THE EFFECTS OF WEB-BASED DISTANCE MATHEMATICS INSTRUCTION ON MATHEMATICS ATTITUDES AND ACHIEVEMENTS: THE CASE OF ERZURUM VOCATIONAL SCHOOL*

Serpil Hamdemirci Yorgancı[1]

ABSTRACT

This study investigated the effects of web-based distance mathematics instruction on vocational school students mathematics attitudes and achievements. The study was carried out in Erzurum Vocational School of Atatürk University during spring term of 2011-2012 academic years. The pretest–posttest control group design was used in the study. The participants were 60 freshmen students enrolled in on-campus and distance education programs at the Department of Computer Programming. Data collection tools consisted of mathematics attitude scale and achievement test. The results showed that implementation of web based mathematics instruction significantly enhanced students' attitude and achievement.

Key Words: E-Learning, Web-Based Mathematics İnstruction, Achievement, Attitudes

ÖZET

Bu çalışmada, web tabanlı matematik öğretiminin meslek yüksekokulu öğrencilerinin matematik dersine yönelik tutumlarına ve akademik başarı düzeylerine etkisi incelenmiştir. Araştırma, 2011-2012 bahar döneminde Atatürk Üniversitesi Erzurum Meslek Yüksekokulu Bilgisayar Programcılığı kampüs ve uzaktan eğitim programına kayıtlı 60 birinci sınıf öğrencisi üzerinde yürütülmüştür. Kontrol gruplu ön test son test deseninin kullanıldığı çalışmada veri toplama aracı olarak Matematik Tutum Ölçeği ve Başarı Testi kullanılmıştır. Çalışmanın sonuçları, web tabanlı matematik öğretiminin matematik dersindeki başarıyı ve matematik dersine karşı tutumu artırdığını göstermektedir.

Anahtar Kelimeler: E-Öğrenme, Web Tabanlı Matematik Öğretimi, Başarı, Tutum

INTRODUCTION

With the development of communication technologies and the changing of learning and teaching paradigms, distance learning has also entered a new era. New Internet learning environments have been developed mainly for asynchronous learning while video conferencing and satellite systems have been used for synchronous activities. All these offer means to overcome some of the shortcomings of the traditional distance-learning environment (Beyth-Marom, Chajut, Roccas & Sagiv, 2003).

According to Morgan (2001), e-learning generations are three types: First generation e-learning, where internet was simply used as a delivery mechanism and second generation e-learning, where internet was a new educational environment. Third generation e-learning, where internet based learning systems which were built on a second generation "learner in control" philosophy while incorporating high band-

[1] *Yrd.Doç.Dr. Atatürk Üniversitesi Erzurum Meslek Yüksekokulu*

width learning tools and supports such as complex simulations, virtual classrooms and other forms of "on-line" collaboration. Contemporary distance learning technology uses commonly two basic technologies, asynchronous and synchronous. Asynchronous communication commonly facilitated by media such as e-mail and discussion boards, supports work relations among learners and with teachers, even when participants cannot be online at the same time. It is thus a key component flexible e-learning. Synchronous communication commonly supported by media such as video conferencing and chat, has the potential to support e-learners in the development of learning communities. Learners and teachers experience synchronous communication as more social and avoid frustration by asking and answering questions in real time (Hrastinski, 2008).

A significant body of literature shows that asynchronous (non-live) methods are preferred much more than synchronous methods. (Dewiyanti, Brand-Gruwel, Jochems, & Broers, 2007; Hammond, 1999; Hlas, Schuh, & Alessi, 2008; Summers, Waigandth, & Whittaker, 2005; Wei & Johnes, 2005). Hammond (1999) claimed that asynchronous text based discussion offers four major benefits for learners:

- an opportunity to articulate ideas on a topic and receive feedback on one's contribution;
- an opportunity to reflect on the ideas and perspectives of others, particularly of one's peers;
- help as and when it is needed;
- a social environment which increases motivation and supports learning.

Much research has been conducted on the advantages and superiority of synchronous communication as well as asynchronous communication (Knapczyk, Frey, & Wall-Marencik, 2005; Lim, 2010; Stewart, Harlow, & DeBacco, 2011; Tucker & Neely, 2010; Vitartas, Jayne, Ellis, & Rowe, 2007). The studies indicated that synchronous communication can be used to enhance learning and teaching and promotes a real-time interaction between students and instructors. Skylar (2009) stated that advantages of using a synchronous learning environment include real time sharing of knowledge and learning and immediate access to the instructor to ask questions and receive answers. However, this type of environment requires a set date and time for meeting and this contradicts the promise of "anytime, anywhere" learning that online courses have traditionally promoted.

One of the factors affecting distance students is the need to feel they belong to the class and that they are not "distant". It is a fact that limiting the exchange of feedback to e-learning postings and discussion forums may not provide distance students with the interactive learning experience and feeling of belonging to a class they usually would get in a traditional face-to-face class. The bonding and the support between mathematical science students are an important factor in the success of some students to overcome what may appear as difficult hurdles (Amin & Li, 2010). Stahl, Wee and Looi (2011) reported that the combination of synchronous and asynchronous media—integrated through a number of tools and features—gave the students both flexibility and structure in negotiating the timing and style of their participation. The nature of the assignments and the sharing of their work encouraged creativity, peer feedback and self-reflection.

Recently a great deal of literature has focused on integrating synchronous and asynchronous technologies (Mulligan, Coll, & Corcoran, 2007; Pullen, 2006; Pullen & Snow, 2007; Scheinbuks & Piña, 2010; Stahl & Çakır, 2008). According to Pullen and Snow (2007), a synergistic combination of these two modes with in-person instruction, designed to provide maximum flexibility to the student within the constraints of the subject, offers the best support for student learning. Hrastinski (2008b) asserted that synchronous communication, as a complement to asynchronous communication, can positively affect participation in online discussion.

Synchronous Internet delivery offers improved accessibility to the student and is the simplest and least expensive to offer. Asynchronous Internet delivery provides high flexibility but interaction with the instructor and other students is poor and should be supplemented. The best way to employ these technologies is blending classroom instruction with synchronous online delivery, supporting the synchronous course with asynchronous Web-based resources, interactive tutorials, quizzes and homework, plus projects that can be completed or submitted online. Creating such a blended course, including an effective set of asynchronous supporting materials that provides strong support and good flexibility for the student, is challenging (Pullen & Snow, 2007).

The purpose of the present study was to examine the effects of web-based distance mathematics instruction with synchronous and asynchronous communication tools on vocational school students' mathematics attitudes and achievements.

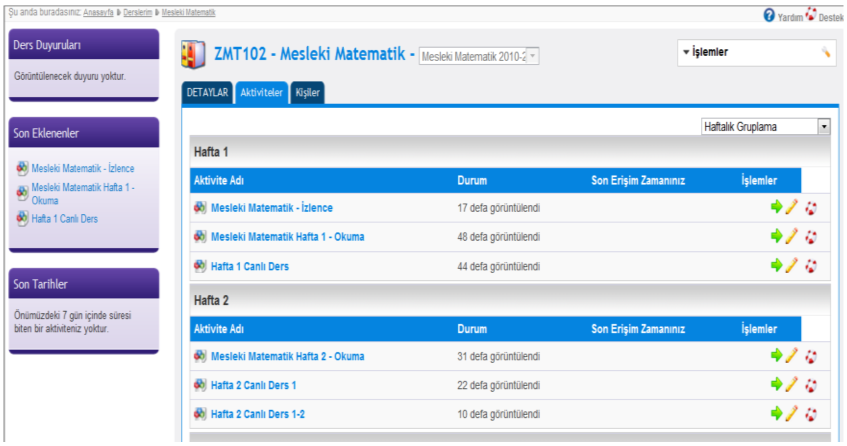
Web-Based Distance Mathematics Education At Ataturk University

Web-based distance mathematics instruction is becoming an innovative training option in many colleges and universities across the world (Alomari, 2009; Amin & Li, 2010; Ashby, Sadera, & McNary, 2011; Baki & Güveli, 2008; Javed, 2008; Loch and McDonald, 2007; Smith and Ferguson, 2004). However, there has been little empirical research published to assess the effectiveness of web-based distance mathematics instruction in associate degree. This study aimed at contributing to literature on impacts web-based distance mathematics instruction.

The Department of Computer Programming at the Ataturk University started its first distance associate degree program (Bilpro) offering in 2010-2011 academic years. The author is part of the team of the distance education program. Synchronous and asynchronous technologies are used in web-based distance education in Bilpro.

AKADEMIC LMS (ALMS) was used for asynchronous instruction, communication and interaction. All content was available for EG students in an asynchronous format and organized by weeks 1-6. Figure 1.1**,** displays an example of the asynchronous text-based lecture materials organized on ALMS.

Figure 1.1 : Example Of Asynchronous Text-Based Lecture Notes.



The synchronous software package is Adobe's Connect Professional (formerly Macromedia Breeze). As technical requirements, all computers have a web browser and the Adobe Flash® Player software. Figure 2, displays an example of a synchronous online mathematics course in Bilpro. This system is the most important field of application in online distance technology.

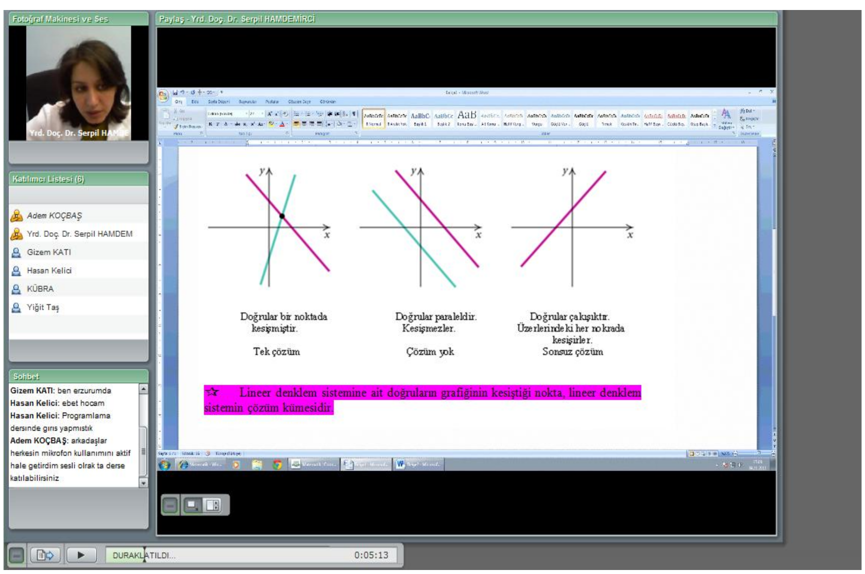
Web conferencing systems – or else, "virtual classrooms"– are the digital version of a classroom meeting; they allow a geographically dispersed group of people to "meet" synchronously online and communicate using a text chat, talk using a microphone or headset and display their face provided they have a camera connected or embedded to their computer (Almpanis, Miller, Ross, Price, & James, 2011). The main advantage of using web conferencing software is that sessions can easily be recorded. Students can re-access to almost all content given in the virtual classroom and playback the recordings for later.

The use of web conferencing to provide a more interactive learning experience for distance students is becoming more widespread. The synchronous voice, text-chat, note-taking, whiteboard, and screen-sharing functionalities provided by systems such as Adobe Connect (Adobe Systems Inc., 2010), Elluminate Live (Elluminate Inc., 2010), and WebEx (Cisco Systems Inc., 2010) provide a powerful suite of tools with which to present information, model processes, and share concepts (Bower, 2011).

One advantage web conferencing software has over many other technologies is that it provides a suite of tools within one environment. For disciplines such as mathematics and science, interactive visual and aural communication conducted from a personal computer is of significant advantage when discussing complex concepts (Loch & Reushle, 2008). However, these synchronous software packages are clearly not designed with mathematics. Adobe Connect has not mathematically oriented tools and does not include the equation editing tool. There is no graphing calculator. These deficiencies prevent us constructing the mathematically rich learning environments. The instructor should make an effort to create effective mediums for learning and teaching mathematics by using different technological tools.

For writing mathematical notation on the whiteboard there are three principal methods, all of which are useful in different circumstances. First, one can prepare mathematical material using, for example, the Beamer class in LaTeX, and convert the resulting PDF slide show to the whiteboard. MS PowerPoint may also be used. Second, one can use a mathematical typesetting system (e.g. LaTeX or MS Word) to produce mathematical notation in real time, which is then pasted onto the whiteboard. The third and most widely used method is to write on the whiteboard using a digital pen, most conveniently using a tablet PC (Mestel, Williams, Lowe, & Arrowsmith, 2011).

Figure. 1. 2: Screenshot Of Synchronous Online Mathematics Course.



METHODOLOGY

This experimental study investigated the effects of web-based distance mathematics instruction on vocational school students' mathematics attitudes and achievements. As the control and experimental groups were not formed randomly, a quasi-experimental "control group with pretest-posttest" design was employed (Karasar, 2010). Table 1. shows a graphic form of quasi-experimental design of this study. In Table 2. EG represents the experimental group while CG represents the control group. O_{MAT} – O_{MAS} represent the pretests while the posttests are represented as O_{MAT*} – O_{MAS*} for the EG and CG respectively. The web-based mathematics instruction treatment is represented as X.

Table 1. Equivalent Pretest-Posttest Control Group Design

Groups	Pre-test	X	Post-test
EG	O_{MAT} – O_{MAS}	X	O_{MAT*} – O_{MAS*}
CG	O_{MAT} – O_{MAS}		O_{MAT*} – O_{MAS*}

Students' achievement levels and attitudes were dependent variables of the study while web-based instruction was the independent variable.

SAMPLE

The sample of the study was 60 freshmen students enrolled in on-campus and distance education programs at the Erzurum Vocational School during spring term of 2011-2012 academic years. The Department of Computer Programming (distance education program, Bilpro) was defined as EG and The Department of Computer Programming (campus based education program) was defined as CG. There were thirty students enrolled in the campus based education program and thirty students enrolled in Bilpro from various locations in Turkey. Table 2. provides the demographic information about the participants.

Table 2. Age And Gender Of The Participants

Groups	Males	Females	Mean Age	Age Range
EG (n = 30)	18	12	32	18-46
CG (n = 30)	14	16	28	18-38

SETTINGS

The study lasted for fourteen weeks. The same instructor conducted both the traditional and experimental classes. The content of two groups was essentially the same with the exception that the students in EG participated web-based mathematics instruction while those in CG did not.

Distance students needed a short training on how to connect to the system and how to use the web-conferencing software. Web conferences were scheduled on Wednesday (two hour live lecture once a week). They were required to participate in weekly synchronous online lectures and to access all materials through the course management software, never meeting face-to-face.

The traditional face-to-face lecture without technology enhancement was based on giving explanation about topic, solving exercises and giving homework assignment in regular classroom environment. Traditional lectures were scheduled on Monday.

DATA COLLECTİON AND ANALYSIS

Two instruments, the Mathematics Attitude Scale and the Mathematics Achievement Test were used to collect data, these are now described in turn.

MATHEMATICS ATTITUDE SCALE

Mathematics Attitude Scale (MAS), which is used in this study, was developed by the researcher. The Cronbach's Alpha reliability coefficient of the scale was 0.88. The MAS consisting of 26 items was built of positive and negative statements related to mathematics. The items of this scale were graded with the five-item Likert scale: "I completely agree," "I generally agree," "I am undecided," "I do not agree," and "I completely disagree." (1= completely disagree and 5= completely agree). The MAS was given to students of the EG and CG at the beginning of the study as a pretest and at the end as a posttest.

MATHEMATICS ACHIEVEMENT TEST

In order to investigate whether there is a significant difference between EG and CG from the point of mathematics achievement, Mathematics Achievement Test (MAT) developed by the researcher was conducted. In the first place, the item and test statistics of the MAT were computed for reliability and validity. In order to determine reliability and validity of the MAT, an exam consisting of 45 questions was prepared with the consensus of the three experts. Item and test analysis yielded to a 25-item test. The item discrimination indices of the test (bi-serial correlation coefficients) ranged between 0.35 and 1.00 and its item difficulty indices ranged between 0.18 and 0.95. The Kuder-Richardson (KR-20) reliability coefficient of the MAT was 0.86.

The MAT was designed to collect information about students' understanding of concepts such as trigonometric functions, solving systems of linear equations, matrices and determinants. The mat included a set of multiple-choice items and open-response items and was given to students of EG and CG at the beginning of the study as a pretest and at the end as a posttest.

EG took the pretests via computer (online form) while CG used paper-and-pencil. Researches showed that the differences between online and paper-and-pencil forms for the same questionnaire are negligible (Denscombe, 2006; Leung & Kember, 2005). The posttests were administered for both groups in a paper-and-pencil format.

In the analyses of the obtained data, independent groups t-test was used in comparing the difference between the pretest mean of EG and CG. A one-way between-groups ANCOVA analysis was conducted to compare the effectiveness of instructional designs (web-based vs. traditional) on each of the dependent variable (posttest scores). SPSS for Windows 16.0 Statistics Program was used in data analyzing. The significance level was taken as 0.05.

RESULTS

Table 3.1, below presents independent samples t-tests for achievement ($t= .60$, $p > .05$) and attitude ($t=.36$, $p > .05$) in the pretest. The results indicated that these differences were not significant at all. This demonstrated that CG and EG were homogenous in terms of both variables.

Table 3.1.: Means, standard deviations and t-test results for academic achievement and attitude in the pretest

Tests	Groups	n	Posttest		Adjusted Posttest	
			M	SD	M	SE
Achievement	CG	30	44.06	11.67	43.95	1.98
	EG	30	54.76	9.77	54.52	1.98
Attitude	CG	30	60.10	11.20	59.58	0.67
	EG	30	66.30	11.82	66.81	0.67

A one-way ANCOVA was conducted to evaluate research questions. Before ANCOVA, the assumption of homogeneity of regression coefficients for achievement pretest ($F_{(1,56)}=2.57$, $p > .05$) and attitude pretest ($F_{(1,56)}=.03$, $p > .05$) was tested. In addition, the homogeneity of variance assumption was also tested. The Levene's test for achievement pretest ($F_{(1,58)} =.16$, $p > .05$) and attitude pretest ($F_{(1,58)} =1.82$, $p > .05$) was not significant. These results indicated that neither homogeneity assumption was violated. Based on these findings, it was decided that the data set was appropriate for the ANCOVA analyses. Table 3.2 shows means and standard deviations for posttest scores, and adjusted posttest scores after removing the effect of pretest scores.

Table 3.2: Means And Standard Deviations For Posttest Scores, And Adjusted Posttest Scores

Tests	Groups	n	M	SD	t	p
Achievement	CG	30	33.73	12.17	0.60	0.54
Pre-test	EG	30	32.00	9.79		
Attitude	CG	30	55.60	13.84	0.36	0.71
Pre-test	EG	30	54.27	14.35		

Table 3.3 shows that there was a significant difference between the two groups on the posttest scores both on the achievement (F=14.03, p< .05, η^2 = .20) and attitude (F=58.71, p < .05, η^2 =.50) after controlling for the respective pretest scores. These findings suggested that web-based mathematics instruction compared to traditional one produced significant effect on achievement and attitude.

Table 3. ANCOVA Results For The Posttests

Dependent Variables	Source	Sum of Squares	df	Mean Square	F	p	η^2
Achievement	Pretest (covariate)	6.62	1	6.62	.056	.81	.00
	Group	1689.60	1	1689.60	14.33	.00	.20
	Error	6718.61	57	117.87			
	Corrected Total	8442.58	59				
Attitude	Pretest (covariate)	6995.77	1	6995.77	523.84	.00	.90
	Group	784.15	1	784.15	58.71	.00	.50
	Error	761.22	57	13.35			
	Corrected Total	8333.60	59				

DISCUSSION AND CONCLUSION

The aim of this study was to find out the effects of web-based distance mathematics instruction on vocational school students' mathematics attitudes and achievements. For this purpose, two instructional methods were used: EG were instructed with fully web-based resources, while CG received the same information as EG with traditional instruction. The results of the study suggested that there was a significant difference between the effects of web-based and traditional mathematics instruction on students' attitudes and achievements. In other words, web-based mathematics instruction has a positive effect on students' attitudes and achievements.

Web-based education can be a very effective tool in enhancing students experience and raising the quality of learning. For e-learning initiatives to succeed, organizations and educational institutions have a limited understanding of the benefits and limitations of synchronous e-learning. Research can support practitioners by studying the impact of different factors on e-learning's effectiveness (Hrastinski, 2008a).

However, the existing synchronous-asynchronous communication tools have not been designed for mathematical use. According to Engelbrecht and Harding (2004), one of the biggest problems so far with developing online mathematical courses has been the difficulty of getting mathematical symbolism on the web. Optimal strategies for implementing mathematical formulae on the web are the subject of a number of projects. They state that there are a number of possibilities to consider for getting mathematics on the web involving mark-up languages such as the Mathematical Markup Language (MathML), The Mathematics Education Markup Language (MeML) and plug-ins including HotEqn, WebEQ, Livemath and MathEQ that make use of Java to represent mathematical formulae.

Leventhall (2004) points out that students and tutors discussing mathematics use a wide variety of verbal and nonverbal behaviors to convey information to their peers. These include: gestures, shared writing space and other documents, as well as the language of mathematics both spoken and written. These must be reflected in the communications areas of learning management systems if students are to learn effectively.

This study contributes to the empirical literature on the effectiveness of web-based mathematics instruction by providing a direct comparison in the Erzurum Vocational School context between web-based and classroom delivery via a naturally occurring quasi-experiment.

Although some research has been done on web-based mathematics instruction, further research should be employed to examine the value of allowing students to share their learning experiences in synchronous-asynchronous environments at all levels. Additionally, another delivery method, blended, a combination of the face-to-face and web-based format, can be used to help enhance learning experience of the vocational college students.

There are many unanswered questions related to the use of technology, both in general and in mathematics education in particular. As Kenny (2001) indicates; "A change in educational techniques is inevitable. What must be done is to figure out how and when, not if, this new combine will be incorporated into instructional designers' thinking about the current batch of students, who are steeped in exposure to new media."

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