



## Effect of Designed In-Service Training to Secondary School Mathematics Teachers Technology Usage Level \*

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### Abstract

By this research, it is aimed to determine the effect of in-service training was designed due to Rieber and Welliver's (1989) technology integration model to the secondary school mathematics teachers' technology usage level. The in-service course was conducted over a 15-week period and 13 secondary school mathematics teachers from Bayburt participated in the course. When the course program was being structured, some software and learning objects developed for mathematics teaching were utilized. The applications were supported by worksheets and activity examples appropriate for the curriculum. In this study where data were gathered using interviews and observations, the case study method was used. The collected data was analysed by means of qualitative and quantitative analysis methods. When the findings were checked, it can be seen a result that teachers took advantage of technology for composing deep conceptual comprehension and structuring concepts by students centred explores and used technology in their lessons frequently. By this manner, it was resulted that the designed course positively affected to teacher's technology usage levels.

### Keywords

Computer Technology  
In-service training  
Mathematics  
Technology Usage Level  
TPACK

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### Introduction

As a result of developments and changes on technologic areas in the recent years, it is cause to be unavoidable that mathematics education should include technology usage. New perspectives, tries, exams, research, simplicities provided by technology enhanced the content of the Mathematics (Baki, 2001) and gave education and learning opportunity which is not possible to be obtained by routine application (Saban, 2007; Alacacı & Mcdonald, 2012). In National Council of Teachers of Mathematics (NCTM), it is stated that technology usage will affect mathematics education positively and enhance the students' learning abilities (National Council of Teachers of Mathematics [NCTM], 2000). Similarly, Pierce and Ball (2009) stated that technology usage is a must in the mathematics lessons and should be adapted to teaching-learning process. Baki (2008) indicated that learning gets easier; learning time quickens; students can reach the information at first hand and also deficiencies are overcome in the technologic environment.

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That, the technology gives very great opportunities and has positive effect to learning-teaching process, requires radical change on Mathematic teaching programs. When the educational targets of many countries are reviewed, it was seen that it was emphasised that technology integration with education programs is prioritised (Plomp, Anderson, & Kontogiannopoulou-Polydorides, 1996) and integration of technology with mathematic learning is required and a must (NCTM, 1989, 1991, 2000). In our country, using effectively of dynamic mathematics and geometry softwares and taking advantage of information and communication technologies were emphasised in the middle school mathematics curriculum introduced in 2013 (Ministry of National Education [MNE], 2013). When performed studies are checked it was seen that however there are beliefs that using technology in the education will be a reform, technology cannot be used in the schools as the planned level, so education could not be integrated with technology (Gülcü, Solak, Aydın, & Koçak, 2013). In fact, this result is not surprising. Because, when the literature analysed, it was seen that teachers have not enough knowledge to use the technology in their lesson (Erbaş, Çakıroğlu, Aydın, & Beşer, 2006; Çakıroğlu, Güven, & Akkan, 2008; Çakır & Yıldırım, 2009; Bozkurt, Bindak, & Demir, 2010; Demir, Özmantar, Bingölbali, & Bozkurt, 2011; Kaleli Yılmaz, 2015), teachers who have difficulties in using technology are reluctant to use technology in their lessons (Ayvaci, Bakırcı, & Başak, 2014; Kaplan, Öztürk, Doruk, & Duran, 2016) ve it was seen that the teachers approach technology with fear/anxiety (Erkin & Gülseçen, 2001).

Besides these, many factors affect the technology to use in the lessons were given wide coverage in the literature. These factors are generally clustered by two parts: inner and outer. According to Ertmer (2005), inner factors are related to the teacher such as attitude, self-reliance, belief; outer factors are not directly related to the teacher such as school conditions, manager support, and technology availability. Ertmer (1999) states that however when technology is wanted to be integrated to the lessons, outer factors can be made away easily; to change the inner factors is longer and more difficult process. For this reason, it is required that teachers should be informed about technology used and directed to have positive attitudes and beliefs for technology. That teachers can not use technology sufficiently and adapt to the changes in the educational systems parallel with technology reduces the teachers affects and education quality (Haddad & Jurich, 2002). To prevent it, it is requirement that teachers should be trained about technology usage in their education curriculum and supported for take advantage from the technology when their teach the lessons.

#### *The Structures of the Course Programs Prepared for Technology Usage*

When the literature is searched, it can be seen that in service training courses about computer technology usage in the lessons are limited availability and in the performed courses technical subjects such as software and hardware mostly focused and in this courses, it was fixed that teachers' needs could not be met sufficiently (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; Uslu & Bümen, 2012; Pamuk, Çakır, Ergun, Yılmaz, & Ayas, 2013). But, it is known that teaching the pedagogic aspect of the technologic tools are more important than teaching how the technology was used technically (Hughes, 2005; Hew & Brush, 2007; Akkoç, Özmantar, & Bingölbali, 2008; Kuşkaya Mumcu, Haşlamam, & Koçak Usluel, 2008; Harris, Mishra, & Koehler, 2009). Thus, only teaching technical details in the service training about technology usage in the lesson is not sufficient. Besides that, Technologic Pedagogic Content Knowledge (TPACK) covers how which technology will be used in which subject should be taken place. Moreover, the relationship between technology and education program was not ignored. So, in service training (IST) will be performed, giving technology information is proper with education program and performing many sample activities about how they use technology in mathematics lessons are required.

Another case attracted the attention in the managed in-service trainings, is that course programs do not base upon any model. However, when the literature was reviewed, it was seen that many model developed for technology integration are available (Rieber & Welliver, 1989; Dwyer, Ringstaff, & Sandholtz, 1991; Moersch, 1997; Valdez et al., 1999; Rogers, 2003). In these models, which stage should be passed for effective technology integration and what should be done in these stages were explained. For this reason, in the in-service trainings will be performed; structuring the course by basing on one of the developed models for technology integration will be more advantage. Moreover, the studies done in the recent years prove that short term in-service trainings do not provide sufficient technology experiences to the attendees (Aydın, 2010; Cengiz, 2012; Banoğlu, Madenoğlu, Uysal, & Dede, 2014). In the research performed by Park and Ertmer (2007) stated that time as 16 hours to change the beliefs of the teacher for technology usage is very short and to obtain the belief change and teachers needs more time. Baki and Şensoy (2004) fixed that, performing the in-service trainings should be extended over the whole term instead of the beginning or the final of the term produces effective results to apply the knowledge and experiences obtained from the course. For this reason, preparing in-service trainings about computer technology usage in the education term by extending over the term has a great importance for taking advantage from the course program and changing the teachers' beliefs about technology.

One the important missing was seen in the literature is that sample applications performed in the real classroom conditions were not showed to the teachers and teachers were not given opportunity to make application in their classrooms. But Baki (2002) stated that if the teachers see the effective samples of the computer usage in the classroom applications and live learning-teaching experiences by computer, they start to take it seriously in their professional life. Also, Ertmer (2005) says that in order that teachers change their beliefs about technology integration, it is required that they have experience about technology at first hand and see the results of the successful applications. Kellenberger (1997) emphasised that teachers lived positive experience with the technology in the real classroom condition will be willing to use technology for the further lessons. In this case, in the end of the in-service trainings will be performed, showing the sample applications to the teachers by course educator and motivating them to perform application in their lessons and discussing with them about applications and help them to solve problems encountered have a great importance. Besides that, it was seen that long-term monitoring and evaluation done after the course to determine whether if the program performed successful or not were not given importance. But to determine whether if the program performed successful or not, monitoring and evaluation studies are very important. For this reason, it is an important consideration that teachers should be observed after the course for a long time and supported on the subjects they need.

#### ***Technology Integration Model of Rieber and Welliver (1989)***

In the scope of this research, designed course program was built due to technology integration model of Rieber and Welliver (1989). However, there are many integration models in the literature, when the steps of those models are searched, it was seen that this model can mostly benefit to achieve the goals. On the other hand, in the last ten years, it was determined that this model was introduced and integration models due to this model were structured in many researches on technology integration (Hixon & Buckenmeyer, 2009; Al-Senaidi, Lin, & Poirot, 2009; Neyland, 2011). These studies lead to select the model of Rieber and Welliver in the course program design.

Technology Integration Model developed by Rieber and Welliver (1989) suggests five-stage hierarchy. This model was presented as a tool can be used in the planning the changes of the teacher roles. According to Rieber and Welliver (1989) and Marcinkiewicz (1994), teachers should progress by the steps of familiarization, utilization, integration, reorientation and evolution while integrating the technology to their lessons. Otherwise, the probability of technology misusing can increase. The stages are available in this model explained briefly as following (as cited in Kaleli Yılmaz & Güven, 2014, p. 152).

*Familiarization Stage:* It is about that individual introduces the technology in first time and trying it. In this stage, teachers introduce with technology and learn the technology terms and basic operation procedures. They inform about technology in its importance. No more progress is seen on teacher's experience and technologic development. Teacher can discuss with the current officer by means of his experience and thoughts but no more operation performs. In this stage, many educations innovations start and finish.

*Utilization stage:* It occurs when teacher starts to use technologic innovation in his lesson or out of lesson. In this stage, computers have not vital importance and teachers are seen comfortable with teaching by conventional methods. Teachers use technology but some of small problems prevent them to use technology. On the other hand there is a natural danger that teachers can be pleased with limited using of the technology. Teachers proceed this stage can give up to use technology when they encounter with any disorder. Since, they have not decision about technology.

*Integration stage:* Teachers decides to take some responsibilities and duties about technology. In this stage, computer usage constitutes the essential part of the education and learning process. If technology is immobilized suddenly or technology cannot be reached, teacher cannot continue to his lessons as he planned. There is some defined education aims and without using computer technology, it cannot be reached these aims. Technology is used as a required education tool. In this stage, many teachers find to teach without chalk and board very hard. For this reason, technology availability is the most critic feature of this stage.

*Reorientation Stage:* Teachers believe the opportunities technology provides and try to constitute learning environment simplifies the students structure their knowledge. In this case, however teachers cannot accept themselves as the expert, their lessons mostly include technology. Their interest is how technology provides advantages to their students' learning processes. So, in this stage, technology becomes a part of the learning and teachers start to re-think how they reach their educational aims by using technology.

*Evolution Stage:* Signals that teachers accept the evolution continuity are taken. Here, the conventional roles of the teachers and students are re-defined for producing effective solution to education problems. Teachers make changes in their teaching and learning methods to simplify the learning process. A teacher on Evolution stage has already integrated technology in his all subjects and contents.

Reorientation and Evolution stages take place in the model of Rieber and Welliver (1989) are the phases can be develop by themselves while using the technology. Course content was structured due to the first three stages of that model. Because reorientation and evolution stages can take long time and course educator cannot affect the students to pass these two stages (As cited in Kaleli-Yılmaz & Güven, 2014, p. 151-152).

### ***Technology Usage Levels***

Hughes (2005) defined three different levels to determine the technology usage levels. These are named as Level-1(Replacement), Level-2 (Amplification), Level-3 (Transformation). When the literature is checked it can be seen that Level-0 (No technology) was defined over than the levels described by Hughes (Akkoç et al., 2011; Demir et al., 2011). Technology usage levels described by Hughes (2005) were explained as following:

***Level-1:*** A teacher is at this level uses the technology for only changing the media (Hughes, 2005). Reflecting the information which will be written on the board by teacher to the wall by projection device or solving a mathematical problem by using tablet can be given samples for this level. A teacher at this level uses the computer instead of the current equipment. But no change become in learning routine (Hughes, 2005; Akkoç et al., 2011).

**Level-2:** At this level, used technology contributes to carry out learning process effectively and quickly (Hughes, 2005). There is no need that teacher makes change in the routines and gains in the classroom. So, in this level, without change the duties or gains, technology can be used effectively (Hughes, 2005; Akkoç et al., 2011; Demir et al., 2011). When a mathematics teacher discusses the subject, quickly calculating sin 20 value by a calculator or a computer without any mistake is a sample for technology using Level 2.

**Level-3:** It is required that the teacher uses the technology at this level should make change on the learning-teaching routines and design the learning environment to help students to deeply comprehend (Hughes, 2005). A teacher at this level can take advantage of the technology to show the relationships between concepts (Hughes, 2005; Akkoç et al., 2011). For example, showing the term of "the shortest distance from a point out of the line is the perpendicular to the line" by Cabri or GeoGebra software with an activity based on exploring can be a sample to use the technology at Level-3.

### *The Aim of the Research*

When the literature is searched, the important researches to determine what are the variable to accept using the technology by teachers and teacher candidates were encountered (Teo, 2010; Teo, Ursavaş, & Bahçekapılı, 2010; Kabakçı Yurdakul, Ursavaş, & Becit İşçitürk, 2014; Ursavaş, Şahin, & McIlroy, 2014). But, it was noticed that in a few of research, researchers joined to the teachers' lessons and observed what students did (Gür, Özoğlu, & Başer, 2010). However, Bogdan and Biklen (1992) stated that happens can be understood well when they are observed in the environment they were formed the best. Also, Judson (2006) proved that there are great differences between the thoughts stated by the teachers and applications they performed. So, most of teachers did not represent their thoughts to their applications. Moreover, Cuban (2001) stated that using computer in the schools projected by the teachers more than the real life and it is essential that what are done in the school to validate the statements of the teachers should be observed. For this reason, teachers should be observed in their lessons and their technology usage at which level and for which aims are so important to determine how and at which level they can project their own beliefs to the real applications In this case, in the performed study it was aimed that observing the three teachers selected from 13 teachers attended to the in-service training (IST) Courses in the pre-course and post-course in their lessons term, determining the technology usage levels for every lesson and fixing in-service training formed what kind of effect on the technology usage levels.

### **Model**

In this research is a case study took place in the qualitative researches. Case study model started to widely use in the researches on education from 1980's gives opportunity to research the one way of the subject deeply and has aim to verify some general theories (Merriam, 1998; Yıldırım & Şimşek, 2005; Çepni, 2007). One of the criterions of the case study method is that it can be preferable when how and why questions are directed to the attendees (Yin, 1984). Aiming to detail researching the subject of the case study requires that the number of participant should be less. Moreover, in the case study, other research method can be took place and a lot of data collection tool can be used. Thus, detailed study chance on the current sample can be obtained. Sample cases are researched without disarranging the natural condition case takes place in. In this study, a lot of observations should be performed for determining that secondary school Mathematics teachers use the technology in their lessons at which level and observation should take long time. In this case, having an in-depth idea about the cases by studying with less people of the researcher is important. Because, implementing this research by reaching huge teacher mass causes that observations become unfit and insufficient observations are performed. And these situations prevent to obtain the aimed results. Thus, this model was decided to use in this research because of studying with less participants with long term observation requirements and using many data collection tool.

### *Sample of Research*

In this research, in-service training course program were carried out with 13 teachers. In the pre-course, every teacher of 13 teachers were observed in the four different courses and it was fixed that whether if they used technology or not and if so, the level of the technology usage. Moreover, some interviews were performed with teachers and it was learned that why they did not take advantage from the technology or at which level they used the technology. While these interviews, it was determined that their beliefs on the technology and whether if they were disposed to do use technology and teachers will be observed in the long time period whose data will form the base data sources if the search. A teacher (Ö1) uses technology in his lessons and a teacher (Ö2) has a negative opinion and do not use the technology in his lessons and a teacher (Ö3) cannot use the technology because of the sufficient technologic equipment were selected because of variation. These teachers were coded as Ö1, Ö2, Ö3, and their specifications were explained detailed as following:

#### *Teacher Coded as Ö1*

He was graduated from Education Faculty, Elementary School Mathematic Teaching Department and he has 6 years-experience in the teaching. He works in an secondary school depends on centre of Bayburt. He teaches the students at 6<sup>th</sup>, 7<sup>th</sup> and 8<sup>th</sup> grades. The populations of the classes which Ö1 teaches change between 12 and 18. And there is a computer and a projection device in every class. At the preliminary interview Ö1 stated he took a lesson about computer in the university but unfortunately he could not remember anything about it and his experiences about computer up to be teacher were bad. He had a computer firstly when started to teaching occupation. He learned to use computer by his own efforts and develop his basic computer abilities. In the first years of his occupation, he prepared presentation by scanning the book. But, then, his work facilitated when un-interactive e-books and smart boards released to the market. And he added he tried to use technology effectively in his every lesson. Also, Ö1 finds teaching without technology difficult and believes that technology simplifies the teachers' work. In brief, Ö1 is a teacher who has positive belief to use computer technology (CT) in his lesson and uses technology in his lessons orderly and finds teaching without technology so difficult and thinks that technology simplifies the teacher's work.

#### *Teacher Coded as Ö2*

He was graduated from Education Faculty, Elementary School Mathematic Teaching Department and he has six years-experience in the teaching. He works in an secondary school depends on centre of Bayburt and he is the unique mathematics teacher in his school. He teaches the students at 6<sup>th</sup>, 7<sup>th</sup> and 8<sup>th</sup> grades. The populations of the classes which Ö1 teaches change between 16 and 24. There are computer and projection device in the some classes and in the computer laboratory. Also, there is a portable projection device can be used in the classes when the teachers request to use. He stated that he did not take computer aided mathematic education while his bachelor education term and he had not sufficient knowledge about CT can be used in mathematics lesson, for this reason he could not have taken advantage from CT in his lesson. On the other hand, he added he could not have integrated computer and mathematics, so he only can prepare presentation, show the questions by the computer and can make some operations by Excel. He did not think that computer is useful for any purpose more. So he did not want to use computer in his lessons. In brief, Ö2 is a teacher who has negative belief to use CT in the mathematic lessons and has not sufficient knowledge about CT can be used in Mathematics lesson and cannot correlate mathematics lesson and CT.

### *Teacher Coded as Ö3*

He was graduated from Education Faculty, Elementary School Mathematic Teaching Department and he has 5 years-experience in the teaching. In the past he had been working in two different cities. Bayburt is his third location. He works in an secondary school depends on centre of Bayburt. He teaches the students at 6<sup>th</sup>, 7<sup>th</sup> and 8<sup>th</sup> grades. The populations of the classes which Ö1 teaches change between 22 and 24. No computer and projection device is available in the classrooms. Projection is available in only computer laboratory and visual classroom. But, while monitoring and evaluation studying, a projection device and computer were put in to the classroom and that classroom started to be used as mathematics classroom. Ö1 stated he took a lesson about computer in the university and he learned some mathematics software. He added the software he learned is so useful and has interest in this software. He tried to take advantage of the computer in his lesson for a few times, but unfortunately, he encountered some technical problems and could not obtain efficiency from the lessons. For this reason, he avoided to use computer in the lessons. Ö3: *“Let’s suppose that we will teach something to the students on computer for a five minutes, it is not reasonable to carry the students to the computer laboratory. The remained part of the lesson is wasted. Moreover, sometimes computer laboratory cannot be suitable and empty. For this reason I put away the computer”* By declaring like that, Ö3 explained the reason why he does not use computer in his lessons. Also, he said that if he has a computer and projection device what he can use in his lessons, he will take advantage of the technology in the lessons. Hence, after the course and putting a computer and projection device in the classroom, it was seen that Ö3 started to use technology in his lessons regularly. In brief, Ö3 is a teacher who has sufficient knowledge about CT can be used in his lesson and has positive belief to use CT. Moreover, in the result of the negative experiences in his past professional life, he gave up use technology in his lessons but if suitable equipment and tools are supplied for his classroom, he wants to use technology in his lessons.

### *The Structure of the Designed Course Program*

For reaching to the success in IST courses, cooperation made with university is important. For this reason, IST course performed in the computer laboratory of Bayburt University has sufficient hardware and equipment technologically on Monday and Tuesday for 3 hours per a day during 15 weeks. 13 elementary school mathematics teachers work in the schools located in Bayburt centre. In the scope of the study, Technology integration model of Rieber and Welliver (1989) was used while structuring the content of IST course. In the stage of Familiarization, Utilization, Integration are set in the model of Rieber and Welliver (1989), it was provided that teachers introduced with technology made them use the technology, integrating with technology at the last stage by taking in consideration the things committed by the teachers (as cited in Kaleli Yılmaz & Güven, 2014, p. 151-152). To see how they teacher can use the taught technologies in such algebra, geometry, data processing the worksheets were prepared due to the subjects taken place in the curriculum (Linear Equation, circles, polygons, inequities, multipliers, etc.) (Appendix 1: Sample Study Page).

In the research, every software was introduced and made them use and then moved to the integration stage because some software and learning objects such as Cabri, Derive, Graphics, Analyse, GeoGebra were used. Since teachers can live the natural integration process, any guidance to teacher for using technology in their lessons was not done. Only at integration stage, researcher requested from the teachers to use technology in their lessons after sample technology aided applications performed in two different schools in order that they can have an idea about the application performed in the real classroom condition and completely integrate with technology. In this process, teachers were observed continuously and all observations were recorded by video record device (Appendix 2: Course Program) (as cited in Kaleli Yılmaz & Güven, 2014, p. 152-153).

### *Data Collection Tools*

In this study, data were collected by means of interviews and classroom observation. Interview is oral communicating with individual to understand what and why they think about a subject. The essential aim of the interviews is to find out individual's emotions, thoughts and beliefs about the researched subject (Yin, 1984; Çepni, 2007). In the scope of the study, interview was used in the two stages. First interview was performed for generally being informed about the teacher in the pre-course term. By this aim, some questions to learn when they met with computer, what their first experiences are, which lessons they took about computer in their high school and university ages and what these lessons contents, how about the technologic equipment and hardware of the school they work were asked to them. The second interview was done at the end of every lesson the teachers were observed by aiming of determining that why they did not use technology in their lesson, if they used why they used it. For this reason, questions were generally prepared before but if it was required additional questions due to the taught lesson were added to the interviews.

What people think and why people think so can be determined by interview model. But obtaining more information about how happens occur in actual fact is so difficult by interview models. At this point, observation model come into play. Observation model clarified how happens actualised in the natural conditions and increase the data confidence (Çepni, 2007). In this study, observations were performed to determine whether if selected three teachers used technology in their pre-course and post-course lessons or not and if so they used technology for which aims, and which levels and every observation recorded by video.

### *Data Analysis*

Interview data were analysed by means of descriptive analysis method takes place in the qualitative analysis methods. First of all, recorded interviews to the digital media transferred to the computer and transcribed. The data obtained from these interviews were used for describing the teachers Ö1, Ö2 and Ö3 taking part in the sampling and determining the reasons of taking advantage of technology.

Recording the observation in the video media, and obtaining data from the first hand is so important because they enable to make detailed analysis by checking the observation again and again (Jacobs, Kawanaka, & Stigler, 1999; Yıldırım & Şimşek, 2005). For this reason, observed all lessons in the scope of this research were recorded by video. While analysing the observation, transcripts were formed for every observation through watching its video again and again. In these observation transcripts, all happens realised in the lesson, learning- teaching process and teacher-student communications were included. Also, transcripts were enriched by adding the taken photos to these documents. Then observation data were reviewed and data were not related to the technology usage level were removed.

To determine at which level teacher took advantage of technology in their lesson, technology indicators for every level were determined by taking consideration of the technology utilising ways and taking support from the studies of Hughes (2005) and Akkoç et al. (2011) Observed lessons of the teachers were analysed according to these indicator and presented technology usage level of every lesson.

**Table 1.** Technology Usage Levels and Indicators belong to Levels

<b>Levels</b>	<b>Indicators</b>
<b>Level-0</b>	Never using technology
	Using technology for introducing programs or tool bars instead of aiming to teach concepts or only helping the students who have encounter problem while using software.
<b>Level-1 Replacement</b>	Reflecting the knowledge can be written on the board to the wall by means of a presentation, following the written on the screen by the students and giving explanation by the teacher on the screen
	Teaching the subjects with using un-interactive e-book by screen and giving explanation via the screen
	Reflecting the exercises and problems by screen, structuring and explaining the solution via the screen images by the students or the teacher
	Solving the exercises and writing them on the screen by using tablet or pen program. Taking notes what is seen on the screen by the students
<b>Level-2 Amplification</b>	Using software or learning subject to perform the operations quicker and more errorless or checking the precision of the operations instead of increasing the comprehension
	Using the software to drawing the equation graphics quickly and errorless
	Using the software, asking questions or making explanations via the screen for learning the preliminary information about the subject more quickly and effectively or fast repeating the information
	Making presentation to repeat the subjects more quickly and effectively or remind the preliminary information instead of changing the media. Using the software to be able to see or show learned knowledge's precision
<b>Level-3 Transformation</b>	Using the technology for structuring the concept and relationships by student centred explores different from conventional applications and constituting deep conceptual comprehension

As seen from Table-1, Level-0 is the stage that technology is never used or program is used for only introducing the tool bar by helping to the students encounter while applying technology. In this stage, there is no contribution of the technology to education. At Level-1, technology is used for changing the media. In this scope, teacher can teach the subject by presentation, software, learning subject, un-interactive e-book, and tablet or pen program on the screen, reflect the question or solve the problem on the screen. No change become on the teacher's routines at Level-1. Level-2 is the stage to use the technology for making operations more quickly and errorless, explaining the subject more effectively and repeating in a short time, learning the preliminary information more quickly and effectively. In this stage, teacher enhances the routine applications by means of technology and provides the lesson be more effective. At Level-3 is the phase that routine applications are changed, concepts, relationships and rules are explored by the students and deep conceptual comprehensions are formed.

Using the defined indicator at Table-1, how many minutes teacher showed the indicators proper with every level were determined. While these time intervals were fixed, video was stopped when the activity for every indicator started, the minute while stopping was noted. Then video was replayed, and the minute when activity ended was noted. Then the difference of the two time point showed that how long the observation time for the activity about the current indicator. For this work, every video was watched again and again and two academicians expert on technology integration supported to check the determinations. After reaching a consensus, technology usage percentages were found by proportioning total minutes per every level to lesson time interval. So it was determined that teachers took advantage of the technology as mostly which level.

## Bulgular

In this chapter, to determine the IST course effectiveness, observations and interview findings of the teachers, Ö1, Ö2, Ö3, obtained were presented individually.

### *Findings belong to Ö1 Coded Teacher*

Total 10 lessons of Ö1 coded teacher as 4 of them on pre-course and 6 of them on post-course were observed. The information related to the observed lessons on pre or post courses were presented at the Table 2.

**Table 2.** Observed lessons of Ö1 coded teacher

Observation Period	Lesson Number	Subject	Grade	Processing of the Lesson
Pre-Course	1	Circles	7	Computer Assisted Instruction (CAI)
	2	Exponential numbers	6	CAI
	3	Equality and equations	6	CAI
	4	Factorization	8	CAI
Post-Course	1	Tables and graphics	6	CAI
	2	Equations	7	CAI
	3	Equality and similarities	6	CAI
	4	Translational and reflection	6	CAI
	5	Angles and arcs on the circle	7	CAI
	6	Solutions of the equation systems	8	CAI

### *Findings belong to the pre-course lessons of Ö1 coded teacher*

It was observed that Ö1 teacher processed the four pre-course lessons by computer and projection device to reflect the images onto the shutter. In their lessons circles, exponential numbers, equality and equations, factorization subjects were explained. Taught pre-course lesson about circles was summarized by the following table and it was emphasised that how technology was used for which aims and by which levels.

**Table 3.** Findings Related to the First Pre-course Lesson of Ö1 Teacher

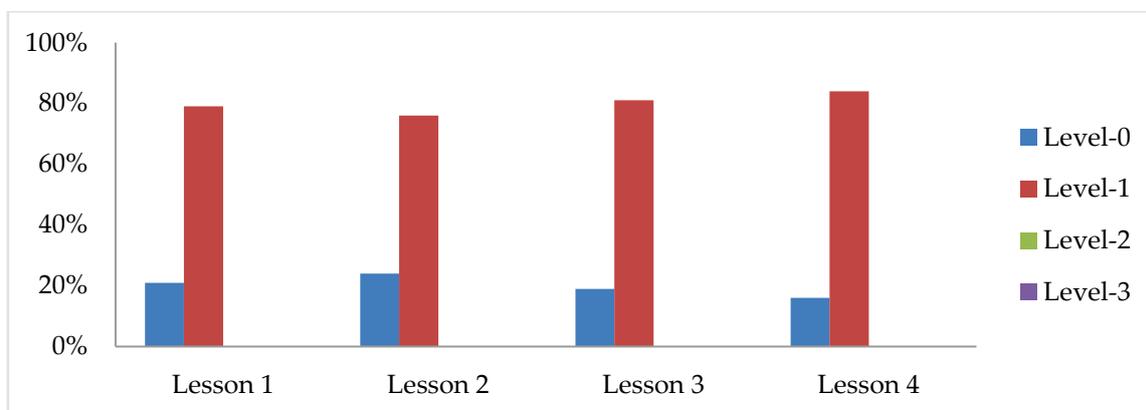
Stage	Explanation	Technology Usage Level	Time (min)
1	Defining the circle and giving daily examples about circles.	Level-0	8 min
2	Showing the diameter and semi-diameter on the image from the e-book reflected to the wall. Emphasising diameter equals the two times of semi diameter by taking the students' comments.	Level-1	4 min
3	Explaining the areas where circle divides on the plane and asking that where some defined points take place on the circle. After taking the students' comments, giving required information and then taking notes by students.	Level-1	9 min
4	Discussing the question creating on the screen together with the students and taking the notes about the solution by students.	Level-1	3 min
5	Drawing the line on the screen by using smart board program and defining the line will showed by which letter.	Level-1	1 min
6	By means of the e-book reflected to the display, explaining concepts of tangent intercept and chord, emphasising their specifications, discussing on the composed images, and then taking notes by students.	Level-1	8 min
7	Asking about the subjects on the e-book, making explanation due to the given answer of the students and finishing the lesson.	Level-1	5 min
Total			38 min

As seen at the Table-3 lesson takes 38 min and technology was not used during 8 min of the whole lesson. (Level-0) Teacher generally taught the subject on the 2<sup>nd</sup>, 3<sup>rd</sup>, 6<sup>th</sup>, and 7<sup>th</sup> stages by e-book and projection device and make explanation by means of the board and request the student to take notes. This finding corresponds Level-1 at the table of “Technology usage levels and indicators belong to levels” presented in the data analysis stage. So, in these stages, technology was used only to change the media. Likewise, technology was used for reflecting of the exercises and problems onto the wall and solving them by students or teachers and explaining them to the students in the 4<sup>th</sup> and 5<sup>th</sup> stages of the lesson. This corresponds to Level-1 due to indicators belong to levels. However, technology was only used on the purpose of changing the media and it was not used for increasing conceptual comprehension and performing the operations more effectively.

Three pre-course lessons explained by teacher were analysed as stated above and determined that technology was taken advantage by which level and how long. At the following table, Ö1' technology usage levels were given with observed four pre-course lessons with minutes and percentages.

**Table 4.** Pre-course Technology Usage Levels Minutes and Percentages of Ö1

Levels	Lesson 1		Lesson 2		Lesson 3		Lesson 4	
	Minute	%	Minute	%	Minute	%	Minute	%
Level-0	8 min	%21	9 min	%24	8 min	%19	6 min	%16
Level-1	30 min	%79	28 min	%76	31 min	%81	34 min	%84
Level-2	-	-	-	-	-	-	-	-
Level-3	-	-	-	-	-	-	-	-
<b>Total</b>	<b>38 min</b>	<b>%100</b>	<b>37 min</b>	<b>%100</b>	<b>39 min</b>	<b>%100</b>	<b>40 min</b>	<b>%100</b>



**Figure 1.** Pre-course Technology Usage Levels of Ö1

As seen from the graphic, teacher took advantage of technology in the all pre-course lessons as Level-1. So, he used the technology with the intent of changing the media.

Due to the interview made with Ö1 after the lesson, he stated that he has not enough information the specific software can be used in Mathematic Lessons. For this reason he teaches the lessons by using only smart board program and books explain non-interactive subjects. Moreover he said that he could have made the operations easily without writing them to the board. In this manner, he could have found more time to solve the problems. He added that he thought teaching without using technology is difficult; thus he had been using technology in his lessons.

### *Findings belong to Post-Course Lessons of Teacher Ö1*

In the six lessons of the teacher Ö1 observed after the course, he taught the equations, equality and similarities, translational and reflection, angles and arcs on the circle, solutions of the equation systems and related tables and graphics through the images reflected to the wall by projection device.

There is a table below shows the technology usage levels of the teacher Ö1 in the post-course lesson. While selecting the sample lesson, it was considered that teacher used the technology by the three levels. Teacher Ö1 taught the subject of reflexion and translational in the current lesson for the students on 6<sup>th</sup> grade.

**Table 5.** Findings belong to Sample Post-Course Lesson of Teacher Ö1

Stage	Explanation	Technology Usage Level	Time (min)
1	Checking the preliminary information about translational subject of the students. Student's explanations about what he comprehends from translational by showing an example.	Level-0	4 min
2	Cabri Software Introduction	Level-0	1min
3	Consisting a triangle by Cabri Software and asking to students what kind of shape is consisted if the triangle displaced to the right as 3 units and down as 1 unit and taking the comments from the students.	Level-1	3 min
4	Quickly translating the triangle by the defined direction and distance and then calculating the distance between triangle and translated triangle and showing the relationships by Cabri Software.	Level-2	1 min
5	Asking to the students that whether if the translation of a polygon to the right as 4 units and down as 2 units was made right or not by Cabri Software. Providing the students comprehended the translation concept by different questions.	Level-2	2 min
6	Taking notes the images on the wall to their notebooks.	Level-1	4 min
7	Defining what kind of questions about translation are asking.	Level-0	1 min
8	It is requested the students to translate a hexagon as defined direction and size.	Level-0	1 min
9	Drawing the coordinate axis and taking the reflexion of the triangle due to y-axis and calculating the distances from the corners of the current and translated triangles to y-axis by Cabri Software.	Level-2	1 min
10	Taking notes the images on the wall to their notebooks.	Level-1	5 min
11	Drawing another shape, taking the reflexion due to the y-axis, calculating the distance, moving the shapes and providing the students to comprehend that distances never change and see how the image occurred after reflexion moves by Cabri Software.	Level-3	4 min
12	Asking to the students what they know about translation symmetry and students' silently reading the definitions written in the book.	Level-0	2 min
13	Composing a shape and translation symmetry on the screen by means of the smart board program.	Level-1	3 min
14	Constituting different question on the screen and making explanation after taking comments from the students and finishing the lesson.	Level-1	7 min
Total			39 min

As seen from the Table-5, the total lesson took 39 minutes. During 4 minutes, technology was taken advantage as Level-3, for 4 minutes technology was used as Level-2, and the part of 22 minutes it has managed as Level-1. In the remained 9 minutes, technology was never used (Level-0). At the 1<sup>st</sup>, 7<sup>th</sup>, 8<sup>th</sup>, and 12<sup>th</sup> stages, technology was never taken advantage so technology usage level is zero.

In the second stage, technology usage level is zero because technology was used to introduce the software instead of teaching technology concepts. In the 6<sup>th</sup> and 10<sup>th</sup> stages, technology usage level is one due to the Levels Indicator Table because students took the notes from the board to their notebooks. Similarly, in the 3<sup>rd</sup>, 13<sup>th</sup> and 14<sup>th</sup> stages information can be written on the board reflected to the wall by projection device, and questions were composed and solved on the screen by using the software or smart board program. In these stages, technology was only used to change the media, so the usage level is one. In the 4<sup>th</sup>, 5<sup>th</sup> and 9<sup>th</sup> stages, because technology used for being able to check the operations accuracies and make the operations faster, errorless and more effective instead of enhancing conceptual comprehension, technology usage level is two due to Levels Indicator Table. In the 11<sup>th</sup> stage, technology usage level is three; since by the different method than the conventional methods, concepts, relationships were taught by student centred explores through composing deep conceptual comprehension.

Totally, teacher's six post-course and technology supported lessons were observed. Other five lessons of the teacher were analysed as explained above table. And then it was determined that technology was used for every lesson at which level and how long.

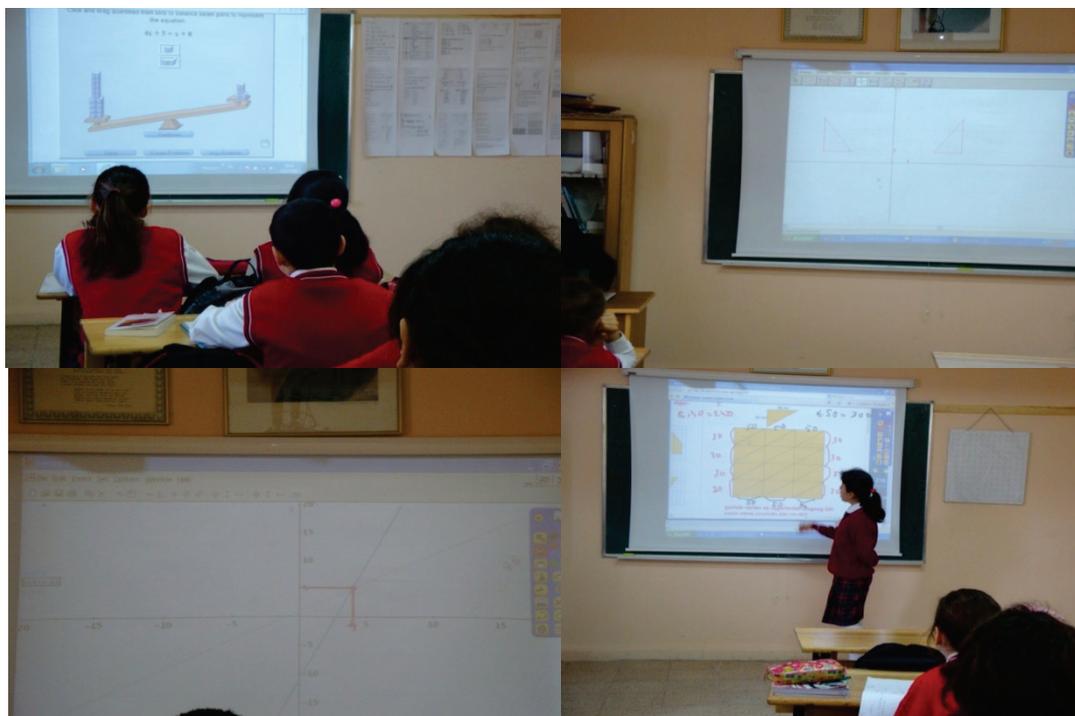
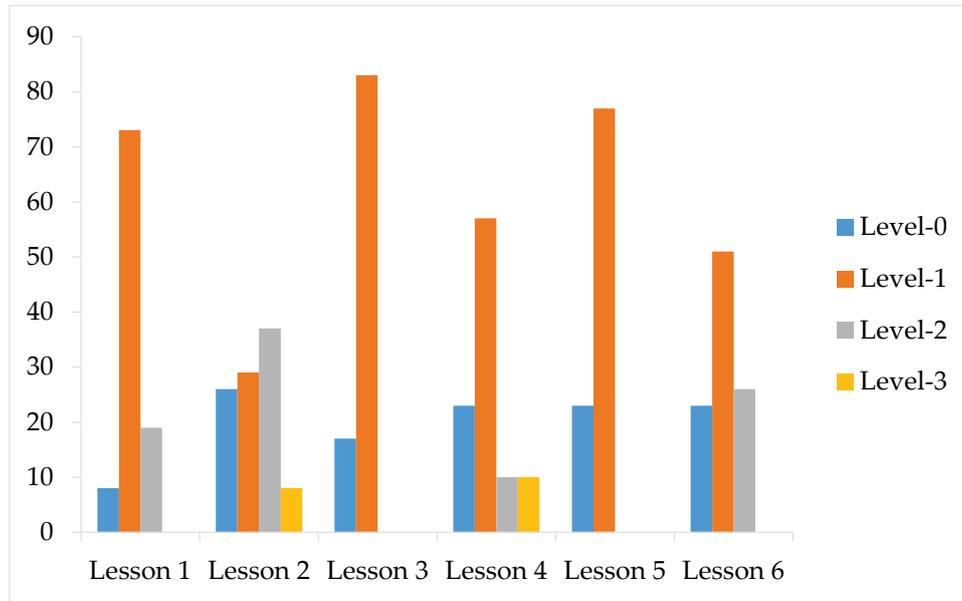


Figure 2. Photos of Ö1 teacher's Technology Supported Lessons

Table 6. Ö1's Post course Technology Usage Levels, Minutes and Percentages

Level	Lesson 1		Lesson 2		Lesson 3		Lesson 4		Lesson 5		Lesson 6	
	min	%										
Level-0	3	8	10	26	7	17	9	23	9	23	9	23
Level-1	27	73	11	29	33	83	22	57	30	77	20	51
Level-2	7	19	14	37	-	-	4	10	-	-	10	26
Level-3	-	-	3	8	-	-	4	10	-	-	-	-
Total	37	100	38	100	40	100	39	100	39	100	39	100



**Figure 3.** Ö1's Technology Usage Levels in the Post-Course Lessons

As seen from table and the figure, teacher Ö1 took advantage of only technology as Level-3 in the second and fourth lessons. In the first, second, fourth and sixth lesson technology usage level was Level-2. In the third and fifth lessons, technology was taken advantage as Level-1 like in the pre-course term. In the other hand, when the lessons are reviewed generally, it was seen that Level-1 technology usage level was mostly used with the exception of 2<sup>nd</sup> lesson. However, lessons which were observed at the post-course and pre-course are different, it was seen that the subject of "Circle" was taken place in the lesson both pre-course and post-course observed. Since the subject of "Circle" is the suitable subject to explore the drawing relationships, Ö1 could design a high level learning condition by using GeoGebra or Cabri software and take advantage of the technology at the technology Level 2 and Level 3. But, because Ö1 used the technology at Level 1 on the "Angles in the Circle" chapters, it can be seen that Ö1 is in tendency to continue the routine applications.

In the interviews at the end of the lesson, teacher Ö1 said that he used the software in a few times in his lessons and it drew attention of the students, they could see the relationships easily and the students had been getting used to the software application, e-book and smart board program for a long time. So, he had a great document and additional preparation is not needed. For this reason he preferred to teach the lessons by this method. On the other hand, teacher added that he must have concentrated on solving the exercises because of the forthcoming SBS Examination and however the information he learned in the course helped the conceptual comprehension; if he continued to teach the lesson by this way, unfortunately he would not be able to find enough time to solve problems. Moreover, he stated that he wanted to take advantage of the technology more to increase the conceptual comprehension, but the current system did not let it, so the education system and examination system were not concordant and matched.

*Findings belong to Teacher Ö2*

4 pre-course lessons and 6 post-course lessons, totally 10 lessons, of the teacher Ö2 were observed. Information related to the observed pre-course and post-course lessons were showed at the Table 7.

**Table 7.** Observed lessons of Teacher Ö2

Observation Period	Lesson number	Subject	Grade	Processing of the Lesson
Pre-Course	1	Operations with Rational Numbers	7	Unsupported by technology
	2	Inequalities	8	Unsupported by technology
	3	Equations	7	Unsupported by technology
	4	Tables and graphics	6	Unsupported by technology
Post-Course	1	Clusters	6	CAI
	2	Parallel, alternate interior, alternate exterior angles	7	CAI
	3	Angles and arcs on the circle	7	CAI
	4	Polygon	7	CAI
	5	Reflexion	7	CAI
	6	Inequalities	8	CAI

*Findings belong the Pre-course Lessons of Teacher Ö2*

Teacher Ö2 taught all the four pre-course lessons without using computer technology under the conventional classroom conditions. For this reason, technology usage level of all four lessons is Level-0. In this part, pre-course lesson analyse was not given place because teacher did not take advantage of technology at any level.

It was interviewed with teacher Ö2 at the end of every pre-course lesson. In the performed interview, teacher said that he had not any information about computer technology can be used. For this reason he could not have associated technology and Mathematics. He thought that technology usage in mathematics lesson did not contribute to comprehension so he did not take kindly to use technology in the mathematics lessons.

*Findings belong to Post-Course Lessons of Teacher Ö2*

In the six lessons of Teacher Ö2 taught the subjects of Sets, parallel, alternate interior, alternate exterior angles, angles in the circle, arcs and polygon, reflexion and inequality in the six observed lessons.

The table as following shows the technology usage levels of the post-course lessons of teacher Ö2. It was selected a sample lesson which the teacher took advantages of the technology at the three levels. In the sample lesson, teacher Ö2 taught subject of Polygons at the 7<sup>th</sup> grade.

**Table 8.** Findings belong to Post-Course Lesson of the teacher Ö2

Stage	Explanation	Technology Usage Level	Time (min)
1	Beginning the lesson with the question "What is the polygon?" After taking the comments from the students, explaining the polygons by means of the daily examples. Then emphasising regular and irregular polygons.	Level-0	2 min
2	Drawing regular polygon by GeoGebra software. Asking that how many pieces polygon separated the plane and taking the comments from the students. Forming a lot of point on, outer side, inner side of polygon by GeoGebra software. And students' fixation which point in the which part.	Level-1	4 min
3	Asking what is the meaning of Diagonal? After taking the comments, making the definition of Diagonal.	Level-0	1 min
4	Drawing a polygon and a diagonal of it by GeoGebra software. And requesting from the students to show the other diagonals. Then composing different polygons and drawing the diagonals on the reflected image by students.	Level-1	8 min
5	Drawing concave and convex polygons by GeoGebra and requesting from the students to drawing the diagonals of them. Asking them what how difference is available between the diagonals. After taking the comments of the students, teaching the subject of the diagonals' staying in and out of the zone.	Level-1	5 min
6	Forming different polygons by GeoGebra and asking how many diagonals can be drawn from a corner, taking the comments of the students by questions. Directing to the students by hints and reminding the diagonal number can be find the formula $n-3$	Level-3	7 min
7	Asking that how many triangle pieces diagonals drawn from a corner separate the polygon, taking the comments from the students by questions. Finding the formula, $n-2$ , by the students through directives and hints. And making the students explore the sum of the interior angles of a triangle can be found as the formula $(n-2)*180$ by the means of previous formula.	Level-3	5 min
8	Forming a polygon on the board and applying by a student all the information he learned on that polygon. Then finishing the lesson by the teacher.	Level-0	3 min
Total			35 min

As seen from the table, teacher's lesson took 35 minutes. In the 12 minutes, technology usage level is 3, In the 17 minutes technology usage level is 1. In the remained 6 minutes, technology was not used, so level is zero. In the first, third, and eighth stages of the lesson, technology usage level is zero. So technology was not used in these stages. In the second, fourth and fifth stages, information can be written on the board was reflected to the screen by GeoGebra. Thus in these stages, technology usage level is one because technology usage is valid for only media change. In 6<sup>th</sup> and 7<sup>th</sup> stages, differently from the conventional application, technology level is 3 because structuring concepts and relationships by student focused explores and deep conceptual comprehension were realised.

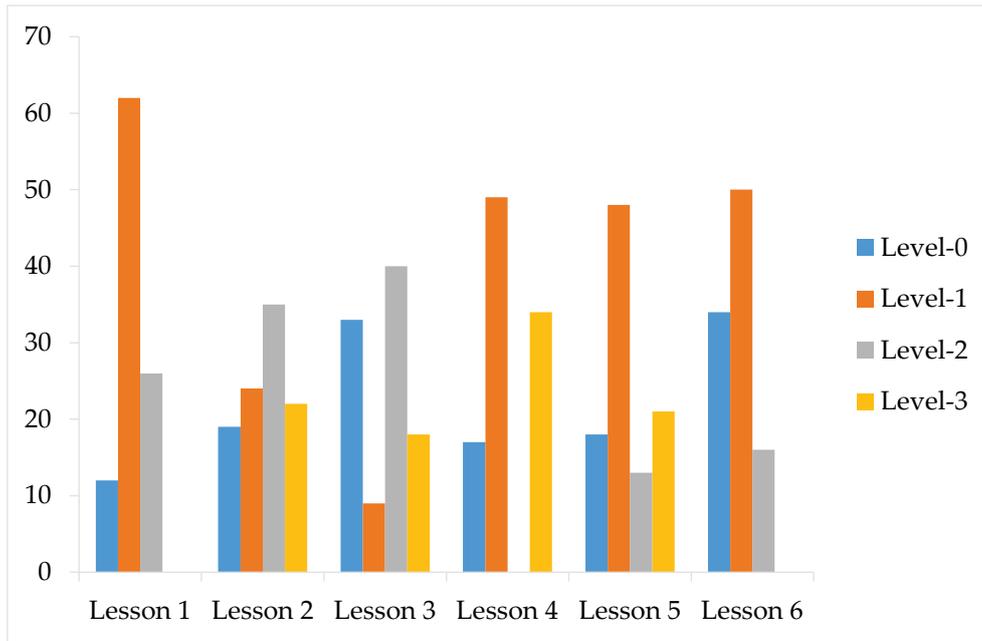
Totally, teacher's six post-course and technology supported lessons were observed. Other five lessons of the teacher were analysed as explained above table. And then it was determined that technology was used for every lesson at which level and how long.



Figure 4. Photos of Ö2 teacher's Technology Supported Lessons

Table 9. Teacher Ö2's Post course Technology Usage Levels, Minutes and Percentages

Levels	Lesson 1		Lesson 2		Lesson 3		Lesson 4		Lesson 5		Lesson 6	
	min	%										
Level-0	4	12	7	19	11	33	6	17	7	18	13	34
Level-1	21	62	9	24	3	9	17	49	18	48	19	50
Level-2	9	26	13	35	13	40	-	-	5	13	6	16
Level-3	-	-	8	22	6	18	12	34	8	21	-	-
<b>Total</b>	34	100	37	100	33	100	35	100	38	100	38	100



**Figure 5.** Ö2's Technology Usage Levels in the Post-Course Lessons

As seen from the Table 9 and the Figure-5, teacher Ö2 took advantage of the technology as Level-3 in the all lessons except of first and sixth lessons. Except of 4<sup>th</sup> lesson, technology, in all lessons, technology was used as Level-2 4. On the other hand, while performing general evaluation, it can be seen that teacher used the technology in his lessons intensely. By considering that he did not take advantage of technology in his pre-course lessons, it can be said that he obtained a great progress in the course to use technology in his lessons.

Teacher Ö2 taught only one lesson in the computer laboratory from the observed ones. Other lessons were taught in the class with carrying pc and projection device to the When the reason was asked to the teacher, he replied that he tried to teach GeoGebra to the students in the computer laboratory but unfortunately, they could not have learned well because they have not pc in their homes. So, they could have forgotten which tool bar works for which action. He taught it second time. Therefore, students encountered many problems to use computer and lesson was interrupted. For this reason teacher added that he did not believe computer aided application contributed to the comprehension, so he did not want to teach lesson in the computer laboratory. Also, he thought additional lesson named "Computer Aided Mathematics" should have been programmed and by this way, students should have learned computer using and software introduction and performing application. Teacher stated that he could have used the time when he taught the lesson in the class and he was less tired and lesson performed more efficiently.

*Findings belong to Teacher Ö3*

Total 10 lessons of Ö3 coded teacher as 4 of them on pre-course and 6 of them on post-course were observed. The information related to the observed lessons on pre or post courses were presented at the Table-10.

**Table 10.** Observed Lessons of Teacher Ö3

Observation Period	Lesson number	Subject	Grade	Processing of the Lesson
Pre-Course	1	Addition and subtraction operations in decimal fractions	6	Unsupported by technology
	2	Angles and arcs on the circle	7	Unsupported by technology
	3	Relations between the sides of the triangle	8	Unsupported by technology
	4	Measures of central tendency and spread	7	Unsupported by technology
Post-Course	1	Circles	7	CAI
	2	Angles and arcs on the circle	7	CAI
	3	Triangle inequality	8	CAI
	4	Polygons	7	CAI
	5	Edge-angle relationship on triangle	8	CAI
	6	Drawing triangle and auxiliary elements in triangle	8	CAI

*Findings belong to Pre-Course Lessons of Teacher Ö3*

Teacher Ö3 taught all four pre-course lessons without taking advantage of computer technology in the conventional class. For this reason, for the four lesson, technology usage level is zero. So in this part lesson analysis was not considered because that teacher did not use technology at any level.

After every observed lesson, it was interviewed with teacher Ö3 and asked to him why he did not take advantage of computer technology. Teacher answered that however he has enough information about Computer Technology, there is not technologic equipment in the class. He tried to teach lesson by using computer technology in computer laboratory. But he encountered some technical problems then the part of lesson when technology was not used is lost and class management was gotten hard and lesson efficiency decreased. Moreover, he could not have found any support from school management. For all these reasons, he does not want to teach lesson by means of computer technology.

*Findings belong to Post- Course Lessons of Teacher Ö3*

In the observed post-course six lessons, teacher Ö3 taught the following math subjects: circle and angles in circle, arcs, triangle inequality, polygons, edge-angle relationship, triangle drawing and auxiliary elements in triangle.

The table shows the technology usage level for the post-course lesson of teacher Ö3. It was selected a sample lesson which the teacher took advantages of the technology at the three levels. In the sample lesson, teacher Ö3 taught subject of angles in the circle and arc at the 7<sup>th</sup> grade.

**Table 11.** Findings related to the sample post-course lesson of teacher Ö3

Stage	Explanation	Technology Usage Level	Time (min)
1	Informing the students about the lesson will be taught and the question may be asked in the exam.	Level-0	1 min
2	Starting the presentation named "Angles in the Circles and Arcs" prepared before and reflecting and reading the gains aimed to be learned.	Level-1	2 min
3	Asking the meaning of centre angle to the students and taking the comments from them.	Level-0	1 min
4	Reading the definition of centre angle from the presentation reflected to the screen by a student.	Level-1	1 min
5	Forming a centre angle by GeoGebra software and showing the students that forming a centre angle and every angle of which corner passes through is the centre angle by moving of line segments.	Level-3	1 min
6	Calculating the centre angle by GeoGebra, showing the student the arc which is opposite to centre angle.	Level-2	2 min
7	Asking the arc determination, after taking the comments from the students, emphasising that centre angle value equals its arc size by GeoGebra.	Level-2	2 min
8	Making explanation about minor and major arcs	Level-0	2 min
9	Showing minor and major arc samples by GeoGebra software.	Level-2	1 min
10	Asking the meaning of inscribed angle and taking the comments from the students.	Level-0	1 min
11	The definition of inscribed angle from the presentation reflected to the screen made the students read oral.	Level-1	1 min
12	Drawing different inscribed angles, moving them, and showing the students that no matter how they changed, these angles are always on the perimeter of the circles.	Level-3	1 min
13	Drawing the centre angle and inscribed angle which see the same arc, calculating the measurements, making bigger and smaller the circle by GeoGebra software. And providing the students comprehend that centre angle equals two times of the inscribed angle by question and answer teaching method.	Level-3	2 min
14	Students' taking the notes on seen rules.	Level-1	6 min
15	Making re-explanations for the students did not comprehend.	Level-2	2 min
16	Forming an inscribed quadrilateral by GeoGebra software and asking the sum of inscribed angles, and providing the students to reach the result that sum of opposed angles equals 180 degree by asking different questions and giving hints to them.	Level-3	4 min
17	Composing different questions on GeoGebra display and solving the questions by tablet.	Level-1	9 min
Total			39 min

As seen from the table, teacher's lesson took 39 minutes. In the 8 minutes, technology usage level is 3, In the 7 minutes technology usage level is 2 and In the 19 minutes technology usage level is 1. In the remained 5 minutes, technology was not used, so level is zero. In the first, third, eighth and tenth stages of the lesson, technology usage level is zero. So technology was not used in these stages. In the second, fourth and eleventh stages, information can be written on the board was reflected to the screen by GeoGebra. By the same way, in 17<sup>th</sup> stage, questions were formed on the GeoGebra screen. Also, in 14<sup>th</sup> stage, students took notes what they saw from screen to their notebooks instead of the board. Thus

in these stages, technology usage level is one because technology usage is valid for only media change. In 6<sup>th</sup>, 7<sup>th</sup>, 9<sup>th</sup> and 15<sup>th</sup> stages, technology usage level is two. Because, in these stages, technology was used to make the operations be more errorless, faster and more effective and to show operation accuracy to the students. In 5<sup>th</sup>, 12<sup>th</sup>, 13<sup>th</sup> and 16<sup>th</sup> stages, the differently from the conventional application, technology level is 3 because structuring concepts and relationships by student focused explores and deep conceptual comprehension were realised.

Totally, teacher's six post-course and technology supported lessons were observed. Other five lessons of the teacher were analysed as explained above table. And then it was determined that technology was used for every lesson at which level and how long.

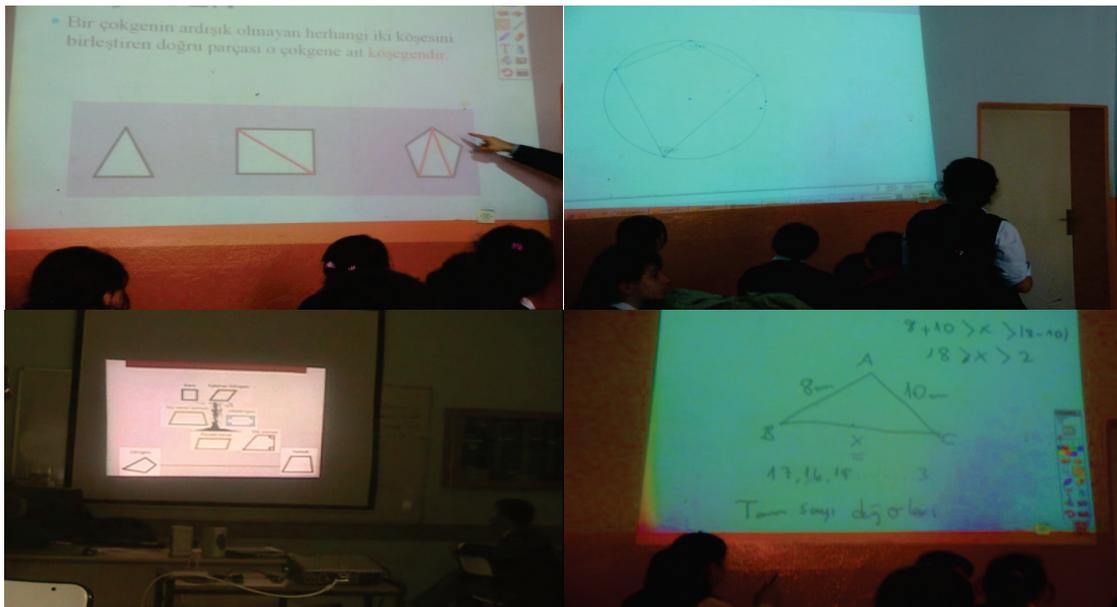
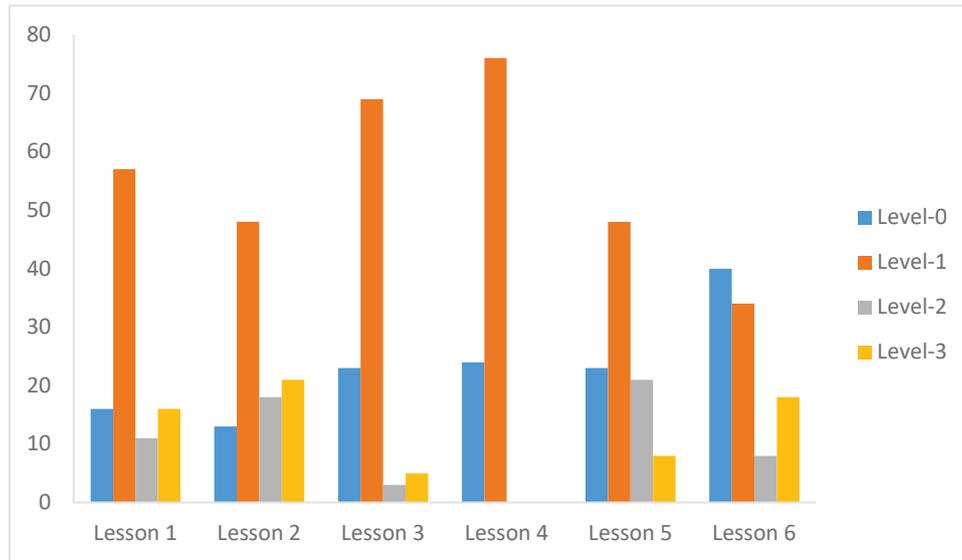


Figure 6. Photos of Ö3 Teacher's Technology Supported Lessons

Table 12. Teacher Ö3's Post course Technology Usage Levels, Minutes and Percentages

Levels	Lesson 1		Lesson 2		Lesson 3		Lesson 4		Lesson 5		Lesson 6	
	min	%										
Level-0	6	16	5	13	9	23	9	24	9	23	15	40
Level-1	22	57	19	48	27	69	29	76	19	48	13	34
Level-2	4	11	7	18	1	3	-	-	8	21	3	8
Level-3	6	16	8	21	2	5	-	-	3	8	7	18
Total	38	100	39	100	39	100	38	100	39	100	38	100



**Figure 7.** Ö3's Technology Usage Levels in the Post-Course Lessons

As seen from the Table 12 and the Figure-7, teacher Ö3 took the advantage of the technology in all lessons as Level-2 and Level-3, except of 4<sup>th</sup> lesson. It can be seen that technology was intensely used in the post-course lessons. Taking into account that teacher did not use technology in pre-course lesson, it can be said that a great progression were obtained by course.

After every observed pre-course lesson, it was interviewed with teacher Ö3. Teacher Ö3 said that his positive thoughts about using computer technology in the lessons are changed more positive after the course. On the other hand he added that he was encouraged through being followed by the researcher while teaching the lesson. Thus he said that he thought to make different constructive applications. When why he did not teach all the lessons in the computer laboratory asked to the teacher, he replied that teaching the lesson in the laboratory is so tiring. He continued that if technology was made the students use, technology should be learned to them very well and they should become being able to use computer operatively. On the other hand, teacher Ö3 stated that some of computers carried to the classes from 1<sup>st</sup> to 5<sup>th</sup> grades. For this reason, a few computers remained in the laboratory. Thus one computer per one student could not have been provided.

Teacher made an agreement with a publishing company. Teacher bought question sets from this publisher. In exchange, publisher donated a projection device to the school. With the permission of the school management, this projection device was set up in the teacher's classroom. And this classroom was started to use as Mathematics classroom. In the lesson which teacher uses technology, teacher generally taught the lessons by means of GeoGebra software and power point presentations. In the interview with the teacher after the lessons, teacher stated that he gave preliminary information about the subject to his students and he obtained a good opportunity to explain the subjects by GeoGebra software. He added that he used different software and education objects but GeoGebra software usage was come right on top of something. Teacher found software and learning objects useful. However he emphasised that elementary education student's need informative software is funnier, easier. He gave example that battleships game can make the students like the mathematics better. For this reason he emphasised that game based mathematics software should be prepared.

## Results, Discussion and Suggestions

In the observation performed before IST course, Ö1 took advantage of the technology for only changing the media and, Ö2 and Ö3 did not use technology in their lessons. When the literature was searched, it was presented that the population of the teachers do not use the technology in their lessons are more than the teachers use the technology (Koçak Usluel, Kuşkaya Mumcu, & Demiraslan, 2007). Before the course, Ö1, is the unique teacher used the technology in his lessons, took advantage of the technology to only change the media by using un-interactive electronic books and smart board program instead of using a geometry or algebra software. So, technology did not make any alteration on his teaching routines, he only use it instead of the current teaching materials and took advantage of the technology as Level-1. When the literature was searched, it was seen that teachers used technology as well as near their own applications without changing current pedagogy (Cuban, 2001; Zhao, Pugh, Sheldon, & Byers, 2002) and tried to integrate technology to the conventional teaching model (Cuban, Kirkpatrick, & Peck, 2001; Baki, 2002; Bauer & Kenton, 2005; Ertmer, 2005). Moreover, teachers use technology integrates the technology to their lessons as Level-1. Thus, it was stated that they take advantage of the technology to only change the media (Demir et al., 2011).

And in the interview made at the end of the observed lessons before the course, Ö2 stated that he did not use technology in his lessons because he did not know about CT. It was produced that teachers do not use technology in their lessons because they have not sufficient information about technology and do not know how they integrate technology to their lessons (Çağiltay, Çakıroğlu, Çağiltay, & Çakıroğlu, 2001; Karagiorgi & Charalambous, 2004; Niess, 2005; Karal & Berigel, 2006; Çakıroğlu et al., 2008; Çakır & Yıldırım, 2009; Bozkurt et al., 2010; Demir et al., 2011). In the interview made with Ö3, he said he wanted to use computer technology in his lessons but, there is not sufficient technologic equipment and hardware (Çağiltay et al., 2001; Uşun, 2003; Karagiorgi & Charalambous, 2004; Karagiorgi & Kyriacos, 2006; Çakır & Yıldırım, 2009). Many research in the literature presents that teachers cannot take advantage of the technology because of technologic deficiencies, missing equipment. Also, Ö3 added that he tried to teach the lesson by using computer laboratory in the past and he encountered with many technical problems and the remained part of the lessons wasted and managing the lesson became difficult efficiency of the lessons decreased. So he could not have taken support from school management. Because of these bad results, he stated he did not want to teach the lesson in the computer laboratory. In the performed researches, it was resulted when technology was tried to use, lesson management was changed dramatically (Sandholtz, Ringstaff, & Dwyer, 1997) and teachers encountered technologic problems for a few times, they were unwilling to use technology (Cuban et al., 2001; Ayvaci et al., 2014; Kaplan et al., 2016) and they need the support of the school management to integrate the technology to their lessons (Becker, 1994; Office of Technology Assessment [OTA], 1995; Kuşkaya Mumcu & Koçak Usluel, 2004; Demiraslan & Koçak Usluel, 2005). Thus, informing the teacher about how they can provide the class management by using technology in the real class conditions in service training is important. In the scope of this course program, however the applications performed in the real class condition, it was a lack that teachers were not sufficiently informed about how they can provide class management. Also in the scope of Fatih Project, equipment will be supplied to the schools, it can be seen that teachers will reach the sufficient equipment and opportunities. But for solving technical problems will be occurred on tablets and interactive board, it is obvious that teachers will need school management's support. On the other hand, that school management team has belief about the usefulness and significance of the technology and motivates teachers to use technology has a great share to increase technology usage frequency. For this reason, to raise the awareness of the school management team is a must in order that they support the teachers.

When the findings are searched, after the course, it was seen that Ö1 took advantage of the technology as mostly Level-1, in only two lessons he used technology as Level-3 for a short time. However, he used the technology by aiming that students explore the relationships through using the software, he generally preferred to teach the lesson by only changing the media such as using smart board program and un-interactive electronic books as before the course. In this case, it can be said that

IST course did not become effective to change technology usage level. But, even so, it is a development on Technological Pedagogical Content Knowledge (TPACK) that teacher, who used technology for only as Level-1 before the course, started to use technology as Level-2 and Level-3 for a short time after the course. In the interview performed at the end of the lessons, it was emphasised that teachers gave important to solve exercises and problems because of studying for the central examinations. To achieve it, he teaches the subject quickly and he concentrated on solving more exercises. By this method, they provides students comprehend the subjects more quickly. For this reason, teachers are obliged to use technology to mostly change the media. In that case examination/testing system should conform with education system for teaching more technology aided lessons by teachers and obtaining expected efficiency from the lessons and focusing the conceptual comprehension.

When the findings are searched, it can be seen that Ö2 took advantage of the technology as the different levels in the lessons of Ö2 after the course. On the other hand, in the great part of the other lessons of the teacher except of two lessons, it remarked that he used the technology as Level-3. This finding is an indicator of his TPACK development. Akkoç et al., (2011) presented that observed six ones from the ten teachers performed activities as Level-3 and this result is an indicator of TPACK development. When the technology usage levels of the teachers before and after the course are compared, it can be seen that a significant positive progress on the technology usage levels directly gave information about the development of TPACK levels. In the interview made at the end of the lessons, why he did not use technology as Level-3 to form deep conceptual comprehension and exploring the relationships by students asked to the teacher. And he replied that a great preliminary plan should have been prepared in order that the students can explore the relationships and he should have thought which questions would have been asked. But he could not have enough time to make these preparations because of his workload and private life. Bauer and Kenton (2005) stated that teachers need more time to plan technology aided lessons and Pelgrum (2001) emphasised that teachers have not enough time to plan it. Moreover, it was seen that teacher taught only one lesson in the computer laboratory, and he taught the remained lessons by bringing projection device and computer to the classroom in the observed lessons after the course. When why he did not teach all lessons in the computer laboratory asked to the teacher, he responded that he could have found time for only teaching Cabri software to his students because of work load, but most of students have not pc in the home. For this reason they quickly forgot which tool bar used for which purpose. So they encountered many problems in the lesson. He added that he made an effort to remove those problems. But unfortunately, a great part of lesson wasted. So he taught the lesson by bringing the projection device and computer to the classroom. In the performed studies, it was presented that to integrate the computer technology to the lessons effectively, students should have computer technology utilization ability. But for getting it, teachers should spare additional time for it and this obligation made the works hard for the teachers (Karagiorgi & Charalambous, 2004; Waite, 2004; Bauer & Kenton, 2005; Demiraslan & Koçak Usluel, 2005). In that case, it is thought that adding Computer Aided Mathematics Teaching lessons in the education curriculum and performing technology aided applications in those lessons can be effective to be able to extend the technology utilization in the lessons, Moreover, that computer teachers teach the mathematics software can be used in the lessons to the students is important for reducing teachers' work load and focusing to the technology aided activities.

When the findings are checked, however teacher Ö3 has very positive thoughts for technology and believes using technology in the lessons is a requirement, he could not have used technology in his pre-course lessons because there is not sufficient technologic equipment in the classrooms. At the end of the course, he used technology in his all lessons after a classroom was started to use as Mathematics classroom by configuring a project device and a computer in there. Although teacher took advantage of technology as Level-2 for carrying out the teaching process more effectively and more quickly, and as Level-3 for structuring the concepts and relationships by student centred explores and constituting deep conceptual comprehension, he used technology dominantly as Level-1 with reflecting the learning gains to the screen, teaching the lesson through presentations and solving the problems on the screen, and wasting the time for note taking by students. When all post-course lessons taught by the teacher are considered, that teacher took advantage of technology as level-3 in all his lessons except of only one lesson is an indicator to develop his TPACK.

When the change of the technology usage levels of the teachers is generally searched, however it was seen that other teachers except teacher Ö1 did not use technology in their lessons, according to the observations after the course it was seen that all of teachers used technology as Level-3 in their lessons. On the other hand, by considering that only teacher Ö1 used technology as Level-1 in his lessons before the course, all of three teachers started to make activities on technology as Level-1, Level-2 and Level-3 after the course has a great importance for the effectiveness of the research. However, it was noticed that teachers took advantage of technology as Level-1 dominantly; their activities as Level-2 and Level-3 is an indicator about they changed their routines and IST course left positive impression on them. Also, when making explanations by generally using the screen and wasting time for note taking by students are considered. Technology usage in this process is at the Level-1. For this reason, mostly using of the technology at the Level-1 by teachers is the expected situation. Because, taking into account the conditions and education system in Turkey, it is known that every student has not own computer, notes must be made students take compulsorily in school/home. If teachers did not make students take notes, then we could understand the teachers did not reflect the natural learning and teaching process. Going to the observation unannounced was effective to understand this natural learning and teaching process. Fatih Project became hope source for teachers who want to use technology effectively in their lessons. Because in the interview made with the teachers, they emphasised that if both students and teachers have computer, they do not need to notes are made students take and they can find more time to make activities. Moreover, one their pointed issue or obligation is the adaptation with examination/testing system and education system. Otherwise, although the students want to focus the technology activities to increase conceptual comprehension, teachers stated that they have to direct to prepare the students for examination / testing and the demands for solving the different problems by students, parents and school management. In this case, as continuously talked about, being synchronised with education system and examination/testing system and removing the outer factors prevent integration of the technology to the lessons are required. If so, no matter how the teachers' beliefs to use computer technology (CT) in their lessons are positive, technology can be used for only changing media in the lessons. Essentially, this situation is noticed when the technology usage levels of teacher Ö1.

In designed course, teaching many software cause the more time was spared for familiarization and utilisation stages. If course managed by focusing only GeoGebra software, may be more effective results could be taken. Teachers could learn the software more effective and quicker because they would dominate only one software. By this mean, more time would be spared for integration stage. Moreover, more applications would be able to be showed to the teachers instead of only two real school applications. And teachers would gain more experience about how they manage the process in the real classrooms. So, focusing the less software, teaching how the software can be used in the lessons, showing the effective results of the application performed by technology to the teacher by means of the real experiences and concentrating the technology integration can be useful to increase technology application in-service training will be designed.

At the end of the course program, it was fixed that teacher used the technology in the Geometry as the higher levels. However both geometry and algebra software was taught, Geometry subjects were dealt with on the work paper more frequently. For this reason, teachers have more experience about how they can use technology as the high levels in the Geometry. Performing more technology activities in the learning domains such algebra, data processing might have given opportunity that teacher can use technology more effectively. On the other hand, however some mathematics concepts are convenient to use technology usage (polygons, circles, transformation geometry, linear equations, etc.), some mathematical concepts' usage can be so limited, such root numbers, rational numbers, factorization. In this case, teachers generally do not prefer to use software. For this subjects, preparing of remarkable and functional learning objects and transporting these learning objects to all mathematics teacher can be beneficial. On the other hand, technology applications together with some work papers related to the selected gains from secondary school mathematics curriculum because of time limit were made perform. Preparing guidebooks include technology aided work papers oriented all gains take place in secondary school mathematics curriculum and how they are used, reaching these books to the all teachers through Ministry of Education can give opportunity to use more frequently.

In spite of all these deficiencies, course program caused increase the teachers' TPACK and technology usage levels. Such that Ö2 coded teacher who thought technology cannot be used in Mathematics education and never used technology in his lessons before the course frequently took advantage of technology to increase the conceptual comprehension after the course. In this case, it can be said that designed IST course made positive affect to improve the technology usage levels of the teachers. Finally, there are many technology integration models in the literature. Structuring IST course programs by using these models by researchers and comparing the taken results from the models and the obtained results from this research can be useful to determine which integration model is more adaptable to Turkish students and to produce which steps Turkish teachers progressed while integrating technology to Mathematics.

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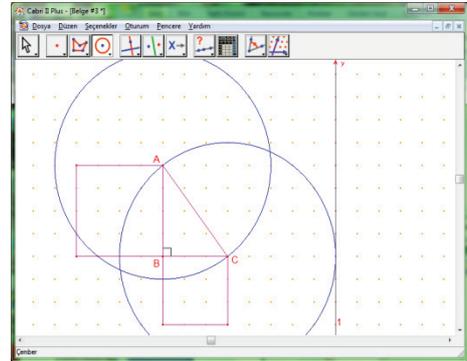
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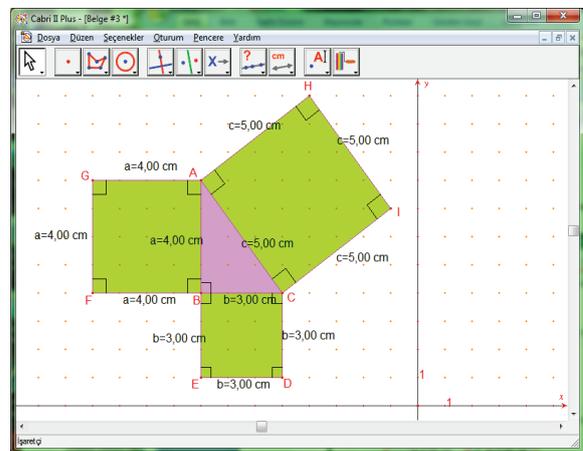
**Appendix 1. Sample Worksheet: Pythagorean Theorem**

- ❖ Open Cabri software and create the axes in the sheet by click “Show the axes” button. After creating axes, click the “Grid” symbol. When the grid active, click on the axes and change the sheet to the grid view.
- ❖ By utilising the unit squares formed on the study sheet, draw a perpendicular triangle of which two edges’ lengths is three and four units another’s length is five units.



- ❖ Draw a square on every edges AB, BC, AC by helping of circles and perpendicular lines. Put the letters on the corners of the new squares
- ❖ Assign “a” letter for BC edge length, “b” letter for BC length and “c” letter for AC length. Calculate a, b, c lengths.

- ❖ By using filling symbol placed on Cabri tools bars, colour the squares ABFG, BCDE, ACIH by the same colour and color ABC triangle by the different colour.
- ❖ By use “Field” command, calculate A(ABFG), A(BCDE) and A(ACIH). Then by using calculator find the values of  $a^2$ ,  $b^2$ ,  $c^2$ . By calculating A(ABFG), A(BCDE), A(ACIH),  $a^2$ ,  $b^2$  and  $c^2$  values and s(ABC) angle, create a table and transfer those values onto the table. Write different values by changing a and b lengths and angle values on the table



	A(ABFG)	A(BCDE)	A(ACIH)	a <sup>2</sup> =	b <sup>2</sup> =	c <sup>2</sup> =	s(ABC)=
1	16,00	9,00	25,00	16,00	9,00	25,00	90,0
2	25,00	9,00	34,00	25,00	9,00	34,00	90,0
3	25,00	16,00	41,00	25,00	16,00	41,00	90,0
4	36,00	16,00	52,00	36,00	16,00	52,00	90,0
5	36,00	25,00	61,00	36,00	25,00	61,00	90,0
6	26,00	25,00	41,00	26,00	25,00	41,00	78,7
7	13,00	25,00	18,00	13,00	25,00	18,00	56,3
8	5,00	25,00	40,00	5,00	25,00	40,00	116,6
9	32,00	25,00	17,00	32,00	25,00	17,00	45,0
10	10,00	9,00	1,00	10,00	9,00	1,00	18,4
11	20,00	9,00	5,00	20,00	9,00	5,00	26,6



When you search the table, what kind of relationship between the values on the table? And how can we formulate these values? How does s(ABC) effect this generalisation? Which relation does the formula related with the obtained angle give to us?

**Appendix 2.** Content of Designed Course Program

<b>Week</b>	<b>Course Content</b>	<b>Stage</b>
1	-Presenting theoretical knowledge about technology integration and preparation of computer aided education work paper	Familiarization
2	-Introducing Cabri software and structuring	Familiarization
3	-Applying the activities prepared on Cabri Software in the course condition, constituting a discussion ambiance by taking the opinions of the teachers about applicability of the activities in the schools, contribution to the learning of the students and compliance with education program. -Giving homework for preparation the activity about using of the Cabri software in the secondary school mathematics lessons to the teachers and applying the activity which was prepared by teachers on the course and discussing the deficiency together and make final on the activity.	Utilization
4	-Introducing Graphics Analysis Software -Applying the activities prepared on Graphics Analysis Software in the course condition, constituting a discussion ambiance by taking the opinions of the teachers, giving homework for preparation the activity about using of the Graphics Analysis software in mathematics lessons to the teachers	Familiarization Utilization
5	-Applying the activity which was prepared by teachers on the course and discussing the deficiency together and make final on the activity.	Utilization
6	-Introducing Derive Software -Applying the activities prepared on Derive Software in the course condition, constituting a discussion ambiance by taking the opinions of the teachers about applicability of the activities in the schools, contribution to the learning of the students and compliance with education program -Giving homework for preparation the activity about using of the Derive software in the secondary school mathematics lessons to the teachers and applying the activity which was prepared by teachers on the course and discussing the deficiency together with teachers and make final on the activity.	Familiarization Utilization
7	Introducing GeoGebra software and structuring	Familiarization
8	-Applying the activities prepared on GeoGebra Software in the course condition, constituting a discussion ambiance by taking the opinions of the teachers about applicability of the activities in the schools, contribution to the learning of the students and compliance with education program -Giving homework for preparation the activity about using of the GeoGebra software in the secondary school mathematics lessons to the teachers and applying the activity which was prepared by teachers on the course and discussing the deficiency together with teachers and make final on the activity.	Utilization
9	-Introducing different mathematics software and learning objects such as Tangram and make them apply.	Familiarization Utilization
10	-Watching the sample videos show technology usages and discussion with the teachers about the sample applications. -During the course, by using learned software making sample activities and discussing activities can be used for which purposes and how the significant effects have on the students	Integration Integration
11	-By selecting two different schools have sufficient equipment, performing sample applications for teachers obtaining gains from first-hand about how technology integrated to the mathematics lessons and discussing about the applied activities whether if prepared activities are used in the lessons or not, if so what kind of contribution occurred and what kind of disadvantages can be seen and what the roles of teachers and students are.	Integration
12-15	-Teachers using computer technologies in their lessons, observing the teachers during this process, video recording, discussing with the teachers about the applications, watching the scenes which were recorded the own classrooms of the teachers to them in the course condition, discussing the sample applications, determining the deficiencies, and taking the opinions of the teachers about what kind of additions could be made, making the required explanations and finishing the course program.	Integration