EXAMINING STUDENT OPINIONS ON COMPUTER USE BASED ON THE LEARNING STYLES IN MATHEMATICS EDUCATION

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ABSTRACT
The purpose of this study is to identify the opinions of high school students, who have different learning styles, related to computer use in mathematics education. High school students' opinions on computer use in mathematics education were collected with both qualitative and quantitative approaches in the study conducted with a survey model. For this purpose, 388 high school students were included in the study. A learning style inventory, questionnaire form and interview questions were used as the data collection instruments. Frequency, percentages and chi-square analysis were used in the analysis of quantitative data and content analysis was used in analyzing the qualitative data. The results of the study showed that students with a diverger and accommodator learning styles have more positive opinions regarding computer use in the mathematics education compared to the students with assimilator and converger learning style.
Keywords: Learning Style, Mathematics Education, Computer Use

INTRODUCTION

Changes and innovations in technology are known to deeply affect our real world and many disciplines. Technology has a significant place in the field of education. Particularly in mathematics education, the use of technology as well as its application in learning-teaching processes has been widespread. In mathematics learning processes where principles of the constructivist learning approach were adopted, technology seems to be an important component. More efficient and functional learning environments can be established by means of using information technology in this approach (Baki, 2002: 23). It is seen that both national and international entities have positive views on technology and computer use in mathematics learning processes. One of the principles that NCTM [National Council of Teachers of Mathematics] (2000: 24-27) determines for school mathematics is technology. It is pointed out that technology is essential in mathematics learning and instruction and that it affects the mathematics learned while improving students' learning. It is stated by MEB [Turkish Ministry of National Education] (2005) that technology should be used effectively in mathematics education. The most important tool that can be used in learning and teaching processes is the computer. Computers are not an option in mathematics education but rather have a complementary role in the system. Moreover, it is emphasized that prepared materials should have content designed according to the constructivist principles of computer-assisted instruction.

Today, it is a fact that student centered approaches and principles should be considered in using computers, the most widely used of the technological tools, in mathematics education. This is because we should regard computers as the components of a learning environment and employ them in the task of facilitating learning. In line with this, the principles of the constructivist learning approach are adopted and students' learning processes are supported while learning environments and materials are designed and developed (Solvie & Kloek, 2007). The learning environment and materials developed do not have the same impact on each student due to the differences in learners' knowledge perceiving and processing and reaction processes (Kolb, 1984). These individual differences are known collectively as a learning style, which is an important issue in mathematics education. Learning style has a deep impact on education planners. It is seen that the quality of educational material increases when designed giving consideration to the individual learning styles of learners (McLoughlin, 1999).

Whether technology and computers used in mathematics education, and the learning environment designed accordingly, match the learning styles of students is an important issue. This is because whether technology used and materials developed affect the learning process of students with different learning styles is an essential question. The basic purpose here is to ensure that computers, and materials used, support and facilitate student's learning. However, since students have different learning styles, there is a probability that the material developed can facilitate one individual's learning process while, in turn, making the learning process of another harder. In line with this, the teacher should feel the necessity to understand the individual learning styles of the students while designing activities by making use of technology (Grasha & Yangarber-Hicks, 2000). Geisert &

Dunn (1990) point out that teachers should be more informed about the benefits of combining learning styles and computer use in classroom teaching. When the strength of students' learning styles and computers are considered together, they become powerful instructional tools. Geisert & Dunn (1991) state that there are two problems at this point: one of these is that most of the computer software programs address a certain learning style and the second is that other learning styles are much ignored (for instance, most programs are visual while auditory and tactual ones are less). The necessary thing to do at this point is to ensure that learning is realized by means of learning styles that individuals are strong and dominant and then reinforced with the other learning styles which are not as dominant (Geisert & Dunn, 1991; Solvie & Kloek, 1997). It is seen that learning style has effects on technology and computer use, just as it has in many other areas. Several different models and inventories have been developed for measuring learning style. Although most of them have different aspects, they mostly focus on learning process and individual differences (Silver, Strong & Perini, 1997: 22). In this study, the learning style model developed by Kolb is discussed.

One of the leading figures of the field, Kolb developed a learning style model which is based on his "Experiential Learning Theory". The theory particularly underlines the effect of experiences in the learning process, and maintains that learning occurs by transforming knowledge and experience. It further argues that the learning process includes two dimensions called perceiving/comprehending and processing/transforming (Kolb, 1984: 41). These two dimensions are independent but support each other. Kolb's learning style model consists of four main categories, which are "concrete experience (CE)", "reflective observation (RO)", "abstract conceptualization (AC)" and "active experimentation (AE)". What is highlighted in these dimensions are learning *"by feeling"* for concrete experience, *"by watching"* for reflective observation, *"by thinking"* for abstract conceptualization and *"by doing"* for active experimentation. In the theory, learning is perceived as a cycle. At times, one of these four categories gains priority over others for the individual, who inevitably repeats this cycle countlessly throughout his/her learning experience. Students are classified according to which category they prefer in this model: Concrete experience or abstract conceptualization (how they perceive and comprehend knowledge) and active experimentation or reflective observation (how they transform and internalize knowledge) (Kolb & Kolb 2005; Felder, 1996).

In identifying students' learning styles, one element does not alone reveal the individual dominant learning style. Learning style of every individual is determined by a combination of the above four elements. Integrated scores show different individual preferences from abstract to concrete and from active to reflection. These two groups of learning styles form the basis of Kolb's two-dimensional learning styles. A combination of the four elements under two dimensions helps determining which of the four dominant learning styles an individual prefers. These include *diverger, assimilator, converger* and *accommodator* learning styles. The categorization defining these four basic learning styles is briefly summarized as follows (Kolb, 1984; Felder,1996; Guild & Garger,1998): divergers (AE + RO) rely on active experience and process these experiences in a reflective manner; assimilators (AC + RO) rely on theory and conceptualize reflectively-processed knowledge in an abstract way; convergers (AC + AE) rely on an abstract conceptualization of the world, performing active processing; and accommodators (CE + AE) rely on their own concrete experience, which they actively process.

The concepts of computer and learning style have been the subjects of research in several different age groups and fields of study. It is seen that studies have been made on subjects such as learning style and attitude towards computers (Miller, 2000; Shaw & Marlow, 1999) and computer assisted learning (Brudenell & Carpenter, 1990; Federico, 2000), blended learning (Akkoyunlu & Soylu, 2008), computer anxiety (Ayersman & Reed, 1995; Cummings & Ballance, 2009), e-learning (Brown, et.al., 2009), computer performance (Buch & Bartley, 2002; Davidson, Savenge & Orr, 1992; Miller, 20005), attitude towards computer assisted learning and computer achievements (Erdoğan, 2006), achievement in different learning environments (Soylu & Akkoyunlu, 2002), multimedia course design (Zin, 2009) and computer assisted cooperative learning (Wang, Hinn & Kanfer, 2001). Erdoğan (2006) examined pre-service teachers' attitudes towards computer assisted teaching and their computer achievements based on their learning styles. He found that computer assisted education attitudes of visual learners are high level and there are significant relationship between attitude scores and computer achievements. Zin (2009) concluded in his experimental study, in which he examined the effectiveness of a multimedia course design he developed for mathematics education based on learning style, that students are effective in developing learning materials in the experimental group created, based on learning styles. Cummings & Ballance (2009) found that computer related anxieties of primary school teachers have significant differences based on learning styles. Miller (2005) put forth in his study, in which the effects of learning styles on performance in computer assisted teaching were assessed according to the Gregorc and Kolb learning style model, that the Gregorc learning style model had a significant effect, while the Kolb learning style model did not. In their study, Buch & Bartley (2002) concluded that converger students in the Kolb learning style model had a stronger preference for computer based presentations, while assimilator students had stronger preferences for written presentations. Federico (2000) designated in his study, in which attitudes towards computer assisted teaching were examined according to the Kolb learning style model that accommodators and assimilators are the most acceptable and convergers and divergers are the least acceptable. Moreover, Miller (2000) assigned that there is no significant difference between students' learning styles and their general attitudes towards computers and students with all learning styles have positive attitudes towards computers.

The necessity of knowing students learning styles and carrying them over to the learning and teaching process is demonstrated by the findings of the research and the principles of the learning style model. Similarly, Erdoğan (2006) mentions about the fact that the education programs that do not consider students' learning styles would not reach the desired level of success. In line with this, it is inevitable that computers, which are integrated with the mathematics education process and students' learning styles in computer assisted education, are noticed. It is a misconception that computer assisted learning activities can only be prepared in the form of visual learning. Aside from this, learning activities can be enhanced by considering the strengths of learners preferring other learning styles (Erdoğan, 2006). Designing such learning environments and processes will support and facilitate learners (Geisert &Dunn, 1991). Regardless of learning style model or learning aspects of the model (visual, auditory, tactual, concrete, abstract, active, reflective…), the basic aim should be to develop computer assisted learning activities compliant to the dominant learning styles of learners. While students find the opportunity to learn more easily through the learning activities which are appropriate to their own learning styles, they will find the chance to deal with difficulties and see the alternatives by means of other learning styles. In line with this, within the scope of the constructivist approach, it is thought of as helpful to apply an approach of multiple learning styles (Solvie & Kloek, 2007).

In the field of mathematics education various studies on computer use and attitudes towards computers have been conducted at different levels and age groups (Birgin et.al., 2010; Birgin, Kutluca & Çatlıoğlu, 2008; Çelik & Bindak, 2005; Güven, Çakıroğlu & Yaşar, 2009; Keşan & Kaya, 2007; Kutluca & Ekici, 2010; Özgen, Obay & Bindak, 2009; Wittwer & Senkbeil, 2008; Zin, 2009). In these studies conducted in mathematics education, the subjects of the research are teachers' and students' attitudes toward computers and computer-assisted education, their self-efficacy perceptions, beliefs, opinions and their profiles on computer use (the frequency of use, ownership status, taking computer related courses…etc.). Moreover, it is important to note that the majority of the research was conducted with the participation of teachers and teacher candidates.

It is seen that research related to learning style and computer use, particularly in high school mathematics education, is limited. In the literature, no studies can be found regarding students' opinions on computer use in mathematics education based on learning styles. With this study, the opinions of high school students with different learning styles on computers in mathematics education processes will be determined. Thus, the study is thought to provide essential information in designing and developing learning processes of students with different learning styles.

THE PURPOSE OF THE STUDY

The purpose of the study is to determine the opinions of high school students with different learning styles regarding computer use in mathematics education. For this purpose, it is considered that the following sub-problems will be answered:

1. Is there a significant difference among the computer use frequency of high school students with different learning styles?
2. Is there a significant difference between the tools that facilitate mathematics learning processes of high school students with different learning styles?
3. Is there a significant difference between the purposes of high school students with different learning styles to use computers in mathematics learning processes?
4. What are the opinions of high school students with different learning styles related to computer use in mathematics learning processes?

METHOD

This is a descriptive study in survey model conducted for the purpose of determining the opinions of high school students with different learning styles related to computer use in mathematics education. It is composed of two stages, one of which includes data about personal information of high school students, their learning styles, status on possessing a computer and preferences about using computers in mathematics education, as well as their purpose of use. In the second stage, data were obtained through interview technique from a certain number of students participating in the first stage of the study for the purpose of determining the opinions of high school students with different learning styles related to computer use in mathematics education in detail. In the present study, qualitative and quantitative research methods were used together during the data collection process. Hence, method triangulation was made; making use of different methods, such as qualitative and quantitative, to obtain data is known as method triangulation (Banister, et al., 2002). By implementing these two stages together, an attempt is made to understand students' opinions and control consistency. In parallel with this, Yıldırım & Şimşek (2005) state that using different methods together is significant in detecting the accuracy and validity of the data collected and the explanations made based on these data.

Participants

In the first stage of the research, a total number of 388 students from three different high schools located at the center of one of the metropolitan cities of Turkey participated in the study in the spring term of the 2009 – 2010 academic year with purposeful sampling (Çepni, 2007). The target population on which purposeful sampling was used is students; therefore, all types of high-schools were considered in three categories, and one school was selected to represent each category. In Turkey, the different types of schools in high school education following mandatory primary education, which lasts eight years, are classified as vocational schools, Anatolian-Science high schools, which have an entrance exam, and general high schools, where everyone can study. The socio-economic level and computer and internet access at the three schools where the research took place is said to be similar. One hundred and twenty-one of the students (31.2%) are studying at government high schools, 174 of them (44.8%) at Anatolian high schools and 93 (24 %) are at vocational high schools. Two hundred and six (53.1%) of these students are male while 182 (46.9%) are female. There are 129 students (33.2%) who do not have a personal computer and 259 students (66.8%) who have a personal computer. Furthermore, in the second stage of the research, semi-structured interviews were carried out, with a total of 48 students from three different schools included in the first stage of the research. It was explained that the interviewees were volunteers and had different learning styles.

Data Collection Instruments

In the study, a questionnaire form was used in order to determine students' personal information, their status of possessing a personal computer, their frequency of using a computer, and the purpose of their preference for using computers in mathematics education. In this questionnaire form, students' purposes for using the tools facilitating the process of learning mathematics and computers were examined with open-ended questions.

In order to identify the learning styles of students, the study employed the *"Learning Style Inventory –Version 3.1"* developed by Kolb (2005). The inventory contains twelve fill-in items, each of which consists of four choices. For each given situation, an individual is asked to rate the most suitable statement with "4", the second most suitable with "3", the third most suitable with "2", and the least suitable with "1" point. Each choice contains statements representing the four learning preferences (concrete experience, reflective observation, abstract conceptualization and active experimentation). As for the organization of "Learning Style Inventory – LSI Version 3.1", the items and rating are the same with LSI 3 (Kolb, 1999), the new version introduced new norms and different interpretation (Kolb & Kolb, 2005). Gencel (2007) performed validity and reliability studies of the Turkish version of the inventory. The studies set the reliability coefficients of the inventory dimensions as 0.61 for concrete experience (CE), 0.76 for reflective observation (RO), 0.66 for abstract conceptualization (AC) and 0.69 for active experimentation (AE). As it has been used in several studies, the inventory is considered as valid and reliable.

Moreover, questions were prepared to be used in the semi-structured interview with students. Students were asked questions such as, "*How and why computers should be used in the process of learning mathematics?", "What are the benefits and limitations of learning mathematics with the assistance of computers?"* Specialists from the field were asked for their opinions on the validity and reliability of the interview questions and the final form of the questions were decided in line with their suggestions. Also, in order to check question coherency and comprehensibility, a preliminary trial was conducted with five students.

Data Analysis

Students answered open-ended questions related to the purpose of using computers in the process of learning mathematics, and about the tools facilitating the process of learning mathematics. After their responses were examined, they were scored within the framework of determinated categories. Should a student have an opinion in any category in the scoring process, "1" point was recorded and if not, a score of "0" was recorded. In the analysis of personal information of students and their opinions on the variables regarding computer use, frequency, percentage and chi-square analyses were used.

By rating the twelve items in the learning style inventory, the participants obtained a minimum score of 12 and a maximum score of 48 for each learning preference. After the rating, composite scores were computed for use in identifying an individual's learning style. Composite scores were calculated in two categories, which are abstract conceptualization (AC) – concrete experience (CE) (perceiving knowledge) and active experimentation (AE) – reflective observation (RO) (processing knowledge). AC – CE and AE – RO composite scores ranged between -36 and +36. The obtained composite scores were placed in the coordinate system given in the Learning Style Type Grid (Version 3.1). The score obtained with AC – CE was placed on the "y" axis, while the score obtained with AE – RO was placed on the "x" axis, and the resulting area of intersection for these two scores was identified to indicate an individual's learning style (*diverger, converger, assimilator, accommodator*) (Kolb & Kolb, 2005).

The content analysis technique was used in analyzing the open-ended questions asked to the students in the first stage and the qualitative data obtained as a result of the interview made in the second stage. The main purpose in content analysis is to reach concepts and relationships that can explain the data obtained (Yıldırım & Şimşek, 2005: 227). Content analysis was used in line with the problems of this study in order to obtain systematic data regarding students' computer use in the process of learning mathematics, and make deductions based on these data. The steps of coding the data, finding themes, organizing data based on the given themes and codes, and defining them were followed. Aside from the main theme determined from the data, sub-themes were formed by means of content analysis. In the method of content analysis, data that resemble each other are gathered together around certain concepts and themes and arranged, interpreted in a way that the reader understands (Yıldırım & Şimşek, 2005). Data obtained within the scope of sub-themes formed were handled without making changes to the individual's statements. Each student was given codes e.g. "*S1-D, S2-A, …*" during the collection and analysis of data. Here, *"S1"* indicates which student s/he is and the symbols of "D, A, C, AC" indicate the learning styles of students as "diverger (D), assimilator (A), converger, (C) and accommodator (AC)". The main themes formed under two headings, and the sub-themes formed under these main themes in the study, are presented in tables in the results section. Tables in the results section were formed based on the repetition frequency, depending on the status of being repeated by the students, according to the learning style. The total percentage column in the tables was calculated in the following way: the number of students stating a theme were added (considering how many people with a learning style that causes a theme to generate) stated the related theme, and divided by the number of all participants with the learning style of the students stating that theme. Hence, participants who did not express an opinion for each theme were prevented from affecting the total percentage and, regarding the total of the general status of participants. While commenting on the total percentages in the results section, it was noted for which learning style the mentioned total was valid and next, the relevant percentage value was given.

In order to test the reliability in the content analysis, it is possible to compare the analysis of data made either by different people or by the same person at different times and calculate the similarity relationship between them. Also, validity can be obtained by answering the question whether there is compliance between the problems/purposes and tools of the research (Gökçe, 2006: 83). For the purpose of ensuring the reliability of the research, data were examined by two researchers using P (Percentage of Agreement) = [Na (Agreement) / Na (Agreement) + Nd (Disagreement)] X 100 (Miles & Huberman, 1994) formula. As a result of this calculation, the value P = 86.8% was found and the research was found to be reliable.

Findings

The results obtained from data analysis according to the order of presentation of the sub-problems are given as follows: In order to find an answer to the first sub-problem of the study, which was mentioned above as *"Is there a significant difference between the computer use frequency of high school students with different learning styles?"*, the information related to students' frequency of computer use and chi-square analysis were given in Table 1.

Table 1. Chi-Square Results regarding students' frequency of computer use according to learning styles.

		Learning Styles				
		Diverger	**Assimilator**	**Converger**	**Accommodator**	**Total**
		f (%)	**f (%)**	**f (%)**	**f (%)**	**f (%)**
Frequency of Computer Use	1-Never	30 (22,1)	9 (18,0)	21 (21,6)	20 (19,0)	80 (20,6)
	2- A few hours a month	19 (14,0)	13 (26,0)	27 (27,8)	14 (13,3)	73 (18,8)
	3-A few hours a week	50 (36,8)	14 (28,0)	31 (32,0)	36 (34,3)	131 (33,8)
	4- A few days a week	10 (7,4)	6 (12,0)	5 (5,2)	18 (17,1)	39 (10,1)
	5- A few hours a day	17 (12,5)	3 (6,0)	11 (11,3)	12 (11,4)	43 (11,1)
	6- Regularly everyday	10 (7,4)	5 (10,0)	2 (2,1)	5 (4,8)	22 (5,7)
Total		136 (100)	50 (100)	97 (100)	105 (100)	388 (100)

$\chi^2_{(15)}$=25.259; *p*=,047

It was found that students in all learning styles use computers at least "a few hours a week". Moreover, it is seen that the accommodator and diverger students use computers more often than the students with other learning styles. It was also found that this difference observed in students' opinions regarding their computer use was significant. In other words, there is a significant relationship between students' learning styles and opinions about their computer use frequency.

Regarding the second sub-problem of the study, Table 2 shows students opinions regarding the tools facilitating the process of learning mathematics.

Table 2. The descriptive statistical information about students' opinions on the tools facilitating the process of learning mathematics

Tools *	f	%
Blackboard	220	56,7
Projector	54	13,9
Overhead projector	27	7,0
Television	16	4,1
Computer	67	17,3
Books	256	66,0
Internet	54	13,9
Poster-Graph	24	6,2
Geometric objects	72	18,6
Calculator	53	13,7
Other	11	2,8

*More than one answer was given

Frequencies in high school students' opinions about the tools facilitating the process of learning mathematics were listed, respectively, as follows: blackboard, books, geometric objects, computers… 17.2 % of the students stated that computers facilitated the process of learning.

The results of the chi-square analysis made in order to find out whether there are significant differences among students' opinions on the tools facilitating the process of learning mathematics based on different learning styles are given in Table 3.

Table 3. Chi-square results of students' opinions on the tools facilitating the process of learning mathematics based on different learning styles

	Learning Style					Result	
	Diverger	Assimilator	Converger	Accommodator	Total		
Tools	f (%)	f (%)	f (%)	f (%)	f (%)	$\chi^2_{(3)}$	*p*
Blackboard	75 (55,1)	27 (54,0)	57 (58,8)	61 (58,1)	220 (56,7)	0.533	*0.911*
Projector	12 (8,8)	10 (20,0)	17 (17,5)	15 (14,3)	54 (13,9)	5.556	*0.135*
Overhead projector	7 (5,1)	5 (10,0)	9 (9,3)	6 (5,7)	27 (7,0)	2,461	*0.482*
Television	7 (5,1)	1 (2,0)	4 (4,1)	4 (3,8)	16 (4,1)	0.922	*0.820*
Computer	25 (18,4)	11 (22,0)	14 (14,4)	17 (16,2)	67 (17,3)	1.533	*0.675*
Books	83 (61,0)	27 (54,0)	76 (78,4)	70 (66,7)	256 (66,0)	11.317*	*0.010*
Internet	13 (24,1)	9 (18,0)	12 (12,4)	20 (19,0)	54 (13,9)	5.352	*0.148*
Poster-graph	9 (6,6)	3 (6,0)	8 (8,2)	4 (3,8)	24 (6,2)	1.779	*0.620*
Geometric objects	25 (18,4)	7 (14,0)	27 (27,8)	13 (12,4)	72 (18,6)	8.865*	*0.031*
Calculator	19 (14,0)	2 (4,0)	17 (17,5)	15 (14,3)	53 (13,7)	5.231	*0.156*
Other	4 (2,9)	2 (4,0)	2 (2,1)	3 (2,9)	11 (2,8)	0.463	*0.927*

Diverger, converger and accommodator students stated mostly "the books" as the tool facilitating the process of learning mathematics while assimilator students stated mostly "the books" and "the blackboard". In their opinions, divergers (18.4%) consider computers the fourth tool facilitating the process of learning mathematics while assimilator students (22%) consider computers the third, convergers (14.4%) the sixth and accommodators (16.2%) the fourth. According to Table 3, it was found that there are significant differences between those stating their opinion as "the books" and "the geometric object" and others who did not express an opinion among students' opinions on the tools facilitating the process of learning mathematics based on different learning styles. It is also seen that there is no significant difference between the opinions about the other tools according to learning styles. In other words, there is a significant relationship between students' learning styles and their opinions about books and geometric objects as the tools facilitating learning.

Regarding the answer to the third sub-problem of the research, Table 4 shows the students' opinions related to their purposes for using computers in the process of learning mathematics.

Table 4. The descriptive statistical information of the students' opinions regarding their purposes for using computers in the process of learning mathematics

Purpose of computer use	f	%
Writing	43	11.1
Research-investigation	236	60.8
Downloadig homework	181	46.6
Calculation	59	15.2
Drawing	70	18.0
Making presentation	53	13.7
Math software programs	73	18.8
Other	22	5.7

In students' opinions with regards to their purposes for using computers in the process of learning mathematics, it was stated that the purpose of using computers is mostly research-investigation. The purposes of computer use are, respectively, research-investigation, downloading homework, math software programs, drawing, calculation, making presentations, writing and others.

Table 5 shows the results of chi-square analysis made in order to determine whether there are significant differences among the opinions of students related to their purpose of computer use in the process of learning mathematics according to different learning styles.

Students in all learning styles stated mostly research-investigation and downloading homework as the purpose of using computers, respectively. It was found that there are significant differences between the students who expressed an opinion about using computers for the purposes of writing and downloading homework and those who did not. In other words, there is a significant relationship between the students' learning styles and their opinions about writing and downloading homework as their purposes for computer use. It is seen that there is no significant difference among the opinions regarding the other purposes for using computer according to learning styles.

Table 5. The results of the chi-square of students' opinions related to their purpose of computer use in the process of learning mathematics according to different learning styles

			Learning Style				
	Diverger	**Assimilator**	**Converger**	**Accommodator**	**Total**	**Result**	
Purpose of computer use	**f (%)**	**f (%)**	**f (%)**	**f (%)**	**f (%)**	$\chi^2_{(3)}$	*p*
Writing	19 (14,0)	2 (4,0)	5 (5,2)	17 (16,2)	43 (11,1)	9.935*	*0.019*
Research-investigation	79 (58,1)	31 (62,0)	58 (59,8)	68 (64,8)	236 (60,8)	1.183	*0.757*
Downloadig homework	72 (52,9)	13 (26,0)	49 (50,5)	47 (44,8)	181(46,6)	11.462*	*0.009*
Calculation	20 (14,7)	7 (14,0)	15 (15,5)	17 (16,2)	59 (15,2)	0.167	*0.983*
Drawing	24 (17,6	11 (22,0)	17 (17,5)	18 (17,1)	70 (18,0)	0.619	*0.892*
Making presentation	18 (13,2)	7 (14,0)	15 (15,5)	13 (12,4)	53 (13,7)	0.439	*0.932*
Math software programs	21 (15,4)	7 (14,0)	23 (23,7)	22 (21,0)	73 (18,8)	3.609	*0.307*
Other	5 (3,7)	6 (12,0)	6 (6,2)	5 (4,8)	22 (5,7)	4.966	*0.174*

Regarding the fourth sub-problem of the research, Table 6 shows the findings obtained with the content analysis of the students' opinions on computer use in the process of learning mathematics.

Table 6. Students' opinions on computer use in the process of learning mathematics

Theme/Sub-theme	Percentages are expressed according to learning styles									
	Diverger		Assimilator		Converger		Accommodator		Total	
	f	%	f	%	f	%	f	%	f	%
Theme I. Computer should be used										
Theme I-a. whole process of learning mathematics	16	89	3	50	7	50	6	60	32	67
Theme I-b. the reasons for computer use										
b.1. It is easier to learn visually.	7	39	1	17	1	7	3	30	12	25
b.2. I am learning by doing	1	6	1	17	-	-	-	-	2	4
b.3. I am learning by observing	1	6	-	-	-	-	-	-	1	2
b.4. I am learning by listening	1	6	1	17	4	29	2	20	8	17
b.5. I am associating real life with mathematics	1	6	1	-	1	7	2	20	5	10
Theme I-c. benefits of computer use										
c.1. it facilitates learning	13	72	3	50	7	50	3	20	26	54
c.2. it helps reinforce the things that have been learnt	5	28	1	17	-	-	2	20	8	17
c.3. repeating the things that have been learnt	1	6	-	-	2	14	2	20	5	10
c.4. attracting attention to the issue	-	-	-	-	2	14	-	-	2	4
c.5. filling in teacher's gaps	5	28	-	-	3	21	1	10	9	19
Theme I-d. usage conditions										
d.1. research-investigation	3	17	3	50	5	36	2	20	13	27
d.2. drawing figure-graph and tables	4	22	-	-	-	-	2	20	6	13
d.3. learning the history of mathematics	1	6	1	17	3	21	-	-	5	10
d.4. visual and auditory course presentations	2	11	-	-	3	21	3	30	8	17

According to Table 6, 32 (67 %) of the 48 students interviewed expressed positive opinions on using computers for the whole mathematics education process. When data are examined in terms of the learning styles of the students interviewed, it is seen that 89 % of the diverger students, 50 % of the assimilator students, 60 % of the accommodator students and 50 % of the converger students presented positive opinions about computer use in mathematics education. Some of the positive opinions of students about computer use in mathematics education are given below:

> **S1-D:** *I think computers should be used in all areas of mathematics*.
> **S29-A:** *Learning mathematics with computers affects students considerably. The students can learn the issues not known by means of a computer and implement them. Therefore, they can learn in a shorter time.*
> **S44- AC:** *When an issue is not understood, it is possible to turn on a computer and solve the problem. We can listen to any problem on a computer, whenever we want, and we can make it explain the problem to us.*
> **S35-C:** *It should be completely and appropriately be used to its purpose. The issues should be handled individually and examined in detail.*

Students presented their opinions on the reasons for computer use in the process of learning mathematics as, "It is easier to learn visually (25 %)", "I am learning by doing (4 %)", "I am learning by observing (2 %)", "I am learning by listening (17 %)" and "I am associating real life with mathematics (10%)". A great majority of the diverger (39 %) and accommodator (30 %) students stated the opinion, "learning visually is easier", as the reason for computer use. A great majority of the converger (29 %) students stated the opinion, "I am learning by listening". On the other hand, assimilator students are of different opinions regarding the reason for computer use. Some of the student opinions regarding the reasons for computer use in the process of learning mathematics are presented below:

S1-D: *It would be better if it were used more as I am a visual learner.*
S4-C: *I think it is very useful to learn mathematics by means of computer because the best way to learn is visually and by investigating.*
S8-A: *Generally, I can learn better by listening. It would be useful by means of a computer.*
S38-AC: *It would be effective visually in understanding mathematics.*
S5-D: *I think computers should be used mostly visually in the process of learning mathematics, and the reason why I think like this is that mathematics can be learnt more easily when it is visual.*
S21-C: *It should be used in research and investigation. It helps us investigate what kind of benefits the issue we learn provides and how we can use it in real life.*

It is seen that students' opinions about the benefits of computer use in the process of learning mathematics are "it facilitates learning (54 %)", "it helps reinforce the things that have been learnt (17 %)", "repeating the things that have been learnt (10%)", "attracting attention to the issue (4%)" and "filling in teacher's gaps (9 %)". When students' opinions about the benefits of using computers are examined in terms of learning styles, it is seen that students in all learning styles presented the opinion "it facilitates learning". Moreover, some of the diverger, converger and accommodator students put forth an opinion that computer use would be helpful in filling in teachers' gaps. Some of the opinions of students regarding the benefits of computer use in the process of learning mathematics are as follows:

S7-D: *Computer should be used in the process of learning mathematics because it facilitates learning. It ensures that we regard events from a more detailed perspective.*
S14-C: *It is helpful when the teacher is not very good or having trouble explaining the subject…*
S19-A: *…in order for the student to reinforce an issue better.*
S27-AC: *Teachers mostly write down the questions on the board and students copy them into their notebooks, which is mostly a waste of time. Studies with computers may eliminate this problem.*
S28-C: *It attracts students' attention more when it is done on computer.*
S33-D: *It is very effective because there are programs to audit the lessons, which helps understand and reinforce the things they have listened to.*
S43-C: *Computers are better than my teacher. I would rather listen to the computer than listen to my teacher. I recommend it to everyone.*
S44-A: *When we use computers, we can repeatedly listen to the subject in the lesson.*

It is seen that student opinions regarding computer use in the process of learning mathematics are "research-investigation (27 %)", "drawing figure-graph and tables (13 %)", "learning the history of mathematics (10 %)" and "visual and auditory course presentations (17 %)". When student opinions regarding computer use in the process of learning mathematics are examined in terms of learning styles, it is seen that a majority of the diverger students presented their opinions as "drawing figure-graph and tables (13 %)"; a majority of the assimilator and converger students presented their opinions as "research-investigation (50 %)"; and a majority of the accommodator students presented their opinions as "visual and auditory course presentations (30 %)". Some of the opinions of students regarding computer use in the process of learning mathematics are as follows:

S3-D: *Computers should be used for researching the origins of mathematics and learning the purpose of mathematics up to the present day.*
S9-AC: *Computers can be used in drawing figures and graphs or in terms of how to apply mathematics to real life.*
S11-AC: *Using computers is significant for mathematics courses. Videos we listen to on the computer are helpful in reinforcing the subject.*
S16-C: *Computers should be used in order to do research.*
S17-D: *It can be used for research, drawing graphs, making presentations, downloading homework and making calculations.*
S20-C: *It is necessary for computers to be used in auditing the lessons and repeating the subjects in interactive education.*
S41-A: *It is important for gaining knowledge about the history of mathematics. For instance, it is important for learning which scientists were successful in mathematics and applying their behavior in your own life.*
S47-C: *Giving lectures visually and vocally…*

Table 7 shows the findings obtained with content analysis of the students' opinions regarding not using computers in the process of learning mathematics.

Table 7. Students' opinions regarding not using computers in the process of learning mathematics

Theme/Sub-theme	Percentages are expressed according to learning styles									
	Diverger		Assimilator		Converger		Accommodator		Total	
	f	%	f	%	f	%	f	%	f	%
Theme II. Computer shold not be used										
Theme II-a. whole process of learning mathematics	-	-	-		1	7	2	20	3	6
Theme II-b. should be partially used	2	11	3	50	6	43	2	20	13	27
Theme II-c. the reasons for not using computers										
c.1. it does not take the place of teachers	1	6	1	17	4	29	1	10	7	15
c.2. it is useless and ineffective			2	33	8	57	3	30	13	27
c.3. mathematics is based on understanding, seeing, feeling and thinking	-	-	2	33	3	21	1	10	6	13
c.4. I cannot learn visually	-	-	-	-	-	-	1	10	1	2

When students' negative opinions regarding computer use in the process of learning mathematics are examined, it was seen that 6 % of the students expressed their opinions as "computers should not be used in the whole process of learning mathematics" and 13 % of them expressed their opinions as "should be partially used". It was also observed that students with assimilator and converger learning styles presented more negative opinions than the others. Below are some of the negative opinions of students:

S6-C: *It is ridiculous to learn mathematics by means of computers. It is a lesson based on explaining, ideas and opinions.*
S32-C: *Mathematics cannot be learned on a computer because understanding is essential in mathematics, not reading.*
S4-AC: *I think computers are not that effective in the process of learning mathematics yet it is good to learn it by means of computers. This is because being visual is more attractive.*
S15-A: *Mathematics cannot be learnt from computers alone. We need to study on our own. We need to make use of books.*

The reasons for not using computers based on students' opinions were found to be as follows: "it does not take the place of teachers (15 %)", "it is useless and ineffective (27 %)", "mathematics is based on understanding, seeing, feeling and thinking (13 %)" and "I cannot learn visually (2%)". It is seen that assimilator and converger students presented more opinions regarding not using computers. Some of the student opinions regarding not using computers in the process of learning mathematics are given below:

S2-AC: *I would not recommend and use it as I learn by writing not visually.*
S3-D: *I think the best way to learn mathematics is through teachers. Under no circumstances can computers take the place of teachers because teachers have plenty of instruction styles. However, a computer has a single way of explaining, which cannot be perceived by all people.*
S9-AC: *I think we need to practice, study and think about mathematics more than computers. I do not think it is right to use computers in this way. Mathematics is learnt by practicing.*
S13-A: *It doesn't have much use because mathematics is the task of seeing and feeling. However, a mathematician making use of computers cannot contribute much because computers affect the brain waves, which may prevent concentration.*
S21-C: *I do not think computers are helpful in learning this subject. Books are more helpful for me. I use computers for homework and fun.*
S24-C: T*here is no point in using it much as, in my opinion, mathematics should be learnt in the lesson.*
S41-A: *I think it is limited. Computers alone cannot help in understanding mathematics.*

DISCUSSION AND CONCLUSION

In this study, opinions of high school students, who have different learning styles, about computers in the process of learning mathematics were examined. This section includes the comments and suggestions about data obtained from students' opinions on their computer use frequency in terms of their learning styles, tools facilitating the processes of learning mathematics and purposes of computer use and computer use in the process of learning mathematics.

The finding of the first sub-problem of the research shows that there is a significant relationship between students' learning styles and their computer use frequency. It is seen that students in all learning styles gave opinions mostly in the category of computer use "a few hours a week", and in this category, students seem to be the diverger, accommodator, converger and assimilator, respectively. In the model they developed, Levine & Donitsa-Schmidt (1998) state that computer use has a positive effect on computer self-confidence and attitudes associated with computers. In the studies conducted with students, teachers and pre-service teachers in various age groups, it is seen that computer use frequency and attitudes toward computers are connected. It is indicated that the ones using computers more often have more positive attitudes (Birgin et.al., 2010; Birgin, Kutluca & Çatlıoğlu, 2008; Çelik & Bindak, 2005; Ekici, Uzun & Sağlam, 2010; Günhan, Yavuz & Başer, 2007; Kutluca & Ekici, 2010; Loyd, Loyd & Gressard, 1987; Özgen, Obay & Bindak, 2009; Taghavi, 2006). Furthermore, Yılmaz & Çelik (2009) state in their study examining attitudes of university graduates, middle-school and high-school students and university students regarding computer use that university graduates have the lowest and university students have the highest attitudes. In the study conducted by Kutluca (2010), it was determined that there are significant differences in attitudes toward computers according to possessing a computer and the frequency and level of computer use. Today, since computers are indispensible tools used in homes, schools and at work, individuals' levels and frequency of computer use have been increasing. Particularly, it is seen that teachers' and students' levels and frequency of computer use outside school affect their attitudes toward computers (Birgin, Kutluca & Çatlıoğlu, 2008; Levine & Gordon, 1989; Wittwer & Senkbeil, 2008). The study by Ferdig (2006) conducted by using PISA data addresses the issue that high mathematics literacy scores and computer use at schools and outside schools is related and computer use at home is a significant predictor of mathematics literacy. It is possible to come across similar and contradictory findings in studies where students' or teachers' attitudes toward computers and their learning styles are examined. Bozionelos (1997) and Sein & Robey (1991) state in their research that converger students are better with computer applications and have more positive attitudes than the students in other learning styles (Cited in Shiue, 2002-2003). Miller (2000) couldn't find significant relationships between learning style and attitudes toward computers and stated that students in all learning styles had positive attitudes towards computers. With these results, if it is considered that learning styles of students and their computer use frequency are connected to each other, it can be thought that learning style can be connected to with attitudes toward computer use and sensual behavior such as self-sufficiency.

In this study, when the student opinions regarding the tools facilitating the process of learning mathematics according to their learning styles are considered, it is thought-provoking that opinions about "the board" and "the book" are mentioned the most in all learning styles. It is determined that there are no significant differences based on learning styles in the analysis of opinions of students who stated the computer category and those who did not. The opinions of students who stated the computer category were examined in terms of the learning styles and it was seen that the percentage of the assimilator students was the highest while the percentage of converger students was the lowest. It can be said that students' opinions on computers are still at an insufficient level although computers have rapidly been integrated into our educational system and, particularly, in the process of learning and teaching mathematics. Findings similar to this situation can be seen in previously conducted studies. In the research conducted by Kaya, Pekel & Sezer (2003), it is pointed out that students mostly use board, reference books, pictures and shapes in biology lessons. The fact that students don't regard computers as tools facilitating learning processes can arise from different reasons. Our learning-teaching approaches in our education system, the physical conditions and attitudes, beliefs and approaches of our teachers can be listed among these reasons. In a study conducted by Ersoy (2005) with mathematics teachers in a science high school, almost all teachers agreed with the statement, "*mathematics courses should be given in information assisted settings*" and "*the tools used in mathematics education are insufficient*". Moreover, it was found that mathematics teachers and pre-service teachers had negative opinions about computer use in mathematics education (Baki, 2002). Aside from this, it is seen in various studies that mathematics teachers and pre-service teachers have positive attitudes related to computer assisted education (Birgin et.al., 2010; Deniz, 2005; Erkan, 2004; Keşan & Kaya, 2007; Özgen, Obay & Bindak, 2009). Güven, Çakıroğlu & Akkan (2009) indicate that there is a gap between program expectations and teachers' beliefs in integrating computers in mathematics courses. In line with this, Baki (2000) emphasizes that the negative beliefs of Turkish mathematics teachers related to computer use in mathematics courses may be a result of their negative experiences and states that these experiences can be changed. When the positive attitudes of teachers and students towards computers and their status of computer use is considered, not considering computer as a facilitating tool for the process of learning mathematics creates a conflicting situation. This does not show a significant difference in terms of learning style. That is to say, the effect of learning styles on these opinions is out of the question because in this study, students in all learning styles don't consider computers as a tool facilitating the process of learning mathematics in the first place. Although there aren't significant differences among opinions in terms of learning styles, the fact that the percentage of assimilator students is the highest can be the result of these students' preference for learning mostly by observing, watching-listening. On the other hand, the converger students' percentage is the lowest, which may result from their preference for learning by practicing and implementing.

In results obtained about the third sub-problem of the research, it is determined that students' purposes for using computers in the process of learning mathematics differed and that they mostly expressed their opinion in those categories of research – investigation and downloading homework. It was found that in the writing and downloading homework categories, there is a significant relationship between the opinions of students who expressed their opinion and those who did not and their learning styles. It is an interesting finding that accommodator and diverger students expressed their opinions with a higher percentage than the students in other learning styles because concrete experiences are more at the forefront for the accommodator and diverger students. This can lead us to the fact that these students' computer use in mathematics education is not based on concrete experiences. Aside from this, opinions in the downloading homework category were examined in terms of learning styles and it was found that assimilators had the least percentage while students in other learning styles had similar opinions. It is thought provoking that students mostly express their opinion as downloading homework as the purpose of using computers in the process of learning mathematics because here students may benefit from the computer in the wrong way or think that it could contribute in the learning process. Buch & Bartley (2002) stated that converger students in the Kolb learning style model have a stronger preference for computer based presentations and assimilator students have a stronger preference for written presentation. It is also determined that students' opinions on computer use in the process of learning mathematics do not differ in other categories in terms of learning styles. However, the fact that students' opinions on the other categories have lower percentages brings some questions to mind. It is clearly understood that these students do not use computers with the right purposes in their processes of learning mathematics and they are not encouraged for different computer assisted activities by their teachers.

It is seen from the interview data obtained related to the last sub-problem of the research that the positive opinions about computer use in the process of learning mathematics are stated by diverger, accommodator, assimilator and converger students, respectively. The majority of diverger and accommodator students, half of the assimilator and converger students stated that computers should be used in whole process of learning mathematics. Considering the research conducted in Turkey in order to determine learning styles of students and studies regarding learning styles in mathematics education, it is seen that students mostly prefer assimilator and converger learning styles (Orhun, 2007; Peker, 2009; Peker, Mirasyedioğlu & Aydın, 2004). This shows that a majority of students still have adverse opinions regarding computer use in mathematics education. In the interviews, it is seen that a part of the students still present opinions about not use of computer in the whole process of learning mathematics or partially. When students' opinions about the reasons for computer use in the process of learning mathematics are examined, it is understood that there are opinions appropriate to the characteristics of learning styles. For instance, the fact that diverger and accommodator students presented more opinions in sub-themes as "it is easier to learn visually", "associating real life with mathematics" may be a result of their preferring concrete experience. In the sub-theme "I learn by listening", assimilators and convergers presented more opinions, which may imply they prefer abstract conceptualization. Moreover, it is a pleasing situation that students in all learning styles mostly presented their opinion in the sub-theme "it facilitates learning" as the reasons for computer use in in the process of learning mathematics. The diverger learners presented opinions with the highest percentage again in this sub-theme. Regarding their opinions about computer use status, it is seen that the status for visual purposes comes to the forefront and divergent and accommodators presented more opinions in this status. Aside from this, when the negative opinions about computer use in the process of learning mathematics are examined, it is seen that mostly assimilator and convergent learners gave their opinions. *"It will not take the place of the teacher, the belief that it will not be helpful, it is not suitable for mathematics and not being able to learn visually*" among the reasons for not using computers in learning mathematics. It can be said that these opinions partially match the divergent and assimilator learners' opinions because these students prefer learning by watching, listening, consulting an expert and practicing. In line with this, it should not be concluded that divergent and assimilator students have a disadvantage in computer use because correct encouragements and designing an effective computer based learning environment related to the learning styles and activities can, it is assumed, facilitate all students' process of learning mathematics. Likewise, Shiue (2009) state that learners who learn with a converger learning style have advantages in learning by using computers. In a study by Federico (2000) conducted for the purpose of examining the attitudes toward computer assisted learning according to the Kolb model of learning styles, it was determined that the most acceptable styles are accommodators and assimilators while divergers and convergers are the least acceptable. Enochs et al. (1985; cited in Ross & Schnulz, 1999) suggested that the concrete learners in the Kolb model of learning styles learn better than abstract learners in computer assisted teaching. It may seem natural that various findings are present in several studies regarding this issue since many factors affecting this situation can be listed. The basis of the model of learning styles can be stated as the cultural structures of students, their learning approaches, mathematics instruction and teachers, all the physical conditions for computer use and sensual behavior.

This study aimed to determine the opinions of high school students who have different learning styles related to computer use in mathematics education. It is partially seen here that the idea that computers should only be used in processes toward visual learning is wrong. As perceiving and comprehending information are involved in the process of learning mathematics, computers should be integrated in information processing and transforming. For this purpose, it would be appropriate to design activities and settings for skills like feeling, dreaming, activating, discussing, interpreting, adopting, discovering and forming with computers. Through realizing these, learning opportunities appropriate to the dominant learning style will be provided for the individuals in different learning styles and aside from this, it will support them in dealing with difficulties and their development in the processes in learning styles that are not dominant.

It should be ensured that, particularly the process of learning mathematics moves away from a teacher-centered approach, full of abstract concepts, where there are mostly activities like listening and writing, and it should be a process where students' learning styles are considered with a constructivist approach, and where computers are integrated with the mathematics courses with a multi-directional approach. While doing this, it is necessary to accept that all learning preferences, learning by feeling, watching, thinking and doing, are equally important as in the Kolb model of learning styles and apply it to the process of learning. In line with this, mathematics teachers should know their students, identify their learning styles and detect the aspects of their students' learning styles. By knowing the learning styles, teachers will ignore none of the styles in line with the learning styles of their students and investigate ways to benefit from computers in mathematics courses with a multi-directional approach. It should also be ensured that students' learning styles are considered in training pre-service mathematics teachers and accordingly, students should be provided with theoretical and practical trainings for designing computer assisted courses and learning settings. Also, students' learning styles and processes towards these styles should be taken into great consideration in the computer assisted learning activities in preparing mathematics textbooks, reference books and teacher guide books.

Since in this study, the opinions of a limited number of high school students, who have different learning styles, related to computer use in mathematics education were examined, it can be suggested that sample sizes in wider and across more varied age groups should be chosen for further research. Furthermore, the attitudes of students with different learning styles towards computer use in mathematics education should be examined together with various variables, such as self-efficacy perceptions. The most important of all is that although the number and status of computer use have increased in the process of learning, just as in real life, and the field of education, the reasons for students' adverse and wrong ideas about computer use for learning purposes in mathematics courses should be examined more in detail and, upon determining these reasons, solutions should be discussed.

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