Are Virtual Manipulatives a Disappointment for Middle School Mathematics Teachers?*

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Abstract

The aim of the research is to exhibit middle school mathematics teachers' experiences on virtual manipulatives. For this purpose, three mathematics teachers were selected, who had no experience in using virtual manipulatives were chosen. Lesson plans were prepared for the teachers, in which they would use virtual manipulatives, and essential information on how to use virtual manipulatives was given before the lesson. Two teachers used virtual manipulatives for four course hours, and one teacher used them for eight course hours. They were interviewed twice. The first interview was carried out before they used virtual manipulatives, and the second one was carried out after the application. The collected data was analyzed by content analysis method. It was found that after the experience, teachers described as disadvantages some situations that they initially described as advantages.

Keywords: Manipulatives, mathematics teachers, virtual manipulatives

1. Introduction

The use of materials in the mathematics teaching and learning process is quite common. NCTM (2000) also emphasizes the importance of using materials in the classrooms. It also touches upon the importance of using not only concrete materials but also digital tools and technology in the mathematics teaching process. NCTM (2010) stated that using technological opportunities in mathematics teaching will contribute to the development of students' skills such as reasoning and problem solving. While the concept of material in

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education is defined as concrete objects that symbolize the abstract world and enable the student to establish a relationship between the old and the new knowledge (Trespalacios, 2008), manipulative is defined as concrete models that appeal to various senses and serve to combine mathematical concepts (Hynes, 1986). In summary, the concepts of material and manipulative have common features in terms of being concrete and enabling the establishment of relationships between concepts.

While teachers are more familiar with concrete manipulatives, they are not yet as familiar with virtual manipulatives, and it is just becoming common for teachers to use virtual manipulatives in their courses (Moyer-Packenham and Bolyard, 2016). Uribe-Flórez & Wilkins (2017) designed a nationwide longitudinal dataset to provide data from students in kindergarten and followed those students until eighth grade in terms of using manipulatives. Based on an examination of the percentage of students categorized as using manipulatives at different frequency levels, they found that students' manipulative use decreases by grade. One possible explanation for these results may relate to teachers' beliefs about manipulatives (Uribe-Flórez & Wilkins, 2010). Uzundağ and Yazıcı (2019) also stated that primary teachers did not use virtual manipulatives in their courses. These two situations suggest that the reason why teachers do not use virtual manipulatives may be their various prejudices and beliefs.

The aim is to exhibit the experiences of middle school mathematics teachers who have not previously used virtual manipulatives in their courses, after using virtual manipulatives. Their prejudices can thus be revealed, and how their views changed as a result of their experiences can be made out. The sub problems of the research are as follows:

(1) What are the views of middle school mathematics teachers regarding virtual manipulatives before their experience?

(2) What are the views of middle school mathematics teachers regarding virtual manipulatives after their experience?

(3) How do their views on virtual manipulatives change after their experiences with the material in question?

1.1. Background Literature

Clements (1999) stated that students who use manipulatives in their lessons are more successful than those who do not use manipulatives and emphasized the effect of using manipulatives. In addition, the use of manipulatives not only contributes to concretization, but also has benefits such as facilitating the remembering of concepts and promoting problem solving. In addition, it is stated that the use of manipulatives increases student attention and motivation and helps students develop positive attitudes towards mathematics (Karakırık and Durmuş, 2006). Brown (2007) determined that students who stated that they did not like mathematics found lessons where manipulatives were used more enjoyable.

Swan and Marshall (2010) conducted a study on the extent to which Perry and Howard (1997)'s study examining the use of mathematics manipulatives in primary school classes has changed. While Perry and Howard conducted their study with 249 teachers, Swan and Marshall worked with more than 800 teachers and semi-structured interviews were also

conducted with volunteer teachers. According to the research, the manipulatives that teachers said they used most are; pattern blocks, basic ten blocks, counting manipulatives and cubes. Regarding the advantages of using manipulatives, the most common answer was that it makes the lesson fun and increases motivation and interest. This answer followed by promoting in concretization, visualization; contributing to experiential learning; aiding in better understanding; ensuring children grasp the concepts. As a result of the surveys and subsequent teacher comments and interviews, it was revealed that teachers believed that the use of manipulatives contributed to learning, but they did not know how they achieved this. Another result of the research was that the use of manipulatives decreased from kindergarten to 6th grade, and this result was parallel to the results of Perry and Howard's (1997) research.

It would not be true to say that the use of manipulatives will support students' engagement in mathematics in a more positive way under all circumstances. If students are expected to construct mathematical meaning based on manipulatives, they need to be given time to focus on mathematics (Marshall and Swan, 2005). Ball (1992) stated that the effect of manipulatives is exaggerated by adults, and he based this on the fact that adults already have a certain understanding of mathematics, and therefore manipulatives make sense to them (Howard and Perry, 1997). Swan and Marshall (2010) also stated that manipulatives would contribute to learning mathematics if used appropriately. However, they underlined that for this to happen, there must be a suitable discussion environment and education. Otherwise, manipulative use may create misconceptions in students. In summary, manipulatives are not a magic bullet and using manipulatives may not guarantee success.

Considering manipulatives only as concrete materials would definitely be an incomplete characterization, considering today's technological possibilities. Swan and Marshall (2010) moved away from the definition of manipulatives as being tangible and concrete by defining manipulatives as objects that can be handled sensually and that contribute to conscious or unconscious mathematical thought. Virtual manipulatives are interactive computer representations of concrete or physical manipulatives (Dorward, 2002). Both concrete and virtual manipulatives provide students with the opportunity to work with representations of mathematical ideas and construct mathematical understanding (Moyer et al, 2002).

Different definitions have been made for the concept of virtual manipulative. The definition that we frequently encounter in the literature is Moyer et al. (2002) as "an interactive, Web-based visual representation of a dynamic object that contributes to the creation of mathematical knowledge". With the passage of a long time since the definition and the development of technology day by day, Moyer and Bolyard (2016) revised the concept of virtual manipulative as "a technology-based visual representation of a dynamic mathematical object that allows the configuration of mathematical information, is suitable for manipulation, and contains all programmable features". Moyer et al. (2016) also stated that the terms computer manipulatives, digital manipulatives and virtual manipulatives have been used interchangeably for years.

Virtual manipulatives have several advantages and disadvantages. Moyer et al. (2002) listed the advantages of using virtual manipulatives as allowing students to see the results

of their own actions, being easy to use, offering flexibility in terms of time, connecting with other resources available on the World Wide Web, being freely accessible, being usable anytime, anywhere, by anyone, and being free from the limitations of concrete manipulatives. Pişkin Tunç et al. (2012) stated that virtual manipulatives allow more student interaction than concrete materials. Karakırık and Durmuş (2006) discussed benefits such as allowing connection between concepts and operations, contributing to problem posing and solving skills, providing quick feedback, and providing insight in mathematics. Temel Doğan (2017) stated that it is an advantage that virtual manipulatives have multiple representations such as visual, numerical, symbolic and verbal tools and that they can be translated into each other.

However, virtual manipulatives, like every tool, have some limitations. They remain more abstract because they do not allow practical activities (Karakırık and Durmuş, 2006). The teacher needs to give more time for students to establish relationships between manipulatives and mathematical representations and for conceptual learning (Temel Doğan, 2017). Speer (2009) conducted research to reveal the limitations of virtual manipulatives. The sample for the research consisted of 4th-grade students from three different primary schools. As a result of the research, it was determined that individuals who have problems using computers may not want to engage in virtual manipulative activities, and that students may not make sense of the activity if there is not enough explanation about the use of the manipulative. Speer stated that the instructions for using the manipulative are not only written but also animated, which will make the instructions more understandable and reveal different strategies.

Brown (2007) conducted a study comparing the effect of using concrete and virtual manipulatives in teaching fractions and stated that it positively affected 6th grade students' mathematics achievement and attitudes towards mathematics. He concluded that even students who did not like mathematics found the course enjoyable. In their study with primary school teachers, Uzundağ and Yazıcı (2019) found that 254 of the 278 teachers participating in the research did not use virtual manipulatives in their mathematics course. Interviews were held with 3 teachers who stated that they used it. They found that teachers generally use virtual manipulatives for the purpose of consolidation or before starting the main tasks. Keldgord and Ching (2022) conducted a study after the Covid-19 Pandemic. They conducted a survey with K-12 mathematics teachers and determined that most of the teachers (48.6%) wanted to use virtual manipulatives in face-to-face education. They stated that teachers found virtual manipulatives useful. Additionally, teachers mentioned some barriers as a result of the study. They divided these barriers into external and internal and listed external barriers as lack of access, time, training and support. They stated internal barriers as the teacher's pedagogical beliefs, beliefs regarding technology, and ability to adapt to change.

2.   Method

In this study, the middle school mathematics teachers' first experiences with virtual manipulatives were examined and it was revealed whether there was a changing in their prejudice, views or expectations related to the mentioned material. Therefore, the design of the research is phenomenology. In phenomenological research, the focus is on delving

into the essence of the experiences of individuals who have experienced the phenomenon under study (Creswell, 2014). The virtual manipulatives were the phenomena of the current study.

2.1. Participants

Since the aim of the study was to exhibit the first experience of middle school mathematics teachers, purposeful sampling method was used in the research. In order to select the participating teachers, nine secondary school mathematics teachers were interviewed. As a result of the interviews with nine mathematics teachers, three of the teachers stated that they did not know virtual manipulatives, and one of them stated that he knew virtual manipulatives but had no experience in using them. Since one of the teachers who did not know the virtual manipulative did not volunteer to participate in the study, the study was conducted with two teachers (P3 and P8) who did not know virtual manipulatives at all, and one teacher (P6), who knew about the virtual manipulative but did not have the experience of using it in his classes. Information about the three participating teachers is presented in Table 1.

Table 1. Characteristics of Participants

Participant Code	Gender	Experience (Year)	Age	Lesson type
P3	Woman	4	31	Distance
P6	Man	1	27	Distance
P8	Man	7	33	Face to face

2.2. Data Collection

In the study, two separate semi-structured interview forms were created to determine the teachers' initial views about the virtual manipulative and their views after use. After preparing the questions for both forms, expert view was obtained and then a pilot interview was held with two mathematics teachers who would not be involved in the study. After the pilot interviews, the interview form was revised. The first interviews lasted approximately 20-25 minutes, as they included demonstration of virtual manipulative examples. Virtual manipulative examples on "https://www.mathplayground.com/" and "https://phet.colorado.edu/tr/" were shown to teachers by associating them with mathematics topics. Then, they were asked how these materials would contribute to mathematics teaching, what the positive and negative aspects of their first impressions of these tools were, and whether they would like to use virtual manipulatives in the mathematics teaching process. In the final interviews, teachers were asked questions

about the effectiveness of the processes of using virtual manipulatives and the advantages and disadvantages of these materials.

2.3.   *Practice Process Between Two Interviews*

Between the two interviews, three teachers, two of them teaching 6th grade (P3 and P6) and one of them teaching 8th grade (P8), taught their lessons according to the lesson plans prepared by the researchers. Since the teachers who participated in the application did not have any experience of using virtual manipulatives and some of the instructions on the virtual manipulative sites were in a foreign language, detailed explanations on how to use virtual manipulatives were made in the lesson plans. In the lesson plans, explanations were given regarding both the mathematical subject and the use of the virtual manipulative. To prepare for the lesson, teachers should review virtual manipulative activities, the plans were shared with the teachers before the day on which the relevant subject would be taught.

6th grade teachers conducted their lessons online and their lessons were recorded. During the practice process of the 8th grade level, face-to-face education was provided due to bureaucratic reasons. One of the researchers attended the lessons as an observer and videotaped them. In the research, activities were prepared on the subjects of ratio at the 6th grade and linear equations at the 8th grade. Three different virtual manipulative activities were carried out during four lessons at the 6th grade. At the 8th grade, six different virtual manipulative activities were carried out during seven lessons. Summary information about the activities used in the process is presented in Table 2.

Table 2. The Information about Subjects and Virtual Manipulatives (VM)

Grade	Subject	Application period (course hours)	Number of the used VM	Web site of the VM
6th	Ratio	2	2	Math Playground
6th	Ratio	2	1	PhEt
8th	Linear Equations	2	2	Math Playground, Shodor
8th	Linear Equations	1	1	Shodor
8th	Linear Equations	1	1	PhEt
8th	Linear Equations	1	1	Shodor
8th	Linear Equations	2	1	PhEt

2.3.1. *Data Analysis*

The data collected in the research were analysed by content analysis method. In the first step of the research, the interviews with nine teachers were transcribed and according to the answers, teachers who did not have the experience of using virtual manipulatives in their lessons were identified. In the second step of the research, two of the teachers were observed for four lessons and one for seven lessons. Lessons in which teachers used virtual manipulatives were video recorded and examined. Thus, it was tried to determine whether teachers adhered to the lesson plans. Then, the semi-structured interviews with the teachers were transcribed as in the first interview and content analysis was conducted by creating codes, categories and themes. Data analysis was carried out by two researchers. Then the codes were compared. In addition, the codes were shared with the interviewed

teachers and confirmed. Thus, the validity and reliability of the data analysis was tried to be ensured.

3. Results

In this section, the results of the interviews are discussed. The categories and codes obtained as a result of the content analysis are given in tables. Examples of teacher statements regarding the codes are presented. The findings are discussed on the basis of the sub-problems of the research.

3.1. Results on Teachers' Views Regarding Virtual Manipulatives Before Their Experience

As a result of the first interviews which was carried out before their experience with three teachers, only the virtual manipulative theme emerged and two categories belonging to this theme were created. The codes regarding the answers given by the teachers were indicated with the code names P3, P6 and P8. Teachers' views are summarized in Table 3.

Table 3. The First Interviews Regarding the Virtual Manipulatives (VM)

Category	Codes
Advantages of Virtual Manipulatives	teacher convenience (P3, P8), increasing permanence (P3, P6), concretization (P3, P6), saving on time (P3, P6), association with life (P3), prevent monotony (P3), improving digital literacy (P8)
Disadvantages of Virtual Manipulatives	barrier on hands-on activities (P3), limited the creativity (P3), required a good lesson plan (P6), go beyond the purpose of the activity (P8), game addiction (P8)

When we look at the findings that the teachers stated as advantages of virtual manipulatives, it is seen that three teachers did not agree on a common view and P3 and P6 mostly described similar situations as advantages. The reason for this may be that P3 and P6 are taking 6th grade mathematics classes. Sample expressions for the codes of concretization (P3), permanence (P6) and teacher convenience and improving digital literacy (P8) are presented below.

P3: "… I think it has a very positive aspect, teacher, because, as I said, we visually concretize things in the child's mind and we give examples from life, so I think it is very positive and more permanent."

P6: "…we want it to appeal to more sensory organs so that children can learn permanently. Of course, the child uses these manipulatives not only by listening but also by seeing. Of course, this increases permanent learning, so we should definitely use them."

P8: "As far as I can see, once the material is ready, it eliminates the need for extra preparation, so there is no need to build a material from scratch, which is nice in that respect. The second thing is related to the fact that we live in a digitalizing world, and it

provides an extra benefit for children to be in this digital environment... Such things also increase their literacy in this way."

Considering the situations that teachers described as disadvantages of virtual manipulatives before the practice, P3 stated that the virtual manipulatives were barriers on hands-on activities. Regarding the disadvantages of virtual manipulatives, P6, contrary to P3 and P8, stated that it would make the teacher's preparation process for the lesson difficult and that a good lesson plan was required. P8 stated that the activity could go beyond its purpose and cause game addiction in students. Sample statements of teachers are as follows.

P3: "...the disadvantage is that the children are not side by side... However, in the school environment, different alternative things and original ideas come out and, as I said, it is important for the child to be able to touch the material."

P6: "A situation may occur that you have not encountered in class, for example, your entire plan may turn upside down… It is a difficult process, but of course it requires mastery in managing it, so we can use them (virtual manipulatives) when we have experience."

P8: "… it can lead to a situation such as game addiction."

3.2. Results on Teachers' Views Regarding Virtual Manipulatives After Their Experience

In the interviews carried out after the practices, only the virtual manipulative theme emerged and two categories belonging to this theme were created. Teachers' views are summarized in Table 4.

Table 4. The Last Interviews Regarding the Virtual Manipulatives (VM)

Category	Codes
Advantages of virtual manipulatives	motivation (P3, P8), increasing permanence (P3, P6), concretization (P6, P8), increasing classroom communication (P3), saving on time (P6), active participation (P6), more examples (P6), visuality (P8), understanding convenience (P8)
Disadvantages of virtual manipulatives	inequality of opportunity (P3, P6), difficulty of prepare a plan (P3, P8), unsuitable for national exams (P6, P8), lack of time (P3), Lack of familiarity with activities both student and teacher (P3, P8), need competency (P3), classroom management (P3), foreign language (P6), unsuitable for high level skills (P6), the problem about internet access (P6), unsuitable interface for classroom environment (P6), requires preliminary preparation (P8)

When the teachers were asked about the advantages of virtual manipulatives after their practice, it can be said that the majority of the answers given by the teachers focused on the benefits for the students. Only P6 mentioned its benefits for the teacher, stating that

it helped to use time effectively. The statements by P3, which stated that permanence and students' motivation towards the course increased, are exemplified below.

P3: "There were very positive feedback from the children. Moreover, it was more attractive for them to have fun and act together… there was an interaction… As for permanence... the child still failed that course, so his mind is there. So he can remember it."

P6 also touched upon permanence and emphasized saving time. Sample statements of the teacher regarding these codes are as follows.

P6: "… I saw in the next lessons that the students who participated in the process had a high permanent of knowledge... If we had used the traditional method, it would have been a waste of time and we would have gained something. But with these manipulatives, we can quickly make a few gains. This is very important. We should use them abundantly. It saves a lot of time."

P8's sample statements, in which he emphasized that students' interest in the course increased and that virtual manipulatives had an effect on concretization, are as follows:

P8: "I think they understand faster and are more willing… The topics were a little more abstract…I think it has a concretizing effect."

Teachers' views about the disadvantages of virtual manipulatives after the practice generally focused on factors from the teacher's perspective. P3 and P8 stated that it was difficult to plan lessons in which virtual manipulatives would be used. It can be thought that this situation is due to the fact that teachers have never known virtual manipulatives before. P3 stated that while using virtual manipulatives, communication between students increases as an advantage, but classroom management becomes more difficult. While P3 said that the time was insufficient in the lessons in which he used virtual manipulatives, P6 stated that he was able to present more content in a limited time and save time thanks to the use of virtual manipulatives. P6 stated that using virtual manipulatives enabled more examples, but was insufficient to measure high-level skills and that virtual manipulative activities were not preparatory content for national exams. Additionally, P6 stated that it is a disadvantage that the virtual manipulatives are in a foreign language. P3 and P6 carried out the lessons through distance education. While some students could use the activities easily because they attended the lesson from a computer, some had difficulty using virtual manipulatives because they didn't have computers and attended

the lesson via mobile phone. Teachers stated this situation as inequality of opportunity. Regarding the disadvantages, the sample expressions are as follows:

P6: "…The internet should be very fast, I understand that. That was one of the difficulties."

P8: "As a disadvantage…virtual manipulative is something that requires work not only by the student but also by the teacher… You also need to prepare beforehand… You need to make a plan."

P8 stated that it would be more beneficial if students were introduced to these materials in early grades. P8's expressions are as follows.

P8: "…if these children got used to virtual manipulatives in the fifth grade, maybe they could use them more comfortably in the eighth grade. Because they spend more time on something they encounter for the first time."

3.3. Results Regarding Changes in Teachers' Views as a Result of Their Experiences

In the third sub-problem of the research, changes in teachers' views before and after the experience of using virtual manipulatives were discussed. Table 5 presents the changes in teachers' views about advantages.

Table 5. Comparison of Teachers' First and Last Views about Advantages

Teacher	First View	Last View
P3	teacher convenience, increasing permanence, concretization, saving on time, association with life, prevent monotony	motivation, increasing permanence, increasing classroom communication
P6	increasing permanence, concretization, saving on time	increasing permanence, concretization, saving on time, active participation, more examples
P8	teacher convenience, improving digital literacy	motivation, concretization, visuality, understanding convenience

As can be seen from the table, there was a decrease in the situations that P3 described as an advantage. On the other hand, there was an increase in situations that P6 describes as an advantage. The teacher stated that saving time, concretization, and ensuring permanence, which he described as advantages before the experience, were also advantages after the experience. Additionally, the teacher mentioned that students were more active in the lesson and that the use of manipulatives allowed them to make more examples. It is seen that there was an increase in the situations that P8 describes as an advantage after the experience. The aspects that P3 and P8 saw as advantages before and

after the experience differed. Table 6 presents the changes in teachers' views about disadvantages.

Table 6. Comparison of Teachers' First and Last Views about Disadvantages

Teacher	First View	Last View
P3	barrier on hands-on activities, limited the creativity	inequality of opportunity, difficulty of prepare a plan, lack of time, Lack of familiarity with activities both student and teacher, need competency, classroom management
P6	required a good lesson plan	inequality of opportunity, nsuitable for national exams, foreign language, unsuitable for high level skills, the problem about internet access, unsuitable interface for classroom environment
P8	go beyond the purpose of the activity, game addiction	difficulty of prepare a plan, nsuitable for national exams, Lack of familiarity with activities both student and teacher, requires preliminary preparation

When the table is examined, it is seen that there is an increase in the situations that three teachers described as disadvantages after the experience of using virtual manipulatives. The situations that teachers described as disadvantages before and after the experience differed from each other. While P3 and P8 pointed out the disadvantages that might occur for the student in the first interview, they focused more on the negative situations experienced for the teacher in the last interview. P6 focused on the negative situations that the teacher might experience both in the first meeting and in the last meeting. The main situations that teachers described as disadvantages were that the use of virtual manipulatives caused inequality of opportunity and difficulty in planning. Another finding is that teachers describe some situations that they described as advantages in the first interview as disadvantages in the last interview. For example, while P3 said in the first interview that the use of virtual manipulatives would make it easier for the teacher, in the last interview she stated that it revealed situations that would increase the teacher's workload, such as difficulty in planning, requiring competency, and ensuring classroom management. Similarly, P8 stated in the first interview that the use of virtual manipulatives would make it easier for the teacher, but in the last interview, his view changed to that it was difficult to plan a lesson in which virtual manipulatives were used and required the teacher to make preparations. While P3 said before the experience that using virtual manipulatives would save time, she stated that the course time was insufficient for using virtual manipulatives after the experience.

4. Discussion

As a result of the analysis of the views of teachers before their experiences with virtual manipulatives, two categories emerged: advantages and disadvantages. Teachers' views about the advantages of using virtual manipulatives are that it makes easier for the

teacher, increases memorability, contributes to concretization saving time, providing connection with real life, preventing monotony and improving digital literacy. It can be said that teachers mostly consider the benefits of using virtual manipulatives for students. In parallel with the current study, Uzundağ and Yazıcı (2013) concluded in their study with classroom teachers that teachers thought that virtual manipulatives increased permanence, contributed to concretization, and made the lesson fun. It can be said that it is similar to the results of the Swan and Marshall (2010) study in terms of the advantages of virtual manipulatives. Teachers' views about the disadvantages of virtual manipulatives are that it prevents on hands-on activities, restricts creativity, requires a good lesson plan, may go beyond the purpose of the activity and may cause game addiction. The need for a good lesson plan was also emphasized in Speer's (2009) study. It can be said that teachers had more limited ideas about advantages and disadvantages before experiencing virtual manipulatives, and then they mainly focused on the disadvantages.

The teachers' views were analysed after their experience with virtual manipulatives. Teachers described the advantages of using virtual manipulatives as increasing motivation for the lesson, providing memorability, contributing to concretization, increasing communication in the classroom, saving time, activating the student in the lesson, allowing them to solve more questions in the lesson, providing visual support, and facilitating understanding. It can be said that the issues that teachers stated as advantages after their experiences are similar to the results of the Swan and Marshall (2010) study. In Keldgord and Ching's (2022) study, teachers found virtual manipulatives useful, and the results of the current study are similar to Keldgord and Ching's (2022) study in this respect.

While teachers generally evaluated the advantages of virtual manipulatives from the perspective of the student, they evaluated the disadvantages from the perspective of both the teacher and the student. Teachers mentioned several disadvantages, including inequality of opportunity, difficulty in planning, virtual manipulatives not aligning with content for national exams, lack of time, lack of familiarity with activities by students and teachers, requirement for competence, difficulty in classroom management, interface being in a foreign language, inability to measure high-level skills, and internet connection issues. They also mentioned experiencing problems, finding the interface unsuitable for classroom use, and requiring the teacher to make preparations. The results of the current study are similar to the results of Speer (2009) in terms of requiring a good lesson plan, and to the results of Temel Doğan's (2017) study in terms of the time component. Results similar to the study of Keldgord and Ching (2022) were obtained in terms of internet-related problems and time requirements.

Finally, changing of the teachers' views after their experience with virtual manipulatives were investigated. It was observed that there was a decrease in the situations that teachers described as an advantage. While P3 and P6 pointed out the advantages for the students both before and after the virtual manipulative experience, P8 also mentioned the advantages for the teacher. In the first meeting, P3's view is the same, only about increasing permanence. The situations that P6 described as advantages in the first meeting continued after the experience. The reason for this may be that the teacher

was familiar with virtual manipulatives before the research, even if he had never used them. The situations that P8 describes as advantages have changed completely.

It is seen that there is an increase in the situations that teachers describe as negative regarding the use of virtual manipulatives. It can be said that in the first and last interviews, P3 and P6 generally focused on disadvantageous situations for the teacher. P8 expressed the disadvantages for the student in the first interview and for both the teacher and the student in the last interview. It can be said that there were completely different views of the three teachers before and after the experience. One of the results regarding the third sub-problem of the research is that the situations that teachers initially described as advantages turned into disadvantages after experience. While P3 and P8 thought that the use of virtual manipulatives would make it easier for the teacher in the first interview, they stated that it increased the teacher's workload after the experience. While P3 thought that using virtual manipulatives would save time before the experience, she had problems with time management after the experience and described this as a disadvantage. From this result, it can be said virtual manipulatives did not meet teachers' expectations totally.

5.   Suggestion

Considering the results of the research; in-service training programs in which virtual manipulatives are introduced to teachers can be applied. Teachers can be encouraged to use these activities in early grades so that students can become familiar with virtual manipulatives. The participants of this study are teachers who have no experience of using virtual manipulatives. A study can be conducted with teachers who have experience of using virtual manipulatives in their lessons and it can be investigated whether there is a difference in the duration of experience in what teachers describe as advantages and disadvantages.

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