teacher-student communication much more than PMs. but, as grade levels (of which teachers and pre-service teachers will give courses) proceed, their beliefs for VMs decrease.

This result is consistent to the result of which VMs will be able to have a negative effect on collaborative learning and communication between students in comparison with PMs. Semereci (2006) have claimed that teachers advocated the opinion of which student-teacher interaction minimally disappeared when material was used.

The existence of teachers and pre-service teachers who believe that VMs inhibit teacher-student communication much more than PMs may be related to that they have positive belief for individual usage of computer (Çakıroğlu, Güven & Akkan, 2008). Then, it is a clear indication that teachers and pre-service teachers, who have this belief, could not have pedagogically loaded a role to computer due to that they have approved computer for individual usage. All of teachers and pre-service teachers in four different branches have indicated that a better group-work can be designed by the help of PMs. Nevertheless, the beliefs for PMs and VMs of secondary mathematics teachers and pre-service teachers are proximate to each other. Whilst secondary mathematics teachers and pre-service teachers believe that VMs will slightly be able to be effective in visualizing mathematical relationships in comparison with PMs, beliefs of other teachers and pre-service teachers are in favor of PMs. The most of teachers and pre-service teachers believe that VMs are more effective than PMs in saving time by long transactions.

This result may be derived from that teachers and pre-service teachers in four different branches have the anxiety of being late from the courses when they use materials in the processing of the course. In contrast, the most of teachers and pre-service teachers believe that PMs will be more effective for teachers to design problems related to daily life. This result can be explained with that PMs are proximate to the examples in daily life. Other teachers and pre-service teachers have expressed that they can teach mathematical concepts better with VMs while pre-school teachers have expressed that they can teach mathematical concepts better with PMs.

A result about learning mathematics has shown that pre-school teachers and pre-service teachers have the belief of which students can learn concepts better with PMs. Since, pre-school pre-service teachers have expressed that PMs will be more beneficial in understanding the concepts better whilst they are having indicated that they can teach mathematical concepts better with VMs. Even if these two results seem inconsistent, the conclusion is that pre-school teachers have desired to use VMs much more and that they are innovative.

The most of teachers and pre-service teachers in other branches except pre-school teachers believe that using VMs in mathematics classes is fun. Although arithmetical average values for VMs and PMs of pre-school pre-service teachers are in favor of VMs, these values are close values.

This result may be derived from such reasons as those VMs include different animations and motion pictures and have vocalizations. The most of teachers and pre-service teachers in different branches have stated that course environments including VMs would take more time in comparison with PMs and that assessing students would be hard in courses including VMs.

The arithmetical average values of classroom teachers and pre-service teachers who believe that assessing students would be harder in courses including VMs are higher than other branches.

This can be derived from assessing criteria of students in the first stage of primary school. The most of other teachers and pre-service teachers except the most of pre-school teachers and pre-service teachers have expressed that mathematics courses will be able to be organized better with VMs.

Thus, results obtained from graphics are supportive to the results obtained from the belief scale. The most of teachers and pre-service teachers except pre-school teachers have chosen VMs in all items of the belief scale.

For example, the most of teachers and pre-service teachers in other branches except pre-school teachers think PMs boring than VMs. The percentages of preference are in favor of VMs and close when graphics of classroom teachers and pre-service teachers are examined.

It has been seen that the percentages of preference are in favor of VMs and far values in comparison with other branches when graphics of secondary mathematics teachers and pre-service teachers are examined.

Moreover, the results obtained from the belief scale has shown that the most of teachers and pre-service teachers have much more positive belief for the use of VMs in mathematics education and the results obtained from the belief scale has shown that the most of teachers and pre-service teachers have chosen VMs. In this case, the question why teachers and pre-service teachers have chosen VMs much more comes to mind.

The reasons, why teachers and pre-service teachers have chosen VMs, from data analyses of the interviews are: *"accessibility on the web, storing and saving users' movements, time-saving, the opportunity to study on own computer, assessing the products comfortably, providing much more motivation, controlling if the answers are right or wrong, providing much more different experiences, taking much more place in education of the future, students' feeling comfort and finding their usage attractive and fun, doing exercises easier, the ease of use, solving processes' resembling puzzles, being effective in reaching the right answers".*

By the way, some teachers and pre-service teachers especially in pre-school branch have chosen PMs. The reasons are: *"simpler and easily movable, difficulty in classroom management in computerized environment, easier student control, and closer to real-life applications, seeing and touching the pieces easily"***.**

RECOMMENDATIONS

When research data are examined, teachers and pre-service teachers in different branches have indicated that they used PMs more than VMs and had much more information about PMs and did not have enough information about VMs. The majority of both teachers and pre-service teachers have stated that they want to use further the both two types of manipulatives in the future.

It has been identified that teachers and pre-service teachers in four different branches have positive beliefs for the use of VMs and PMs in mathematics learning and teaching.Therefore, it can be offered that the use of both PMs and VMs takes place further in the process of teacher training and in-service seminars in terms of efficiency.

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