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Comparison of Different Roles that Teachers give to Technology in Pre and Post-training

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ABSTRACT

This study examines the roles that teachers' give to technology in mathematics lesson by teachers. Data were acquired within the scope of a professional development project supported by Scientific and Technological Research Council of Turkey (TUBITAK). Technology integration education given within the scope of the project lasted for a month, four hours a week. In the educational program, teachers were informed about what should be taken into consideration when integrating technology into their lessons. This study used case studies and qualitative research methods. The participants consisted of 10 teachers. The participants were randomly chosen among the teachers who received the educational training given within the scope of the project and who were available for technology use in their classes. The videos were analyzed within the context of roles given to technology. According to the findings obtained from video analyses, before the educational program, teachers did not use technology in their lessons even though their classroom environment was convenient for technology usage or used replacement, which is the lowest level among technology usage roles. After the program, teachers were observed to realize technology integration beginning generally from the lowest level. In addition, after the program, as well as replacement, two teachers used technology in the transformation role and five teachers used technology in the amplification role.

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Keywords:
Technology integration, Mathematics education, Roles that teachers' give to technology, Teacher training, Technological and pedagogical content knowledge (TPCK)

Introduction

There are various definitions of educational technology (Hill & Hannafin, 2001; Seels & Richey, 1994; Gentry, 1995; Reiser, 2002; Molenda, 2004). One of the most popular of these definitions is made by the Association of Educational Communication and Technology (AECT), educational technology is theory and practice of using process and resources in the stages of design, development, practice and evaluation with the objective of learning (Seels & Richey, 1994). Educational technology has been in place for a variety of ways, ranging from keeping students' records to facilitating student learning (MNE, 2005a). For instance, educational technology is used in different contexts, including a. learning-teaching settings, b. pedagogical studies, c. pedagogical services management, d. counseling services, e. library services, f. means of communication, and g. teaching technology (Aksoy, 2005; Fabry & Higgs, 1997).

Having the technology is not the whole goal for effective instruction; but, it is also critically important how to use the technology in educational settings. All users of the technology should be comfortable in using

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the technological tools and they should also know how to promote student learning via technology integration. It should also be noted that individuals at the ranks of educational leadership should also know the integration of technology in educational environments as well as support the staff for effective use of technology. Technology integration is the process of facilitating all teaching and learning activities via various technological tools (Cerniamo, Ross & Ertmer, 2010, p.17). For successful technology integration, teachers should benefit from the use of technology at the highest level and the use of technology should enhance their professional effectiveness by providing extra tools and skills for better student learning(So and Kim, 2009). Using technology efficiently requires modifications and new teaching strategies in the instructional environment, which can serve as a catalyst for the integration of technology (Byrom, 2008). In this context, it is essential thatthe teachers should use the technology for various purposes; but, it is more important for the teacher to pick and use the appropriate pedagogical approach for the subject matter at hand(Mumcu, Haşlaman & Usluel, 2008).

There have been so many discussions on teacher knowledge necessary for effective technology integration in instructional settings (Koehler, Mishra & Yahya, 2007; Hofer & Swan, 2008).Among various topics of discussions, teachers' use of the appropriate pedagogy for the proper content has been noted as critical aspects of effective technology integrations. Yet, the discussion was not limited to this aspect. Good planning has been noted as another essential component of technology integration Teachers' successful planning will ensure strong relationship between technology and instruction where technology integration is implemented (Zhao, Pugh, Sheldon & Byers, 2002; Demir & Bozkurt, 2011).

Theoretical Framework

In line with the determined education objectives, enabling a high quality education and student success create the need for integrating technology into education. Within this scope, the role that teachers give to technology integration should be determined since it does not only mean the use of technology in education; but, it needs to be properly, accurately and effectively integrated and used in the teaching and learning process (Altan, 1998). Increasing the effectiveness of the education process with technology does not only occur by learning how to use certain hardware and software. It needs the comprehension of appropriate pedagogic principles and the application of these principles into educational settings (Diaz & Bontenbal, 2000). According to Hughes (2005), teachers develop technology-supported pedagogy in their classes for teaching purposes according to their interpretation of the value of technology. This interpretation depends on their past experiences and accumulations (Bransford & Schwartz, 1999). Many issues revolving around teaching and subject matter may potentially lead teachers to question their practices, which in turn may cause them to change their beliefs and practical implementations.

If learning activities provide an opportunity for new alternative implementations and creates learning contradictions, these activities will cause new technology-aided pedagogical practices. Single use of technology in education does not mean it has been integrated into education. The literature on this issue confronts the necessity to bring forth the relations, interactions and limitations among content, pedagogy and technology, and the necessity to take them as a basis for the development of teachers within the frame of technological and pedagogical content knowledge (TPCK) (Bozkurt & Cilavdaroğlu, 2011; Hacıömeroğlu, Şahin & Arcagök, 2014; Mishra & Kohler, 2006). The theoretical framework of TPCK defines how teachers' technology, pedagogy and content comprehensions affect each other in order to reveal a discipline-based teaching approach with effective education technologies (Harris, Mishra & Koehler, 2007). TPCK takes its form as a result of each of these contents and their intersection. An accurate presentation of this intersection requires good content and pedagogic knowledge as well as the ability to choose the most appropriate technology that is easy to use and that will enable the teacher to teach the subject. Then, the pedagogy that will convey the curriculum acquisitions to students using this technology should be determined or planned (Övez & Akyüz, 2013). Education pedagogy seeks the answer to the question, "How can a better and effective education be achieved?" using more accurate strategies in education. Pedagogy based education refers to the education given under the light of teaching method used to teach a subject (Shulman, 1987; Kinach, 2002). Both technology and pedagogy-based education are necessary for effective technology aided teaching. Therefore, a pedagogy-based education should be prioritized over a traditional technology-based education (Diaz & Bontenbal, 2000). All these aforementioned reasons create the necessity to examine teachers' in-class technology practices since the teacher can only provide meaningful learning when they

change their pedagogical approaches and class routines to accommodate the use of technology (Hughes, 2005). Within the scope of this study, the teachers' lessons were analyzed in terms of the roles they gave to technology according to the technology-aided pedagogic levels suggested in the study of Hughes (2005). Descriptions of these roles are as follows (Demir, 2011; Hughes, 2005):

Replacement: There is no change in the objective or acquisitions of the lessons with the use of technology at this level. The previous teaching material replaces technology. Within this context, time can be saved. For example, a teacher may prepare a question as a PowerPoint demonstration instead of writing it on board, which can be evaluated as the use of technology at the replacement level.

Amplification: Technology used in this category facilitates the teaching-learning process and offers a time saver. The technology use at this level does not require any changes to the objectives and acquisitions. For example, in a physic course students may use calculators in order to compute arithmetic operations, which can be evaluated as the use of technology at the amplification level. Since performing the mathematical operations is not the main goal of this problem, it was appropriate to use the calculator for the computations. Using the calculator is an effective way of saving time and energy to better understand and solve the problem.

Transformation: Technology in this category has the potential to re-organize intellectual processes and problem-solving activities for students. Therefore, the technology use helps students understand the subject matter and improve their learning. This way of using the technology promotes conceptual learning by making abstract concepts more concrete through visual aids. In this category, objectives and acquisitions are carried into a more advanced level. For example, conducting activities that will provide a conceptual comprehension with the help of software establishes dynamic relationships between different representations (table, graphic, etc.) of the function concept (Figure 1) may be given as an example of transformation categories. Showing the relations between trigonometric functions in Figure 1 through drawings on the board would require too much time and determining the relations between graphics would be hard since they would not be dynamic. In addition, the use of flash (Figure 1) or dynamic geometry software can be given as an example of the transformation category of technology.

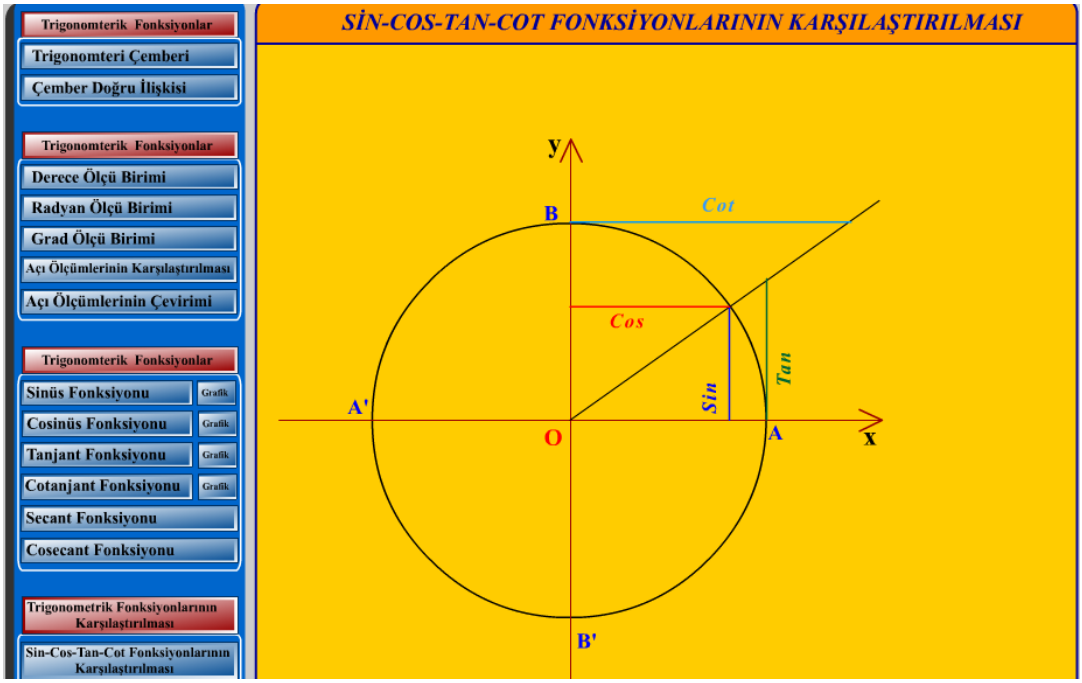


Figure 1. The relationship between the trigonometric functions

This study examines the effect of a professional development education on the use of technology in teachers 'mathematics lesson, the changes in pre and post-training technology integration levels, and the effect of these changes on learning. Within this context, we tried to answer the following questions:

1. In what category do teachers integrate technology into their lessons? Does the given training have any effect on this integration?
2. How did technology integration categories affect the teaching of lessons?

Many studies on the integration of technology into classrooms have shown the importance of the presence of technology as well as the pedagogy-supported use of technology (Bozkurt, 2011; Forgasz, 2006; Goos & Bennison, 2008; Harris, Mishra & Koehler, 2007; Işıksal & Aşkar, 2005; Mishra & Koehler, 2006). With respect to this importance, the analysis of the integration of technology in lessons, and the determination of the roles given to technology and academic evaluation of this integration, are important to determine evidence of accurate implementation. Furthermore, this study is thought to be important in terms of using the technology-aided pedagogic levels as an assessment tool to evaluate the development of teachers what roles they give technology in their classes. In other words, the study is expected to contribute to the literature by providing an example of how the technology-aided pedagogic levels can be used as an assessment tool to evaluate the roles teachers give the technology in their classes.

Method

In this study, it was investigated the effect of a professional development education on technology integration in mathematics classroom, the changes in pre and post-training technology integration levels, and the effect of these changes on learning. This study used case studies and qualitative research methods. Case study is a method in which the case is thoroughly observed in its natural environment and data collected is systematically acquired and analyzed, and the results are presented (Given, 2008). Within this framework, the case study was used in order to thoroughly analyze teachers' in-class implementations within the context of the roles given to technology in mathematics lessons.

Background of the Research

Research data were acquired through professional development education supported by Scientific and Technological Research Council of Turkey (TUBITAK). The theoretical dimension of training is important, and we attempted to balance theory and implementation in the subject which also required an in-depth implementation like technology integration. While designing training programs, the benefits for the teachers and presenting the content were particularly taken into consideration. Therefore, the implementations were continuously involved in the education and theoretical knowledge and perspective given and were presented as a summary at the end of the training. The TPCK theoretical framework was taken into consideration while designing and implementing the education content given to teachers. Within the scope of the project, the teachers were given a technology integration education that lasted for 16 hours in four weeks. Expert academic staff taught the lessons.

Participants

The educations given within the scope of the project included 14 classroom and 15 primary school mathematics teachers, who were still serving in the provinces in which the project was carried out. Table 1 shows the distribution of these teachers according to gender.

Table 1. Demographic features of the teachers who participated in training within the project

Branch	Gender		Service year			Total
	Male	Female	1-5	6-10	11+	
Classroom teachers	10	4	2	10	2	14
Mathematics teachers	10	5	2	12	1	15
Total	20	9	4	22	3	29

The participants included five classroom and five primary school mathematics teachers randomly chosen among the teachers who participated in the education program and who were available for technology use in their classes. Table 2 shows the names, branches and their video-recorded pre and post-training technology usages.

Table 2. The names, branches and video-recorded pre and post-training technology usages of the participants

Branch	Teachers*	Teachers were using technology in their lessons or not before education	Teachers were using technology in their lessons or not after education
Mathematics	Tokay	No	Yes
Mathematics	Tahsin	No	Yes
Mathematics	Enver	No	Yes
Mathematics	Nazım	No	Yes
Mathematics	Sevgi	No	Yes
Classroom	Gürselen	Yes	Yes
Classroom	İsmet	Yes	Yes
Classroom	Gizem	Yes	Yes
Classroom	Gül	No	Yes
Classroom	İsmail	Yes	Yes

*The teachers' real names were not used in the research; instead, pseudonyms were used according to their gender.

Table 2 shows that before education, four classroom teachers were using technology in their lessons but none of the primary school mathematics teachers were. In addition, after the educational program, all teachers were observed using technology in their video-recorded lessons.

Data Collection Process

Within the scope of the research, the teachers' pre and post-training in-class mathematics lessons participating in the research participants were video-recorded by a professional cameraman. All video recordings include two lessons which were taught. Since the teachers' lessons were regularly recorded for five months, the impact of the teachers' awareness of being part of study may have been reduced.

Data Analysis Process

Video-recordings were analyzed according to Hughes 'technology usage roles (2005). Primarily, the video-recordings were pre-analyzed and the classroom present norms were determined through dialogues between teachers and students. Considering these norms, categories regarding the effect of these norms on education were determined. Using these categories, four hours of lessons (two hours of lesson before the educational program and two hours after) were analyzed. In addition, data obtained before and after the educational program, and analyzed according to technology usage levels, were compared. Table 3 shows the technology integration levels, the explanation of these levels and an appropriate example of these levels.

Table 3. Roles and explanations of technology integration

Roles	Explanation	Example
1-Replacement	The level of technology use in activities that can also be realized without using technology in lessons.	Teacher Ismet's reflection of questions to the board using a projection device instead of writing.
2-Amplification	The level of technology use that will contribute to a more effective and faster learning process.	Teacher Gürselen's exhibits fractions using software in her post-training lesson.
3-Transformation	The cases that teachers change their routine and provide meaningful learning. The level that teachers use technologic opportunities with a pedagogic approach.	Teacher Ahmet's draws graphs of first-order and second-order functions and finds solutions with the help of software.

In the data analysis process, all videos were transcribed. Three experts analyzed written texts and videos. These analyses were compared with each other. Comparing the categories presented by the researchers, levels with "consensus" and "dissensus" were determined. Consensus was accepted if the researcher coded with the same principle, and dissensus was accepted if the researcher coded with different principles. The discussion of topics led to the necessary regulations. The process continued until consensus was achieved for all analyses. Then, the reliability of the data was confirmed by comparing these analyses. The finding summarizes the video-recorded pre and post-training lessons of three teachers considering the level of their technology use. Within this context, this part involves in-class dialogues of Teacher Enver, Teacher İsmail and Teacher Tekin, when they used technology at the replacement level, amplification level and transformation level, respectively. Then, data obtained from comparing the level of technology of each teacher were presented.

Findings

This section summarizes the video-recorded pre and post-training lessons of Teacher Enver, Teacher İsmail and Teacher Tekin, with regard to their technology use.

The Summary of Video-Recorded Lesson of Teacher Enver within the Scope of Education

The video-recorded pre-training lessons of Teacher Enver, a primary school mathematics teacher, showed that he did not use technology, and so were not analyzed. After the educational program, he used technology to teach "exponential numbers" in a 7th grade mathematics lesson. Teacher Enver began the lesson by asking where and how exponential numbers are used then moved on PowerPoint presentation after taking some ideas from the students. He taught the subject using the presentation for the entire lesson and used board when necessary. Saving time appeared to be the most important benefit of technology used in this lesson since the teacher preferred to show the formulas and examples in the presentation instead of writing them on board. Therefore, the level of technology use in teaching exponential numbers was determined as *replacement*. In-class dialogue of this subject is as follows:

Teacher: How many 2s did we use here? 3. We multiply 2 with 2, 4; 4 with 2, 8. Now let's look at second example. What is base number here? Negative, right?
Student(s): Yes…
Teacher: Which power of negative number? 3rd power of negative 2. Well, what is the result? Negative. Then, why -8?
Emine: multiplying a negative number with negative is positive. Multiplying a positive number with negative is negative…
Teacher: Then we have to multiply one by one? Let's try. Multiplying -2 with -2 is +4. Multiplying +4 with –2 is –8. Well, isn't there a short way? How can we express this?
Pınar: If the power is an uneven number, the solution is always negative.
Teacher: Well, this solution is positive and its power is an uneven number.
Pınar: Of negative number…
Teacher: Our friend says that if the power of a negative number is uneven, the solution is negative. Then, we can reach this explanation.

As can be seen from dialogues, Teacher Enver included students into process in order to provide their conceptual knowledge and taught his lesson with the question-answer method. The role of technology is only the reflection of the question on board.

The Summary of Video-Recorded Lesson of Teacher İsmail within the Scope of the Education

Teacher İsmail used technology in a primary school 2nd grade mathematics lesson while teaching the subject "Problems requiring addition and subtraction." He began his lesson by reflecting the solutions of the problems on board using the projection board. In-class practices were conducted individually, in-groups, and as a whole class activity. The level of technology in that lesson was *replacement* since it was used to reflect the question on the board instead of writing.

Teacher İsmail also used technology while teaching "multiplication" in his post-training lesson. Beginning the lesson by reminding students what they learnt in previous lesson, the teacher introduced the subject with a PowerPoint presentation. The relationship between addition and multiplication was taught by reflecting various addition and multiplication problems on the board. Therefore, the level of technology used in this lesson was *replacement.* After the presentation, the lesson was continued using an interactive mathematics application called "Balance Numbers." With this application, students were asked to find the solutions of certain multiplication problems. If the solution was correct, two bears on a seesaw remained balanced when they stroked the "Balance" key. The teacher taught the remaining lesson using this application and the level of technology was evaluated as *amplification*. In-class dialogue of this subject is as follows:

Özkan: I will multiply4 and 7. It is 28.
Teacher: We push here for28. Let's look if it's correct. Well done. I will give a plus for this group. Yes, Dilan come here. Let's see if Dilan will find the correct solution.
The 33rd minute
Dilan- I don't know how to count 9 by 9 so I will count 3 by 3 until 9.
Teacher:-Then, count. Yes, let's see if 27 is correct.
First Group- Ole!
Teacher: Wait, it looks like it is falling. Yes, a plus for the first groups and a second plus for this (2nd) group. Yes Metin, multiply 9 with 4.
Metin: There are 9 times 4. But I don't want to count 4 by 4. I want to count 9 by 9.
Teacher: you want to count 9 by 9. Ha! There is 9 times 4 but you don't want to count 4 by 4. Look, your friend says there is 9 times 4 but he doesn't want to count 4 by 4. He says I will get the same result when I count 4 times 9 and I want to count 9 by 9. Let him count.
Metin: 9-18-27-36
Teacher- Come, let's write 36. Push this button to check whether it falls. Yes, correct. A plus for this (2nd) group. Come Sima Nur.
Sima Nur – There is 5 times 7.
Teacher- There is 5 times 7. Wait a second! Your friend will not speak until there is silence. You should stay in your places. We shall not change our places with as we like. Your friend will not speak until there is silence.

As can be seen from the dialogues of Teacher İsmail, technology was used in the lesson to check whether the students' calculations were correct. Technology used in this process facilitated the teaching-learning process and enabled it to be done in less time. It was observed that the technology was used effectively without any changes to the acquisitions.

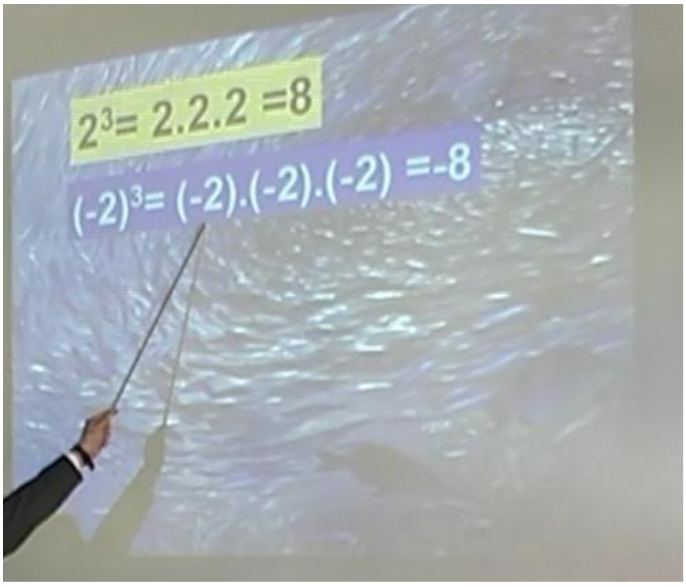


Figure 2. An image from the classroom of teacher Enver

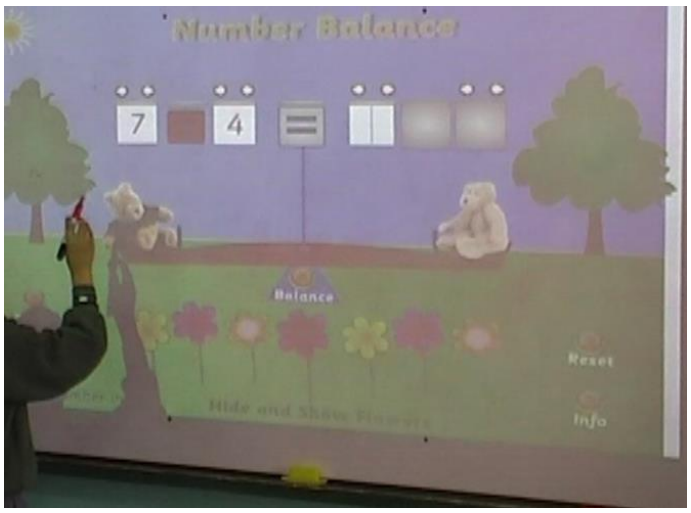


Figure 3. An image from the classroom of teacher Ismail

The Summary of Video-Recorded Lesson of Teacher Tekin within the Scope of Education

The video-recorded pre-training lessons of Teacher Tekin were not analyzed due to the absence of technology use. In his post-training lessons, the lesson was taught with technology-aid in the school's computer laboratory. Teacher Tekin taught the subject "symmetry" in his video-recorded primary school 8th grade mathematics lesson. Technology was effectively used throughout the lesson conducted in the school's Computer-Aided Technology Class. The teacher tried to convey the subject "reflection" to the students using a PowerPoint presentation and the level of technology use was determined as *replacement*.

In order to assure the participation and motivation of students, Java Applet mathematics software was primarily introduced to students who were informed about how to use it. Thanks to this software, many activities, which are impossible to show on the board, could be easily applied. For example, for the subject of symmetry, how an object converges to the axis of symmetry as the object converges to the symmetry axis and the image of how an object becomes distant from the symmetry axis as the object moves away from the axis of symmetry, which was illustrated by the Java Applet software, would have been impossible to show on the board. Therefore, the teacher's level of technology use in this activity was determined as *transformation*. In-class dialogue of this subject is as follows:

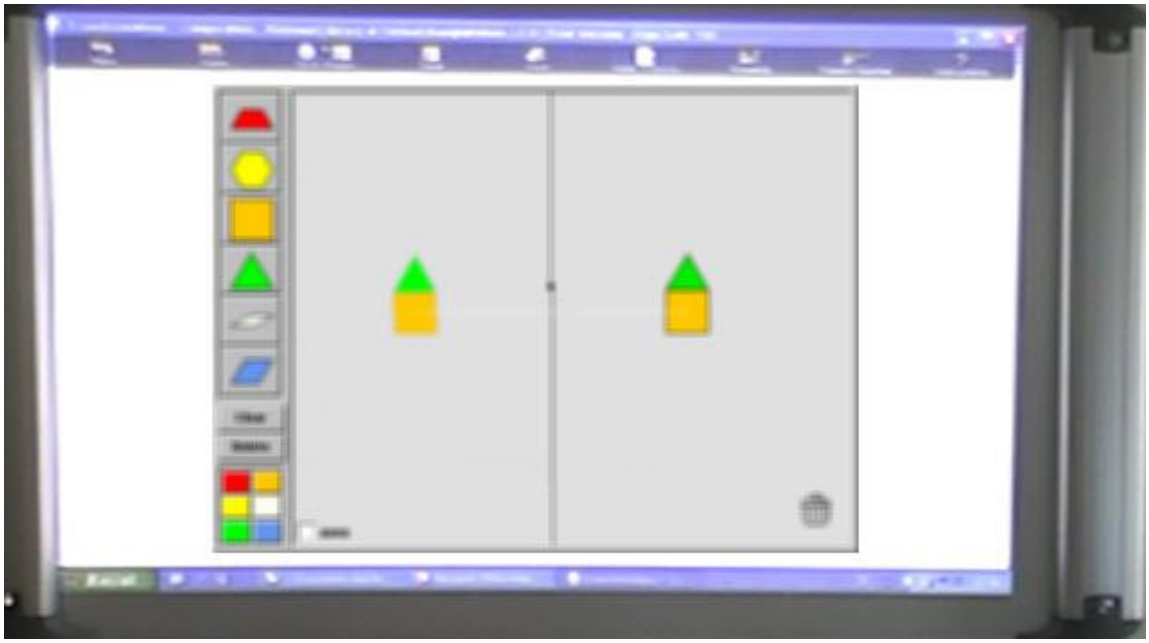


Figure 4. An image from the classroom of teacher Tekin

Teacher: Now look. I get this square close to mirror. What do you see?
Class: (All together) It gets close.
Teacher: What about the image at this side?
Class: It gets close.
Teacher: Look, the image gets closer as much as the object.
Betül: Yes.
Teacher: Look here! When I move this away?
Class: It becomes distant.

The level of technology used in some parts of the lesson was determined as *amplification,* which resulted from the fact that the same activities could be conducted without technology but the same quickness and effect could not have been achieved. For example, the activity calculating the distance of an object and its image on the coordinate plane of the symmetry axis can be taught on the writing board. However, drawing a new coordinate plane for each object will cause time loss and will not achieve effective and fact learning.

Table 4 shows data obtained from the comparison of the role of technology use of teachers, whose lessons were video-recorded.

Table 4. The comparison of the roles that teachers give to technology in mathematics lessons

		Pre-training				**Post- training**			
Branch	**Teacher**	**No technology**	**Replacement**	**Amplification**	**Transformation**	**No technology**	**Replacement**	**Amplification**	**Transformation**
Mathematics	Tekin	+					+	+	+
Mathematics	Tahsin	+					+	+	
Mathematics	Enver	+					+		
Mathematics	Nazım	+					+		
Mathematics	Sevgi	+					+		
Classroom	Gürselen		+				+	+	
Classroom	İsmet		+				+		
Classroom	Gizem		+				+		
Classroom	Gül	+					+	+	+
Classroom	İsmail		+				+	+	

According to the findings obtained from video analyses. The fact that, teachers either used technology at the lowest level, *replacement*, or did not use it at all in their pre-training lessons, is most remarkable point in Table 3. After the educational program, two teachers conducted activities at the *transformation* level and five teachers at *amplification* level.

Discussion and Conclusion

The aim of the study was to investigate the effect of a professional development education on the use of technology in teachers 'mathematics lesson, the changes in pre and post-training technology integration levels, and the effect of these changes on learning. According to the findings of the research, before the educational program was given within the scope of the project, teachers either used technology at the lowest level, *replacement*, or did not used at all. After the educational program, all teachers integrated technology in their lesson. In addition, five teachers were observed to conduct activities by giving amplification and transformation roles to technology. According to Hughes (2005), teachers would achieve an upper-level integration only when they changed their pedagogic approaches and class routines and provided in-depth learning. After the educational program, the teachers conducted activities giving transformation and amplification roles to technology, which is an indicator of a development regarding this acquisition.

The study findings indicated that only two teachers used technology in the transformation role and five teachers in the amplification role. Conducting activities by giving these roles to technology is an indicator of good progress. It should be stressed that technology integration is hard and requires long-term study, which has been determined by many research and researchers (Byrom, 2008; Groff and Mouza, 2008; Koehler, Mishra and Yahya, 2007; Zhao et al., 2002). Considering the long-term nature of the technology integration process (Groff and Mouza, 2008), those aforementioned efforts of teachers can be evaluated as an evidence for the change in the teacher.

Based on in-class dialogues, the effect of the difference in the roles given to technology on learning may be presenting information visually and dynamically instead of orally to students may positively affect the understanding of students. In addition, instead of orally objectifying an abstract concept in students' minds, visuals in a dynamic environment are observed to help students objectify concepts. Also, the use of technology, especially in the amplification role, can provide teachers a way to save time and solve problems in less time. In addition, technology may help to concretely illustrate the relations between concepts. For example, Figure 3 shows that the balance and equation concept can be used in terms of balance.

The examples provided to the teachers related to classroom educational practices and the investigation how the teachers implement what they have learnt during the education given in the study are important to contribute to the development of the use of the technology of the teachers. In this regard the studies done on this subject showed that it is not sufficient alone to teach teachers how to use educational technology but also they should be taught how to prepare educational materials so that the teachers may prepare educational materials using technology and use them in their classroom.

This study tried to examine the effect of a technology integration education given within the scope of a project on the in-class implementations of teachers and the levels of technology use by teachers. The framework (the technology aided pedagogic levels) used in this study has revealed that it can be used as an assessment tool to evaluate the development of teachers what roles they give technology in their classes. Within this context, future studies can re-examine teachers' levels of technology use who have taken further education by re-observing their in-class lessons. Therefore, future studies can examine whether they raise their teaching levels from that of replacement. In addition, in order to examine whether technology integration level changes according to the content of lesson, in-class implementations of different teachers regarding the same subject, or of the same teacher regarding different subjects, can be examined.

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