INVESTIGATING THE EFFECT OF ASYNCHRONOUS DISCUSSIONS ON STUDENTS' LEARNING AND UNDERSTANDING OF MATHEMATICS SUBJECTS

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ABSTRACT

Recently, learning activities have gone beyond conventional environments and started to be performed via computer supported instruments. One of these instruments is asynchronous discussion forums (ADFs) used as computer-supported collaborative learning means. Learners practice various learning activities in ADFs and produce knowledge construction. In the present study, document analysis was employed and all Turkish originated ADFs relating mathematics teaching were scanned and put subjected to content analysis. Besides, a survey was implemented on 86 high school and undergraduate students. Both qualitative and quantitative data were obtained through this survey. These data were put subjected to qualitative and quantitative data analysis. Attitudes of students towards computer-supported collaborative learning and asynchronous discussion forums as mathematics learning instrument were tried to be revealed via this study. Also, behaviors of the learners and their views relating the learning activities in these environments were evaluated by means of this study. Results of the study demonstrated that asynchronous discussion forums are widely and efficiently used as computer-supported collaborative learning instrument in terms of mathematics learning.

Keywords: **Computer-supported collaborative learning environments, asynchronous discussion forums, asynchronous dialogues, online learning communities, mathematics learning**

INTRODUCTION

The development of internet technologies has led to important changes in educational terms as well as in terms of different fields. The use of computer supported communication environments named as Computer - mediated Communication (CMC) increases day by day because of the prevalence of the internet and because of the fact that it has become a part of our daily life (Aleven, Stahl, Schworm, Fischer, & Wallace, 2003; Holmes, 2005, Himelboim, 2008; Bulu, & Yildirim, 2008; Lo, 2009).

The use of Asynchronous discussion forums (ADFs),which is one of CMC instruments, for learning and teaching activities both by teachers and students is increasing day by day (Dringus, & Ellis, 2005; Fujitani, 2007; Liaw, Chen, & Huang, 2008; An, Shin, & Lim, 2009). Various studies were conducted in the matter of in which ways ADFs are used in learning activities and how these environments can be used more efficiently as learning instruments (Larkin-Hein, 2001; Graesser, Gernsbacher, & Goldman, 2003; Schrire, 2006; Dringus, & Ellis, 2010; Gomez, Wub, & Passerini, 2010).

Basically, collaborative learning is a social interaction through which learners share their information and views with each other (Puntembekar, 2006; Liaw, Chen, & Huang, 2008; Amhag, & Jakobsson, 2009). Computer-Supported Collaborative Learning (CSCL) is the communication and discussion of individuals via asynchronous discussion boards which is generally text based (Weinberger, & Fischer; 2006; Gress, Fior, Hadwin, & Winne, 2010). Therefore, ADFs have an important place in CSCL environments (De Wever, Schellens, Valcke, & Van Keer, 2006). As a result of social constructivism, individuals share information and views with each other in ADFs. These environments enable the individuals who are physically away from each other to communicate with each other and work together (Taradi, & Taradi, 2004; Chiu, & Hsiao, 2010). Via ADFs, individuals may share their information and views, also, they can write their opinions into the topics that were opened beforehand. Thus, ADFs help individuals to construct knowledge by themselves. Construction of knowledge by the individual occurs thanks to collaboration and communication in ADFs. Interaction between students and exchange of opinions are of importance in terms of cognitive and social process development (Li, 2002; Taradi, & Taradi, 2004; Perez, 2005; Birch, & Volkov, 2007; Woo, & Reeves, 2007; Hrastinski, 2009; Saade, & Huang; 2009; Yeh, 2010; Wang, 2010). Many studies proved that this collaboration and discussion in ADFs provide several advantages to students. These advantages may be stated as the increase in critical thinking skills, their thinking on what they learn and practicing knowledge construction by reflecting these advantages (Marra, Moore, & Klimczak, 2004; Moore, & Marra, 2005; Wu, & Hiltz, 2004; De Weber et al., 2006; Wang, 2008; Amhag, & Jakobsson, 2009; Klisc, McGill, & Hobbs; 2009). Therefore, ADFs have an important place among the CSCL instruments (Turcotte, 2004, Wade, & Fauske, 2004; Liaw, Chen, & Huang, 2008; Pozzi, 2010).

Knowledge is constructed by the individual according to Constructivist theory (Driscoll, 2000). ADFs provide the learners with the opportunity to interact, to share knowledge and make comments on knowledge. ADFs create a constructivist environment for individuals thanks to these features. Messages in discussion forums develop in such a way to increase the interaction between students. When the answer relating to a question starts to be discussed, different opinions concerning that question or topic are suggested and all students observe and evaluate these opinions. Therefore, activities such as collaborative working and opinion sharing occur frequently. Interaction between students and exchange of opinions have an important effect on social process in addition to cognitive process (De Wever, et al., 2006; Patricia, & Dabbagh, 2005; Birch, & Volkov, 2007; Montreo, Watts, & Garcia-Carbonell 2007; Woo, & Reeves, 2007; Amhag, & Jakobsson, 2009; Hrastinski, 2009; Saade, & Huang; 2009).

Participation in ADFs is based on willingness. Since participation depends on willingness, participants may be expected to be individuals who are self-motivating, goal-oriented, who acquire from experiences, read and evaluate other messages relating the discussed topic, and who think about the topic. Willingness of the participation will create a social support environment in which individuals who essentially want to learn or exchange opinions on specific terms will participate willingly.

Conducted studies proved that ADFs are important and successful tools in terms of social support (Eastin, & LaRose, 2005; Campbell, Logan, & Frost 2005; Zhu, 2006; Deryakulu, & Olkun, 2007; Hou, Chang, & Sung, 2008).

Besides the fact that there are studies claiming that CSCL environments have adverse impacts on learning (Kreijns & Kirschner, 2004), there are many studies which emphasize that collaborative and group working are better than individual working in terms of learning outputs (Barron, 2000; Neo, 2003; Li, 2002; Lipponen, Hakkarainen, & Paavola, 2004; Dewiyanti, Brand-Gruwel, Jochems, & Broers, 2007, Dennen, 2008; Palmer, Holt, & Bray, 2008; Wang, 2009).

There are many studies relating the use of ADFs as learning environments and CSCL, however, there is not a wide study relating the use of these environments in mathematics learning. In this study, the use of ADFs for mathematics learning was searched. To this end, all Turkish originated text based ADFs relating mathematics in internet was scanned. Learning activities occurring in these ADFs were analyzed via content analysis. Also, behaviors of the individuals in these environments and their attitudes towards these environments were tried to be revealed with this study. Within this context, research questions below were tried to be answered:

- **What is the role of ADFs in mathematics learning?**
- **What kinds of behaviors do learners using these ADFs display in these environments?**
- **What are the opinions and attitudes of learners using ADFs as learning instruments towards the learning activities occurring in these environments?**

METHODOLOGY

Document analysis method was employed and all Turkish originated ADFs relating mathematics learning were scanned in this study. With this scan conducted in the first nine months of 2010, all ADFs of this topic were detected. Obtained ADFs were put subject to content analysis and learning activities occurring in these environments relating mathematics were examined. How ADFs are being used for mathematics learning and the interactions in addition to communications between learners in these environments were analyzed. Besides, questionnaire study was conducted in order to have the opinions of individuals using ADFs. Quantitative and qualitative data that obtained via questionnaire were analyzed.

Participants

The study was conducted with 86 high school and undergraduate students.

Data Collection and Data Collection Instruments

A scan was made using search engines with the key words; mathematics, mathematics forum, mathematics forums, mathematics forum sites, mathematics world, mathematics school, philosophy of mathematics, mathematics education. With the scan made in the first nine months of 2010, 72 Turkish originated sites relating mathematics were reached in total. While some of these sites were published intended only for being a forum, there are also some other mathematics portals containing forums. While forum sites were straightly used in the present study, only forum parts of mathematics portals were taken into consideration. Discussions made over mathematics in forum environments were detected.

In order to determine the attitudes and opinions of the individuals using ADFs as learning instruments, a questionnaire form containing 9 items was used. First 8 questions of this form were intended to obtain quantitative data while the last question was intended to obtain qualitative data.

Data Analysis

Data were analyzed in two ways. The first one of these is the content analysis of discussions in order to examine learning activities relating mathematics and social support network. The second one is the analysis of both quantitative and qualitative data obtained from students via questionnaire form. Hundreds of discussion samples were examined while making content analysis, and the topics that are being discussed in these discussions were tried to be determined. Topic titles and discussion contents of forums were examined in a detailed way and the topics discussed were categorized within this direction.

The topics that were categorized are presented in Findings section. We tried to reveal over which topics the discussions were made with the categorization. After categorization, sample discussions were examined. Learning activities occurring in discussions and interactions between the individuals participating in discussions were tried to be revealed.

The opinions of the individuals participating in learning activities that occur in ADFs are of importance since they reflect the opinions of real persons using these environments. To this end, questionnaire study was conducted with 86 students. Therefore, a questionnaire consisting of 9 items was prepared. The first eight items are intended to obtain quantitative data while the last item is intended to obtain qualitative data. These data were put subject to quantitative and qualitative data analysis. ADF usage profiles and behaviors of individuals using ADFs were tried to be determined. In addition, the opinions of individuals relating the learning activities that occur in ADFs were tried to be revealed via qualitative data.

FINDINGS

ADF Environments for Mathematics Teaching

Of the 72 web sites put subject to content analysis, the one which has the largest content and the highest number of members as well as discussions in this site and the information relating this site are as follows:

http://www.matematikcafe.net/index.php
Its members sent 77,315 messages for 15,964 topics.
It has 155,944 members now.
The latest member is bekir6671.

In 13-10-2008 at 22:39 6,051 users were online corresponding to the highest number of simultaneous online users.
http://www.matematikcafe.net/index.php
Our members sent 80,543 messages for 16,703 topics.
We have 162,867 members now.
Our latest member steaven, welcome aboard.

In 13-10-2008 at 22:39 6,051 users were online corresponding to the highest number of simultaneous online users. The rates which were read in 02.06.2010 and in 16.09.2010 are presented above. Over the course of three and a half months approximately, the number of forum members rose from 155964 to 162867.

The increase in the number of members is 6923 during this period. Considering the fact that this was summer and therefore it was a vacation period, it is understood that this is an important increase. These rates are increasing each day and new individuals are becoming members to the system. Besides, the number of topics and messages also gives us important information. The case is that there are 16703 topics and 80543 messages just in a forum totally. It is possible to think that this much discussion will result in a significant information repository which also will lead to an extensive knowledge acquirement.

Categorization of the Discussed Mathematics Subject Contents in ADFs

In order to determine the discussed topics and shared contents relating mathematics in more detail, a categorization process was conducted. All the categories were attained as a result of examination of all ADFs put subject to content analysis, revision of topic titles and content analysis. Seven main categories were formed in consequence of analysis. The categories formed at the end of categorization and the contents of these categories are presented in Table: 1

Table: 1
Categories that were deter
mined via content analysis and their contents

The Name of the Category	Content
Question-Answer Centre	Exercises, problem, sharing relating the questions that were asked in examinations and their solutions etc.
Course Contents-Lectures	Lectures of all levels, course notes etc.
Articles	Teaching of Mathematics, Education of Mathematics, the place of Mathematics in daily life etc.
The History of Mathematics and Famous Mathematicians	General Mathematics History, Historical development of mathematical concepts, Mathematical philosophy, about famous mathematicians etc.
Entertaining Mathematics	Mathematical games, intelligence questions, paradoxes, brainstorming, mathematics Olympics etc.
Theory-Proof Techniques	Theories, proofs and etc. relating mathematics
Others	Other Sharing

With this categorization process, it was observed that both discussions and dialogues were made nearly about all topics. Individuals exchange opinions for a wide range of purposes from problem solving to source sharing.

Discussion Samples Relating Mathematics and Content Analysis in ADFs

Discussions in ADFs were examined and put subject to content analysis in order to determine learning activities occurring in these environments.

To this end, hundreds of discussion samples from the sites were examined. Considering the exchange of opinions, opinion sharing and the course of dialogues, the interaction between individuals were tried to be determined.

A sample discussion text is presented in Table: 2.

Table: 2
Sample Discussion

Topic	**Perfect Numbers**
Link	**http://www.matematikcafe.net/mukemmel-sayilar-t-355.html**
Member Names	**Message Contents**
fish_mekan	**Perfect numbers are the numbers whose factors' addition except from itself is equal to itself such as: 6, 28, and 496. Perfect numbers are infinite. Their general formulas are not discovered yet. However considering 2^n (2^ (n+1)-1), each n even numbers and 1 can be considered as perfect number. But of course this does not mean that perfect numbers are all even. In other words, it is not known if this formula is the common formula of all perfect numbers. However, there cannot be found a single uneven perfect number.** **First 5 perfect numbers are: 6, 28, 496, 8128, 33550336**
matematiksever	**Yes, there are many problems that have not been solved related to perfect numbers. I have a question for you. Each even perfect number's units digit is 6 or 8. I remember that I was so close to the proof of this but somehow I could not manage. I request that someone with information on this explain this topic. Thanks...**
shapsgh	**There is a proceeding of perfect numbers, I discovered it, just kidding I could not remember the name but perfect numbers are formulated as below** **2^(p-1)*[(2^p)-1] or I'll write more clearly {2 through (p-1)} multiply {(2 through p) minus 1}**
Hypnosit	**Super formula, thanks. Of course we should not forget that p>1**
edirnekapi	**Is it true that each perfect number's units digit is 6 or 8?**
Hamashe	**Thanks shapsgh, good formula!**

A discussion text made over perfect numbers is presented in Table 2. This discussion consists of 6 participants and 6 messages. Members conducted a discussion over the formula of perfect numbers.

Two members suggested that the first two digits of perfect numbers are 6 and 8 respectively and they wondered the accuracy of it. Besides, a general formula relating perfect numbers was also shared.

Student opinions relating ADFs

A questionnaire study was conducted with 86 students in order to reveal student views relating ADFs. Quantitative and qualitative data obtained from the questionnaire were analyzed. Questionnaire items and the analysis of quantitative data obtained from questionnaire are presented as frequency distribution in Table: 3.

The last question of the Table 3 is intended to collect qualitative data. Qualitative data obtained from the questionnaire were analyzed and main deductions were attained as a result of this analysis. In addition to these deductions, student views concerning questionnaire items were obtained; they are also presented with the items.

Table: 3
Frequency distribution of quantitative data obtained from questionnaire form

Gender		**Female**	**Male**		
	F	**%29**	**%71**		
The Number of Forums Which Users Have Membership		**0**	**1**	**More**	
	F	**%23**	**%30**	**%47**	
Forum Usage Frequencies		**Almost everyday**	**Twice of three times a week**	**Twice of three times in a month**	**Rarely**
	F	**%18**	**%31**	**%29**	**%22**
Forum usage profiles		**Active participant**	**Passive Participant**		
	F	**%65**	**%35**		
The rate of attaining the information you search in forums		**High**	**Medium**	**Low**	
	F	**%40**	**%54**	**%6**	
The contributions of the information that is obtained from forums in terms of learning a subject of resolving a problem		**Much**	**Medium**	**Scarce**	
	F	**%65**	**%32**	**%3**	
Social interaction and collaborative learning levels in forums		**High level**	**Medium level**	**Low level**	
	F	**%53**	**%47**	**%0**	
The necessity and usability of forums for learning or resolving problems		**Really necessary**	**Necessary**	**Unnecessary**	
	F	**%34**	**%62**	**%4**	
Your opinions relating the learning activities about mathematics and learning from forums		**They were taken as qualitative.**			

According to the obtained data, 79% of the students participating in the questionnaire use ADFs while the rest 21% do not use them. While 23% of students using ADFs do not have any forum membership, 30% of them have forum membership. As for the 47% of students, they have more than one forum membership.

The frequencies of the students using ADFs are seen in Figure: 1

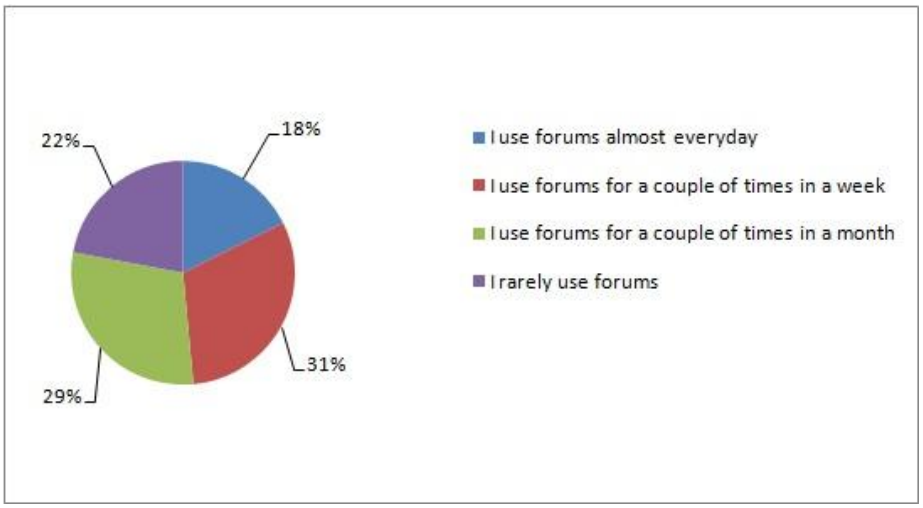

Figure: 1
Forum usage distributions of students who use ADFs

Participants' rates of frequencies of using forums were obtained as follows according to Figure 1: %18 almost every day; %31 2 or 3 times a week, %29 2 or 3 times a month, %22 rarely.

65% of students use forums actively, which means that they participate in discussions by writing, opening questions or replying answers in response to questions opened beforehand. 35% of students use forums passively, which means that they only read pre-made discussions. According to the analysis of qualitative data obtained through questionnaire, the students who use forums passively stated that they do not use them actively since the topics in forums are sufficient for the information they are looking for. On condition that they cannot find the information they search for, then they turns into an active participant and open a topic.

Related opinions of students encoded as Stu7 and Stu16 are presented below.

Stu7:"Exchange of opinions and sharing of information in forums provide important knowledge acquirements. We can attain the knowledge we are looking for by participating in discussions as well as using the pre-made discussions at times. If there is a discussion made about the topic we are searching or some other topics which are close to it, then there is no need to open a new topic again. We can find the information we are searching for from these discussions."

Stu16:"Whenever I need some piece of information, I search for it in the forums in the first place. In this case, pre-made dialogues are enough most of the time. Thereby, I use a learning activity constructed before. In case that I could not find what I was looking for I open a topic and make other members discuss it. Thus, I manage to reach a conclusion. At times, I participate in a discussion or a topic if it interests me."

While 40% of students using ADFs stated that the rate of attaining the information is high, 54% of them stated that the rate is middle. 6% of the student stated that the rate of attaining the information they are looking for is low.

The student encoded as Stu27 noted his/her opinions as below relating this item.

Stu27:" I generally use forums when I am in difficulty or when I cannot find source. I have not opened a topic in the forum yet. Pre-made discussions in forums were very useful for me. I got the information I needed through them easily. I think the discussions in these forums are of importance in terms of information sharing. It is an important learning instrument, I think. "

The data regarding the contributions of information attained from forums to learning a subject or solving a problem are seen in Figure 2.

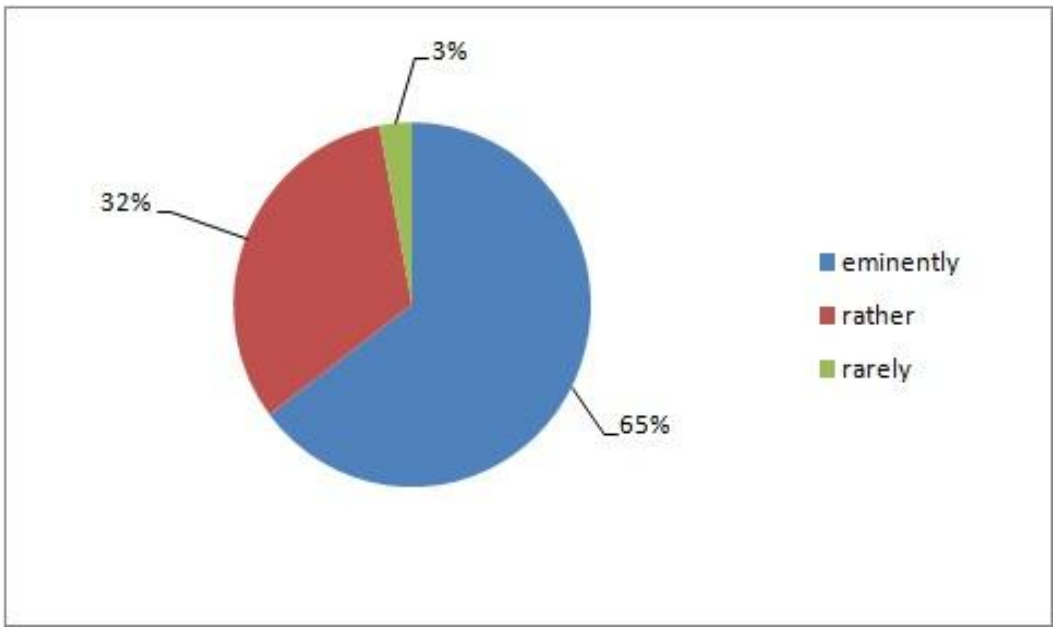

Figure: 2
The distribution of problem resolving or learning
a subject from the information obtained from forums

According to Figure 2, students evaluated the contribution of information obtained from forums to learning a topic or solving a problem as follows:

- **65 % of them stated that it has a great contribution;**
- **32 % of them stated that it has a medium contribution while 3 % of them stated that it has a little contribution.**

Regarding this item, the opinions of the student encoded as Stu44 are as follows:

Stu44:"I use forums frequently. The discussions and dialogues made in forum environments are important in terms of knowledge acquirement. We find the opportunity to discuss over a subject about whom we know nothing or something about which we are curious with the peers or other individuals. Mutual exchange of opinions creates information repository."

The data regarding the social interaction level and collaborative learning environment are seen in Figure: 3.

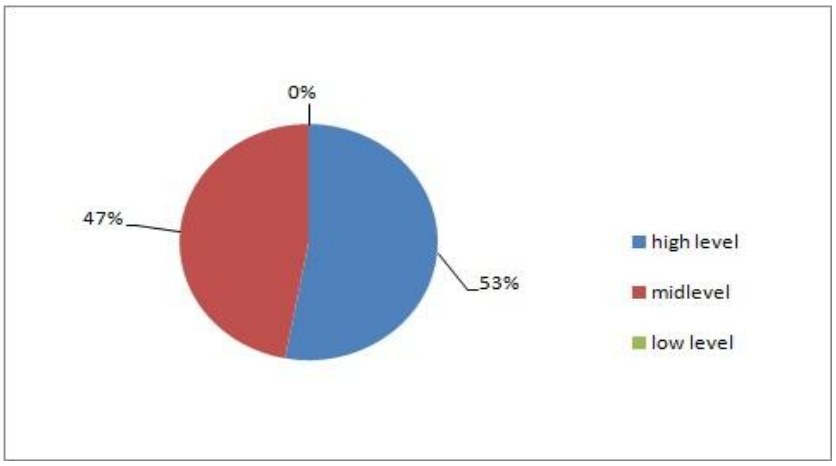

Figure: 3
The distribution of social interaction levels and the emergence of collaborative learning environment in ADFs

53% of the students participating in the questionnaire consider the social interaction level and collaborative learning level high while 47% consider them as middle level. None of the students considered the social interaction level and collaborative learning level low. The opinions of the student encoded as Stu13 are presented below regarding this item.

Stu13:" According to my viewpoint, forums have become a part of life. I use forums not only for mathematics but also for other fields and consider them as beneficial. I think, the most important advantage of forums is to be able to contact with large masses. When we take into consideration the number of members, we can easily comprehend the number of people we are interacting with. Thousands of people even tens of thousands of people can see a topic you wrote and state their opinion."

While 34% of ADF user students consider forums as something vital both in terms of removing problems and learning, 62% of them consider it as necessary and the rest 4% consider it as something unnecessary.

Findings Relating the Structural Characteristics of ADFs

ADFs are environments based on individual participants and mutual discussions. Individuals practice learning activities using these environments and play a direct role in the production of knowledge. Interaction between individuals and information sharing become possible via ADFs. Physically ADFs are based on the communication of individuals via environment while logically they are based on interaction and sharing information with each other. While an individual is writing his/her opinion in forum environment, he or she is physically interacting with the forum content. If we consider this logically, an individual who writes or reads a message in forum environment exchanges opinion with other individuals and may gain acquirements from the information there. Thereby, knowledge construction and collaborative learning occur.

When the behaviours of individuals in ADFs and their user profiles were examined, two types of usage were encountered. These are active and passive participations. Individuals may play an active role by opening topics or writing responses to the opened topics in forum environments.

In addition, a person looking for a specific subject at anytime firstly searches the forum if there is the information he or she is looking for. If he or she can attain the information thanks to pre-made discussions, he/she does not open a new topic. In this way, he/she uses the information repository created by pre-made discussions and can attain the information he/she searches for. This participation may be considered as passive participation.

DISCUSSION

In this study, learning activities relating mathematics that occur in ADFs were examined. User profiles and behaviors of the individuals using these environments were tried to be determined by means of this study.

The number of members of ADFs put subject to content analysis and the extent of the discussions in these environments are conspicuous. When these rates are taken into consideration, the extents of learning activities occurring in these environments are comprehended better. Content analysis and the opinions of the users support the idea in the literature that ADFs are used as collaborative learning instruments (Barron, 2000; Neo, 2003; Li, 2002; Lipponen, Hakkarainen, & Paavola, 2004; Dewiyanti, Brand-Gruwel, Jochems, & Broers, 2007, Wang, 2009).

Analysis of quantitative data obtained from the study reveals the attitudes and opinions of individuals towards these environments using ADFs for mathematics learning. According to the data of questionnaire study conducted with 86 students, 79% of questionnaire participant students use ADFs as mathematics learning environments, 21% of them do not use ADFs for this purpose. While 23% of ADF users do not have any forum membership, 30% of them have a forum membership and 47% of them have more than one forum membership. Participants' rates of frequencies of using ADFs for learning purposes were obtained as follows according to Figure 1: %18 almost every day; %31 2 or 3 times a week, %29 2 or 3 times a month, %22 rarely. When these findings were interpreted, we observed that 79% of students use forums as mathematics learning instrument generally. This rate can be considered as important. Similarly, 22% of questionnaire participant students stated that they use forums rarely while a big proportion of them, which make up 78% of the participants, stated that they use forums for 2 or 3 times at least in a month. When forum usage frequencies are taken into consideration, we can easily observe that students use these environments prevalently.

According to data obtained from the study, 40% of questionnaire participants stated that the rate of finding the information they need in forums is high, 54% of them considered it as a medium level while the rest 6% considered it as low. This finding indicates that individuals use ADFs at a high rate generally and their level of attaining the information is relatively good. In addition, students evaluated the contribution of information obtained from forums to learning the related topic or solving the problems as follows: 65 % of them stated that it has a great contribution; 32 % of them stated that it has a medium contribution while 3 % of them stated that it has a little contribution.

According to these findings, a considerable amount of students participating in the questionnaire accept the information obtained from these environments as useful and of service. 53% of questionnaire participants consider social interaction and collaborative learning levels of ADFs as high while 47% of them consider these levels as medium. None of the questionnaire participants considers the social interaction and collaborative learning levels of ADFs as low.

This finding is supported by the qualitative data. Both quantitative and qualitative data support the idea in the literature that ADFs have positive effects on cognitive and social developments of individuals (Li, 2002; Perez, 2005; Birch, & Volkov, 2007; Woo, & Reeves, 2007; Hrastinski, 2009; Saade, & Huang; 2009; Wang, 2010).

The opinions of individuals using ADFs as learning environments give us important information about these environments. The first one of this information is the role and place of individuals in discussions. 65% of questionnaire participants considered themselves as active participants, which means that they participate in discussion by writing, opening topics or replying the opened topics while 35% of them considered themselves as passive participants, which means they participate in discussions by reading pre-made discussions. According to Taradi and Taradi (2004), online discussion and writing are two of the most powerful and efficient ways for learning. The findings obtained from the study support this idea. It is because individuals generally stated that they can easily attain the information they need by opening topics or participating in discussions, which is active participation.

According to the analysis of qualitative data obtained from questionnaire form, the students using forums as passive users stated that the subjects in forums are enough for them to attain the information they need, therefore they do not become active users. In relation to these findings, individuals may participate in learning activities in two ways which are active or passive. Individuals play a straight role in construction of knowledge in terms of active participation. As for the passive participation, knowledge acquirement occurs thanks to pre-made discussions. Individuals socially interact and acquire knowledge with both active and passive participations. These findings support the idea in the literature that students socially interact and acquire knowledge via ADFs (Marra, Moore, & Klimczak, 2004; Moore, & Marra, 2005; Wu, & Hiltz, 2004; De Weber et al., 2006; Wang, 2008; Amhag, & Jakobsson, 2009; Klisc, McGill, & Hobbs; 2009).

CONCLUSIONS

The purpose of this study is to examine learning activities relating mathematics that occur in ADFs as computer supported collaborative learning environments. Also, the attitudes and behaviors of students using these environments as learning instruments were tried to be revealed through this study. To this end, all Turkish originated ADFs relating mathematics learning were scanned. These ADFs were put subject to content analysis. Via content analysis, learning activities in these environments and their structural characteristics were tried to be determined. Besides, a questionnaire study was conducted with 86 students in the study. Quantitative and qualitative data were obtained by means of this questionnaire. With this data, the attitudes and opinions of individuals using ADFs as learning environments were tried to be revealed.

The findings obtained from the study suggested that ADFs are important instruments for mathematics learning and that these environments are frequently used by individuals. In other words, the individuals who practice learning activities in ADF environments stated that they prevalently use these environments as learning instruments. The idea that the knowledge attained from these environments is useful and plays an important role in resolving the problem/obstacle became prominent.

The findings of the study contain many positive opinions; however they revealed some adverse opinions as well. These adverse opinions are generally about the fact that the content of ADFs is complicated. According to students who stated negative opinions, the content of some forums are complicated and there are many unnecessary dialogues in discussions.

Forum environments should be structurally more comprehendible in order to overcome this problem; also, removing unnecessary information from content may increase the productivity of these environments. Forum administrators are under big responsibilities for overcoming this problem.

In consequence, ADFs are widely used as mathematics learning instruments, provide opportunity for collaborative learning and contribute to the social interaction between individuals.

Therefore, it is suggested that these environments contribute to their social development processes in addition to cognitive development processes. Learning activities relating mathematics that occur in these environments play an important role in constructing knowledge and contributing to students' cognitive and social developments. Thus, we came to the conclusion that ADFs have positive effects on learning of the individuals.

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