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The Views of Mathematics Teachers on the Factors Affecting the Integration of Technology in Mathematics Courses

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Abstract: The aim of this study was to determine the views of mathematics teachers on the factors that affect the integration of technology in mathematic courses. It is a qualitative case study. The sample size of the study is 10 teachers who are receiving postgraduate education in a university in Turkey. The current study was conducted in three stages. At the first stage, software and learning objects were introduced to the teachers. At the second stage, activities were performed with the teachers. At the third stage, teachers practiced a technology-assisted course in a real classroom environment. After all stages were fulfilled, a retrospective interview was conducted with all teachers individually. The content analysis of the interviews indicated that there are many factors affecting technology integration, namely, the categories of teacher-based factors, student-based factors, content-method-resource-time-management based factors and technical considerations.

Introduction

In teaching environments equipped with technology, learning becomes easier, and the learning process quickens; deficiencies are eliminated by means of feedback, individual learning increases, active learning, creativity and equality of opportunity are enabled and consequently students reach the information first hand (Baki, 2008; Hollebrands, 2007; Voogt, 2003, Heid, 1997). It is stressed by the NCTM (National Council of Teachers of Mathematics) that, the usage of technology in mathematics lessons is a necessity and that technology must be adapted to the teaching-learning process (NCTM, 2000). Using of technology becomes a necessity for all types of courses, especially Mathematics, since technology gives remarkable opportunities. For this reason, the mathematics curriculum of Turkey was renewed in 2005, and technology had a more important role in education and training. Additionally, teachers were requested to adopt technology and use the computer software efficiently in their courses (MEB, 2005). Related studies showed that there are a vast number of beliefs that using the technology in education will bring about reform. In fact, it was observed that technology was not being used adequately and the current education system could not be integrated with technology in the learning environment (Marcinkiewicz, 1994; OTA, 1995; Cuban, 2001; Monaghan, 2004; Koçak-Usluel, Kuşkaya-Mumcu & Demiraslan, 2007; Author, 2012).

Previous studies asserted that many factors were effective for technology integration in courses. In general, these factors can be categorized in two main groups: Internal and External factors. According to Ertmer (2005) internal factors are related with teacher's own conditions (such as attitude, self-confidence, belief, etc), external factors are consisted with outer effects that are not individual (such as school conditions, management support, technology accessibility, etc.). Mazman and Koçak-Usluel (2011) have expressed that

internal factors involve openness to change, ability to use technology, perception of self-sufficiency and beliefs about the technology; all of which originate from a person who is eager to use technology himself/herself. External factors were composed of technological infrastructure, institutional support, cultural and social effects which originate from the environment. Current research also depends on previous studies emphasizing effective factors such as computer insufficiency, teacher absence, difficulties with the integration of the technology in education, time constraints for computer aid training, insufficient equipment, non-availability of proper software, excessive intensity on education program, inadequate simultaneous accessibility, absence of expertise and insufficient technical support (Karagiorgi & Charalambous, 2004; Kuşkaya-Mumcu & Koçak-Usluel, 2004; Bauer & Kenton, 2005; Ertmer, 2005; Koçak-Usluel, Kuşkaya-Mumcu & Demiraslan, 2007; Çakır & Yıldırım, 2009; Tatar, 2013). Moreover, the present research hypothesized that teacher's attitudes towards technology; their technological experience and sense about the importance of the technology are powerful predictors of technology usage in classrooms (see Miranda and Russell, 2012; Petko, 2012).

Teachers have important duties and responsibilities of the education and training integration. If the key elements of training are not enough to make them competent then expected changes cannot be realized (Köseoğlu, 1994; Wyatt, 1996; Demirel & Kaya, 2003). Hence, previous research showed that teachers could not use technology in their courses because they felt themselves incompetent and to have had inadequate information about technology (Pelgrum, 2001; İşman, 2002; Usluel & Haşlaman, 2003; Karagiorgi & Charalambous, 2004; Niess, 2005; Çakıroğlu, Güven & Akkan, 2008; Çakır & Yıldırım, 2009; Demir, Özmantar, Bingölbali & Bozkurt, 2011). In this case, in order to realize the integration, firstly, informing the teachers about the technology has a critical value. This process, however, is not enough. Niess (2005) pointed out the difference between technological competence and how to teach it. Similarly, previous studies also emphasized only knowing how technologic tools should be used is not enough but also being aware of their pedagogical functions was significant (Hughes, 2005; Hew & Brush, 2007; Lawless & Pellegrino, 2007; Akkoç, Özmantar & Bingölbali, 2008; Harris et al., 2009). So, it can be understood from this statement that only having technologic knowledge is not adequate. Teachers also require "Technological Pedagogical Content Knowledge" (henceforth TPACK) to integrate this technologic information to the current branch through proper pedagogical approaches.

To determine the effective factors on technological integration, teachers were required to be trained in accordance with TPACK. Thus, firstly this research aimed to train teachers in accordance with TPACK. In this respect, the primary aims were to inform teachers about technology integration in math courses, to promote technology integration practice in real life classrooms and finally to determine which factors were effective on technology integration. Hence, in the scope of the selective course "*Computer assisted mathematics teaching"*, theoretical and practical information had been introduced to 10 mathematics teachers for 14 weeks. Then, the factors affecting technology integration were determined by means of individual interviews. This is different than related literature which showed that the main instruments used previously were questionnaires and Likert-scales (Koçak-Usluel, Kuşkaya-Mumcu & Demiraslan, 2007; Çakır & Yıldırım, 2009).

Whereas, collecting longitudinal data in case studies can produce more effective results. It is noticed that the teachers' opinions about technology integration were determined by means of interviews in a number of case studies. However, these studies scrutinized teachers' opinions without focussing on a specified subject area or giving any training to the teachers. Thus, the present study is distinguished among similar case studies. A remarkable, related research study was conducted by Ross, Sibbald and Bruce (2009). Their study, however, mainly used quantitative methodology involving questionnaires and proficiency

tests. By contrast, the current research relies on qualitative procedures including a semi-structured interview and content analysis. Hence, the present research is considered as original due to its distinguished methodology.

Thus, as the current case study includes longitudinal data, the findings and results are expected to contribute to the subject area. In this respect, this research aims to determine the opinions of the mathematic teachers in the post-graduation program about the factors affecting technology integration to the mathematic courses. In the scope of that aim, the answers for the following research questions were sought;

i) What factors are involved in integrating technology to mathematics courses?

ii) What are the opinions of the mathematic teachers about the factors that are influential on technology integration to the mathematics lessons?

Method

Research Model

The present research is a longitudinal case study with a qualitative research design. With "how" and "why" questions, this design aims for an in-depth analysis of the related issue (see Yin, 1984). As the in-depth analysis of limited cases requires, sample size was limited (also see Çepni, 2007). In this research, it was decide to use the case study method because of the limited number of participating teachers who continue their post-graduation education. The research aims to examine the in-depth interviews for factors that affect technology integration.

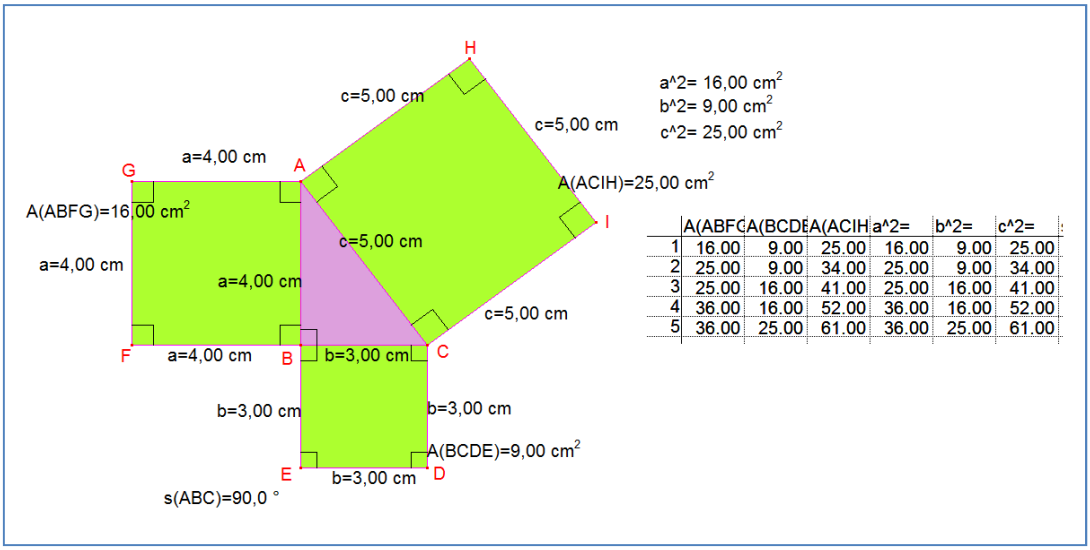
Procedure

The main aim of this study is to inform teachers of technology integration because most of the studies in literature stress that teachers usually do not have sufficient knowledge of technology and they also do not know how to integrate technology in mathematics. In the context of "*Computer assisted mathematics teaching"* course, education on technology integration in mathematics was provided to teachers for 14 weeks, with 3 hours per week. The weekly program for this course is presented in Table 1.

Week	Content
Week 1	Providing information regarding on technological pedagogical content knowledge, technology-supported mathematics, technology integration, technology-assisted worksheet preparation.
Week 2-9	Introducing Cabri II Plus, Derive, Graphic Calculus and GeoGebra software and toolbars, implementing sample activities that are orientated towards the use of the software by teachers in the class environment, discussing the deficiencies in worksheets, which were prepared by teachers and finalizing worksheets
Week 10	Introducing learning objects that can be used in mathematics education, doing sample activities about how they can be used in in classes, and discussing the effectiveness of the activities
Week 11-12	Making numerous practices towards the use of technologies learned in mathematics classes, watching sample videos in class environment about technology assisted mathematics lessons and discussing the effectiveness of them
Week 13-14	Ensuring teachers teach a technology assisted mathematics lesson on any topic they want in a real classroom environment, video recording lessons, watching videos in a course environment and critically appraising the effectiveness.

Table 1: Schedule for the computer assisted mathematics teaching course

In the first 10 weeks, teachers were instructed how to use Cabri II Plus, Derive, Graphic Calculus, GeoGebra software and learning objects. The learning object are not known widely because if they were developed by Turkish Researchers. Step-by-step instructions and worksheets enabled students to use the software. An example was given of every practice about the software and learning subjects as follows:



	A(ABFG	A(BCDE	A(ACIH	a^2=	b^2=	c^2=
1	16.00	9.00	25.00	16.00	9.00	25.00
2	25.00	9.00	34.00	25.00	9.00	34.00
3	25.00	16.00	41.00	25.00	16.00	41.00
4	36.00	16.00	52.00	36.00	16.00	52.00
5	36.00	25.00	61.00	36.00	25.00	61.00

Figure 1: Explaining of Pythagorean Theorem by using Cabri II Plus

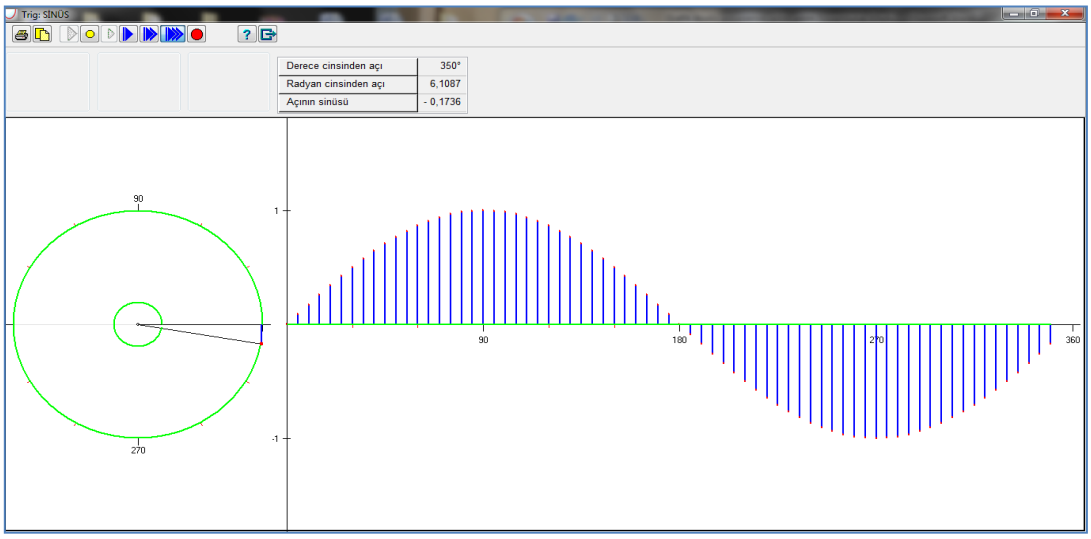


Figure 2: Drawing Sinus Graphic by using Graphic Calculus

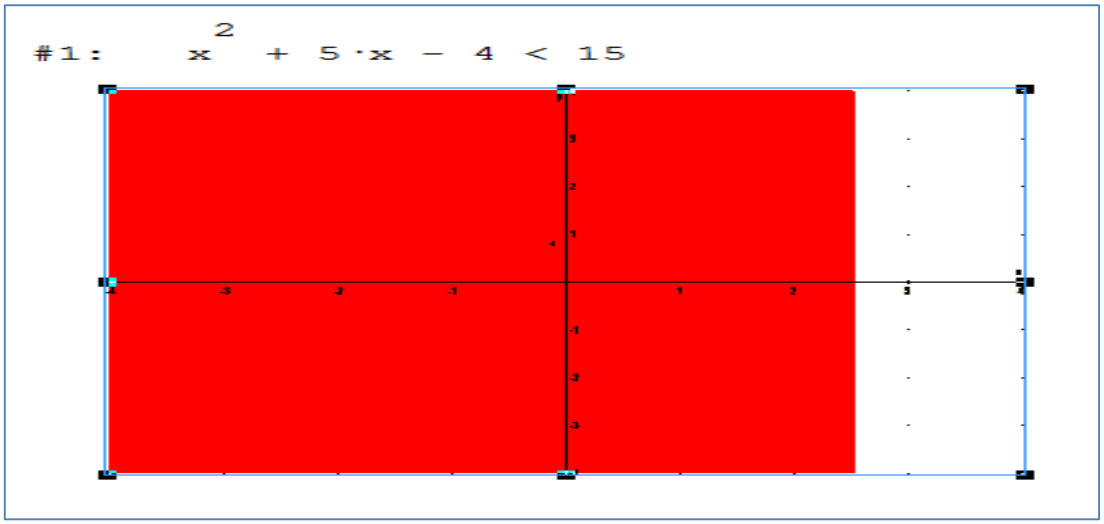


Figure 3: Drawing of in-Equation Graphics by using of Derive Software

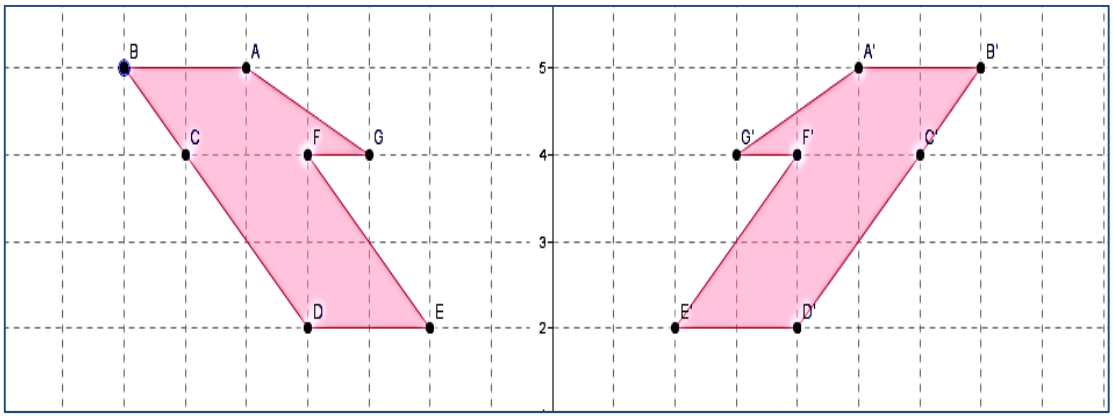


Figure 4: Explaining of Reflection Transformation by using GeoGebra Software

There are Turkish versions of Cabri II Plus, Graphic Calculus and GeoGebra software. Only Derive Software does not have a Turkish Version. For this reason, Derive Software was explained in English. So, teachers were observed to have problems of comprehension.

In the following 2 weeks, many applications were performed regarding the usage of this software in mathematics lessons. After two weeks, the teachers performed technology aided lessons in real class environment and were observed and supported incessantly in this process. After the teachers had enough knowledge on the technology integration in mathematics lessons, an interview was conducted and they were required to identify which factors affected the integration of technology in their lessons and which factors prevented them from performing their lessons as they had planned.

Participants

This study involved 10 mathematics post-graduate teachers who already had either a master or doctorate degree from a university in Turkey. Participant details were as follows:

Coded of Teachers	Gender	Years of Experience	Level of Working School	Knowledge of Software
1 Aylin	Female	12 years	High School	Some
2 Selma	Female	2 years	Secondary School	No
3 Ela	Female	5 years	Secondary School	No
4 Uzkam	Male	8 years	Secondary School	Some
5 Damla	Female	2 years	High School	Some
6 Aykut	Male	8 years	High School	Some
7 Irmak	Female	3 years	Secondary School	No
8 Demet	Female	2 years	High School	Some
9 Meryem	Female	2 years	Secondary School	No
10 Derya	Female	2 years	Secondary School	No

Table 2: Participant features

All participants were volunteers. Due to ethical considerations, teachers' real names are not mentioned in this paper. Names were coded as pseudo names, such as Aylin, Selma, Ela, Derya... etc. Eight of the teachers were females and two of them were males. Six of the teachers have 0-4 years of experience, three of them have experience of 5-10 years and the one has an experience of more than 10 years. Each teacher works in a different school. So, ten mathematics teachers working in 10 different schools participated in this research. Six of them work in secondary schools (Secondary school has the range between the 5th and 8th years of education terms in Turkey. These years equal the students' age of 11-14 years) and four of them work in high schools (High school has the range between the 9th and 12th years of education terms in Turkey. These years equal the students' age of 15-18 years).

Six of the teachers had no idea about the software which can be used in mathematical lessons. Another six teachers have limited information about the software such as Cabri, or Derive, due to their university education. Nevertheless, they did not remember much about the software details and functions. On the other hand, all of the teachers stated that they did not utilize technology in the activity courses in the school or out of the schools. According to them, the main reason behind this was their inadequate competence about related software. Furthermore, available course time being limited was mentioned as another reason. Thus, it was noticed that teachers should be supported and informed about software and technology assisted mathematics education.

Data Collection Tool

Semi-structured interviews were used in this study to seek answers for research questions. As is widely known, the primary aim of an interview is to identify the feelings, opinions, beliefs and viewpoint of the participant on the research topic (Cohen & Mannion, 1998; Yıldırım & Şimşek, 2005). In addition, semi-structured interviews were preferred in this study because there was an opportunity to change the order of questions and clarify the questions (Çepni, 2007).

Additionally, to obtain first hand data on technology integration and provide validity for the research, two volunteer teachers were observed in their courses. So, detailed information about the questions could be asked of the teachers while interviewing them. Interview questions were prepared in consultation with previous related studies and data obtained from observation results. To increase validation and reliability of the interview questions, all interview items were double checked by two experts. Initially, questions' readability and intelligibility were controlled by an expert of the field and required corrections were made. After the corrections, the final form of items were checked and validated by another expert. In the interviews, the question of “In your opinion, what are the factors affecting the integration of technology in mathematics education?" was directed to the

participants. And following the answer to this question, other questions were asked such as "Could you clarify your opinion?", "What other reasons do you think there may be?", "May the population of class affect the technology integration as for you; and if it may, can you express why is it?", "Can you identify how knowledge of students on technology affect the integration process?", "Could you explain the importance of the software knowledge of a teacher in technology integration?..." Every interview was recorded by voice recorder in order not to lose any data.

Data Analysis

In this study, content analysis technique; one of the qualitative data analysis techniques, was employed. Content Analysis can reveal interview codes and these codes can be categorized into meaningful qualitative findings. Then these edited and interpreted findings are presented to the readers (Yıldırım & Şimşek, 2005). Depending on these reasons, the current research used content analysis technique since this research aimed to assess qualitative codes and categories of technology integration in relation with effective factors by relying on teachers' opinions on the issue. On the other hand, while presenting findings, data were supported by true adaptations taken from teachers opinions. Before starting the data analysis, all the audio data recorded was transcribed by the researcher to written format. Then, by re-listen the records, it was determined whether there was a difference between the listening and dictated notes or not. And in case of a difference, the required corrections were done. Following these corrections, data was reduced to avoid misinterpretation by reading the transcription in detail. The transcriptions were translated into English without making any semantic changes and they were interpreted in results section.

For example, if a teacher stated a sentence as "Students may not prefer using technology because of test anxiety", a note was written next to this sentence as "anxiety of the students". Likewise, if another teacher said that "student should have adequate technology knowledge in order that we could use technology effectively"; a note was written next to this sentence as "technology knowledge of the students". In this case, some codes were created for every sentence or phrase belonging to the teachers. In order to ensure reliability and validity of the related codes, an expert of the field checked them. After the checking procedure, suggestions were requested as "available/not available" about codes' harmony. The conformity between researcher and codes performed by the expert were calculated by means of Cohen Kappa and it was seen that they have conformance as %88 between them. For example, students' anxiety and students' technologic knowledge came together in the category of student based factors. In this way, by re-checking the codes made by 10 teachers, the following categories were created: Teacher-Based Factors, Student-Based Factors, Content-Method-Source-Time-Management-Based Factors and Technical Subjects".

Results

The results obtained from 10 mathematics teachers are presented under categories and codes, by referencing the answers of teachers directly. To avoid data redundancy, only one teacher opinion is included for each code. Findings were presented under the following categories;

i) Teacher based factors
ii) Student-based factors
iii) Content-method-source-time-management based factors
iv) Technical considerations

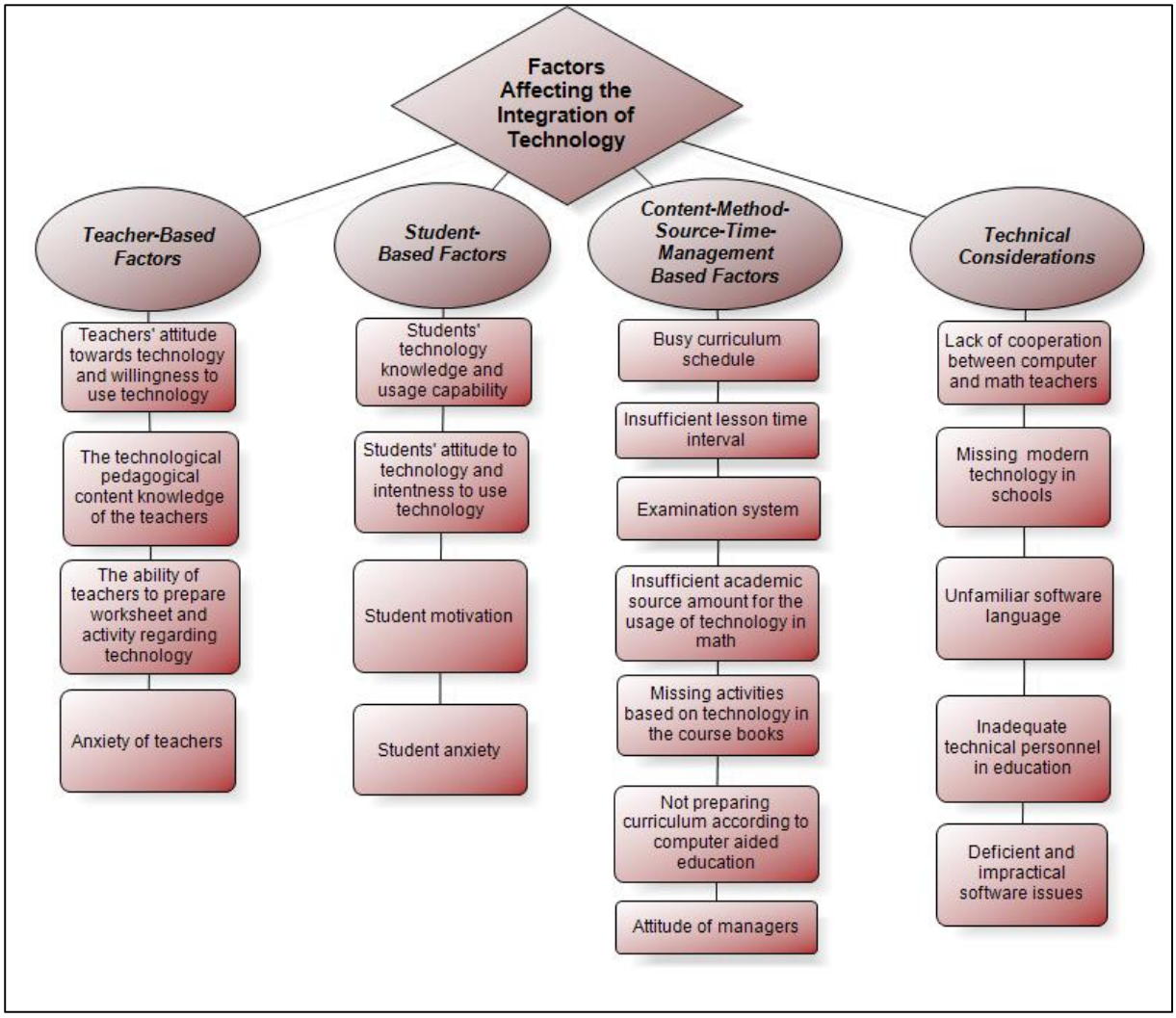


Figure 5. Nvivo Output of Factors Affecting the Integration of Technology

Teacher-Based Factors

The frequencies and percentage distributions regarding the codes of "teacher based factors" categories are presented in Table-3.

Codes	f	%
Teachers' attitude towards technology and willingness to use technology	10	29
The technological pedagogical content knowledge of the teachers	10	29
The ability of teachers to prepare worksheet and activity regarding technology	8	24
Anxiety of teachers	6	18
Sum of Opinions	34	100

Table 3: Teacher-Based Factors

According to Table 3, there are four codes under the "teacher based factors" category. All of the teachers express their views on "Teachers' attitude towards technology and willingness to use technology" code. Selma expressed her view on these codes as follows:

"Before having knowledge about technology, I supposed that technology could not to be used in Mathematics. Even if some peoples said technology was useful for mathematics educations, I did not want to use, because I believed it was not useful. But after I noticed the real situation was different, technology is essential element for mathematics education."

When Table-3 is examined, it was seen that 10 teachers have expressed their views on the "The technological pedagogical content knowledge of the teachers" code. Uzkam expressed his opinions as;

"I comprehended very well that how importance of TPAB should been have by the teachers in the technology aided courses I practiced. Because, knowing which software will be useful for which subject, planning how the technology implemented in the activity and what kind of education will be done are very hard duties. If planning is well, at that case, course is very effective".

When Table-3 is examined, it was observed that 8 teachers have expressed their views on the "The ability of teachers to prepare worksheet and activity regarding technology" code. Demet expressed her views as;

"To be honest, I think that preparing activity paper on every course causes a great impose. Because, preparing activity paper according to technology is not easy. It is required very detailed study. I encounter some problems in this issue. But if ready activities are available, and if we take advantage from them, it will be better for us".

As was seen from Table-3, 6 teachers have expressed their views on "Anxiety of Teachers". Damla expressed her views as;

"Only thing I am worried is that our students forgot the software which we will use for mathematics education. If they forget it, I will have to teach the software again before applying the worksheet and that will cause considerable waste of time".

Student-Based Factors

The frequencies and percentage distributions regarding the codes of "student-based factors" categories are presented in Table-4.

Codes	f	%
Students' technology knowledge and usage capability	10	33
Students' attitude towards technology and willingness to use technology	10	33
Student motivation	6	20
Student anxiety	4	14
Sum of Views	30	100

Table 4: Student-Based Factors

As was seen from Table-4, the category of "student-based factors" has codes. All of the teachers have expressed their views on the "Students' technology knowledge and usage capability" and the "Students' attitude towards technology and willingness to use technology" codes. Irmak expressed her views on this subject as;

"*The usage of technology in the courses partly depends on students. They are required to gain basic computer usage capabilities and to know software knowledge. Otherwise, most part of the course time is expended with explaining the technical issues to the students. In this case, time is not sufficient to the curriculum proceeding during the planned term. In addition, the students should be desirous in order to make this application successful. The students familiar with the computer and enjoy to use it become more successful. There are some students who have not ever used computer before, know nothing and beware to use of because infraction. In this situation, my job is getting difficult. I spend time for teaching the students how to use the computer and then the activity does not meet the goals".*

According to Table-4, 6 teachers have expressed their views on "Student Motivation" code. One of these teachers, Ela expressed her opinion as;

"*When I was prepared my lesson well and performed computer-aided activities, my students had higher motivation. The lesson became more enjoyable and fluent. But, I observed that the students lost their motivation when I hadn't made preparation for the lesson. They were out of lesson and I strived a lot to get them back. In other words, if we want to use technology, we have to motivate students; so we can have efficient lessons"*

As was seen from Table-4, that 4 teachers have expressed their views on "Student anxiety" code. One of these teachers, Meryem expressed her views as;

"The upcoming examinations to the students are big obstacles for the application of these technologies. Although the students like these applications, especially the students at the final year said that they wished to solve more problems to study for the exam rather than doing the applications because they believed that their times were expended waste".

Content-Method-Source-Time-Management Based Factors

The frequencies and percentage distributions regarding the codes of "*Content-method-source-time-management based factors*" categories were presented in Table-5.

Codes	f	%
Busy curriculum schedule	10	20
Insufficient lesson time interval	10	20
Examination system	10	20
Insufficient academic source amount for the usage of technology in math	8	15
Missing activities based on technology in the course books	8	15
Not preparing curriculum according to computer aided education	3	6
Attitude of managers	2	4
Sum of Views	51	100

Table 5: Content-Method-Source-Time-Management Based Factors

As was seen from Table-5, "content-method-source-time-management based factors" category has 7 codes. All of the teachers have expressed their views on the "Busy curriculum schedule. Uzkam expressed his views as;

"*The curriculum is too busy, therefore we have time constraint. We usually have to pass the next unit without solving sufficient amount of questions. It is almost impossible to make computer aided education in this business."*

When Table-5 is examined, it is seen that all the teachers have expressed view on the "Insufficient lesson time interval" code. Demet expressed her views on this subject as;

"Essentially classes are so crowded. You should be look after every student on computer aided education. There is not enough time to do it. We need additional time for also preparing computer aided worksheet and activity. The best is that a new course named Computer Aided Mathematics Education should be opened and we should perform our activities in that lesson. Current time is not sufficient."

When Table-5 was examined, it was observed that all the teachers have expressed view on the "Examination system" code. Meryem expressed her views on this subject as;

"It is very difficult to use technology in lessons unless the examination system changes. Because there are many units and exams consisting questions from every unit. The student will fail in the exam if we cannot complete to teach every unit. Technology makes the conceptual comprehension easier but it does not contribute much to the operant skill. However, the examinations are more oriented to operant skill more".

As was seen from Table-5, 8 teachers have expressed their views on the "Insufficient academic source amount for the usage of technology in math" and the "Missing activities based on technology in the course books" codes. Aykut expressed his view on these two codes as;

"When the workload of teachers is considered, it is very difficult to be designed computer aided activities for every lesson by the teachers. It would be so beneficial if there were ready made sources for this and how to use the technology was described for every course but there is not any source. The detailed examples explain how the technology can be used are not given place sufficiently in the course books.

According to Table-5, it was observed that 3 of the teachers have expressed view on the "Not preparing curriculum according to computer aided education" code. Aylin expressed her views on this subject as;

"However, technology should be used is emphasised in the curriculum, it is not explained how we perform the proper activities. Firstly, curriculum should be corrected as include the information how technology can be used in mathematics courses".

As was seen from Table-5, 2 teachers have expressed their views on the "Rigid manners of management and their objection to technological applications" code. One of these teachers, Derya expressed her view on this subject as;

"Unfortunately, managers are against to these kinds of applications. They express that math lessons cannot be performed in computer labs and lessons will be ineffective by this way. Honestly speaking, I am worried about performing my courses in lab.

Technical Considerations

The frequencies and percentage distributions regarding the codes of "*Technical Subjects*" categories are presented in Table-6.

Codes	f	%
Lack of cooperation between computer teachers and math teachers	10	29
Missing modern technology in schools	8	23
Unfamiliar software language	7	20
Inadequate technical personnel in education	6	17
Deficient and impractical software issues	4	11
Sum of Views	35	100

Table 6: Technical Subjects

As was seen from Table-6, the "Technical Subjects" category has 5 codes. All of the teachers have expressed their views on the "Lack of cooperation between computer and math teachers" code. One of these teachers, Aykut expressed his view on this subject as;

"I strived a lot time and taught students using the software but after a short time, they forgot to use it. In the lesson time mostly passed by technical problems about the software rather than explaining the unit to them. If the computer teachers teach software to the students in their lessons and make example studies every week, the students do not forget the software and reiterate the subjects they learned. Thus, math teachers do not need to remind the software for a lot of times. Besides, technology can be used efficiently if computer teachers interfered in into instant technical problems in math lessons".

Table-6 asserted that 8 of the teachers have expressed views on the "Missing modern technology in schools" code. Selma expressed her views on this subject as;

"Computers are dateless. They freeze while performing activities and continue to work after five minutes. The image quality of projectors is poor and so we cannot get efficiency".

As was seen from Table-6, 7 teachers have expressed their views on the "Unfamiliar software language" code. One of these teachers, Ela expressed her view on this subject as;

"Some software have not Turkish version I want to use them in lessons but I have some difficulties to understand it and refrain that they cannot understand".

According to Table-6, it was realized that 6 of the teachers have expressed their views on the "Inadequate technical personnel in education" code. Irmak expressed her views on this subject as;

"There should be technical personnel who will prepare the laboratory, turn on the projection, and load the daily activities into the computer etc. before the lesson. In addition, this person should interfere in the technical problems of computers, projection, and electrical connections; this kind of person should facilitate the lesson so we can integrate technology in mathematics".

When Table-6 is examined, it is seen that 4 of the teachers have expressed their views on the "Deficient and impractical software issues" code. Ela expressed her views on this subject as;

"Some software are effective on geometry subjects, some of them are effective on algebra. In fact, while designing the software, it should designed as being effective both algebra and also geometry. For example, x software has both specifications on Algebra and Geometry. But when algebra features work, it is seen that they cannot be useful. I prefer to use different software. Also, some of the software requires subscription fee; so we can not suggest that software to our students. For this reason new software enables us to use more common in the lessons should be designed or the current software should be developed proper with the above needs".

Discussion, Conclusions and Recommendations

This study primarily examined the opinions of postgraduate mathematics teachers on the factors affecting the integration of technology in mathematic lessons. The results in general indicated that the opinions of the teachers mainly gathered under the "*Teacher-based factors, student-based factors, content-method-source-time-management based factors, and technical subjects"* categories. The discussion, conclusion and suggestions about each of these categories are presented below.

The most remarkable opinion on the "teacher based factor" category was that all of the teachers expressed that "Teachers' attitude to technology and willingness to use technology" factors was significant in technology integration. In the interviews, the teachers stated that before they took the computer assisted mathematics teaching course, they could not have used technology in their courses adequately because they did not have enough knowledge about technology integration. Studies in the literature emphasize that teachers did not use technology in their lesson because they had limited knowledge on technology integration (Karagiorgi & Charalambous, 2004; Niess, 2005; Demir, Özmantar, Bingölbali & Bozkurt, 2011). Thus, initially, the teachers should be informed about technology integration in order to eliminate the factors affecting the technology integration.

Besides, teachers stated that they had negative belief and manner to technology because they could not adapt technology and mathematics education before, thus they were unwilling to use technology. Commonly held beliefs of teachers have a powerful effect during the education process (Ernest, 1989; Thompson, 1992; NRC, 2001) and it plays a significant role in the technology integration (Baki, 1994; Ertmer, 2005). On the other hand, it is known that teachers in Turkey encounter some problems with technology and the subjects on the mathematic courses (Baki, 2002). Hence, reasons for not being able to utilise the technology show parallelism with the previous related studies. However, these reasons are

thought to be eliminated by means of the given trainings. In an interview at the end of the course, Selma's response was "After I learned, you can see that the situation is different. Technology is an essential element for the mathematics course.*"* This is an indicator that teachers' beliefs and manners for technology aided mathematic education have been positively changed by means of the given courses.

All teachers stated that teachers' technological pedagogical content knowledge was an important factor of technology integration. With rising teacher technological awareness, they declared that TPACK was an important factor on technology integration. On the other hand, teachers thought that performing technological applications was challenging and laboured. This was found to be consistent with Karagiorgi and Charalambous, (2004) statement asserting that using technology in the courses could cause excessive work load for the teachers. As teachers are not used to preparing and practicing this kind of work papers, they had timing problems. For this reason, at the beginning of the present study, they reacted to the innovation and resisted the change (Çelik & Bindak, 2005; Gökçek, 2008; Güneş, 2008). So, in order to rectify this problem, teachers were provided with support for the preparation of work papers and activity design. In this respect, instruction manuals that explained and illustrated how effective work papers were prepared and teachers were instructed regarding their efficient usage.

Another factor based teacher affecting technology integration is apprehension. Teachers have some technological hesitations: Students can forget the software will be used; they may encounter some technical problems such as electrical cut off during an exam, computer freezes. Thus they were unwilling to use technology in courses especially because of test concerns. Teachers stated that they feel reluctant to use technology in the classroom as it might cause loss of time and decrease the efficiency of the course. To prevent such problems, some support from computer teachers might be requested.

According to the category of "Student based factors", all teachers indicated that "Students' technology knowledge and usage capability" was an effective factor for technology integration. In the interviews performed it was seen that students lost the time because of the problem they encountered while using technology on the courses and then they could not obtain the target outputs. A number of related research articles, emphasise that students should have technological competence in order that technology could be integrated to the courses (Karagiorgi& Charalambous, 2004; Waite, 2004; Bauer& Kenton, 2005; Demiraslan& Koçak-Usluel, 2006). Baki (2002) defined that students did not have adequate technology literacy level. Thus, in order to obtain the optimal efficiency, students should always be supported on technology applications and the related software. In this case, it is obvious that only mathematics teachers are not sufficient. For this reason, computer teachers should support learners in cases of a technological problem.

Another student-based factor was "Students' attitude to technology and willingness to use technology". Teachers declared some observations about this issue that some of students had a concern to break down or affect the computer and some of students preferred to play computer games instead of performing a pedagogical activity. Furthermore, teachers also mentioned that motivation was influential on technology integration. For example, Ela asserted that her students are well motivated when she was well prepared to the computer-aided course. On the other hand, when the course was not planned effectively, the students lost their attention. So, in order to use technology effectively in the courses, a well-established lesson plan was a prerequisite. Another student-based factor was student's technological apprehension. According to the present results, teachers stated that students prefer to solve test problems rather than using a computer in the courses since they did not think examination questions were in accordance with computer aided education. These thoughts derived from their concern about the possibility that computer aided practices

decreased the examination success rate. To avoid this, the examination system and the training system should be synchronised as soon as possible.

When the opinions in the scope of the "Content-method-source-time-management based factors" category were examined, it was seen that all of the teachers indicated "busy curriculum schedule, insufficient course time interval and examination system" as important factors for technology integration. The teachers mainly indicated that the curriculum was very intensive, they could not catch the time even for routine activities, the time certainly would not be enough and they would fall behind the schedule if the students used technology in lessons. Also Güneş (2008) examined the teachers' opinions for curriculum in the scope of his PhD. thesis. She noticed that for teachers, one of the big problems is that mathematic courses time interval is not sufficient to give the knowledge and experiences to the students. Furthermore, she stated that teachers gave up using the activities because of concerns over whether they can be given all knowledge in the course time interval. It is also stressed in literature that the busy curriculum schedule and insufficient lesson time interval cause teachers to refrain from using technology (Uşun, 2003; Waite, 2004; Çakır & Yıldırım, 2009). So, in order that technology can be used effectively in the mathematics courses, it can be useful either to reduce the subjects in the curriculum or by having additional courses for technologic assisted mathematics lessons.

The teachers emphasised that since the examination system was not synchronised with the education program properly, the students might refuse technology practises and some of them prefer exam oriented learning rather than performing technology activities. In addition, it is important that examination questions should be prepared in accordance with conceptual comprehension instead of investigating operation skills. If the test items require conceptual recognition, the students will try to understand the logic behind the matters rather than solving a lot of questions. Since the technology aided math activities and increase conceptual recognition, the students will have positive attitude towards technology and become willing to use it in their courses. Besides, the teachers also indicate that the factors of "missing academic source for technology usage, not being available of technology activities in the course books, not being prepared of curriculum due to computer aided education" are remarkable factors for technology integration. Increasing the source amounts prepared for the technology usage in mathematics courses is a must to eliminate these factors. The teachers should be given a chance to choose from various academic sources and they should use whichever source they want to perform in mathematics lessons. The efforts in this field are vital for rapid technology integration. Last but not the least, the teachers have expressed that the technology integration was negatively affected by the "Attitude of managers" code which is very significant issue. To prevent it, managers should have been informed about technology practices and been made aware about the aims of technology aided mathematic education.

When the opinions under technical issues are "lack of cooperation between computer teachers and mathematics teachers" code is an important factor in technology integration. As mentioned before, due to heavy workload, it is impossible for mathematics teachers to teach students the technologic issues, software in detail and to repeat the subjects frequently. . Hence, it is very important for math teachers to collaborate with computer teachers. Besides, inadequate modern technical hardware in the schools is a very important factor affecting the proper pedagogical integration. And "the language of the technology will be used is not Turkish", "Deficient and impractical features of the software" and "Well-educated technical staff missing." statements were identified as important factors affecting the integration process negatively. It was also emphasised in literature that the factors such as "Insufficient hardware, inadequate technical support and lack of suitable software" adversely affected the technology integration (Pelgrum, 2001; Kuşkaya-Mumcu & Koçak-Usluel, 2004, Tatar, 2013). So, to be able to provide the technology integration to the mathematics courses, first of

all, external factors such as hardware, software, technical support should be taken under control. To fulfil these aims, it is a must that schools should be equipped with adequate modern hardware such as smart board and wireless internet connection for every classroom. However, it has not been completed in Turkey, yet, Fatih Projects, is known as Opportunity Increase and Technology Improvement Act, and is a very important initiative. Increasing this kind of initiatives, and constituting contemporary classrooms equipped with technologic hardware are very important factors to realise the effective technologic integration.

This research also proposes that worksheets and activity papers prepared by researchers can help teachers to integrate technology in their math courses. On the other hand, it is important that teachers' awareness about technology integration should be raised through organising proper in-service trainings. Besides, support by computer teachers who can provide technical aid during technology integrated math courses for both learners and teachers can promote the quality of the integration process in the classroom.

Finally this study is a case study and the results obtained are valid for the current research group. In this study, any result generalisation was not pursued. But, many obtained results were found to be highly consistent with literature. In addition certain missing point in previous literature was filled. For this reason, it is considered that this study will be providing useful insight for future related studies in the field.

Note: This research is the extended format of the paper was presented in Conference on Primary Education in 2013.

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