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Message from the Editor-in-Chief

Dear Readers,

Today, technology is developing very fast around the world. This technological development (hardware and software) affects our life. There is a relationship among technology, society, culture, organization, machines, technical operation, and technical phenomenon. Educators should know this relationship because technology begins to affect teaching and learning facilities. For this reason educators are increasingly using technology in all aspects of their profession (e.g., creating curricula, classroom instruction, work assignments) This trend can be enhanced by educating the educator about cultural and cognitive aspects of technology and technikos, as well as the associated advantages and disadvantages related to educational and human development goals.

When people think of "technology," they tend to think of human artifacts such as machines, electronic devices, scientific hardware, or industrial manufacturing systems. However, a formal definition (College Dictionary) of technology indicates that it has a more general meaning which includes any "practical application of knowledge" or "manner of accomplishing a task":

DEFINITION OF "TECHNOLOGY":

1 : ***the practical application of knowledge*** especially in a particular area…

2 : ***a manner of accomplishing a task*** especially using technical processes, methods, or knowledge…

3 : the specialized aspects of a particular field of endeavor <educational technology>

Human's use of technology involves not only machines (e.g., computer hardware) and instruments, but also includes structured relations with other humans, machines, and the environment. In short, technology is more than a collection of machines and devices. To go beyond simplistic intuitions about technology requires investigation of the human mind and sociocultural environment as well as interactions with technological artifacts.

TOJET is also a technology which affects educators and education systems because it diffuses new development all around the world. It is always successful to diffuse new developments.

I am always honored to be the editor in chief of TOJET. I am always proud of TOJET for its valuable contributions to the field of educational technology.

TOJET is interested in academic articles on the issues of educational technology. The articles should talk about using educational technology in classroom, how educational technology impacts learning, and the perspectives of students, teachers, school administrators and communities on educational technology. These articles will help researchers to increase the quality of both theory and practice in the field of educational technology.

The guest editors of this issue were Cengiz Hakan AYDIN, Hasan ÇALIŞKAN and Murat ATAİZİ. TOJET thanks the guest editors and the editorial board of this issue for their valuable contributions.

Prof. Dr. Aytekin İŞMAN
Sakarya University

Message from the Guest Editor

Dear Academics and Authors,

Welcome to October 2009 issue of the Turkish Online Journal of Educational Technology. When we were asked to be the guest editors we were pleased to accept this duty. Although we had experience in editorial work we did not think of how difficult it could be. Before we get into details of the editing process and the overview of the articles accepted we would like to take this chance to mention about our two major observations in the field of educational technology.

Educational technology has always been a dynamic field of study since its early days. Not only never-ending developments in information and communication technologies but also learning more about how people learn trigger the dynamic nature of the field. This dynamism, at the same time, brings new issues into the field.

One of the significant issues is about focal point of the field and the developments in other fields, such as open and distance learning and human resources development. For some years, the field of educational technology has changed its focus on K-12 settings and moved a bit away from other settings where it was actually originated. Nowadays you see more education technology departments shifting their programs to training teachers on how to integrate technology into classrooms. Meanwhile, open and distance learning (ODL) and human resources development (HRD) fields are being recognized more as separate and mature fields of study and filling the settings where once educational technology was dominant.

Another issue is about the research and the best practices. Edutainment, virtual environments, open courseware, social networking, connected learning, Web 2.0, intelligent tutoring and many more technologies have been introduced the field for some time but not enough number of studies have been provided guidance to practice. A big majority of these studies are short term implementations and concentrate usually on perceptions or satisfactions of learners and instructors. These kinds of studies may be perfect in terms of methodology but usually lack providing guidance to practice. We strongly believe in that the research should guide the practice.

After stating two issues, we would like to express our hope that the articles included in the October 2009 issue will guide practitioners help people learn. As we have mentioned above we did have hard time to review and select the articles. We have received 29 manuscripts and asked around 50 reviewers to help us. Unfortunately we have not received enough reviews back at the first time. So, we had to find more reviewers. At the end every manuscript was reviewed by at least two experts and us.

The article by Mesut Duran, Stein Brunvand and Paul R. Fossum focused on, one of the current trends in educational technology, communities of practice. The authors conducted an exploratory study to examine the impact of a professional development program where a K-16 networked learning community approach was implemented to provide training and support for technology integration in science education. Using collaborative partnerships helped many teachers to use technology with their students and increased their motivation and enthusiasm towards technology based training. The study demonstrates that an approach to professional development that encourages networking, mutual learning, and sharing of strategies and resources among science educators is an effective strategy to improve technology integration in science education.

Critical thinking is one of those crucial topics we, as the academicians, could not provide enough guidance to the practice. Özgen Korkmaz and Ufuk Karakuş took critical thinking into consideration and studied the impact of blended learning on students' critical thinking dispositions and skills. This experimental study have shown that blending learning motivated students developing positive attitudes toward the subject area and improved their critical thinking disposition.

In another experimental study Buket Akkoyunlu and Meryem Yılmaz-Soylu investigated whether learning styles of learners have an affect on their achievement in various learning environments in which learners received the instructions in different formats (text-based, narration-based, multimedia-based). The study shown that time and place of using a certain type of media is more important than the type of media used for the design of learning environments.

The other articles focused on student teachers and technology integration in different location of the world. Timothy Teo examined the relationship between computer self-efficacy and intended uses of technology of student teachers at a teacher training institute in Singapore. He used the structural equation modelling approach and found out that student teachers' self-efficacy is a significant influence on whether they use technology in a traditionalist or constructivist way.

Another quantitative study by İsmail Şahin and Serkan Soy investigated the Turkish student teachers' pedagogical experiences in a U.S. Department of State sponsored international internship program. The program required a group of student teachers observe integration of technology with a student-centered approach into classrooms at rural Midwest high schools in USA. The study uncovered that providing the best practices about use of technology into classrooms help student teachers develop motivation to integrate technology-based student centered learning strategies into their teaching practices.

Finally, we would like to thank all the authors who submitted their manuscripts to be published in the October 2009 issue of TOJET. We strongly believe in that all the manuscripts were very beneficial for the field and should be shared with the educational technology community in different formats (article, conference paper etc.).

Cengiz Hakan AYDIN
Hasan ÇALIŞKAN
Murat ATAİZİ

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EXAMINING THE RELATIONSHIP BETWEEN STUDENT TEACHERS' SELF-EFFICACY BELIEFS AND THEIR INTENDED USES OF TECHNOLOGY FOR TEACHING: A STRUCTURAL EQUATION MODELLING APPROACH

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ABSTRACT
This study examines the relationship between computer self-efficacy and intended uses of technology of student teachers (N=1094) at a teacher training institute in Singapore. Self-efficacy was assessed by three factors: Basic Teaching Skills (BTS), Advanced Teaching Skills (ATS), and Technology for Pedagogy (TP), and intended use of technology was measured by two factors: Traditional Use of Technology (TUT) and Constructivist Use of Technology (CUT). Participants responded to a 7-point Likert-type scale for each factor. Analysis was conducted using the structural equation modelling approach and a good model fit was found for both the measurement and structural models. Results showed that significant relationships exist among BTS, TP, TUT, and CUT. However, ATS did not influence TUT and CUT in a significant way. Overall, the results of this study offer some evidence that student teachers' self-efficacy is a significant influence on whether they use technology in a traditionalist or constructivist way.

Keywords: student teachers, structural equation modelling, self-efficacy, use of technology.

INTRODUCTION

In many educational systems, teachers are expected to use ICT in their teaching (Haydn & Barton, 2008) and to act as change agents for technology integration in the schools (Zhao, Tan, & Mishra, 2001). However, technology adoption by teachers has been slow and below expectations in many parts of the world (Selwyn, 2003). This is despite evidence that suggest teachers want to teach well and are open-minded about infusing technology into their teaching (Zhao & Frank, 2004). As such, it is important to understand the factors that drive teachers' use of technology for teaching and instructional purposes. Research has found that many factors influence teachers' use of technology. Broadly, these factors arise from the external environments where the teachers work (Ertmer, 2005) or teachers' attitude towards computer use (Teo, 2008a; 2008b). However, Ertmer (2005) argued that although the environmental conditions affecting technology use, such as infrastructures to enable technology integration, have improved, how personal factors such as teachers' beliefs affect technology use in teaching, are yet to be resolved. Employing a Perceptual Control Theory (PCT) perspective, Zhao and Cziko (2001) identified one condition that is necessary for teachers to use technology to be their perceived ability and availability of resources to use technology. Also known as computer self-efficacy, teachers' judgements of their ability has been found to be a significant predictor of technology usage and intention to use technology (Teo, 2009). In other words, teachers' beliefs about using ICT play an important part in shaping their responses to instructional reforms, including technology integration (Selwyn, Dawes, & Mercer, 2001). Some examples of teachers' beliefs include their beliefs about how technology should be used in teaching and beliefs about their ability to use technology.

REVIEW OF THE LITERATURE

Uses of technology in teaching

Teachers integrate technology for teaching in different ways. Some use technology for mainly presentation purposes while others allow students to use a full range of technology resources. It is possible that teachers' use technology for instructional purposes is influenced by their beliefs about teaching and learning. As such, a teacher who believes that students learn content best through teacher-led instruction will be less inclined to encourage students to explore a technology tool for learning. This view was supported by previous research that found teachers' beliefs to have an influence on the way they organized their classrooms, interacted with students, and how they act in the classroom (Hannafin & Savenye, 1993). The strategies employed by teachers to integrate technology in the classroom were examined by Tubin (2006) who found that teachers use technology in two ways. One way is to use technology to attain the same traditional goals under the same conditions, without significant changes to the classroom activities. The second way if to use technology to expand classroom boundaries, connect students to real-world events, and guide students to become independent learners. These two ways of using technology for teaching was supported by Brawner and Allen (2006) who asked 462 students teachers how they had used technology during their internship. The authors found that the responses could be grouped according to Type 1 (drill and practice) and Type 2 (user-centred) uses of technology (Maddux, et al., 1997). Research has found a positive relationship between teachers' beliefs and uses of technology. For example, Becker (2000) found that teachers who hold constructivist beliefs about teaching are more aligned to the Type II application of computers. A study on student teachers' beliefs about teaching and learning and technology use found a positive and strong correlation between a belief in constructivist teaching and constructivist (or user-centred) use of technology (Teo, Chai, Hung, & Lee, 2008).

Computer Self-efficacy

Bandura (1986) defined self-efficacy as one's judgments of their capabilities to organize and execute courses of action in alignment with desired goals. The focus is not on the skills one has but on the judgments one has of what one can do with whatever skills one possesses. Bandura also affirmed that self-efficacy beliefs develop in response to four sources of information. Self-efficacy beliefs can be used to explain technology usage behaviours. For instance, Compeau and Higgins (1995) examined the factors that affect an individual's use of technology and found that participants with higher self-efficacy beliefs used computers more often and experienced less computer-related anxiety. Compeau and Higgins also noted that individuals with higher computer self-efficacy beliefs tend to see themselves as able to use computer technology. On the other hand, individuals with lower computer self-efficacy beliefs become more frustrated and more anxious working with computers and hesitate to use computers when they encounter obstacles.

However, few studies have investigated the nature of self-efficacy beliefs in technology for teaching (Wang, Ertmer, & Newby, 2004). An early study on self-efficacy beliefs and its relationship with technology use in teaching and learning was conducted by Enoch, Riggs, and Ellis (1993). This study focused on the development and validation of a survey instrument that would provide insight into the self- efficacy beliefs of in-service teachers toward the use of computer technology in classroom teaching practices. Later research examining self-efficacy beliefs toward technology use have focused on their influence on attitudes toward computers (Torkzadeh, Koufteros, & Pflughoeft, 2003) or intention towards use (Teo, 2009). These studies have, however, provided insight into the relationship between self-efficacy beliefs toward technology in predicting usage behaviour. Albion (1999) noted that teachers' self-efficacy or belief in their capacity to work effectively with computers was a significant factor in determining their patterns of computer use. This implied that decisions to use computers in classrooms or in schools are likely to be influenced by teacher beliefs. That is, teachers' beliefs about their ability to use computers effectively significantly influence the patterns of classroom computer usage.

PURPOSE OF THIS STUDY

While past research have supported the role of computer self-efficacy as a predictor or antecedent of computer usage or attitude towards computer use, its relationship with how technology is used (type 1 or type 2) in teaching remains unclear. The literature contains research that reveals the factors which influence teachers' technology use in education, few have examined the ways in which teachers use technology in teaching. The purpose of this study is to examine the relationship between student teachers' self-efficacy beliefs and their intended use of technology for teaching. Figure 1 shows the research model. In the model, teachers' self-efficacy beliefs are hypothesized to comprise three beliefs: beliefs in their (1) Basic Technology Skills, (2) Advanced Technology Skills, and (3) Technology for Pedagogy. The intended uses of technology for teaching are organised according to the Type 1 and Type 2 uses of technology as mentioned above. In this study, Type 1 (drill & practice) is denoted as Traditional Use of Technology (TUT) and Type 2 (user-centred) denoted as Constructivist Use of Technology (CUT). Implicit in figure 1 are six hypotheses:

H1: Student teachers' beliefs in their basic technology skills (BTS) will significantly influence their use of technology for teaching in a traditional way (TUT).
H2: Student teachers' beliefs in their basic technology skills (BTS) will significantly influence their use of technology for teaching in a constructivist way (CUT).
H3: Student teachers' beliefs in their advanced technology skills (ATS) will significantly influence their use of technology for teaching in a traditional way (TUT).
H4: Student teachers' beliefs in their advanced technology skills (ATS) will significantly influence their use of technology for teaching in a constructivist way (CUT).
H5: Student teachers' beliefs in their ability to use technology for pedagogy (TP) will significantly influence their use of technology for teaching in a traditional way (TUT).
H6: Student teachers' beliefs in their ability to use technology for pedagogy (TP) will significantly influence their use of technology for teaching in a constructivist way (CUT)

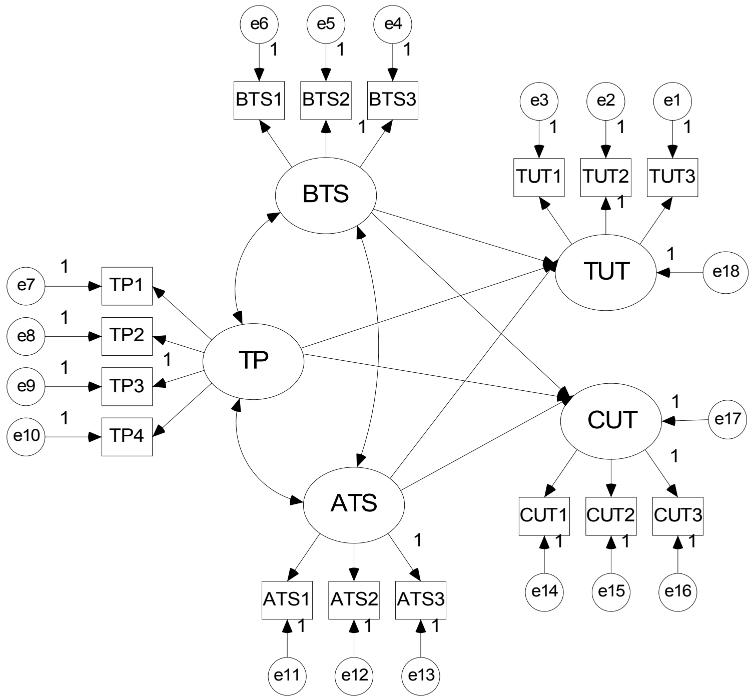

Figure 1: Research Model

METHODOLOGY

Research Design

This study employs a structural equation modelling (SEM) approach to analyze the relationship between student teachers' self-reported self-efficacy beliefs and use of ICT in teaching. Data was collected through a survey questionnaire comprising questions on demographics and multiple items for each construct in the study. Normal procedures for SEM analysis were applied in this study. Data were screened for missing data and outliers. This was followed by establishing the convergent and discriminant validities of the data. To obtain reliable results in structural equation modelling, researchers recommend that a sample size of 100 to 150 cases (e.g. Kline, 2005). In addition, Hoelter (1983) critical N, which refers to the sample size for which one would accept the hypothesis that the proposed research model is correct at the .05 level of significance, was examined. The Hoelter critical N for the model in this study is 199, and given the sample size of this study is 547 for both the model development and validation samples, they are considered adequate for the purpose of structural equation modelling.

Research Participants and Data Collection

Participation in this study was voluntary and 1094 student teachers were recruited. These were student teachers enrolled in either the one-year Postgraduate Diploma in Education (PGDE) (n=708, 64.7%) or the two-year Diploma in Education programme (n=486, 35.3%) at the National Institute of Education (NIE) in Singapore. The participants in this study represent about 90% of the population in each programme. They responded to an invitation issued by the author and those who agreed to take part in this study were given a website address to access the survey questionnaire. The mean age of all participants was 25.8 (SD=5.15). All participants were briefed on the purpose of this study and told of their rights to withhold their participation during or after they had completed the questionnaire. No course credit or reward was given to the participants who, on average, took not more than 10 minutes to complete the questionnaire. In structural equation modelling, it is recommended that proposed models be validated with another sample that is not used in the initial model development (Schumacker & Lomax, 2004). For this reason, the sample of this study (n=1094) was randomly split into two (n=547). However, the ratio of participants in the two programmes was retained to ensure that the characteristics of both samples remain similar.

Measures

A 16-item survey questionnaire was developed to measure participants' self-efficacy and uses of technology, in addition to demographic information. The scale for self-efficacy beliefs include three constructs: Basic Technology skills (BTS) (three items), Advanced Technology Skills (ATS) (three items), and Technology for

Pedagogy (TP) (four items). The scale for uses of technology includes Traditional Use of Technology (TUT) (three items) and Constructivist Use of Technology (CUT) (three items). The items in this survey reflect the use of specific technology tools or actual use of technology for instructional purposes. Examples of self-efficacy items include "I am able to use the internet to search for information and resources" and "I am able to use digital media collection tools (e.g., digital camera, digital video camera) for teaching or administration purposes".

The items that measure uses of technology include **"**In my lessons, I would teach my students to use ICT to "find out ideas and information" and "Communicate electronically with other people." Relative to the computer self-efficacy scales that are found in the literature (e.g. Murphy et al., 1989), this author has chosen to include the actual technology tools (e.g. powerpoint) and situations (e.g. "to use ICT to express themselves in writing") in the questionnaire items with a view to allow participants to take reference from their personal experiences when responding to these items. In addition, as a faculty member in the institutions where the participants in this study was selected, this author has a good understanding of the technology tools that students are exposed to. Each item was measured on a seven-point Likert scale with 1=strongly disagree to 7=strongly agree. A total of 10 items were used to measure self-efficacy and 6 items to measure the use of ICT in teaching. These items are listed in the Appendix.

RESULTS

Analysis of the measurement model

The research model in this study was tested using the structural equation model approach, using AMOS 7.0 (Arbuckle, 2006) and the parameters were estimated using the Maximum Likelihood (ML) estimator. Data was tested for reliability and validity using confirmatory factor analysis (CFA). The model in this study includes 16 items loading on five constructs. To establish the reliability, convergent and discriminant validities of the constructs in this study were measured.

Following the recommendations from the literature, the item reliability of each measure, composite reliability of each construct, and the average variance extracted were computed. To examine the reliability of each item, Hair, Black, Babin, Anderson, & Tatham (2006) recommended a factor loading of .70 and the R^2 value to be at least 0.50. At the construct level, composite reliability was used instead of the Cronbach's alpha as the latter tends to understate reliability. For composite reliability to be adequate, a value of .70 and higher was recommended (Hair et al.). Finally, the average variance extracted (AVE) was computed as a measure the overall amount of variance that is attributed to the construct in relation to the amount of variance attributable to measurement error. Convergent validity is judged to be adequate when average variance extracted equals or exceeds 0.50, when the variance captured by the construct exceeds the variance due to measurement error (Hair et al.). Table 1 shows the result of the analysis of the measurement model. All values, except the R^2 for item TUT3, appear to provide support for convergent validity. Because the other values for TUT3 are acceptable, it was not removed from further analyses.

Table 1: Results for the measurement model

Latent Variable	Item	FL[a] (> .70)*	SE	t-value[b]	[c]R^2 (=> .50)*	CR[d] (=> .70)*	AVE[e] (=> .50)*
Basic Technology Skill						.89	.74
	BTS1	.831	.938	22.036	.627		
	BTS2	.904	.844	26.407	.879		
	BTS3	.840	.890	---[f]	.713		
Advanced Technology Skill						.89	.73
	ATS1	.878	.822	20.038	.676		
	ATS2	.798	.712	17.616	.507		
	ATS3	.892	.890	---[f]	.792		
Technology for Pedagogy						.88	.65
	TP1	.752	.783	19.063	.612		
	TP2	.836	.892	21.740	.795		
	TP3	.839	.780	---[f]	.609		
	TP4	.783	.729	17.535	.531		
Traditional Use of Technology						.86	.67
	TUT1	.836	.808	18.559	.652		
	TUT2	.849	.886	---[f]	.786		
	TUT3	.762	.614	14.394	.377		
Constructivist Use of Technology						.89	.73
	CUT1	.877	.883	23.169	.697		
	CUT2	.830	.824	23.550	.679		
	CUT3	.848	.835	---[f]	.780		

SE: Standardised Estimate
*Indicates an acceptable level of reliability or validity.
[a] Factor Loading
[b] Known as a *critical value*, this value tests whether a parameter is significantly different from zero. All values were significant at $p < .01$
[c] This represents the proportion of variance in the latent variable that explained by this item.
[d] Composite Reliability= $(\sum\lambda)^2/(\sum\lambda)^2+(\sum(1-\lambda^2))$
[e] AVE: Average Variance Extracted=$(\sum\lambda^2)$ / n
[f] This value was fixed at 1.00 in the model for estimation purposes.

Discriminant validity is present when the variance shared between a construct and any other construct in the model is less than the variance that construct shares with its indicators (Fornell et al., 1982). Discriminant validity was assessed by comparing the square root of the average variance extracted for a given construct with the correlations between that construct and all other constructs. If the square roots of the AVEs are greater than the off-diagonal elements in the corresponding rows and columns, it suggests that the given construct is more strongly correlated with its indicators than with the other constructs in the model. In Table 2, the diagonal elements in the correlation matrix have been replaced by the square roots of the average variance extracted. The values suggest that discriminant validity was present at the construct level or all the variables in the research model. From the information given in tables 1 and 2, the data obtained in this appear to be reliable and valid for the purpose of structural equation modelling.

Table 2: Discriminant validity for the measurement model

Construct	BTS	ATS	TP	TUT	CUT
BTS	(.86)				
ATS	.16**	(.85)			
TP	.45**	.39**	(.81)		
TUT	.25**	.09*	.28**	(.82)	
CUT	.39**	.05	.28**	.47**	(.85)

Notes:
(1) *p< .05; **p< .01
(2) Diagonal in parentheses: square root of average variance extracted from observed variables (items);
Off-diagonal: correlations between constructs

In testing for model fit, it is usual to use variety of fit indices. Hair et al. (2006) suggested using fit indices from various categories: absolute fit indices that measure how well the proposed model reproduces the observed data, parsimonious indices that is similar to the absolute fit indices but take into account the model's complexity, and incremental fit indices that assess how well a specified model fit relative to an alternative baseline model. In this study, Tucker-Lewis index (TLI), comparative fit index (CFI), root mean square error of approximation (RMSEA), and standardized root mean residual (SRMR) will be used. Because the χ^2 has been found to be too sensitive to an increase in sample size and the number of observed variables (Hair et al. 2006), the ratio of χ^2 to its degree of freedom (χ^2/df), was used, with a range of not more than 3.0 being indicative of an acceptable fit between the hypothetical model and the sample data (Carmines & McIver, 1981).

As part of confirmatory factor analysis, several models were computed to allow comparisons of different conceptualization of the factor structure to be made. First, a null model that assumes all the factors to be unrelated. Second, a one-factor model that tests whether all the factors load on one overall factor. Support for the one-factor model suggests that participants do not differentiate among the factors and that all items are representative of a unidimensional construct. Third, an uncorrelated factor model that tests whether all the five factors in the model are independent. Support for this suggests that these five factors are not related to one another and are indeed five different constructs. Fourth, a correlated factor model that tests whether the five factors are related to one another. Support for this model indicates that participants had discriminated between the five factors but they are intercorrelated with one another. Fifth, a hierarchical model that tests the idea that a second-order factor exist to account for the relationships among the five factors. Support for this model suggests that while all five factors are related, they are also related to a higher order factor. A series of CFA were conducted to test the five models described above. Table 3 shows the fit indices for each model. Results indicate that the correlated model has the best fit and on this basis, it was the retained as the model of best fit.

Table 3: Confirmatory Factor Analysis of alternative models

Model	χ^2	df	χ^2/df	TLI	CFI	RMSEA	SRMR
Null	5119.895*	120	42.666	---	---	.276	---
One-factor	2990.197*	104	28.759	.334	.423	.225	.164
Uncorrelated factor	775.563*	104	7.457	.845	.866	.109	.218
Correlated factor	323.622*	94	3.443	.941	.954	.067	.049
Hierarchical	420.979*	99	4.252	.922	.936	.077	.084

*p <.001

Analysis of the structural model

The same fit indices used for testing the measurement model are applied to the structural model. Table 4 shows the level of acceptable fit and the fit indices for the proposed research model in this study. Except for the χ^2, all values satisfied the recommended level of acceptable fit. The results of the model fit for both the initial and validation samples are listed in Table 3, indicating that the research model has a good fit.

Table 4: Good-of-Fit measures

Model fit index	Initial Sample (n=547)	Validation Sample (n=547)	Acceptable fit*
χ2	247.669, p < .001	217.273, p < .001	Non-significant
χ2 /df	2.752	2.414	< 3
TLI	.958	.971	=> .95
CFI	.968	.978	=> .95
RMSEA	.057 (.048, .065)	.051 (.042,.060)	< .08
SRMR	.048	.043	< .05

*References were taken from: Hair et al., 2006; Kline, 2005; McDonald & Ho, 2002, Browne & Cudeck, 1983.

Hypothesis testing

Table 5 shows the results of the hypothesis test and path coefficients of the proposed research model. All hypotheses, except H3 and H4 were supported by the data. The hypotheses relating the BTS and TP (H1, H2, H3, and H4) were significant. Two endogenous variables were tested in the research model. Traditional use of technology (TUT) was found to be predicted by BTS and TP, resulting in an R^2 of 0.129. This means that BTS and TP explained 12.9 percent of the variance in TUT. The variance in constructivist use of technology (CUT) was explained by BTP and TP in amount of 21.5%.

Table 5: Hypothesis testing results

Hypotheses	Path	Path coefficient	t- value	Results
H1	BTS → TUT	.169	3.017*	Supported
H2	BTS → CUT	.353	6.563*	Supported
H3	ATS → TUT	-.044	-.858	Rejected
H4	ATS → CUT	-.074	-1.532	Rejected
H5	TP → TUT	.253	4.070*	Supported
H6	TP → CUT	.185	3.183*	Supported

* $p < .001$

DISCUSSION

The aim of this study is to examine the relationship between student teachers' self-efficacy beliefs and their intended use of technology for teaching. Using structural equation modelling, the results show that four out of six hypotheses were support. Student teachers' perception of their basic technology skills and ability to use technology for pedagogy were significant predictors of their intention to use in either a traditional (i.e. drill and practice) or constructivist (i.e. student-centred) way. However, student teachers' perception of their advanced technology was not significant influences of their intended uses of technology.

While teachers' perception of their ability has been shown to affect their technology usage, this study goes a step further to examine the relationship between perceived ability and ways in which technology will be used in the classroom. It is possible that the student teachers did not perceive the advanced technology skills as important relative to the basic technology skills for use in teaching. This is supported by the weak correlation between ATS and TUT and CUT (Table 2). In contrast, basic technology skills and technology for pedagogy are significantly correlated with TUT and CUT with effect sizes greater that that between ATS with TUT and CUT. However, it should be noted that ATS correlated significantly with BTS and TP.

The results of this study also show that a significant correlation exists between TUT and CUT. This suggests that the student teachers in this study do not view the two uses of technology in teaching (type 1 and type 2) as separate but complementary. The connection between traditional and constructivist beliefs held by student teachers and how these beliefs influence their uses of technology was examined by Author, Chai, Hung, and Lee (2008) who found that traditional and constructivist uses of technology for teaching has a positive significant relationship (r= .771). The profile of the sample in Author et al. study was similar to the one used in this study.

This study contributes to theory by highlighting the relationship between teachers' beliefs about their ability to use technology and how they would use technology in teaching. In an age where many education systems advocate the use of technology in a more constructivist and learner-centred way, it is important to understand the drivers that motivate teachers to move in this direction. This study provides empirical evidence for a significant relationship between the perception of one's ability to use technology and how a person plans to use technology in teaching. This study also contributes methodologically by using items that require the participants to respond to the use of actual tools ("I am able to use word processor to create, edit and format documents for specific purposes (e.g. Microsoft Word)" and situations where technology are used (In my lesson, I use technology to teach my student to work collaboratively). In contrast, many studies on self-efficacy had employed scale items that were worded in very general terms (e.g., I could complete a job or task using the computer if I could call someone for help if I got stuck.).

LIMITATIONS OF THE STUDY

Although the use of self-reports to collect data has benefits, it may lead to the common method variance, a situation that may inflate the true associations between variables. Next, using students teachers may not present the true picture of the association among the variables examined in this study. This is because the experiences of the student teachers in using technology may use may differ from that of the practicing teachers. It is also possible that student teachers engage in more volitional uses of technology than the practicing teachers, and such opportunities to exercise one's volition in sing technology may have shaped their self-efficacy beliefs. Finally, the variance of the dependent variables, TUT and CUT, were explained by the BTS, ATS, and TP by a mere 12.9%, and 21.5% respectively. In pursuing model parsimony, it is possible that other significant variables that may impact significantly on student teachers' intended uses of technology have been excluded.

IMPLICATIONS FOR PRACTICE

The results of this study suggest that teacher educators and administrators should place emphasis on building student teachers' perception of their ability to use technology with a view to transform classroom practices. In order to encourage teachers and teacher-to-be to integrate technology into teaching and learning, teacher educators need to ensure that opportunities are given the former to acquire basic technology skills such as the use of presentation and word processing tools and at the same time, organize courses on the strategies to infuse technology for pedagogical purposes. For example, Yuen, Law, & Chan (1999) found that, in order for teachers to facilitate and adjust their instructional strategies that will optimize their students' learning, they need to be provided with the relevant skills and possess successful experiences in technology use at the teacher training stage. Finally, bbecause perceptions do not remain static, student teachers who perceive themselves as adept users of technology may soon experience limitations if they do not keep abreast with advances in the technologies relevant to them. In the case of in-service teachers, they may soon develop feelings of insecurity when they students, who might mostly be digital natives, appear to be more technologically savvy than them (Sugar, Crawley, & Fine, 2004). From the perspective of self-efficacy, it is possible that teachers, who are surrounded by effective support structures that provide them with successful experiences in technology, would develop more positive judgments about their ability to use technology for teaching. Over time, such feeling of being able to use technology may motivate the teacher to apply technology in ways that are described in this study as traditional or constructivist uses of technology. Finally, the role of teacher education to ensure timely and effective integration cannot be over-stated. Teachers must not only be able to use the technology of the day but be prepared to handle tools of the future (Hunt, 1997).

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APPENDIX

List of items used in this study

Item No.	Item
BTS1	I am able to use the internet to search for information and resources
BTS2	I am able to use word processor to create, edit and format documents for specific purposes. (e.g. Microsoft Word)
BTS3	I am able to use Presentation Software (e.g. Microsoft Powerpoint) for classroom delivery
ATS1	I am able to use website Editors (e.g. Microsoft FrontPage, Macromedia Dreamweaver) to create and/or modify web pages.
ATS2	I am able to use video editing software (e.g. Microsoft MovieMaker, Adobe Premier, Ulead VideoStudio)
ATS3	I am able to use animation software (e.g. Macromedia Flash, Authorware, Director) to create animations.
TP1	I search, evaluate and select appropriate IT resources to support lesson activities
TP2	I am able to adopt and adapt given IT-based learning activities.
TP3	I can manage IT-based learning activities in a computer laboratory.
TP4	I am able to adopt and adapt activities that incorporate the use of IT to assess pupils' learning and provide immediate and constructive feedback
In my lesson, I use technology to teach my student to …	
TUT1	Master skills just taught.
TUT2	Remediate of skills not learned well.
TUT3	Practice on multiple choice questions
CUT1	work collaboratively.
CUT2	work independently.
CUT3	find out ideas and information.

EXPERIENCES OF TURKISH STUDENT TEACHERS IN PEDAGOGY AND EDUCATIONAL TECHNOLOGY DURING AN INTERNSHIP PROGRAM IN THE US

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ABSTRACT
This quantitative research study was conducted to examine technological and pedagogical experiences of Turkish student teachers in a US Department of State sponsored international internship program. The internship program had a specific emphasis on student-centered teaching and technology integration. Turkish interns completed a 6-week teaching internship at rural Midwest high schools. The main objective of the internship program was to promote professional, cultural, and personal development of the Turkish pre-service teachers. The findings of the current study suggested that the Turkish student teachers had the opportunity to observe the professional and educational applications of computer technologies during their internship program.

Especially, those who reported to have student-centered teaching methodology, expertise in computer use, and a high level of technology integration in their teaching expressed more positive attitudes toward using computer applications for instructional purposes. Also, these student teachers reported to have observed instructional computer use by the mentor teacher, effective student learning, and a variety of teaching strategies more frequently.

Keywords: Turkish Student Teachers, Internship Program

INTRODUCTION

We have witnessed a wide spread of digital technologies in the schools over the last two decades. Among a number of developed countries, U.S. is leading these efforts and many developing countries are trying not to fall behind in providing cutting-edge educational opportunities for their youth. Some scholars suggested that the efforts to equip every classroom with computers are not justified because the technology is highly overrated as a tool to help make a difference in educating the young minds (Cuban, 2001; Postman, 1995). However, others suggested that technology could be an effective cognitive tool for learning when certain conditions are met (Becker & Ravitz, 2001; Jonassen, 1996; Mishra & Koehler, 2006).

As Becker & Ravitz pointed out, to make the technology effective tool for learning, the teachers themselves must have proficiency in using technology, have access to a reasonable number of (5 to 8) computers in their classroom, and "believe more strongly in a constructivist pedagogy that attends to making learning activities meaningful to students (rather than just transmitting content)" (Becker & Ravitz, 2001). Constructivism, a contemporary teaching philosophy, maintains that the students should no longer be the passive recipient of information but they should in fact be actively involved in constructing knowledge. Jonnasen (1996) argued that the technology should be used as a tool to learn with as opposed to using it as a teaching tool to learn from. This requires students to be in the center of learning while designing artifacts or manipulating information with technological tools. Mishra & Koehler (2006) further suggested that for an effective technology integration to occur in the classroom, teachers need to posses the knowledge of content, pedagogy, and technology.

International Student Teacher Internship Project

Parallel to rapid innovations in communication, travel and transportation technologies, the world has shrunk in an incredible size and people of the world have come into contact in many different ways as never seen before. In this fast changing world, people need to understand their own culture in a larger context of a global society and establish common understandings along which they can create mutual respect and appreciation towards each others' cultures. With similar concerns a unique international internship project called Turkish Student Teacher Internship Project, funded by U.S. Department of State, came to light.

At the core of this eight-week long project was a six-week teaching internship in an area high-school in Central Iowa. Two Turkish interns were paired with a mentor teacher who was selected for excellence as a teacher and the ability to work with and guide novice teachers. The mentor arranged activities for the students, including observation of classes (both the mentor's and other teachers' classes), introduced the students to the school community, and helped them begin teaching–first by observing, then by assisting the mentor, and finally by taking more and more responsibility for teaching until they were teaching independently with full responsibility for lesson planning as well as teaching the class. The project had a specific focus on technology integration. In addition to mentor teachers support and guidance interns also participated in technology and content seminars at a large Mid-western university to learn more about current theoretical and pedagogical approaches in using technology in the classroom as well as effective teaching techniques in their respective content areas.

Purpose of the Study

As the internship program involved crucial elements of an effective professional development such as one-on-one mentoring, technical and pedagogical help and support, we wanted to investigate how international student-teaching experience contributed to Turkish student teachers' professional, technological, and pedagogical development. This study addressed the following research questions:

1. In the internship classrooms, how do Turkish student teachers' experiences in the following areas related to each other: personal computer use, use of computer technologies in the classrooms, instructional techniques, their perception of students' learning experiences, and instructional strategies?

2. How do Turkish student teachers' experiences vary according to their teaching methodology, computer proficiency level, and process of computer technology integration in education?

METHODOLOGY

This quantitative research study was conducted to examine technological and pedagogical experiences of Turkish student teachers in a US Department of State sponsored international internship program. In this section of the paper, the participants, instruments, procedures and data analysis of the study were explained.

Participants

Participants of the study were Turkish student teachers who took part in an international internship project in 2005 and 2006. The population for this study consisted of the total of 61 participants who completed their internship in the US. Of the participants, 80% were female (n = 49) and 20% male (n = 12). The average age of the participants was 24 years old. 46% were the first-year participants (n = 28) and 54% the second-year participants (n = 33). The student teachers were specializing in five different subject areas: Turkish language and literature, history, biology, mathematics, and English language and literature.

As presented in Table 1, all majors had enough representatives in this study but mathematics was the most representative major (n = 15) among the subject areas. The majority of the participants described their teaching methodology as evenly-balanced between teacher-directed and student-centered (n = 27). 28 participants reported their computer proficiency level as "advanced", 23 as "average," seven as "expert," and three as "beginner." Turkish students' responses were distributed across the following stages related to the process of integrating computer technology in teaching activities: creative application (n = 25), adaptation (n = 18), familiarity (n = 15), and learning (n = 2).

Table 1: Participant Demographics

Survey Item	Option	Frequency	Percent
Subject Area	Biology	14	23.0
	English Lang. &Lit.	13	21.3
	History	9	14.8
	Mathematics	15	24.6
	Turkish Lang. &Lit.	10	16.4
Teaching Methodology	More teacher-directed than student-centered	3	4.9
	Even balance between teacher-directed and student-centered	27	44.3
	More student-centered than teacher-directed	15	24.6
	Largely student-centered	16	26.2
Computer Proficiency Level	Beginner	3	4.9
	Average	23	37.7
	Advanced	28	45.9
	Expert	7	11.5
Process of Integration	Learning	2	3.3
	Familiarity	15	24.6

	Adaptation	18	29.5
	Creative Application	25	41.0

Instruments and Procedures

The survey was administered to the Turkish students at the end of their internship. Data were collected from two consecutive years of their participating in the project. The instrument for the data collection was a survey that was originally developed by the Centre for the Study of Learning and Performance (CSLP) at Concordia University, Canada (2007). The survey consisted of six sections:

> *Section 1:* Participant demographics contained items regarding gender, age, subject area, teaching style, perceived computer proficiency level, and process of integration.
> *Section 2:* The second section consisted of items regarding computer use in general and in education. A five-point Likert-type set of alternatives ranging from "*1=strongly disagree*" to "*5= strongly agree*" was used. Higher scores in this subscale indicated more positive attitudes toward personal and educational computer use.
> *Section 3:* In this section, the participants indicated that during their internship, how frequently computer technologies were integrated into teaching activities. A five-point Likert-type set of choices ranging from "*1=never*" to "*5=always*" was used to measure the frequency level of computer use in the class. Higher scores reflected more frequently uses of computer technologies for instructional purposes.
> *Section 4:* In this section, the participants reported how often the listed instructional techniques were used during their internship. A five-point Likert-type set of alternatives ranging from "*1=never*" to "*5=very often*" was used. Higher scores indicated more frequent use of the instructional techniques in the class.
> *Section 5:* This section included items regarding the participants' perception of high school students' learning experiences. A five-point Likert-type set of choices ranging from "*1= strongly disagree*" to "*5= strongly agree*" was used. Higher scores reflected stronger opinions regarding student learning experiences in the class.
> *Section 6:* The last section contained items to find out how often the mentor teacher used the listed teaching strategies during their internship. A five-point Likert-type set of alternatives ranging from "*1= never*" to "*5= very often*" was used. Higher scores indicated more frequent use of the teaching strategies in the class.

Data Analysis

In this study, descriptive statistics and correlation analysis were used. Reliability analysis, which assesses the internal consistency among sets of survey items (Mertler & Vannatta, 2002), was employed to measure the reliability of each section of the survey. Cronbach's alpha value, usually ranging from 0 to 1, was used to report the reliability. One-way analysis of variance (ANOVA) was used to test the difference between the participants' teaching style, perceived computer proficiency level, and process of integration. Statistical analyses were conducted using SPSS (Statistical Package for Social Sciences) 13.0 software.

RESULTS

Turkish Student Teachers' Experiences in Pedagogy and Technology

The first research question investigated the relationship between student teachers' experiences in the five categories: personal computer use, computer use for instructional purposes, instructional techniques, their perception of high school students' learning experiences, and instructional strategies used in internship classrooms. Before reporting on the relationship between those categories, it would be helpful to discuss the mean score for each section, which were provided in Table 2. The highest mean score indicated that Turkish students had positive attitudes toward computer use (M=4.30). Also, the participants stated higher levels of perceived student learning experiences (M=3.97) during their internship. Overall, higher uses of computers for instructional purposes (M=3.78), different instructional techniques (M=3.46), and a variety of teaching strategies (M=3.86) were reported by Turkish students. The data analysis suggested that the student teachers gained and observed a high level of learning experiences during their internship.

Table 2: Correlations between Variables used in the Study

Variable	1	2	3	4	5
1. Personal Computer Use	-				
2. Instructional Computer Use	0.61**	-			
3. Instructional Techniques	0.49**	0.58**	-		
4. Perceived Student Learning Experiences	0.47**	0.61**	0.72**	-	
5. Teaching Strategies	0.47**	0.58**	0.64**	0.63**	-

Mean	4.30	3.78	3.46	3.97	3.86
Std. Dev.	0.49	1.07	0.64	0.77	0.75
Std. Item Alpha	0.72	0.90	0.64	0.93	0.79

*: p<0.05; **: p<0.01

It was found that there was a strong positive relationship between those five categories based on Turkish student teachers' observations during their internship experience. For instance, the highest correlation was found between instructional techniques and perceived student learning experiences. This result suggested that the students whose teachers used a variety of instructional techniques frequently had a high level of learning outcomes. In the correlation analysis, the second strongest relationship was between instructional techniques and teaching strategies. This result showed that the mentor teachers who used different instructional techniques more also used a variety of teaching strategies more. Similar to these findings, all other correlations among the variables were high and statistically significant. In addition, the results of the reliability analyses showed that the value of the Cronbach standardized item alpha for each section of the survey was either moderate or high, confirming the reliability of the instrument.

Turkish Student Teachers' Experiences based on Teaching Methodology, Computer Proficiency Level, and Process of Instructional Computer Use

The second research question addressed the difference between student teachers' experiences based on teaching methodology, computer proficiency level, and process of computer technology integration in education. Using one-way ANOVA, the variables were examined based on the participants' teaching methodology, computer proficiency level and process of computer technology integration in education (see Table 3).

Table 3. ANOVA F-Scores for Difference between Teaching Methodology, Computer Proficiency and Process of Integration

Variable	Teaching Methodology *F*	Computer Proficiency Level *F*	Process of Integration *F*
1. Personal Computer Use	3.22*	5.35**	3.79*
2. Instructional Computer Use	3.42*	6.15**	2.09
3. Instructional Techniques	1.58	2.30	1.99
4. Perceived Student Learning Experiences	3.31*	6.48**	1.03
5. Teaching Strategies	0.95	3.14*	1.62

*: $p < 0.05$; **: $p < 0.01$

The participants who had a largely-student centered teaching methodology had more positive attitudes toward personal computer use. Similarly, the participants who had a more student-centered than teacher-directed teaching approach reported a higher level of instructional computer use by the mentor teacher and student learning outcomes during their internship. Secondly, the participants who were experts in computer use reported more positive attitudes toward personal use of computers. They also observed a higher level of instructional computer use by the mentor teacher, student learning outcomes, and use of different teaching strategies during their internship. Finally, the participants who integrated creative computer applications into teaching stated more positive attitudes toward personal computer use.

CONCLUSIONS

The findings from the current study showed that the Turkish student teachers' experiences in the following categories were all related to each other: personal computer use, computer use for instructional purposes, instructional techniques, their perception of high school students' learning experiences, and instructional strategies used in internship classrooms. The high and statistically significant correlations between and the high mean scores for these variables suggested that the Turkish student teachers had the opportunity to observe the professional and educational applications of computer technologies in education during their internship program. Especially, the ones who had student-centered teaching methodology, expertise in computer use, and a high level of integrating instructional computer technologies in education reported more positive attitudes toward using computer applications for instructional purposes. These participants were also the ones who observed better instructional computer use by the mentor teacher, higher student learning outcomes, and a variety of teaching strategies.

These results suggest that increasing the student teachers' knowledge in constructivist learning approach, computer expertise, and educational technology integration might positively affect their attitudes toward instructional computer applications. Thus, it is crucial that they have the knowledge before starting their internship. Also, it is important to highlight that the knowledge might better help them get benefit from the internship by observing the learning and teaching activities along with instructional computer use.

The findings show that the internship program is a successful attempt to reach the desired change in pedagogy and educational technology use. Although the evaluation of the effectiveness of the project is not the purpose of this study, the findings show that the project contributes substantially to the change process of the professional and pedagogical development of Turkish student teachers. It is clear that the project provided student teachers with experiences that fostered their information technology skills by observing successful uses of technology.

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PREPARING SCIENCE TEACHERS TO TEACH WITH TECHNOLOGY: EXPLORING A K-16 NETWORKED LEARNING COMMUNITY APPROACH

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ABSTRACT
This exploratory study examines the impact of a professional development program where a K-16 networked learning community approach was implemented to provide training and support for technology integration in science education. The study presents findings from a three-year project with five cohort groups that included 17 student teachers, 17 cooperating teachers, 5 university-level faculty, and 3 student teaching supervisors. Data were collected from pre and post surveys, journal entries, participant observations, and electronic portfolios. Findings indicate that over the course of the program the project participants significantly increased their confidence and competence to integrate technology into the teaching and learning process. Technology-integrated lessons developed by the project participants included the use of a variety of advanced technology tools to facilitate learning in science. Using collaborative partnerships helped many teachers to use technology with their students and increased their motivation and enthusiasm towards technology based training. The study demonstrates that an approach to professional development that encourages networking, mutual learning, and sharing of strategies and resources among science educators is an effective strategy to improve technology integration in science education.

Keywords: Teacher education; Teacher preparation; Professional development; Learning communities; Networked learning communities; Science education; Technology integration

INTRODUCTION

Preservice teachers in science education programs are often required to take an educational technology course taught by an educational technology expert. In such classes, students are supposed to develop a variety of technology-related skills, including the ability to use productivity tools, educational software, and the multitude of resources available online. Students typically are then expected to apply these technology skills to teach content in their subject area. According to Flick & Bell (2000) "this approach is backwards." They argue that teaching a set of technology-related skills and then expecting to find a science content for which these technology skills might be useful limits the use of technology in the science classroom. This is akin to learning about a tool first and then seeking out the educational problem that the tool might help solve rather than letting the curriculum determine what tools should be used (Cooper & Bull, 1997). Flick & Bell suggest that if the goal of using technology in science teaching is to enhance teaching and learning, a different approach is necessary.

Several research initiatives have been exploring how to teach technology within the context of specific content areas. At Curry School at the University of Virginia, for instance, preservice teachers in secondary education take beginning technology courses within their content areas providing students with unique technology experiences related to their own subject area (Thompson, 2006). Research also indicates that focusing on the development of faculty so that they may serve as model users of technology within their content and methods courses is another way to train preservice teachers (CEO Forum on Education and Technology, 2000; Office of Technology Assessment, 1995; Teclehaimanot & Lamb, 2005). Other institutions are exploring field-based models focusing on future teachers' student teaching placements in which field-based mentor-teachers model the integration of technology into educational activities in order to assist preservice teachers with their use of technology during student teaching experiences (Kelley, Wetzel, Padgett, Williams, & Odom, 2004).

A common thread among these initiatives is the intentional effort to teach technology within the context of specific content areas rather than as an isolated topic. The literature suggests that integrating technology in this manner can have a positive impact on preservice teacher attitudes and confidence with regards to technology (Bennett & Scholes, 2001; Pope, Hare, & Howard, 2002) as well as their overall skill level with technology (Albee, 2003; Pope et al., 2002). These outcomes are largely attributed to the fact that preservice teachers are given the opportunity to learn and teach *with* technology rather than just learn *about* it.

In addition to providing teachers with opportunities to learn about technology integration within the context of the different content areas, it is also helpful to give them the chance to collaborate with others as they learn about and experiment with technology tools. Lawless and Pellegrino (2007) recently published a literature review that focused on research dealing with professional development designed to help teachers become proficient in the integration of technology. As part of their review they found several studies that reported on the use of mentors or coaches as a way to help teachers learn more about and practice the effective use of technology in the classroom. These studies revealed that providing teachers with tech savvy mentors and partnering them with teachers who are experienced in the area of technology is an effective way to provide the technical and pedagogical support they need when they attempt to integrate technology (Cole, Simkins, & Penuel, 2002). In addition, using collaborative partnerships helps to allay the fears many teachers have about using technology with their students (Mulqueen, 2001) and can increase the motivation and enthusiasm teachers exhibit towards technology based training (Holbein & Jackson, 1999). This emphasis on collaborative work and mentorship is at the core of the "networked learning community" approach to professional development investigated in this study.

The rationale for learning communities is mostly associated with Wegner's (1998) social theory of learning that calls for communities of practice in which participants mutually engage in the task at hand, focus on joint enterprise, and develop shared ways of working. With respect to teachers, the notion is to provide an ongoing, sustainable vehicle for teacher learning (Parr & Ward, 2006). Parr and Ward describe learning communities as having distinctive features that include shared norms and values, collective learning through collaboration, the application of that learning in a focus on student learning, shared personal practice, and reflective dialogue. Parr and Ward further argue that strong professional learning communities are those focused on "joint work" involving not only acquiring new knowledge but also revisiting the basic assumptions about teaching and learning to improve practice and, as a consequence, student learning.

The increasingly popular online learning environment in which we currently live and work has generated considerable interest in "networked learning communities" where technical infrastructure and networked learning technologies such as the Internet are utilized to support and complement learning communities for the creation and transfer of knowledge within and between individuals and groups as a means for continuous, systematic improvement of practice. As Kerr et al (2003) describe, central to networking is the notion of increasing communication channels that provide opportunity for interaction at different levels. Such communication leads to a range of benefits, such as opportunities for participants to share their knowledge and expertise, opportunities for participants to discuss, plan, reflect on and explore professional issues, increased inspiration, innovation and motivation among participants, increased social contact between individuals from differing backgrounds, empowerment and professional development, a reduction in feelings of isolation (both geographically and emotionally), and increased access to shared resources.

While studies about implementing networked learning community approach to facilitate technology training for teachers exists (see Hartnell-Young, 2006; Lock, 2006; McNeil & Pierson, 2001; Najafi & Clarke, 2008; Parr & Ward, 2006), there is a gap in the research literature examining the impact of these communities among K-16 educators with a specific focus on technology integration in science education. Too little is known about what K-16 educators might gain from a professional development program that calls for their engagement, interaction, and collaboration to use technology effectively in science education classrooms.

In accordance with the existing literature and in response to the growing need for content-area specific technology preparation, the purpose of this study was to investigate the impact of a professional development program where a K-16 networked learning community approach (explained in the following section) was implemented to provide training and support for technology integration in science education. The following research questions were examined in this study:

1. What is the impact of a K-16 networked learning community approach to professional development on technology literacy (knowing *about* technology) and technology integration (teaching *with* technology) among student teachers, cooperating teachers, education and content faculty, and student teaching supervisors in a science education program?
2. What are the patterns in technology integrated projects designed by the project participants that are important to technology integration in science education?
3. What kinds of professional development activities promote and/or influence participating science educators' professional development on technology integration in the classroom?

In the following sections, we first describe the program in which a K-16 networked learning community approach was implemented to provide professional development for technology integration in science education. In this section, we discuss the critical framework that provided the basis for the development of the networked learning community investigated in this study. We then describe the research study that used multiple methods to determine the impact of the professional development model presented. In the subsequent section, we present the study findings accompanied by a discussion of those findings. In the conclusion section, we identify and discuss ways in which the model presented responds effectively to the need for comprehensive technology preparation to improve technology integration in science education.

THE MITTEN PROGRAM AND THE CONCEPTUAL FRAMEWORK

The professional development activities that are presented in this study were part of the Michigan Teachers' Technology Education Network (MITTEN) program, which was a three-year project funded through the Preparing Tomorrow's Teachers to use Technology (PT3) initiative of the United States Department of Education. MITTEN facilitated a networked learning community among K-16 educators, calling for the engagement, interaction, and collaboration of student teachers, cooperating teachers, education and content faculty, and student teaching supervisors. The "center of pedagogy" advocated by Goodlad (1994) provided the conceptual framework for the type of network learning community approach undertaken in this study.

Conceptual Framework: Center of Pedagogy

For Goodlad (1994), the improvement of teacher education requires the collective participation of three principal institutional entities: schools of education, school districts, and colleges of arts and sciences. Although each of these three bodies certainly has critical educational functions that are best pursued in relative isolation, Goodlad emphasized the importance of each as an equal player in a healthy "ecosystem" (p. 9) of teacher preparation and sought to provide a coherent means of providing sustained and meaningful contact among these essential parties in the teacher education enterprise. Thus, the center of pedagogy idea constitutes a means of addressing the shortcomings of the status quo in teacher education, which is normally typified by an "undergraduate curriculum of general and special studies interspersed with essentially required courses in education and student teaching" (p. 10).

As figure 1 illustrates, the MITTEN program's Networked Learning Circle (NLC) mirrors Goodlad's center of pedagogy, calling for the involvement of four groups of participants: (a) student teachers, (b) content-area faculty of the arts and sciences specializing in the student teachers' major field of study, (c) education faculty specializing in educational technology and methods, and (d) experienced practitioners comprised of the student teachers' mentoring teachers and university-based field supervisors. The cooperative activities undertaken among these participants of the MITTEN NLC model enabled the sustained interaction toward the kind of shared meaning that Fullan (2001) identified as vital to educational change and improvement in education.

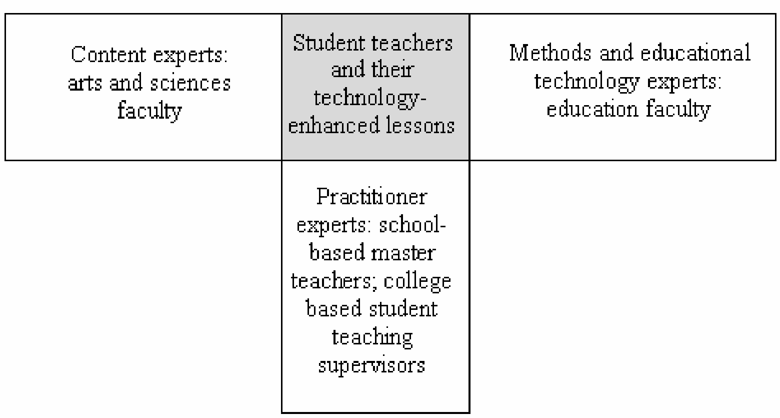

Figure 1. The "Networked Learning Circle" (NLC): a structure for collaboration on technology integration, adapted from Goodlad (1994).

At the heart of the NLC is the focus on the progress of preservice teachers, a focus that has certain strengths. Foremost among these strengths is the conscious effort to help preservice teachers bridge the gap between the postsecondary and K–12 educational worlds in which they are learning. Most often, having concluded all or nearly all of their coursework, students entering the teaching force are released by their academic instructors into the hands of their supervising, or host, teachers. A supervising teacher appointed by the student teacher's college or university has an important role in synthesizing the student teacher's teaching experiences with the content and pedagogical knowledge already learned. Yet, like the student teachers themselves, during this clinical experience these supervisors rarely have sustained contact with members of the faculty mainstream. Therefore, the typical student teaching experience has tended to foster—at a most critical juncture in the preservice teacher's preparation—distance between the preservice teachers and their college- and university-based faculty members, rather than promoting important and necessary interaction.

Such patterns of structured separation have been typical of the teacher preparation enterprise in the United States and have had negative consequences of at least two sorts. First, the preservice teacher has been unable to benefit from meaningful continuing contact with content and pedagogical expertise. Second, perhaps even more limiting, the faculty members themselves have been unable, under most prevailing models, to reconnect with the K–12 world in ways that might inform and rejuvenate their own instruction. Smith and Kaltenbaugh (1996) have noted the desirability of establishing the meaningful input of "academicians, master teachers, and master practitioners" to overcome the tendency for each of these vital participants in teacher education to stand as an "autonomous unit" (p. 96). Venues that can foster genuine dialogue between and among preservice teachers and members of these three groups are necessary elements of programs aimed at spurring structural change. The NLC model provides a basis for pursuing this kind of cooperative engagement.

Implementing the NLC Model: The MITTEN Project

The MITTEN project involved the School of Education and the College of Arts and Sciences at a major Midwestern university. A neighboring Community College also participated, as did several local K–12 institutions sponsoring the project's preservice teachers during their clinical appointments. The project's main goal was to prepare future educators with improved knowledge, skills, and confidence regarding the integration of information technology into the teaching and learning process.

In pursuit of this goal, MITTEN offered three different but interrelated professional development activities to project participants: (a) a series of capacity-building activities, (b) a sequence of meetings of the NLCs, and (c) a pair of seminar activities designed for whole-group engagement of all participants. Figure 2 shows the sequence of these events within a single cycle of the project. The meeting of NLCs and the work undertaken within these learning circles were of principal importance to the project, while the additional activities comprised important means of support for those circles.

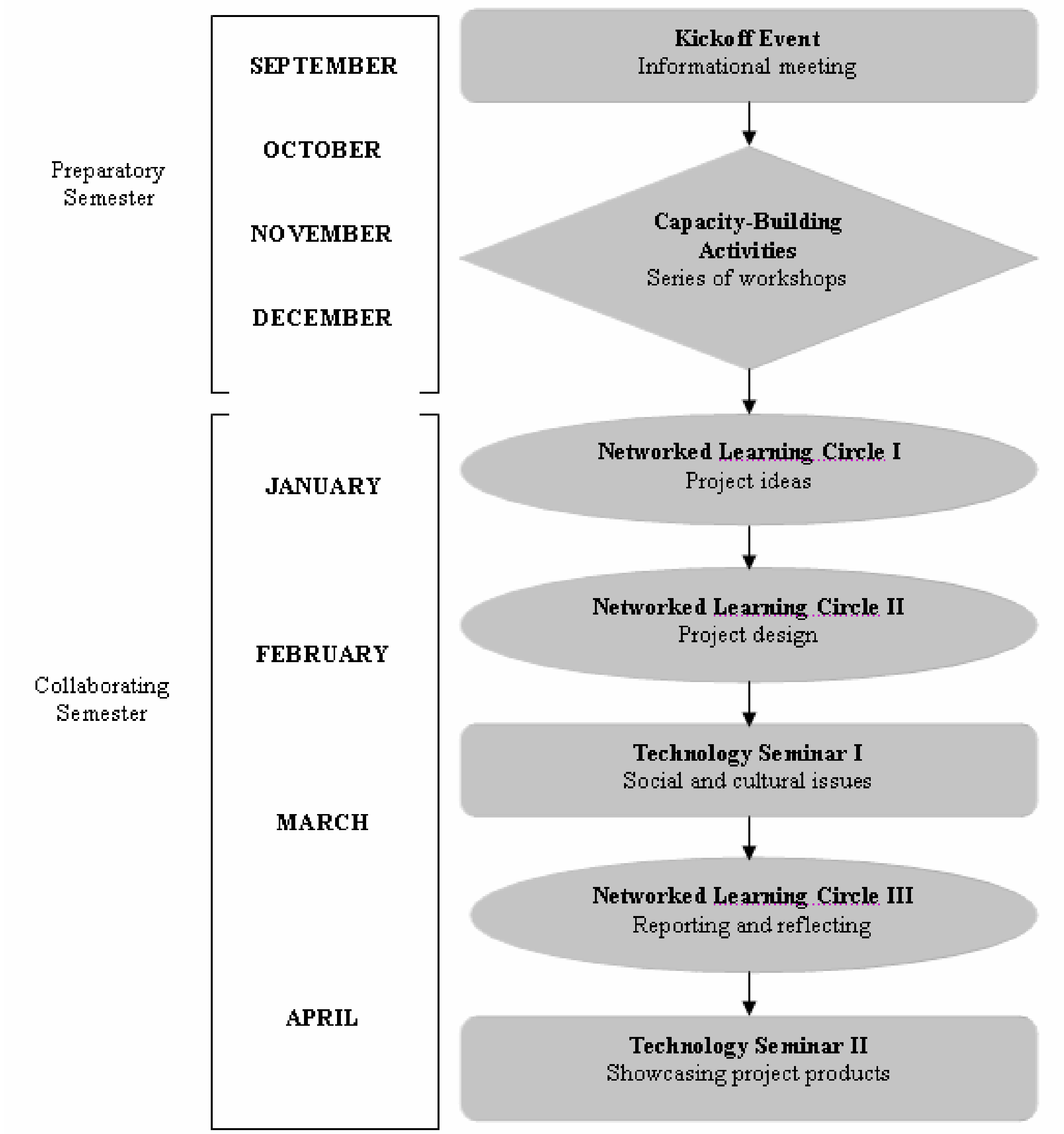

Figure 2. One round of MITTEN events.

Capacity Building Activities. At the post-secondary institution in which this study was conducted, all preservice teachers were required to take an educational technology course prior to their student teaching. To improve the technology readiness of the project's cooperating teachers, field supervisors, and methods and content faculty members and bring their technology skills more in line with those of the participating student teachers, MITTEN offered a set of Capacity Building Activities. The structure of these capacity building activities included workshops, working lunch sessions, and one-to-one mentoring sessions. The general scope of these sessions encompassed three areas of need—telecommunication tools, productivity tools, and educational multimedia—while specific emphasis corresponded to the needs that participant identified on assessment surveys. By improving the technology readiness of the participants and bringing their skills more in line with those of the participating student teachers, the entire cohort was prepared to undertake the work of designing and implementing technology-enhanced instruction, work that occurred during the subsequent collaborating semester.

Networked Learning Circles. The Networked Learning Circle meetings during the collaborating semester involved the most critical set of activities within the program. NLC members met at minimum three times during the course of the term in order to design, revise, and implement technology-enhanced instruction in their classrooms (e.g., course or unit redesign in K-12, syllabi revision at the university level).

As Figure 2 reflects, the first circle meeting (NLC I) provided inspiration and guidelines to encourage technology integration ideas among project participants. Typically, examples of best practices in technology integration were demonstrated. The first NLC meeting readied the participants to consider their instructional practices and how they might be improved through technology integration. Specifically, all participants were asked to survey the learning and technology environments in their classrooms and schools and prepare proposals for learning activities and experiences supported by educational technology.

At the second NLC session, all circle members presented their proposals for technology integration into their professional practice. Student teacher/cooperating teacher pairs presented joint projects for their respective classrooms whereas faculty members and field supervisors focused on their own settings. Consistent with the current Technological Pedagogical Content Knowledge (TPCK, Mishra & Koehler, 2006) discussion in the educational technology community, during and after these presentations, other members of the circles raised questions and made suggestions for the content, technology, and pedagogy of the technology integration projects presented. A range of content, methods, technology, and practitioner experts in the NLCs supported each other with the design of technology-integrated projects. The presentation and discussion activities featured during the NLC II meeting helped circle members for the classroom implementation phase of the cycle.

NLC III generally occurred after the completion of most of the implementation phase and provided time for each participant to report and reflect on successes and challenges encountered during implementation. Because discussion and networking across members of the circle was encouraged, the participants usually learned from the experiences of circle colleagues but also considered how specific uses of technology might be adapted to their own instructional settings and circumstances.

Various assumptions shaped the collaboration within the NLCs. First, all members of the group were primarily present as learners and that each circle included educators at different "levels" but all had a stake in developing their capacity to use instructional technology in meaningful ways. Technology demands openness to learning, even for people close to the realm of technological innovation. A second major assumption embraced by project participants was that co-learning supports the learning of all the members of the NLC (Kariuki, Franklin, & Duran, 2001). The helpful candid observations of other members in each learning circle had the capacity to develop the abilities of each member. Therefore, observing others' progress in using instructional technology was mutually beneficial.

Seminar Activities. The seminar activities served two different but complimentary purposes. First, they built awareness of broader social and cultural issues related to educational technology with attention to topics such as the "digital divide," "assistive technology," and "plagiarism and copyright." For the school-based master teachers in particular, these opportunities augmented their home schools' efforts to contribute to teachers' continuous learning (Darling-Hammond, 1998). A second purpose of the seminar activities was to build and maintain the investment and commitment of those involved by showcasing current products and works in progress, consistent with Fullan's (2001) observation that knowledge exchange is both a motivator and an integral attribute of the competent professional.

In collaborative interaction with members of their respective NLC, each MITTEN participant created a standards based electronic portfolio (Barrett, 2000) that documented their own progress in planning and executing technology-enhanced lessons. Participants used these portfolios to reflect on their growth and learning as well as connect their achievements to the National Technology Standards for Teachers (ISTE, 2000). Each portfolio included five major sections consisting of an introduction, an overview, a narrative of achievements, exhibits, and reflections (see a sample portfolio at http://www.umd.umich.edu/mitten/mnemeth). Production of the e-portfolios containing technology-integrated lessons and learning resources allowed networking among project participants in different cohorts and provided an important venue for the sharing of experiences of project members with broader audiences in the education community.

METHODOLOGY

Research Design

A mixed methods design was used in this study. As Gay, Mills, and Airasian (2006) describe, mixed method research combines both quantitative and qualitative data collection and analysis in a single study. The use of descriptive, comparative, and interpretive components of this study required a combination of quantitative and qualitative research methods in order to appropriately answer the research questions. The first step of the study involved the dissemination of a needs assessment survey and the pretest Technology Survey prior to the beginning of the program. The second step involved an ongoing collection of program participation data and artifacts from the program activities. The third step involved the administering of the posttest Technology Survey. The final step involved the content analysis of the program participants' e-portfolios.

Participants and Setting

Over a three-year period with five cohort groups (from September 1, 2001 to April 30, 2005), the subjects for this study included 17 student teachers, 17 cooperating teachers, 5 university-level faculty, and 3 student teaching supervisors. In their respective cohorts, each participant was assigned to a networked learning circle, typically consisting of a faculty member in the content area (1), teaching methods (1), and educational technology (1), science education student teachers (4), his or her cooperating teachers (4), and their field supervisor (1). The overarching task of each cohort was to develop and field-test technology-enhanced lessons and projects, leading to course or unit redesign in the K-12 classroom and syllabi revision at the university level.

For each cohort group, the study was announced to student teachers six-months prior to the student teaching semester and volunteers were solicited to participate. Names of the volunteering students were placed in a box and four individual names were randomly drawn to select student teacher participants in each cohort. Student teachers' assigned school districts identified cooperating teacher volunteers to team up with student teachers and participate in the study. Student teacher/cooperating teacher pairs were placed in 14 different schools (5 elementary and 3 high schools) in 10 different school districts. The study was announced to faculty members and student teaching supervisors prior to each academic year and volunteers were asked to participate. Three methods faculty participated in the study, one of them joining the project in two different cohorts. Two content faculty participated in the study, both of them joining in multiple cohorts. Three student teaching supervisors assigned to participating student teachers within their respective cohorts participated in the study, two of them participating in multiple cohorts.

All participants attended capacity building activities, participated in NLC meetings, and engaged in whole group activities such as a kickoff event, a technology seminar focusing on a featured social issue, and a final exhibition showcasing project products. All participants (with three exceptions) performed required activities including implementation of technology-rich lessons, maintaining journals, and developing electronic portfolios. Each participant conducted site assessments using School Technology & Readiness (STaR) Charts (CEO Forum on Education and Technology, 2000) and then developed their projects and lessons considering the technology and resources available to them. There were wide disparities in both equipment and technical support that was available to the project participants in their classrooms and schools. Some "high-tech" level schools had more than two computers (with Internet access) in each classroom, in addition to other computer labs. These schools had the traditional computer labs as well as specialized labs with software and hardware for students to complete complex projects such as digital video editing and production. The schools within the "low-tech" tech group showed lack of technology resources. Classrooms had computers, but were not usually connected to the Internet. Labs and technical support were minimal. The majority of the schools in the project fell in between these two poles at the "mid-tech" level of technology. The schools within this group generally had 1-2 computers with Internet access in each classroom and one computer lab at the elementary schools and 5+ labs at the high schools. Specialized labs and projection capability within the classrooms were limited. Schools in the mid-range had devoted considerable resources to improving their technology resources and training.

Instrumentation

A technology survey designed by the project's external evaluator was used to evaluate the project participants' technology confidence (comfort level) and competence (frequency of use) in two parts (see Appendix A). Part I is comprised of two scales that consist of nine (9) items measuring participants' confidence/competence related to technology literacy (knowing *about* technology). Part II is also comprised of two scales with thirteen (13) items measuring participants' confidence/competence related to integration of technology into teaching and learning (teaching *with* technology). The external evaluator reported successful and satisfactory use of the technology survey for a number of years in different professional development programs confirming its reliability. Additionally, a panel of experts in educational technology reviewed and revised the instrument for content validity.

The researchers developed and used a guideline for journal entries underlining the purpose of the journals and its framework to help participants in writing their respective "evaluative journal" entries. The researchers also developed and used an electronic portfolio guideline describing the purpose of the electronic portfolio and its framework to help participants to present their achievement in teaching with technology in a meaningful way. Copies of the journal and e-portfolio guidelines are available by contacting the lead author.

Data Collection

Various forms of data were collected related to each of the research questions. A combination of quantitative and qualitative methodologies were employed, including (a) quantitative data collected from the pre- and post Technology Survey, and (b) qualitative data collected from the needs assessment survey, participants' journal entries, participant observations in NLC meetings, and technology projects and summery reflections within the electronic portfolios.

Data Analysis

The research questions drove the data analysis. The data were acquired through the technology survey administered twice in a pre-test/post-test design. Five-point Likert scales were used to measure participants' confidence (1 = very anxious or even afraid of to 5 = eager) and competence (1 = never to 5 = daily) in both technology literacy and integration of technology into teaching and learning. As described by Hinkle, Wiersma, & Jurs (1994), a paired-samples *t* test was conducted to compare means for the same variable measured at two time points (e.g., pre-test and post-test) on the same set of subjects. To treat the missing data, the researchers excluded cases analysis by analysis and used all cases that had valid data for two variables in a pair in the test for that pair.

Qualitative data analysis of the needs assessment survey, journal entries, and reflections articulated in electronic portfolios were conducted on a continuous basis throughout the program. The leading researcher organized and sorted data as they were collected and followed three repeating steps (reading/memoing, describing, and classifying) in analyzing qualitative data (see Gay, Mills, Airasian, 2006) for the retrieval of information and understanding of the data. A peer debriefing process among the researchers was used to check emerging themes and conclusions generated during the analysis.

Two researchers of this study are educational technology faculty and have extensive expertise in technology integration in the classroom. They conducted a content analysis of the e-portfolios developed by the project participants to identify the patterns in technology integrated projects. The Exhibits section of each e-portfolio included copies of units of instruction, lesson plans, examples of student work, and other instructional materials. Analysis of each lesson included within the individual e-portfolios consisted of reviewing the technology used and determining both the role of the teacher and students in the use of that particular technology.

There were a total of 38 e-portfolios created by the project participants. Each student teacher was paired with a cooperating teacher to develop and implement a set of technology enhanced lesson plans. Therefore, for every cooperating teachers' portfolio that was analyzed there was a corresponding student teacher portfolio that included an identical set of lesson plans. These portfolio "pairs" were viewed together as one since they featured the same lessons. This resulted in the analysis of 17 paired portfolios, 14 of which were at the elementary level and 3 at the high school level. None of the project participants were teaching at the middle school level. Two content faculty, one methods faculty, and one student teaching supervisor who worked independently, created the remaining 4 portfolios. One student teaching supervisor submitted an incomplete e-portfolio and it was not analyzed. There were two methods faculty and one field supervisor who did not complete e-portfolios.

The number of data sources and the frequency of the data collection effort helped to create a fuller understanding of the impact of the MITTEN experience.

Limitations

The present study has some limitations that need to be taken into account when considering the study and its contributions. A total of 42 participants in the study is characteristic of what might be considered a pilot in preparation for a more extended study. The study participants were volunteers based on their interest in using technology in science teaching and may not be representative of science educators in general. The quantitative survey data was collapsed across project participants and had too few in each subgroup to be analyzed by subgroups (e.g., science student teachers vs. faculty).

FINDINGS

Confidence and Competence in Technology Use

The technology survey examined the project participants' technology confidence (comfort level) and competence (frequency of use). The paired-samples *t*-test results indicated that over the course of the program the project participants significantly improved their confidence and competence in technology literacy as well as the integration of information technology into the teaching and learning of science.

Technology Literacy (knowing about technology). As shown in Table 1, the paired-samples *t*-test results for Part 1 (Technology Literacy) on the survey indicated a significant increase (at the .05 level) in scores from pre-test to post-test for each item tested on the survey with only two exceptions.

Table 1: *Paired-Samples T-Test Results: Part 1-Technology Literacy*

Survey Question	Degree of Freedom (df)	Comfort *t* test (2 tailed >.05sig.)	Frequency of Use *t* test (2 tailed >.05 sig.)
1.	29	-1.720 (.096)	-1.682 (.103)
2.	29	-2.105 (.044)	-.817 (.420)
3.	29	-2.041 (.050)	-2.112 (.043)
4.	29	-3.832 (.001)	-3.010 (.005)
5.	29	-3.072 (.005)	-2.454 (.020)
6.	29	-5.000 (.000)	-2.850 (.008)
7.	29	-4.650 (.000)	-3.159 (.004)
8.	29	-4.279 (.000)	-3.465 (.002)
9.	29	-3.393 (.002)	-3.071 (.020)

The results of the *t*-test for Part 1 indicate that throughout their participation in the MITTEN program the project participants made significant increases in their use of computers for common purposes of connectivity such as sending and receiving e-mail with attachments, using Internet search engines, and retrieving, saving, and using electronic information. Similar increases were made for creating multimedia presentations, using advanced computer functions such as using chat rooms, QuickTime movies, and video input, manipulation, and output. Participants increased their use of graphics application to create professional looking documents, newsletters, and publications. They also made significant changes in the frequency with which they created and modified personal or professional web pages and employed technology in assessment such as using electronic portfolios or grade books. Study participants significantly improved their understanding about some social and ethical issues related to technology use in the classroom such as data privacy, equitable access, free speech, copyright, and school technology policies.

There was no significant change in participants' comfort in using the computer for the "ordinary" purposes: word processing; opening, modifying, printing documents; record keeping, or to use computers and appropriate software to use or create databases and spreadsheets.
Scores for these questions did not increase significantly over the course of the program where a negative value for *t* for each of these cases indicated that the mean post-test score was larger than the mean pre-test score. These results weren't surprising as participants already performed these types of tasks on a regular basis and were, therefore, quite familiar and comfortable with them.

Integration of Technology into Teaching and Learning (teaching with technology). As shown in Table 2, the paired-samples *t*-test results for Part 2 (Integration of Technology into Teaching and Learning) on the survey indicated a significant increase (at the .05 level) in scores from pre-test to post-test for each item tested on the survey with no exception.

Table 2: *Paired-Samples T-Test Results: Part 2-Integration of Technology into Teaching and Learning*

Survey Question	Degree of Freedom (df)	Comfort *t* test (2 tailed >.05 sig.)	Frequency of Use *t* test (2 tailed >.05 sig.)
1.	29	-3.071 (.005)	-3.353 (.002)
2.	29	-5.524 (.000)	-4.948 (.000)
3.	29	-3.315 (.002)	-4.416 (.000)
4.	29	-3.427 (.002)	-4.777 (.000)
5.	29	-4.883 (.000)	-5.067 (.000)
6.	29	-4.650 (.000)	-5.110 (.000)
7.	29	-4.349 (.000)	-6.430 (.000)
8.	28	-4.559 (.000)	-4.887 (.004)
9.	28	-2.736 (.011)	-4.623 (.000)
10.	27	-2.274 (.031)	-3.349 (.002)

11.	28	-4.589 (.000)	-5.087 (.000)
12.	29	-5.137 (.000)	-7.738 (.000)
13.	29	-4.878 (.00)	-3.832 (.001)

The results of the *t*-test for Part 2 indicates that throughout their participation in the MITTEN program the project participants made significant improvements in helping students to operate a variety of hardware tools such as computers, LCD projectors and scanners, and to use video hardware and software in engaging and constructive ways. Similarly, they made significant increases in the amount of time spent helping students use sophisticated and content specific applications as well as developing student abilities to learn applications outside of formal training. Participants significantly improved their ability to help students become proficient in using search tools and evaluating and using results of Web searches as well as developing their skills and helping students develop skills in creating multimedia presentations and products that support engaged learning. They also made significant improvements in helping students become skilled at developing technology-enriched learning activities that are authentic, multidisciplinary, and connected to district, state, and national standards; helping students to utilize technology-enriched instructional strategies in which learning is highly interactive and responsive to student needs; and helping students use technology to support authentic, performance-based, ongoing assessment including portfolios. Study participants significantly improved their ability to help students understand how to create a classroom environment in which technology is a shared responsibility between teachers and students, and where its use is transparent and in need of limited teacher direction. There was also a significant increase in the use of interactive electronic tutorials to teach specific lessons or material to specific students or groups of students. Further, participants made significant gains in understanding and using technology to enhance teaching and research and to maximize student learning as well as mentoring their colleagues in using technology to improve the teaching and learning process.

Patterns of Technology Use in Science Classrooms

Electronic portfolios of project participants contained technology-integrated projects at the K-12 and university level. Content analysis of electronic portfolios provided data useful for understanding the project participants' patterns of technology use in their classrooms.

Projects created by the preservice/inservice teacher pairs included the use of a variety of advanced technology tools while facilitating the learning in science. Some examples at the early elementary level (1^{st} and 2^{nd} grades) included using digital pictures and presentation tools such as KidPix to learn about animals and using a Multimedia Encyclopedia, Kidspiration, and educational software such as Dinosaurs: An Interactive Journey into the World of Dinosaurs to learn about comparing and contrasting animals. Examples from multi-age classrooms (2^{nd} and 3^{rd}, and 3^{rd}, 4^{th}, & 5^{th} grades) involved using graphic organizers and research on the Internet to learn about sound and light and using Microsoft Excel and PowerPoint, Kidspiration, and electronic learning logs to learn about animals and habitats.

Upper elementary level (4^{th}-5^{th} grades) examples included using Kidspiration, Microsoft Excel and Power Point, iPhoto, and iMovie to learn about the relationship of living things; using similar productivity tools including the Internet to learn about simple machines; and using Internet search engines, directories, and databases, and HyperStudio to understand behavioral and structural attributes of animals as well as learn about their habitats.

None of the project participants were teaching at the middle school level. Some of the examples at the high school level included using eChem, MDL Chime Web plugin, PowerPoint, and ChemFinder to learn about molecular biology. Other examples included using a variety of Web sites that provided audio and visual representations to develop science projects in the area of integrated natural science on maps and earth physical science maps, plate tectonics, earth crust deformation, earthquakes, and volcanoes.

Projects created by university faculty also presented multiple forms of technology use. One content faculty incorporated technology into her teaching using electronic reserves to improve student preparation for her class. She also used weekly electronic "warm-up" question pages, a Flexcam, video monitor and digital projector, and developed a database that stored exam questions in an easily retrievable format. Another content faculty used the VideoCam microscope projector, incorporated a new program called CyberEd that was installed on her computer in a lecture room, and used digital cameras and Photoshop in her Zoology class. One methods faculty created a course management site where he could hold discussions, share files and links, and facilitate the submission of assignments. He also used different simulation programs to help students examine and construct an understanding of issues related to weather. One faculty who supervised student teachers' field experiences showed increased use of technology in their daily practice such as using emails, sending and receiving email attachments, using online discussion boards, and developing and sharing electronic versions of lesson plans.

There was a clear distinction in the plans for technology integration between the university faculty and the K-12 student/cooperating teachers. As Figure 3 illustrates, the university faculty were focused on using technology for organization, information dissemination, and to enhance the delivery of content. Faculty use of technology was more focused on how the instructor would use different tools in their instruction and to communicate with students. Providing access to resources such as websites, downloadable files and videos of model teaching were higher priorities than providing the students the opportunity to create artifacts using a broad range of technologies.

Student teacher/cooperating teacher pairs placed more emphasis on having their students conduct research, create artifacts, and present information. All but one of the portfolios analyzed in this area included students conducting research or finding information online and then sharing that information by typing a report, creating an electronic presentation or making some other type of technology-based artifact. As Figure 4 illustrates, Microsoft Office products were quite popular with PowerPoint being used most frequently followed closely by Word and Excel. Many of the lessons also included students using Kidspiration to create concept maps and other graphic organizers to represent their knowledge.

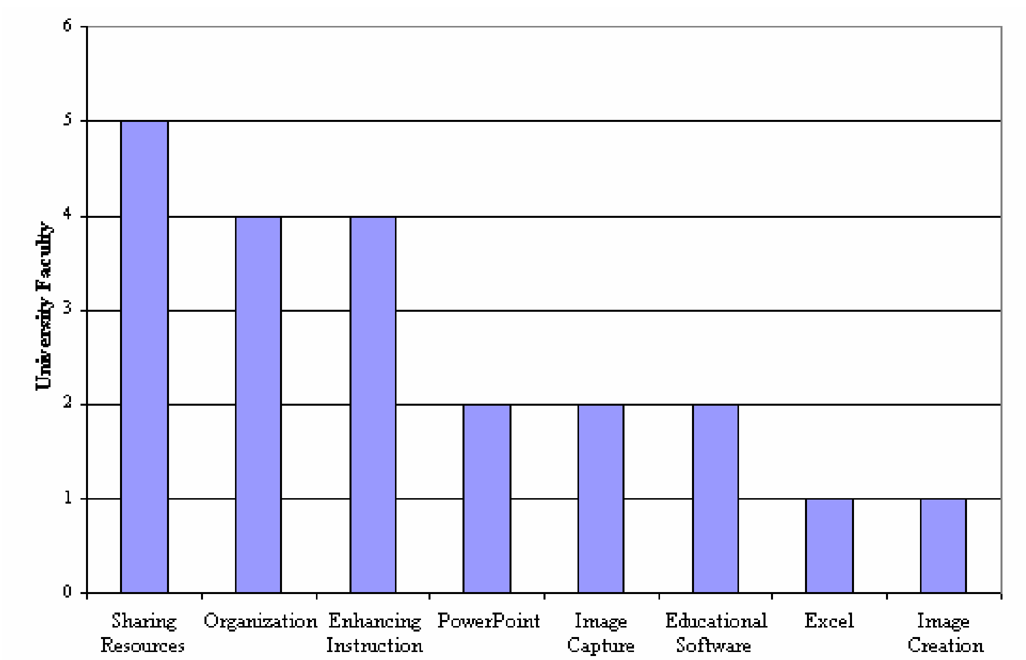

Figure 3: Technology Use by University Faculty.

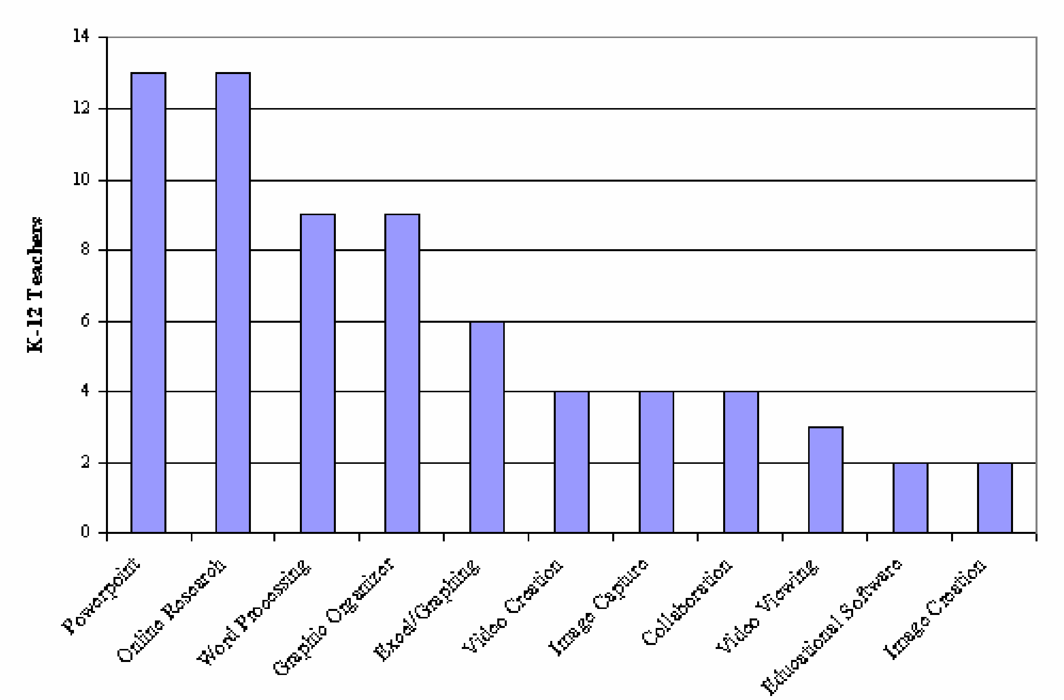

Figure 4: Technology Use by K-12 Teachers.

Appendix 2 includes the listing of the technology-integrated projects developed by the various participants. Projects are listed by grade level including information about the curriculum/unit, content, technology used, and corresponding URLs.

Factors that Promote and/or Influence Teaching with Technology
Analysis of the journal entries, participant observations in NLC discussions, and summary reflections in electronic portfolios provided data useful for understanding some of the factors that promoted and/or influenced participating science educators' technology integration in the classroom. The qualitative analysis generated three broad themes impacting participants' technology initiatives; (a) motivation and determination, (b) sharing resources, information, and ideas, (c) time, preparation, and technical support.

Motivation and Determination. For most participants, the MITTEN program was a "valuable" professional development experience in many ways. They felt excited about and "determined" to find more ways of utilizing technology in the classroom even with limited resources, and "motivated" to implement technology in the curriculum. One student teacher reflected on her experience:

> I would not change a single minute of my experience with this project…Because of this experience, I am determined to find more ways to utilize a single computer in the classroom…Throughout this project I have learned a great deal about how to use technology in the classroom. I think my greatest achievements however have been learning how to make things happen with what is available and finding additional (free) resources.

One cooperating teacher expressed her feelings in a similar way:

> My participation in the MITTEN program has been a most rewarding experience for me, my MITTEN student teacher and my students! I feel so empowered and confident about my technology skills! After 14 years of teaching, I feel as if my batteries have been recharged again, with many fresh and exciting ideas to use with my students! I am more motivated than ever to implement technology into my curriculum. It has been one of the most rewarding experiences of my life! I'm so proud of the work that we created in this project.

Similar to student teachers and cooperating teachers, one faculty member wrote the following passage on the reflection page of her e-portfolio expressing her feelings for her MITTEN experience:

> Prior to my involvement with MTTTEN, I was aware of most of the technology in this portfolio, but I was not completely comfortable with incorporating it into my teaching…Overall, my MITTEN experience made me aware of how effective technology can be in teaching classes. It provided me with the impetus to try things that I had been reluctant to try before.

A student teaching supervisor shared a similar reflection:

> Through my own increase in professional information power, I can facilitate greater use of the Internet among my students. I surely enjoy taking a "technological odyssey" in my search for instructional strategies for the new millennium.

The reflections provided above clearly indicate that most participants appreciated the professional development opportunities that the MITTEN program provided for them. It appears that the MITTEN program positively impacted participants' motivation and determination to use technology in the classroom.

Sharing Resources, Information, and Ideas. Participants enjoyed meeting with other teaching professionals and valued the networking among K-16 educators that the MITTEN program facilitated. The following passage from a cooperating teacher illustrated the feelings of many others:

> I realized once again how important it is for people to cooperate and share resources, information, and ideas…I have also learned the value of networking with others for support and information. The sum of people involved with this project, including the university professors and lab staff, are responsible for the success of each individual.

Another cooperating teacher expressed similar experiences and feelings working with her student teacher:

> The MITTEN project brought a new aspect to the collaboration between student teacher and cooperating teacher. It allowed for a learning environment between both of us. I was able to assist Megan [student teacher] with curriculum and management in the classroom, and she was able to assist me with utilizing technology in the classroom…This experience has motivated me to continue implementing technology into the curriculum…I will definitely utilize technology to enhance my lessons in the future.

One student teacher echoed the feelings of the cooperating teachers above:

> Entering the classroom in January, I was feeling a little bit nervous about how exactly I was going to incorporate technology into my unit. I was aware of many types of technology that were available, but I was not sure how to utilize them in the classroom. After talking with my [cooperating] teacher, we found that between the two of us we had many good ideas to work into our unit.

A faculty member expressed her feelings of appreciation towards the MITTEN project since it introduced her to a group of people with whom she can "discuss the uses of technology in teaching." A student teaching supervisor described his feelings in a similar way articulating on the NLC meetings where he especially found it helpful when [they] "could find and share new ideas that were simple enough to apply to [his] projects." He said on his e-portfolio reflection page that "sharing [ideas] with other supervisors …provided [him] many opportunities to develop [his] own projects."

As the passages above suggest, most participants appreciated the collaboration and the teamwork that the NLC model provided. The regular communication and collaboration among project participants helped foster a productive "learning community."

Time, Preparation, and Technical Support. Participants expressed need for extra time, preparation, and technical support for enhancing lessons with technology. The following passages from a student teacher and a cooperating teacher illustrate the feelings of many others:

> I learned that enhancing lessons with technology takes time and preparation. It was worth the effort because the students were highly motivated and really enjoyed learning.

> A lack of technical support and limited resources has made it difficult to integrate more technology into my classroom of fifth graders…Dealing with computer and software glitches while supervising students can be overwhelming for even an experienced teacher. Lack of preparation time was also a huge concern, although our experimentation was eased by having both of us [student teacher and cooperating teacher] available in the classroom.

The reflections provided above indicate that most participants at the K-12 level believed that being prepared and organized was critical for educators and maybe even more important when using technology.

Even though the technical support was readily available at the university level, the time factor seemed even more critical for most faculty members. Project leadership observed increased confidence and competence in technology skills of those faculty members who volunteered to participated in multiple cohorts. Considerable time and professional development seems needed to help these faculty members to move beyond their traditional practice. Two methods faculty who participated in the MITTEN project and were involved in most project activities including helping student teacher/cooperating teacher pairs in their technology initiatives, were not able to develop their *own* technology projects nor were they able to complete their e-portfolios due to various time constraints they expressed in informal communications. This was also the case for a student teaching supervisor. At times, project leadership observed that it was a challenge to help some faculty give up the teacher role and become a learner.

DISCUSSION

The new understanding gained from our research highlights some of the benefits and limitations of the network learning community approach among K-16 science educators in order to learn about and integrate technology into the teaching and learning process.

The first objective of this study was to investigate the impact of the K-16 networked learning community approach to professional development on technology literacy (knowing *about* technology) and technology integration (teaching *with* technology) of student teachers, cooperating teachers, education and content faculty, and student teaching supervisors in a science education program. The paired-samples *t*-test results suggest that over the course of the MITTEN program the project participants significantly improved their confidence (comfort level) and competence (frequency of use) in technology literacy as well as integrating technology into the curriculum. Project participants made significant improvements in using computers for connectivity, graphics applications, multimedia presentations, creating and modifying a personal or professional web pages and electronic portfolios. They also significantly improved their understanding about social and ethical issues related to technology use in the classroom such as equitable access, copyright and plagiarism, and school technology policies. More impotently, project participants made significant improvements in helping students use a variety of technology tools with content specific applications as well as becoming skilled at developing technology-enriched learning activities that are authentic, multidisciplinary, and connected to district, state, and national standards.

Participant growth in technology knowledge and skills was also evidenced by the vast array of technology-enhanced lesson and unit plans contained within the electronic portfolios. Projects created by the preservice/inservice teacher pairs included the use of advanced technology tools while facilitating the learning of science in different grade levels. For their "exemplary" technology projects, four participating student teachers received statewide recognition from the Consortium of Outstanding Achievement in Teaching with Technology (COATT, http://www.coatt.org). One student teacher/cooperating teacher team published their project titled "Seeing the Unseen: Molecular Visualization in Biology" in the Learning and Leading with Technology journal (see vol. 32 no. 4, p. 24-29). Some faculty members made changes in their courses and syllabi that reflected a greater use of technology to teach and communicate with their university students. Faculty who oversaw the student teachers' field experiences employed the use of telecommunication tools in their daily practice.

The authors' second objective was to investigate the patterns in technology integrated projects designed by the project participants that are important to technology integration in science education. Content analysis of the e-portfolio assessments suggested a clear distinction in the plans for technology integration between the university instructors and the K-12 teachers. The university instructors focused on using technology to improve their instruction and communicate with students. This emphasis might be partly explained by the fact that the university instructors were working with adult learners as opposed to K-12 students and they likely had higher expectations for their students to take responsibility for their own learning. Therefore, providing access to resources such as websites, downloadable files and videos of model teaching were higher priorities than providing the students the opportunity to create artifacts using a broad range of technologies.

The K-12 teachers placed more emphasis on having their students conduct research, create artifacts and present information. Most of the technology-integrated lesson plans at the K-12 level included students conducting research or finding information online and then sharing that information by typing a report, creating an electronic presentation or making some other type of technology-based artifact. Productivity tools were also quite popular among the K-12 teachers with PowerPoint, Word, and Excel being used most frequently. Many of the lessons also included students using graphic organizers such as Kidspiration to create concept maps to represent their knowledge. The authors would like to point out that students could have created each of these artifacts (concept maps, class presentations, research reports, graphs) without the use of the corresponding technology. However, using Word to type a report, for instance, or Kidspiration to create a concept map allowed them, potentially, to be more productive and work more efficiently and these are the most common benefits that teachers strive for when working at what Sandholtz, Ringstaff, & Dwyer (1997) call the "adaptation stage" of technology integration. At this stage, the emphasis is placed on students using technology to produce things more efficiently. As described by Dias (1999), during the adaptation stage there is more frequent integration of new technologies into the classroom. One interesting finding of Dias that relates directly to the MITTEN project is that teachers operating at the adaptation stage benefit from a system of support that may include peer observation and team teaching, flexible scheduling for the planned activities, and introduction to, and discussions of, alternative pedagogies. This is precisely the kind of support system created by the Network Learning Circles.

The third objective of this study was to investigate what kinds of professional development activities promote and/or influence participating science educators' professional development on technology integration in the classroom. The findings suggest that most participants appreciated the collaboration and the teamwork that the MITTEN NLC model put in place. By participating in collaborative professional development activities, student teachers and practicing teachers were able to work with university level content experts while getting valuable field experiences in authentic classroom settings where they could try their hand at teaching with technology. The findings highlight the fact that providing teachers with opportunities to learn about technology integration within the context of their teaching environment and allowing them to collaborate with others as they learn about, and experiment with, new technology tools is an effective way to provide the technical and pedagogical support they need when they attempt to integrate technology. Consistent with the findings of this study, the emphasis on collaborative work within an authentic setting for teacher professional development is well documented in the literature (see Cole, Simkins, & Penuel, 2002; Holbein & Jackson, 1999; Lawless & Pellegrino, 2007; Mulqueen, 2001). It appears that using collaborative partnerships helps many teachers to use technology with their students and increase their motivation and enthusiasm towards technology based training. Providing teachers time and technical support are also critical factors within this structure in order to utilize technology for instructional purposes.

The collaborative activities undertaken among the participants of the MITTEN program presented mixed results for the university faculty when it comes to their professional development in technology use. An assumption shaped the collaboration within the network learning circles with an expectation that all members of the group are learners regardless of their "levels" and all have a stake in developing their capacity to use instructional technology in the classroom. The findings imply that for some faculty this assumption has been proven in this study. Some faculty; however, need considerable time and professional development to move beyond their traditional practice.

CONCLUSION

Most higher education institutions require an educational technology course as a core component of their teacher preparation programs (Leh, 1998). Such courses play a critical role in introducing preservice teachers to fundamental technology concepts and skills (Kim and Peterson, 1992; Lambert, Gong, & Cuper, 2008). However, a stand-alone technology course is not considered a sufficient way to prepare new teachers to use technology effectively in their future practice (Hunt, 1994; Flink & Bell, 2000). One way to help preservice teachers learn how to teach with technology is to provide them with models of teachers using technology effectively in various learning environments (Ross & Wissman, 2001). These models could be in the form of university faculty who use technology in the instruction of their methods or content area courses (Hughes, 2003) or provided as the result of field experiences that take place in technology rich K-12 classrooms (Marshall, 1993). Combined with these notions, the Network Learning Community approach implemented in the MITTEN program encourages networking, mutual learning, and sharing of strategies and resources among K-16 educators and provides an effective strategy to improve technology integration in the classroom. Establishing and fostering a genuine dialogue between and among preservice teachers, inservice teachers, and education faculty provides a basis for cooperative engagement and addresses the need for comprehensive technology preparation in order to improve technology integration in the classroom.

Student teachers particularly gain from NLC engagement, interaction, and collaboration as they experience the applications of technology tools in a real classroom setting. Collaborative partnership with their mentoring teachers along with the content and pedagogical support they have from their university faculty increases their motivation and enthusiasm when they attempt to integrate technology in the curriculum.

Although many practicing classroom teachers believe computers are valuable sources of information for students and integral to functioning in society (Wepner & Tao, 2002), they also often lack knowledge (Karchmer, 2002) and time for planning to use the computer for instructional purposes (Novak & Knowles, 1991). The existing research suggests that effective inservice teacher professional development should place teachers within environments that are learner-centered (Bransford, Brown, & Cocking, 2000), take place within a relevant contextual setting (Loucks-Horsley & Matsumoto, 1999), focus on content knowledge, general pedagogical knowledge, and pedagogical content knowledge (Shulman, 1987), align with teacher practice (Garet, et al., (2001), last over a sustained period (Supovitz & Turner, 2000), and include activities teachers participate in, rather than get lectured about (Garet et al., 2001). Aligned with this notion, the NLC model provides the encouragement and support practicing teachers need to become comfortable with using different technologies for specific instructional purposes. The NLC model also facilitates the development of a collaborative relationship between the student teacher and cooperating teacher in which each fulfills the role of mentor for the other depending on the skills to be acquired and the abilities of the participants.

There are various questions to consider in regards to the development of technology use among faculty through the NLC structure. Faculty welcome opportunities for sharing their knowledge and expertise with preservice and inservice teachers concerning their technology-integrated projects but indicate mixed progress on their own development in using instructional technology in the classroom. Some faculty members find the NLC structure mutually beneficial and assume the learner role in addition to their expert role. Some need considerable time and professional development to move beyond their traditional practice. For some other faculty it is a challenge to give up the expert role and become a learner. Further studies should include a sampling from a much broader faculty audience in order to more adequately study the impact of the NLC model on faculty members' professional development in technology use.

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APENDIX 1
Technology Survey
NAME*:……………………………………………….* **Date***:……………………………………*

I. Technology Literacy

Each question requires two answers. First, indicate how you ***feel*** about the technology competency in question. To what degree is this competency within your "comfort zone"? Please use the following scale of 1-5:

1 = very anxious or even afraid of
2 = reluctant
3 = ambivalent
4 = comfortable
5 = eager

Secondly, indicate the ***frequency*** or degree to which you employ or use or do this competency or tool or task. Please use the following scale of 1-5:

1 = never
2 = seldom or monthly
3 = occasionally or weekly
4 = often
5 = daily

1. Use computer for the "ordinary" purposes: word processing; opening, modifying, printing documents; record keeping.
How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

2. Use computer and appropriate software to use or create databases and spreadsheets.
How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

3. Use computer for the most "common" purposes of connectivity: sending and receiving e-mail including attachments; using URL's and search engines on the Internet; retrieving, saving and using electronic information.
How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

4. Create multimedia presentations including sound, graphics, or animations in an application such as Appleworks, HyperStudio, PowerPoint, KidPix, Avid Cinema.

How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

5. Use more "advanced" computer functions such as chatrooms; QuickTime movies; video input, manipulation and output; large-group presentations connecting computer and projection devices.
How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

6. Use graphics to create professional-looking documents, newsletters, publications; these might include such programs as PrintShop or Corel Draw, clip art from disks or the Internet, or the use of a scanner or digital camera.
How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

7. Create and modify a personal or professional web page.
How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

8. Employ technology in assessment (e.g. electronic portfolios or gradebooks)
How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

9. I am aware of controversial aspects of technology use including data privacy, equitable access, free speech issues; understand ethical use issues and know the differences among freeware, shareware and commercial software; understand university or school district's policies related to these issues.
How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

II. Integration of Technology into Teaching and Learning

1. Help students to operate a variety of hardware tools (e.g., computers, LCD projector, scanner).
How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

2. Help students use video hardware and software in engaging and constructive ways rather than for passive viewing.
How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

3. Help students use sophisticated and content specific applications as well as develop their abilities to learn applications outside of formal training.
How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

4. Help students become proficient in using search tools and evaluating and using results of searches.
How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

5. Develop and help students develop skills in creating multimedia presentations and products that support engaged learning.
How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

6. Help students become skilled at developing technology-enriched learning activities that are authentic, multidisciplinary, and connected to district, state, and national standards.
How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

7. Help students to utilize technology-enriched instructional strategies in which learning is highly interactive and responsive to student needs.

How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

8. Help students use technology to support authentic, performance-based, ongoing assessment including portfolios.
How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

9. Help students understand how to create a classroom environment in which technology is a shared responsibility between teachers and students, and where its use is transparent and in need of limited teacher direction.
How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

10. Use tailored (to the individual or to small groups) editable learning modules (interactive electronic tutorials to teach specific lessons or material to specific students or groups of students).
How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

11. Generally understand and use technology to enhance teaching and research.
How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

12. Generally understand and use technology to maximize student learning.
How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

13. Mentor professional colleagues in using technology to improve teaching and learning.
How do you ***feel,*** to what degree is this competency in your comfort zone (1-5)? ____
With what ***frequency*** do you do this, or employ this competency (1-5)? ____

APPENDIX 2

Technology-Integrated Projects in Science Classrooms

Grade Level	Curriculum/ Unit	Content	Technology Used	URL
1st Grade	Incorporated Science	Animals with jointed legs	Digital pictures, Kid Pix, Way Cool Creepy Crawlers video, thinkquest.org, Math Keys software, Kidspiration software	http://www.umd.umich.edu/mitten/emuylaert
2nd Grade	Scientific Exploration	Teaching science process skills: observation, classification, communication --compare and contrast animals by creating a binary classification system	VCR, camcorder, digital camera, Kidspiration, KidPix, Dinosaurs: An Interactive Journey into the World of Dinosaurs software, Dinosaurs!: The Multimedia Encyclopedia, Microsoft Word and the Internet.	http://www.umd.umich.edu/mitten/ssobocinski
Multi-Age (2nd-3rd)	Science	Sound & Light	Graphic organizers, reading and writing, research on the Internet, and variety of software	http://www.umd.umich.edu/mitten/lvanhauter
Multi-Age Classroom	Life Science	Animals and Habitats	Microsoft Excel and PowerPoint,	http://www.umd.umich.edu/mitten/handerson

(3rd,4th,5th)			Kidspiration, e-learning log,	
4th Grade	Electrical Energy	Static electricity, Building a Circuit, magnetic poles, magnetic fields, batteries	Digital video and still cameras, scanners, Kidspiration, Appleworks and PowerPoint, WebQuest	http://www.umd.umich.edu/mitten/jherm
4th Grade	The Relationship of Living Things	Food chains; the idea of adaptation and camouflage	Kidspiration, Microsoft Excel and Power Point, Mac iPhoto, and iMovie.	http://www.umd.umich.edu/mitten/hpeterson
4th grade	Science	Electrical energy and the properties of Magnetism	Kidspiration, Word, PowerPoint, LCD Projector, Digital Camera Digital Video Software, Scanner Digital Video Camera, Internet	http://www.umd.umich.edu/mitten/mnemeth
4th & 5th Grades	Weather	Four seasons	Digital camera, digital video camera, MS Word, Kidspiration, LCD projector, Internet, PowerPoint	http://www.umd.umich.edu/mitten/jabuzahria
4th & 5th Grade	Simple Machines	Simple machines	PowerPoint, Internet, Excel, MS Word, iMovie	http://www.umd.umich.edu/mitten/aevans
5th Grade	Earth science	Why Do We Have Seasons-misconceptions students have about the seasons?	Software: Science Court-Seasons, WWW	http://www.umd.umich.edu/mitten/soswald
5th Grade	Forces At Work	Understanding of the terms velocity, average speed, constant speed, acceleration,	Kid Pix, student-graphing program, MS Word, Inspiration	http://www.umd.umich.edu/mitten/kltarpley
5th Grade	Human Circulatory System	Circulatory system, components of blood, the human heart and how it works, journey of a red blood cell in the human body	Video equipment, Digital cameras, Internet, Microsoft Word, PowerPoint, Excel, Calculators Stop watches Altiris Vision	http://www.umd.umich.edu/mitten/jguibord
5th grade	Science	Rainforest	WWW, Kidspiration, Power Point	http://www.umd.umich.edu/mitten/cavis
Elementary Learning program for gifted & talented students	Life Sciences	Behavioral, structural attributes of animals and their habitat	Internet using Search Engines, Directories, and Subscription Databases; digital camera; MS Word; Hyper Studio	http://www.umd.umich.edu/mitten/czink/czink_index.htm
9th grade	Science Foundations	Human Impact	Internet, Inspiration Microsoft Word, PowerPoint, Publisher Blackboard.com	http://www.umd.umich.edu/mitten/rwilliams
9th and11th	Physical	Earth Physical	MS Word, Excel,	http://www.umd.umich.edu/

Grades	Science and Integrated Natural Science	Science Maps, Plate Tectonics, Earth Crust Deformation, Earthquakes, and Volcanoes	PowerPoint, Internet, digital camera, video camera, scanning device, Web sites with a variety of audio and visual	mitten/rbrockhaus/indexrb.html
9-12th grade	General Biology	Molecule visualization	Software: eChem, MDL Chime Web plugin, PowerPoint, chemfinder.com	http://www.umd.umich.edu/mitten/jfinnan
University Level	BIOL 130 and NSCI 233	Introduction to Organismal & Environmental Biology; Learning By Inquiry: Life Science	Electronic Reserves (ERes), Online "warm-up" questions, Flexcam, video monitor and digital projector, Digital camera, Test bank database	http://www.umd.umich.edu/mitten/jnesmith
University Level	General Biology and Zoology	Structures of living organisms, Anatomy and Physiology, respiratory system	Excel, FrontPage, Photoshop, Digital Camera VideoCam, CyberEd CD Set	http://www.umd.umich.edu/mitten/cbida
University Level	Science Methods	Course Website Gradebook, Online discussion board, simulations and data collection	Coursetools (a course management site) with discussion board option, Filemaker Pro, riversci.com	http://www.umd.umich.edu/mitten/cburke
University Level	Supervising Student Teaching	Recommended websites, presentations, Online Calendar, Lesson plan templates	FrontPage, PowerPoint, MS Word	http://www.umd.umich.edu/mitten/bkolnowski

THE EFFECT OF LEARNING STYLES ON ACHIEVEMENT IN DIFFERENT LEARNING ENVIRONMENTS

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ABSTRACT
Every learning environment may attempt to raise successful students, but will not achieve the desired results if several essential elements are not considered in the instructional design process. These elements can be classified interior and exterior conditions. Learner characteristics, items of the interior conditions such as learning style, age, maturity level, interest are essential in designing learning environments process. The purpose of this study is to investigate the effect of learning styles on students' achievement in different learning environments which were designed according to principles of Generative Theory of Multimedia Learning. Research was conducted in the framework of single group repeated measures experimental design model and three different learning environments (text based, narration based and computer mediated (narration + music + text + static picture) were planned and study group studied in these environments at different times. The two instruments were used to collect data for this study. The pre-posttest designed to identify students' achievement score and Kolb's Learning Style Inventory to measure students' learning style. As a result, it has been clarified that the type of the learning style was not significantly effective on students' achievement in different learning environments.

Keywords: Learning style; Learning environment; Generative theory of multimedia learning

INTRODUCTION

The level of learning achieved by a learner is one of the most important factors which indicate the success of a learning environment. In order to ensure the effectiveness of teaching environments, it is important to take account of characteristics, abilities and experience of learners as individuals or as a group when beginning to plan a learning environment (Kemp, Morrison, Ross, 1998).

It is important for the effectiveness of teaching environments to take account of group or individual learners' characteristics, competence and experiences (pre-learning) throughout the process of planning learning environments (Kemp, Morrison, Ross, 1998). Though all human beings have common bio-psychological and social characteristics in learning process, individual preferences concerning the ways of giving meaning and acquiring information may vary. Even identical twins who share the same environment may give meaning in different ways the phenomena and events which have common characteristics. All information which becomes the subjective life of an individual after giving meaning process may have individual-specific differences in ensuring permanence of learning and remembering. One of these individual-specific differences is the learning style which is the topic of this study.

In literature there exist numerous learning styles and learning style models. The differences among definitions and models result from the fact that learning is achieved at different dimensions and that theorists define learning styles by focusing on different aspects. Shuell (1986) explains that "different ways used by individuals to process and organize information or to respond to environmental stimuli refer to their learning styles". Jensen (1998) defines learning style as a sort of way of thinking, comprehending and processing information. To Kolb (1984), learning style is a method of personal choice to perceive and process information. In this sense, learning style is, on one hand, sensory and, on the other hand, mental.

In the context of this study, Kolb's Learning Style Model is used since it identifies with "Generative Theory of Multimedia Learning" which forms the basis of the study.

Kolb states that Experiential Learning Theory, which defends that learning is a combination of experience, cognition, perception and behavior, lays the foundation of Learning Style Model (Kolb, 1984).

The level of learning achieved by a learner is one of the most important factors which indicate the success of a learning environment. In order to ensure the effectiveness of teaching environments, it is important to take account of characteristics, abilities and experience of learners as individuals or as a group when beginning to plan a learning environment (Kemp, Morrison, Ross, 1998).

A twelve-item inventory of learning styles is administered to identify the learning styles in Kolb's model. The scores obtained from these inventories indicate the coordinates related with organization (Active Experimentation – Reflective Observation) and perception (Abstract Conceptualization – Concrete Experience); and the interaction of these two points indicate the learning style. The learning styles on this system of coordinates are Accommodator, Diverger, Assimilator and Converger.

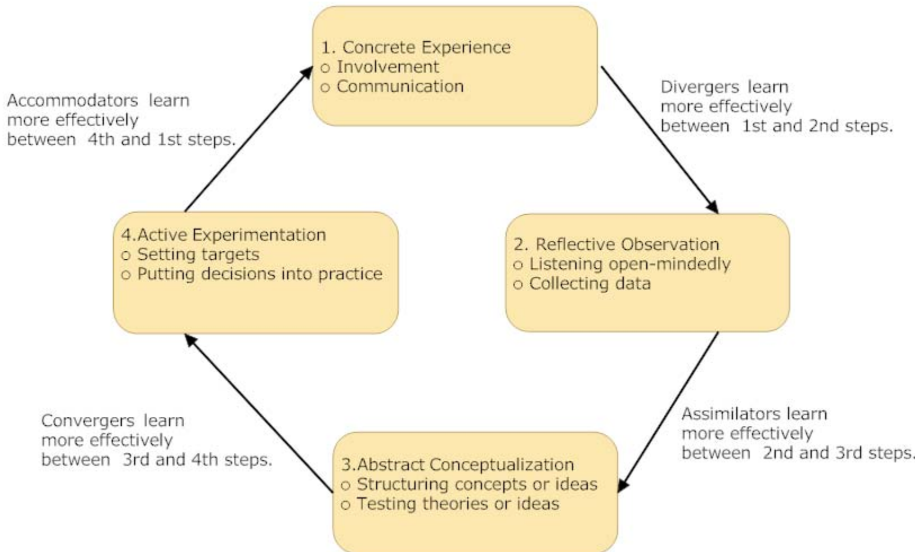

Figure 1. Learning styles in Kolb's learning cycle (Kolb, 1984)

Though learning styles are not stable and unchangeable elements, it takes some time for them to change. That is why, it seems as an easier and more effective way to select and organize methods and strategies, classroom environment and teaching materials according to learning styles rather than expecting the students to adapt to the existent organization. The literature is rich in studies focusing on learning environments which are designed with respect to the characteristics of the learner (Clariana, 1997; Stroot et al., 1998; Pimentel, 1999; Rourke and Lysynchuk, 2000). For the purpose of this study, three different environments are designed on the basis of Generative Theory of Multimedia Learning.

Generative Theory of Multimedia Learning developed by Mayer will be summarized before providing information about the research problem and the research process. In his Generative Theory of Multimedia Learning, Mayer defines multimedia as the presentation of a material by supporting it with a picture or a text or, in other words, in more than one form. In this context, a PowerPoint presentation, a film on television and a voiced animation prepared on computer are examples of multimedia.

According to this theory, multimedia, as a noun, refer to the technology by which a material is presented visually and verbally. The term, as an adjective, is a word which qualifies the messages and presentations related with learning. In this context, multimedia learning refers to learning through words and pictures; multimedia message/presentation refers to a presentation which includes words and pictures; and multimedia instructional message/presentation refers to a presentation which includes words and pictures with a view to ensure learning (Mayer, 2001).

Mayer makes use of three cognitive theories when structuring his theory: Dual Coding, Limited Capacity, Active Processing

Table 1. The cognitive theories underlying the Generative Theory of Multimedia Learning (Mayer,2001)

Name of the Theory	**Definition**	**Developers of the Theory**
Dual Coding Theory	Human beings use two different channels to process visual and auditory information.	Paivio, 1986; Baddeley, 1992
Limited Capacity Theory	Human beings are able to process limited information in each channel simultaneously.	Baddeley, 1992; Chandler & Sweller, 1991
Active Processing Theory	Human beings are active learners who perceive external information, and select relevant data and organize them into meaningful information, and then integrate this information with their prior knowledge.	Wittrock,1989; Mayer, 1999

Mayer (2001), whose theory on the design of effective multimedia learning environments is based on Dual Coding, Limited Capacity and Active Processing theories, define individuals who enter into a process of learning as active learners who use two channels to process visual and auditory information, process limited information in each channel simultaneously, perceive external information, and select relevant data and organize them into meaningful information, and integrate this information with their prior knowledge. Mayer distinguishes between auditory/verbal and visual/pictorial channels used by learners to process information. Mayer (2001) mentions that, in a presentation, verbal or nonverbal auditory elements (e.g. narration (uttered words), background music, etc.) are processed in the auditory/verbal channel and verbal or nonverbal visual elements (e.g. animation, written text, etc.) are processed in the visual/pictorial channel; and that these channels process limited amount of data in one go.

Kolb introduces the abovementioned learning styles, asserting that individuals differentiate in organizing and perceiving information. Accordingly, accommodators make use of Concrete Experience in perceiving and Active Experimentation in organizing. They learn by doing and feeling (Aşkar and Akkoyunlu, 1993; Ergür, 1998). They like new experiences and planned working. They prefer acting on the basis of their feelings rather than mental analyses and acquiring information through dialogues with people rather than technical analyses. The most outstanding strengths of the people having this learning style are practicality, leadership and courage to take risks (Kolb, 1993).

Divergers make use of Concrete Experience in perceiving and Reflective Observation in organizing. Individuals having this learning style are able to see concrete situations from different perspectives. Their approach to events is limited to observing rather than taking action. They enjoy producing various ideas on an ample scope through methods such as brainstorming. They have vast cultural knowledge and like collecting information. Among the remarkable strengths of divergers are creativity, understanding others, being aware of problems and developing a large perspective about an event by brainstorming (Kolb, 1993).

Assimilators make use of Abstract Conceptualization in perceiving and Reflective Observation in organizing. Individuals having this learning style are able to comprehend and transform comprehensive information in a large interval into a meaningful whole. They prefer dealing with abstract concepts and topics rather than tackling people. They generally attach more importance to logical validity of theories than their practical value. They are good at planning, creating models, defining problems and developing theories. It will be useful to develop their skills through exercises on organizing information, creating conceptual models, testing theories and ideas, designing experiments and carrying out quantitative data analysis (Kolb, 1993).

Covergers make use of Abstract Conceptualization in perceiving and Active Experimentation in organizing. They are quite good at taking practical advantage of ideas and theories. They prefer dealing with technical works or problems to social relations. Among their strengths are skills of problem-solving, decision-making, deductive reasoning and problem-detecting (Kolb, 1993).

This study discusses the effect of learning styles on the success of individuals in various learning environments, within the framework of Mayer's information processing and Kolb's perception and organization ideas.

In this study the effect of learning environments on achievement in different learning environments are examined; and the responses to following questions are sought for in this context:

- What is the effect of learning styles on success in a text-based learning environment?
- What is the effect of learning styles on success in a narration-based learning environment?
- What is the effect of learning styles on success in a computer-mediated (narration + music + text + static picture) learning environment?

METHOD

The method of the study is pre-post test experimental method. In this study, achievement is the dependent variable whereas different learning environments and learning styles are independent variables.

Participants

The research group of the study is composed of 39 from the Department of Computer Education and Instructional Technology, Faculty of Education, Hacettepe University.

Instruments

In this study pre-posttests including 30 items concerning the behaviors to be gained in three different learning environments and Kolb's Learning Style Inventory are used to collect data.

Pre and Post-Tests

A pre and post test was designed consists of 30 multiple choices questions to define effectiveness of the learning environments. The alpha reliability coefficient of the test was found as .54, validity of the test was found as .53.

Kolb's Learning Style Inventory

David A. Kolb's Learning Style Inventory consists of 12 questions about the ways in which one learns best. Each question has four answers, which are ranked by an individual in terms of best fit on a scale of 1 – 4 (being best). Responses are organized into two bipolar concepts: Concrete Experience vs. Reflective Observation and Abstract Conceptualization vs. Active Experimentation. The numbers are summed to give scores for CE, AC, RO and AE. Then (AE – RO) and (AC – CE) are calculated and used abscissa and ordinate, respectively, on a graph that determines one's ultimate learning styles.

Kolb's Learning Style Inventory (LSI, 1976), revised in 1985, purports to categorize individuals on the basis of their self-reported preferred learning style. LSI adapted into Turkish by Aşkar and Akkoyunlu (1993) and its validation and the alpha reliability coefficient of the scale were calculated.

Procedure

Three different learning environments are designed within the scope of this study. The characteristics of learning styles and the details concerning the data collection process are as follows:

Text-based learning environment: Mayer's (2001) principles of multimedia instructional design are taken into consideration to prepare the text to be used in this environment. The text including directions and questions was distributed among students; and the students were asked to progress at their own pace.
Narration-based learning environment: The topic used in this environment was prepared and narrated by the course instructor, Ms. Akkoyunlu.

Computer-mediated (narration + music + text + static picture) learning environment: The topic used in this environment was devised by the researcher through an authoring tool in PC environment in view of Mayer's principles of multimedia instructional design.

Analysis of the Data

The data collected in this study were analyzed through repeated measures of one way ANOVA test.

FINDINGS

The findings of the study are presented in the order of aforementioned research questions:

What is the effect of learning styles on success in a text-based learning environment?

Table 2. Pretest-posttest achievement score means and ANOVA results of learners who have different learning styles in a text-based learning environment

	Pretest			Posttest		
	N	$\bar{x}$	sd	N	$\bar{x}$	sd
Assimilator	19	4.16	1.8	19	5.47	1.7
Converger	20	4.25	1.5	20	5.55	1.5
Source of the Variance Within Subjects	**Sum Squares**	**(df) Sd**	**Mean Squares**		**F**	**p**
Achievement score (pre-posttest)	33,34	1	33,34		22,78	.00
*Learning style * Achievement score*	,001	1	.001		,001	.98
Error	54,15	37	1,46			

Table 2 shows the pretest-posttest achievement scores of assimilator and converger learners in a text-based learning environment. As seen in Table 2, it is identified that, of 39 students in the research group who filled in Kolb's Learning Style Inventory, 19 students have an assimilator learning style and 20 students have a converger learning style.

The pretest and posttest score means of students having assimilator and converger learning styles differentiate in favor of posttest. As seen in Table 2, the achievement of learners who have different learning styles in text-based learning environment does not show a statistically significant change ($p = .98$). The absence of a significant difference among the scores of students having different learning styles though the achievement increases may be due to the fact that students having assimilator and convergent learning styles have common ability to organize and use the information they acquire from the text.

Rasmussen and Davidson-Shivers (1998) state that converger and assimilator individuals are successful in similar learning environments. Bostrom, Olfman and Sein (1990) found out in their study that assimilator and converger students were more successful in comprehension test compared to students having the other learning styles. Wu, Dale and Bethel (1998) point out that converger and assimilator students have comparable success.
Furthermore, students' opportunity in text-based learning environment to study at their own pace, make use of their own studying strategies (highlighting, note-taking, etc.), re-read the points they have missed and be involved in the process actively with the help of questions and directions about the text may also contribute to this result.

What is the effect of learning styles on success in a narration-based learning environment?
Table 3 shows the pretest-posttest achievement scores of assimilator and converger learners in a narration-based learning environment.

Table 3. Pretest-posttest achievement score means and ANOVA results of learners who have different learning styles in a narration-based learning environment

	Pretest			Posttest		
	N	$\bar{x}$	sd	N	$\bar{x}$	sd
Assimilator	19	4.42	1.35	19	5.42	1.57
Converger	20	4.15	1.09	20	5.45	1.23
Source of the Variance Within Subjects	**Sum Squares**		**(df) sd**	**Mean Squares**	**F**	**p**
Achievement score (pre-posttest)	25.77		1	25.77	23.78	.00

*Learning style * Achievement score*	.44	1	.44	.41	.53
Error	40.1	37	1.08		

As seen in Table 3, the pretest and posttest score means of students having assimilator and converger learning styles differentiate in favor of posttest. The achievement of learners who have different learning styles in narration-based learning environment does not show a statistically significant change (p = .53). The absence of a significant difference among the scores of students having different learning styles though the achievement increases may be due to the fact that students having assimilator and convergent learning styles have the opportunity in narration-based learning environment to make use of their own studying strategies (note-taking, etc.) and ask the points they have not understood and due to the style of communication between the course instructor and students through the methods and techniques used in the course. Currie (1995) indicates that assimilator and converger students are more successful in classroom environments where narration and discussion methods are used. Furthermore, Sein and Robey (1991) observed that assimilator and converger students had comparable successes in comparable learning environments.

What is the effect of learning styles on success in a computer-mediated (narration + music + text + static picture) learning environment?

Table 4 shows the pretest-posttest achievement scores of assimilator and converger learners in a computer-mediated (narration + music + text + static picture) learning environment.

Table 4. Pretest-posttest achievement score means and ANOVA results of learners who have different learning styles in a computer-mediated (narration + music + text + static picture)

	Pretest			**Posttest**		
	N	$\bar{x}$	**sd**	**N**	$\bar{x}$	**sd**
Assimilator	19	3.84	1.26	19	5.26	1.28
Converger	20	4.10	1.77	20	5.90	1.48
Source of the Variance Within Subjects	**Sum Squares**		**(df) sd**	**Mean Squares**	**F**	**p**
Achievement score (pre-posttest)	50.55		1	50.55	24.64	.00
*Learning style * Achievement score*	.70		1	.70	.34	.56
Error	75.91		37	2.05		

As seen in Table 4, the mean pretest and posttest scores of students having assimilator and converger learning styles differentiate in favor of posttest. The achievement of learners who have different learning styles learners in a computer-mediated (narration + music + text + static picture) does not show a statistically significant change (p = .56).

There are similar findings in the literature. Melara (1996) designed two computerized learning environments and found out that success of students did not vary according to learning styles. Dalkir (1998) also states that learning acquired in computer-assisted learning environments do not vary according to learning styles.

McWilliams (2001) observed student performances in computer-assisted learning environments and did not find a significant difference in terms of learning styles. In a similar study, Corman (1986) did not find a significant difference between learning styles and performance.

The lack of a significant difference among the scores of students having different learning styles learners in a computer-mediated (narration + music + text + static picture) may be explained due to the fact that students progress at their own pace and make use of their own studying strategies. Furthermore, students having both learning styles prefer individual study because they have concrete conceptualization and learn through thinking and logical thought analysis, which may have resulted in a differentiation of achievement in this environment.

DISCUSSION AND CONCLUSIONS

Consequently, it seems that learning styles do not have effects on the achievement of students in different learning environments.

Studies on various learning environments in the literature also support this finding. Rouke and Lysynchuk (2000) studied the effect of learning styles on success in web-based learning environments. Students whose learning styles were determined by Kolb Learning Styles Inventory were divided into two groups and took place in two different learning environments. The first group studied in a web-based learning environment, and the other group studied in a learning environment composed of printed materials. Then, both groups took an exam. The exam results showed that diverger students received high scores in both learning environments and assimilator students received low scores in both environments. These results indicate that web-based learning environments affect the success of learners having different learning styles.

Daniel, Price and Merrifield (2002) studied the effect of learning styles and learning environments on the distance education of students in the department of physiotherapy. They made use of synchronous (interactive TV) and asynchronous (computer-assisted teaching) learning environments as well as Kolb's Learning Styles Inventory. The data show that neither of these variables affected the success of students.

Werner (2003) studies the effect of self-awareness about learning styles on the selection of learning strategies and the development of comprehension process. Kolb Learning Styles Inventory was used to identify the learning styles of forty-one adult learners who were observed for six months. The subjects tackled strategies and techniques on the basis of time, keeping in the memory, reading, note-taking and decision-making. The data concerning the learning preferences of subjects were collected through the compositions they wrote. The findings of the study show that the learning types (strategies) preferred according to the learning styles of the subjects were not the appropriate strategies.

This finding demonstrates that audiovisual materials used in well-designed learning environments do not affect the achievement of students who have different learning styles. This result shows that the time and place of using a certain type of media is more important than the type of media used for the design of learning environments.

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THE IMPACT OF BLENDED LEARNING MODEL ON STUDENT ATTITUDES TOWARDS GEOGRAPHY COURSE AND THEIR CRITICAL THINKING DISPOSITIONS AND LEVELS

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ABSTRACT
The present study aims to determine the impact of blended learning model on student attitudes towards Geography course and their critical thinking dispositions and skills. An experimental pattern with pretest-posttest control group was used in the study. The study group consists of a total of 57 students – 28 in the experiment group and 29 in the control group – at Kırşehir High School. The experiment group was subject to hybrid learning through the Geography web page, while the traditional learning model was used for the control group. The data were collected through literature review, the Geography Attitude Scale, and the California Critical Thinking Disposition Inventory with Cronbach Alpha values of 0.92 and 0.88, respectively. The data were then subjected to percentage, arithmetic mean, t-test, ANOVA, Scheffé and Pearson correlation tests and the results were interpreted ($p<0.05$). As a results: Blended learning model contributed more to student attitudes toward geography course when compared to the traditional learning model; blended learning model contributed more to student critical dispositions and levels when compared to the traditional learning model; and there was a positive correlation between student attitudes toward geography course and their critical thinking dispositions and levels.

Key Words: Blended learning; Academic Achievement; Attitude; Geography Education

INTRODUCTION

Information technologies and economic reforms have brought about social, political, and economic changes throughout the world. Developments in information technologies have reshaped people's views towards themselves and their environments, as a result of which a parallel change and development at the same pace has become inevitable in the field of geography education. This change and development in the field of geography education is determined by numerous factors. One of the most important among these factors is teachers, which is undoubtedly followed by information technologies. A teacher has a crucial function in managing information technologies and establishing a link between students and information technologies (Oral, 2004).

It is indisputably accepted that the use of information technologies in geography education will greatly facilitate access to and transmission of information (Deniz, 1994). Today, the first thing that comes to mind about the impact of technology on education is computers and Internet use. Computers and the Internet which have become an integral part of daily life could not have been expected to be left out of teaching-learning environments (Deniz, 1994). Computers and Internet use have come to the foreground in the recent practices in geography education. In particular, geographical information systems (GIS) take the lead in this respect and there have been important attempts to introduce these systems into geography education (Bednarz 2004).

It could be argued that as a result of the increasing prevalence of computers and the Internet, in particular, online learning-teaching environments are rapidly becoming more widespread. However, online teaching-learning environments lack many advantages that face-to-face environments have, which led to the notion of blended learning. Sikora and Carroll (2002) reported that online higher education students tend to be less satisfied with totally online courses when compared to traditional courses. Therefore, a combination of online learning and traditional learning environments could be much more useful in solving education problems and meeting educational needs (Murphy, 2003). Furthermore, Graham, Allen and Ure (2003) argue that blended learning was developed for its potential advantages in offering a more effective education, convenience, and access to teaching-learning environments. On the other hand, advocators of the blended learning approach define blended learning simply as "maximizing the best of both worlds", or in other words, the chance to simultaneously benefit from the advantages of online environments and face-to-face learning environments (Morgan, 2002).

In the literature, blended learning is usually perceived in three different ways as media-based, method incorporation or a combination of online and traditional education methods (Usta, 2007). Media-based definitions generally underline the need to combine instructional media and techniques to produce educational output (Bersin, 2004; Singh & Reed, 2001). Apart from this approach which perceives blended learning as a combination of tools, Driscoll (2002) consider blended learning as an environment in which different methods and strategies are used together. On the other hand, Young (2002) defined blended learning as a situation where online education is combined with traditional classroom-based instruction. In this instructional method, the advantages of traditional and online learning methods are supplementary for all education environments. Online educational components naturally become a part of traditional instruction method for students to experience interaction, flexibility, and harmony in classroom environment while they take all their courses online. Using the same approach, Singh and Reed (2001) defined blended teaching as an instruction program that uses more than one presentation method to improve the cost of program presentation and educational output. Blended learning is to incorporate various environments, activities, and technologies designed for a particular learner group and the term "blended" means bolstering classical teacher-centered instruction with other electronic media and materials in an integrative manner (Bersin, 2004). Consequently, blended learning could be considered as an approach which could allow creating suitable environments for students to achieve their learning objectives more easily in improved educational environments by applying appropriate technologies in various classroom environments under different conditions and thus, reducing education costs.

If properly designed, blended learning environments might combine the power of online environments with that of classical face-to-face environments. For designing blended learning environments, Horton (2000) proposes certain methods such as online components that combine face-to-face and online elements for a particular course and familiarize students with face-to-face sessions, online courses defined by students in class and supported by the teacher again in class, and online presentation materials to be used by teachers for in-class presentations.

One of the practices that are most often mentioned among those provided by blending is the opportunity for development on educational applications prevailing in both computer-centered and face-to-face learning environments. Within this framework, blended learning environments might help increase the student-centered strategies and activities (Morgan, 2002; Collis, 2003); facilitate the transition from teacher-centered instruction to a student-centered one (Morgan, 2002); increase student interest towards learning (Collins, 2003); and improve individual consultation services for students.

Access to education is one of the key factors which ensure development of distance education environments. Ease of access has increasingly become more important as more mature students with different external responsibilities are increasingly in need for more additional training. Blended education environments are regarded as a way of increasing conveniences while maintaining and balancing personal communication at the same time (Morgan, 2002; Collis, 2003). Reducing the time allocated to face-to-face sessions might reduce the limitations of time and place for students, thus providing students with flexibility with regard to time, place, and access to course content.

When designing a blended learning environment, the first point to be decided is to design a part of the blended subject matter as face-to-face and some as online. The more common blending technique is usually half-and-half. In other words, 50 percent consists of face-to-face activities in classroom environment and the other 50 percent of activities performed in an online environment (Osguthorpe & Graham, 2003). Table 1 presents the possible components that could be found in a blended environment and used in an online- and traditionally-managed classroom (Eunjoo, 2006 cited in Usta, 2007)
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Table1. *Blended Instruction Model*

Blended Learning (Courses in which a portion of online instruction is replaced by traditional classroom activities)					
Online Instruction			**Traditional Instruction**		
Instruction environment	Activities	Applications	Instruction environment	Activities	Applications
1.Computer-based online learning 2.Synchronous 3.Asynchronous 4.Unidirectional communication 5.Bidirectional communication	1.Introduction 2.Exercise 3.Individual study 4.Discussion 5.Homework 6.Group work 7.Analogy 8.Evaluation	1.Course supervision instruments 2. Video 3.Audial 4.Presentation tools (PowerPoint, Flash) 5.Communication tools	1.Classroom 2. Synchronous 3. Bidirectional communication	1.Introduction 2.Presentations and group work 3.Exercise 4.Evaluation	Varies from one classroom to another

Online blended learning is one of the best practices in a technology-based classroom (Usta, 2007). As a reason for a teacher to prefer a blended instruction environment, Osguthorpe and Graham (2003) point out to some considerations such as educational richness, access to information, social communication, individual activity, cost-effectiveness, and easy correction. Online communication media such as discussion forums, virtual classroom environments, listserv, and blogs could assist individual and group activities in synchronous and asynchronous learning. These media also assist various instructional approaches and learning models such as problem-based learning and cooperative learning, which allows students to work together irrespective of the number of group members (Slavin, 1987). Rossett and Frazee (2003) suggest that instruction tools and planning approaches are crucial components for a successful blending, and that all components of the instruction method can be appropriately combined. A blended model usually includes certain educational components. However, teachers have a wide range of options for blending and they are not only limited to the applications and activities previously known and used. Education might be a combination of formal and informal approaches, technology- and human-based activities, independent and enjoyable activities or direct and exploratory materials.

Schools of the information age are environments that train creative and critically thinking individuals who produce information and have access to the needed information; actively employ and spread information; and actively use information technologies (Balay, 2004). Within this framework, it is an anticipated outcome that the methods and technologies employed in the schools of the information age positively contribute to students' critical thinking dispositions and levels (Branch, 2000). Facione defines critical thinking as the process of purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based (Özdemir, 2005). On the other hand, although critical thinking is defined as an individual's ability to think openly, independently, and rationally, emphasis is made on the fact that the concept does not denote debate and constant negative criticism (Külahçı 1995). It is argued that various education stages include some course content that could only be learned through thinking and without intellectual processes, students will end up in attempting to memorize most information (Paul & Elder, 2001). Nevertheless, students are expected to analyze any presented information, or know how to use it (Brad, 1994). In this context, increased academic achievement is a natural outcome of making critical thinking education a part of educational processes (Elias & Kress, 1994). Yet, individuals cannot improve their critical thinking levels on their own. Currently, it is largely a responsibility of schools to help individuals acquire the skills of critical thinking and information analysis (Kökdemir, 2003).

Geography course has a distinct position for its possible contributions to critical thinking skills. As a discipline analyzing and synthesizing the information collected in the context of human-natural environment interaction, geography requires students to structure the acquired information by questioning it using these criteria at all stages. Thus, they improve their critical thinking skills through a questioning and synthesizing approach.

Schools of the information age are also expected to develop positive student attitudes both toward academic and social issues. To develop positive student attitudes towards geography course, teachers need to have positive attitudes and a sound information background, and to use technology along with modern instruction methods (Tekinarslan, 2006). Given the learning-instruction processes and their effectiveness, it is important to know about the affective characteristics of students such as their interest and attitude towards information technologies and academic subjects (Petty & Cacioppo, 1996).

In the context of the above explanations, the use of blended learning model in geography courses with dimensions such as human, environment, and human-environment interaction is expected to improve students' academic achievement in geography courses, to develop positive attitudes among them towards technology and geography course, and to positively contribute to their critical thinking dispositions and levels. Drawing upon this proposition, the present study attempted – as its problematic – to determine how blended learning model affects student attitudes towards geography course and their critical thinking dispositions and levels.

Research Questions

The present study aims to determine the impact of blended learning model on student attitudes towards Geography course and their critical thinking dispositions and skills. Thus, it sought answers to the following questions:

1. Does blended learning change student attitudes towards Geography course?
2. Does blended learning change students' critical thinking dispositions and levels?
3. What is the relationship between students' critical thinking dispositions and levels and their attitudes towards Geography course?

METHODS

An experimental pattern with pretest-posttest control group was used in the study. The study group consists of a total of 57 students – 28 in the experiment group and 29 in the control group – randomly selected from among the students studying in the Equally Weighted field at Kırşehir High School.

Procedures

The following steps were pursued throughout the experimental operation:

1. The experiment and control groups were randomly assigned. Thus, Class 10TM-G was selected as the experiment group, and Class 10 TM-H as the control group. Class size was taken into consideration in selecting the groups, while student success rates for the previous years and individual differences were neglected.
2. A presentation on "Blended Learning" was presented to the students on March 25, 2008. The students in the experiment group were informed about the way this instruction method would be used, as well as about the characteristics of the instruction process.
3. Both groups were administered the critical thinking and attitude pretests in order to determine whether the experiment and control groups were equivalent in terms of research variables and preliminary information.
4. The research application was carried out four hours a week in a four-week period between April 1, 2008 and April 30, 2008.
5. On May 6, 2008, one week after the application ended, the attitude scale and the critical thinking disposition inventory administered to the students before were re-administered as the posttest.

The following four-week program was administered on the experiment and control groups (Table2):

Table 2. *Four-week program was administered on the experiment and control groups*

Date	Application	
	Experiment Group	Control Group
March 25, 2008	Presentation on "Blended Learning"	-
April 1, 2008	Administering the pretest on critical thinking dispositions and levels and the attitudes towards geography	
April 8, 2008	Using the website designed in accordance with the Blended Learning Model, the geographical subject of soil, soil formation, and the factors affecting soil formation was treated	Using the classical methods (lecturing, questions and answers), the geographical subject of soil, soil formation, and the factors affecting soil formation was treated.
April 15, 2008	The subject of soil types and the factors affecting them was treated using the planned method for the experiment group.	The subject of soil types and the factors affecting them was treated using the planned method for the control group.
April 22, 2008	The subject of vegetation cover and the factors affecting their development was treated using the planned method for the experiment group.	The subject of vegetation cover and the factors affecting their development was treated.
April 29, 2008	The subject of chief plant formations and their distribution on the Earth was treated according to the Blended Learning Model.	The subject of chief plant formations and their distribution on the Earth was treated using the classical methods.
May 6, 2008	Administering the pretest on critical thinking dispositions and levels and the attitudes towards geography	

Within this framework, the following procedures were performed for the experiment and control groups:

a. Control Group

The control group was taught the Soil and Plant Geography, two subjects from the unit on The Three Elements of Nature using the traditional method. The traditional method used for the control group generally consists of teacher-centered, face-to-face learning environments in which the methods of lecturing and questions-answers are employed.

b. Experiment Group

In accordance with the online learning approach of the research, the experiment group was taught the subjects of the Soil and Plant Geography through a website with various visuals and animations specially designed for this purpose. The classes for the experiment group were held in a computer lab with one computer for each student. In this face-to-face learning process during the classes, the instructor introduced an outline of the subject and illustrated it with the visuals in the website.

After the course subject was presented, the students were assigned to perform the activities on the website outside the classroom environment to provide them with further details about the course subject, as well as with further various examples through the website.
The students delivered their activity assignments to the instructor through e-mail. Furthermore, they could also communicate with the instructor through e-mail whenever they had questions about the subject or the assignments. These activity assignments delivered to the instructor through e-mails were then added into the observation files of each student to follow up their improvement. The blended instruction model used in the study is seen in Table 3.

Table3. *Blended Education Model Designed for Geography Course*

Blended Learning (A sample geography course in which traditional classroom activities are replaced with a part of online instruction)					
Online Education Dimension			**Traditional Education Dimension**		
Instruction environment	Activities	Applications	Instruction environment	Activities	Applications
1.Computer-based online learning (Geography Website) 3.Asynchronous (e-mail) 5. Bidirectional communication	1.Introduction 2.Individual study 3.Homework 4.Analogy 5.Evaluation	1. Course supervision instruments 2. Animations 3.Other visuals (images, texts) 5.Communication media (e-mail)	1.Classroom 2.Synchronous 3. Course supervision instruments	1.Introduction 3.Exercise 4.Evaluation	No in-class applications were carried out.

General characteristics of the website used for the application are as follows:
1. Prior to the application, all students were given a username and a password to have access to the system. When they thus have access to the system using their usernames and passwords, they see a page with units, announcements, and activities, as seen in Figure 1. Currently, only the unit on "Natural Systems" is active on the page as the only unit included in the scope of the research.

The announcements section includes questions for students, activity assignments, and other announcements concerning the application.

Figure 1: Unit Introduction Page

2. Clicking on the unit on the screen shown in Figure 1, one sees the page presenting the subjects of the unit, which is displayed in Figure 2. As seen in Figure 2, the subjects of the unit are listed on the left hand side, and the titles are presented as a concept map, in which one can have access to any subject by clicking on the title.

As seen in Figure 3, textual information, images, and animations were designed for each concept in the concept map, which provides students with adequate examples about the subject. Moreover, the animations in the subject pages aimed to present step by step the concept formation stages and students were provided with the opportunity to repeat these animations as many times as they liked to. Some of these animations used on the website had been designed by the researchers, while some others had been taken from other websites.

3. The student administration system working on the website background saved certain information about each student such as the login time to the system, login duration, and the subjects studied. This allowed the researchers to check this information throughout the application period and warn students whenever they felt the need to do so. Thus, they tried to make the students perform the required activities on the website outside the classroom.

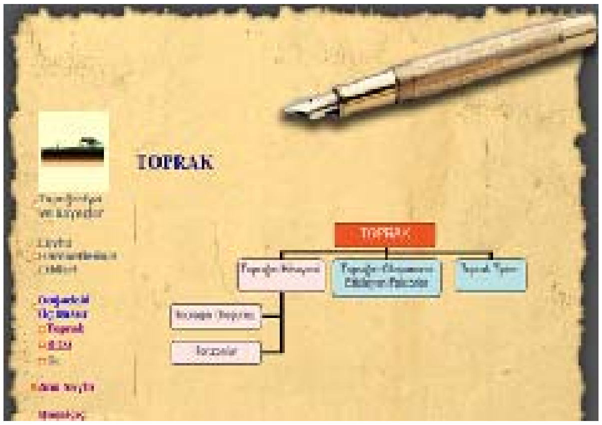

Figure 2: Subject Selection Page

Figure 3: Presentation Page

DATA COLLECTION

a. The Geography Attitude Scale

The data concerning the attitude under study were obtained by administering the five-point Likert-type geography attitude scale developed by Demirkaya and Arıbaş (2004). The geography attitude scale consists of 30 items and has a reliability coefficient (Cronbach Alpha value) of 0.92. The odd numbered items in the geography attitude scale were designated as positive attitude items, while even-numbered items were designated as negative attitude items (Demirkaya & Arıbaş, 2004). The responses for each item used in the attitude scale were scored as "strongly agree=5", "agree=4", "undecided=3", "disagree=2", "strongly disagree=1". After the data entry, the scores in the negative items were changed into "strongly agree=1", "agree=2", "undecided=3", "disagree=4", "strongly disagree=5" and the arithmetic mean values were calculated in line with this scoring.

b. The Critical Thinking Disposition Inventory

To measure the critical thinking disposition, the study uses the California Critical Thinking Disposition Inventory (CCTDI). This inventory was developed thanks to the Delphi project sponsored by the American Philosophical Association in 1990. Rather than measuring any particular skill, the CCTDI is intended to assess an individual's critical thinking disposition, or in broader terms, his/her critical thinking level. The total CCTDI score is also used to test the validity of training programs developed to improve critical thinking dispositions and/or skills (Kökdemir, 2003).

Originally written in English, the inventory was translated into Turkish and was subjected to the required validity and reliability analysis by Kökdemir (2003). For the new version of the inventory consisting of a total of six subscales and fifty-one items, the internal consistency coefficient (Cronbach alpha) was found to be 0.88. The total variance explained by the inventory is 36.13 %. The internal consistency coefficient (Cronbach alpha) for each subscale is as follows: 0.75 for Analyticity Subscale and Open-Mindedness Subscale; 0.78 for Inquisitiveness Subscale; 0.77 for Self-Confidence Subscale; 0.61 for Truth-Seeking Subscale, and 0.63 for Systematicity Subscale (Kökdemir, 2003).

Adding up the response scores on this six-point Likert-type critical thinking disposition inventory, the researcher calculated the raw scores for each subscale, and by dividing the raw scores by the number of questions and then multiplying the quotient by 10, converted them into a standard score ranging between 6 at the lowest and 60 at the highest. For all the subscales, the possible lowest and highest values are constant. Facione, Facione and Giancarlo (1998 cited in Kökdemir, 2003) suggest that individuals with scores lower than 40 for each subscale have low critical thinking disposition skills in the subscale in question, while a score higher than 50 indicates high critical thinking dispositions. Therefore, taking the CCTDI as a whole, it could be argued that individuals with a score lower than 240 (40 x 6) have in general low critical thinking dispositions, while those with scores higher than 300 (50 x 6) have high dispositions (Kökdemir, 2003). The sum of the correct responses obtained in the achievement pre- and post-tests, each consisting of 30 multiple choice questions with five options each, were multiplied by the coefficient 3.3, and the scores of each student were evaluated out of 100 points.

Analysis
The data collected using the scales were subjected to the percentage, arithmetic mean, t-test, Anova, Scheffé and Pearson correlation tests, and the findings were interpreted. For the differences and relationships, a significance level of $p<0.05$ was deemed as sufficient.

RESULTS
1. Findings on Attitude
1.1. Equivalence of the Groups Prior to the Application
Table 4 summarizes the findings on the equivalence between the experiment and control groups in terms of attitude scores prior to the application.

Table 4. *Equivalence between Attitude Scores of the Groups prior to the Application*

	Variables	N	$\overline{X}$	sd	t	df	p
Attitude	Experiment Group	29	103,79	14,08	-2,259	55	0,072
	Control Group	28	111,28	10,78			

An examination of the t test results in Table 4 reveals that there is not any significant difference between the groups in terms of their attitude scores ($t_{(2\text{-}55)}=-2.259$ $p>0.05$). This could be interpreted as indicating that the groups were equivalent in terms of their attitudes towards geography course prior to the application, or, to put it differently, that the experiment and control groups had similar attitudes towards the geography course.

1.2. The Impact of Blended Learning Model on Attitude
Although the difference between the pretest attitude mean scores was found to be not significant, pretest-posttest attitude difference scores were calculated in order to check the effect of the obtained difference. Then, the significance between these difference scores was investigated using the one-way analysis of variance (ANOVA) for non-related measurements. Table 5 presents the pretest-posttest difference scores of the control and experiment groups.

Table 5. *The Pretest-Posttest Mean Attitude Difference Scores of the Groups*

Groups	$\overline{X}$	sd	N
Experiment Group	6,71	7,049	28
Control Group	-2,76	11,618	29

An examination of the pretest-posttest mean attitude difference scores of the groups in Table 5 reveals the following results: The experiment group is $\overline{X}= 6.71$, while the control group is $\overline{X}=-2.76$, indicating a higher mean difference score for the experiment group. Furthermore, following the application there was a negative change in the attitudes of control group students – who were administered the traditional method – towards geography course. A variance analysis was conducted to determine whether this observed difference was significant, and the results are presented in Table 6.

Table 6. *The Variance Analysis of the Pretest-Posttest Attitude Difference Scores of the Groups*

	Sum of Squares	df	Mean Square	F	P
Between Groups	1278,344	1	1278,344	13,729	0,000
Within Groups	5121,025	55	93,110		
Total	6399,368	56			

($\eta2=0,199$)

An examination of the results of the one-way analysis of variance in Table 6 demonstrates a significant difference in terms of pretest-posttest attitude difference scores in favor of the experiment group [$F_{(1\text{-}55)}=13.729$, $p<0.01$]. This finding indicates that when compared to the traditional instruction method, the blended learning model contributes more to student attitudes towards geography course.

According to the results of the variance analysis, the factor's (inter-group) rate of explanation for the total variance in the dependent variable was calculated as $\eta^2=0.199$. This finding suggests that the 19% of the total variance in the difference scores of students' learning levels stems from the experimental application.

2. Findings on Critical Thinking Dispositions and Levels
2.1. Equivalence of the Groups Prior to the Application
Table 7 summarizes the critical thinking disposition and level pretest scores of the control and experiment group students.

Table 7. *The Critical Thinking Disposition and Level Pretest Scores of the Control and Experiment Group Students*

Subscales	Experiment Group (N=28)			Control Group (N=29)		
	Low-Scoring Group (%)	Middle-Scoring Group (%)	High-Scoring Group (%)	Low-Scoring Group (%)	Middle-Scoring Group (%)	High-Scoring Group (%)
Analyticity	3,6	46,4	50,0	10,3	65,5	24,1
Open-Mindedness	25,0	71,4	3,6	44,8	51,7	3,4
Inquisitiveness	32,1	53,6	14,3	41,4	48,3	10,3
Self-Confidence	78,6	17,9	3,6	55,2	37,9	6,9
Truth-Seeking	57,1	42,9	0	51,7	44,8	3,4
Systematicity	53,6	39,3	7,1	62,1	27,6	10,3
Total	35,7	64,3	0	44,8	51,7	3,4

As seen in Table 7 which presents the critical thinking subscales of both the control and experiment group students, the subscale with the highest high-scoring group percentage is analyticity (50.0% for the experiment group; 24.1% for the control group), which refers to being alert to potential problem areas and the use of reasoning and objective evidence even in the face of difficult problems (Kökdemir, 2003). On the other hand, the lowest one is truth-seeking for the experiment group (0%), which refers to the tendency to take into account the alternatives or differing opinions (Kökdemir, 2003); and truth-seeking and open-mindedness for the control group, which refers to tolerance to divergent views and self-monitoring for possible errors (3.4% for both) (Kökdemir, 2003).

An examination of total critical thinking scores reveals that the high-scoring group percentage of the experiment group is 0%, and the high-scoring group percentage of the control group is 3.4%. On the other hand, the middle-scoring students make 64.3% of the experiment group and 51.7% of the control group. These findings suggest that both groups have medium levels of critical thinking dispositions and levels.

Table 8 summarizes the change in critical thinking dispositions and levels of the experiment and control group students pertaining to the pretest.

Table 8. *Changes in Critical Thinking Dispositions and Levels of the Experiment and Control Groups according to the Pretest*

Variables		N	$\overline{X}$	sd	t	df	p
Critical Thinking Dispositions and Levels	Experiment Group	28	248,71	20,336	0,339	55	0,736
	Control Group	29	246,83	21,630			

An examination of Table 8 reveals that the experiment group students have slightly higher critical thinking dispositions and levels when compared to the control group students. However, the same table also demonstrates that there is not a significant difference between the total critical thinking scores of the experiment and control group students ($t_{(2-55)}$=0.339 p>0.05). This could be interpreted as indicating that the groups were equivalent to each other before the application, or, in other words, that the experiment and control groups had similar critical thinking dispositions and levels.

2.2. The Impact of Blended Learning Model on the Improvement of Critical Thinking Dispositions and Levels
Although there is not a significant difference between the pretest mean scores, the pretest-posttest difference scores were calculated in order to check the effect of the obtained difference. Then, the significance between these difference scores was investigated using the one-way analysis of variance (ANOVA) for non-related measurements. Table 9 presents the statistics on the pretest-posttest difference scores of the control and experiment groups.

Table 9. *The Pretest-Posttest Mean Critical Thinking Dispositions and Levels Difference Scores of Groups*

Groups	$\overline{X}$	sd	N
Experiment Group	18,07	14,912	28
Control Group	5,24	22,808	29

An examination of the pretest-posttest mean difference scores in Table 9 demonstrates that the mean difference score pertaining to the critical thinking dispositions and levels is $\overline{X}$= 18.07 for the experiment group, and $\overline{X}$=5.24 for the control group, indicating a higher mean difference score for the experiment group. In order to determine whether this observed difference was a significant one, a variance analysis was performed for the pretest-posttest difference scores in the critical thinking dispositions and levels, and the results are presented in Table 10.

Table 10. *Variance Analysis of the Difference Scores of the Groups in the Pretest-Posttest Critical Thinking Dispositions and Levels*

	Sum of Squares	df	Mean Square	F	p
Between Groups	2344,973	1	2344,973	6,270	0,015
Within Groups	20569,167	55	373,985		
Total	22914,140	56			

An examination of the one-way analysis of variance results in Table 10 demonstrates a significant inter-group difference in terms of their pretest-posttest difference scores in the critical thinking dispositions and levels in favor of the experiment group [$F_{(1-55)}$=6.270, $p<0.05$]. This finding could be interpreted as indicating that, when compared to an instruction performed using the traditional instruction method, the one using the blended learning model contributes more to student critical thinking dispositions and levels.

Table 11 summarizes the findings on the difference between the experiment and control groups in which of the sub-dimensions of the experiment and control groups.

Table 11. *Variance Analysis of the Pretest-Posttest Difference Scores of the Groups in terms of the Sub-dimensions of Critical Thinking Dispositions and Levels*

Variables		N	$\overline{X}$	sd	t	df	p
Analyticity	Experiment Group	28	-1,14	3,960	-1,886	55	0,065
	Control Group	29	0,93	4,325			
Open-Mindedness	Experiment Group	28	4,32	4,611	3,377		0,01
	Control Group	29	-0,31	5,670			
Inquisitiveness	Experiment Group	28	1,04	5,783	-0,155		0,878
	Control Group	29	1,31	7,479			
Self-Confidence	Experiment Group	28	04,93	9,341	1,443		0,155
	Control Group	29	1,59	8,118			
Truth-Seeking	Experiment Group	28	5,61	7,927	2,329		0,024
	Control Group	29	0,79	7,678			
Systematicity	Experiment Group	28	3,50	9,355	1,304		0,198
	Control Group	29	0,69	6,756			

Examining Table 11, it could be observed that student critical thinking dispositions and levels significantly differ in favor of the experiment group at the sub-dimensions of open-mindedness ($t_{(1-55)}$=3.377, $p<0.01$) and truth-seeking ($t_{(1-55)}$=2.329, $p<0.05$). On the other hand, such difference between the control and experiment groups is not the case for other dub-dimensions. This finding could be interpreted as indicating that, when compared to an instruction performed using the traditional instruction method, the one using the blended learning model contributes more to student critical thinking dispositions and levels, particularly at the sub-dimensions of open-mindedness and truth-seeking.

3. The Relationship between Attitude and Critical Thinking Dispositions and Levels

Table 12 summarizes the findings on the relationship between the attitudes of experiment and control group student towards geography course and their critical thinking dispositions and levels.

Table 12. *The Relationship between Attitude and Critical Thinking Dispositions and Levels*

Variables		Attitude	Critical Thinking
Attitude	**r**	1	0,309
	p		0,021
	df	0	54
Critical Thinking	**R**	0,309	1
	P	0,021	
	df	54	0

An examination of Table 12 reveals that, when the group variable is kept under control, there is a positively significant relationship between the pretest-posttest difference scores of student attitudes towards geography course and their pretest-posttest difference scores in critical thinking dispositions and levels ($r=0.309$ $p<0.05$). This could be interpreted as indicating that, the more positive the student attitudes towards the geography course, the higher their critical thinking dispositions and attitudes.

CONCLUSION AND DISCUSSION

The results of the study are discussed below:

1. Blended learning model contributes more to student attitudes towards geography course when compared to the traditional learning model. This finding is compatible with the literature: In a study examining attitude changes of adults towards an online course, Westbrook (1999) investigated attitude changes with regard to the use of technology in class, interaction, learning, time, and satisfaction. The participants of the study consisted of 22 graduate students enrolled in the online course titled “The Basics of Leadership” in a private university in the US. In the study, each student was administered the pretest and posttest measuring their attitudes toward education. The study demonstrated that a significant change took place in student attitudes towards their satisfaction levels in the online course. On the other hand, an examination of the time spent on course content revealed that the students spent significantly longer time for online courses when compared to the time spent for classical online courses. Furthermore, it was also stated that high participation obtained and the similarities in learning levels helped eliminate doubts whether online instruction offered an education that is as high-quality as face-to-face instruction.

Ersoy (2003) carried out a study with 65 undergraduate students enrolled in the course named “Programming Languages II” in the academic year 2002-2003 in order to demonstrate the contributions of web-based instruction to traditional face-to-face instruction. The course was taught using the traditional face-to-face instruction method and was supplemented by a web site. Three questionnaires were administered to the students to collect data to investigate the perceptions of students about web-based instruction, online cooperative learning, and web-based learning environment with regard to the online instructor. The results of the study revealed that students had positive perceptions about web-based instruction and online instructor, while they were uncertain about their perceptions about online cooperative learning.

Robison’s (2004) study investigated the experiences of ten faculty members in designing and teaching blended learning courses at Brigham Young University. The results of the study revealed that the participant faculty members perceived three major benefits in the blended learning experience. First was the more effective use of class-room time; second was increased flexibility in meeting time constraints of both student and professor; and third was greater ability to meet the needs of individual students. Consequently, the study underlined the effectiveness of blended learning environments and recommended it to be used extensively in undergraduate courses.

A study by Ünsal (2007) which mainly aimed to compare the effectiveness of blended and face-to-face learning environments in terms of student achievement and motivation examined the course designed for the study with the dimensions of reaction, achievement and behavior assessment. In the study, both a web-based learning environment was designed in accordance with the blended learning approach, and a face-to-face learning environment was organized. Through this method, the study made a multidimensional evaluation of the effectiveness of the blended learning approach. The study was conducted on 22 control and 24 experiment group students enrolled in an undergraduate course called “Introduction to Computer Science-II.” The results of the study revealed no significant difference between blended learning and face-to-face learning approaches in terms of academic achievement and motivation scores of students. However, a significant difference was detected between blended learning and face-to-face learning approaches in terms of retention scores. On the other hand, the mean general achievement scores obtained in mid-term examinations by the students exposed to the blended learning approach significantly increased when compared to the mean scores of the students taught by face-to-face instruction approach. Other results of the study demonstrated that web-supported learning environment plays a crucial role in areas such as access to information, progressing at one's own pace, enriched learning, and individual studies.

Examining the effect of web-based constructive approach on student achievement in a PhD thesis, Eşgi (2005) investigated the effects of various methods on student achievement and their views on various applications, which included a website designed according top the Cognitive Construction Approach in the light of specified design principles, as well as printed material and face-to-face instruction support. Consisting of a total of 55 students, the sampling of the study was divided into three groups. 18 students in the first group were taught only through website; 18 in the second group were provided with printed material along with the website; and 19 students in the third group were offered the website, printed material and face-to-face instruction support. In the application process, the data were collected through a student achievement test and an opinion survey. At the end of the study, the third group came the first, the second group the second, and first group the third in terms of achievement. It was found that web-based instruction was boring and decreased sociability for the students in the first and second groups, while it was just the opposite for those in the third group.

Usta (2007) conducted a study titled "The Impact of Blended Learning and Online Learning Environments on Academic Achievement and Satisfaction" on 73 students enrolled in the course on "Planning and Evaluation in Instruction." This study reported that blended learning contributed more to academic achievement and retention of information when compared to online learning; and that the experiment and control group students were satisfied with student-student interaction, student-instructor interaction, instructor support, course structure and institutional support in distance education.

To sum up, in their studies Westbrook (1999) and Ersoy (2003) state that online courses positively affect both student attitudes and instructor perceptions. On the other hand, studies by Usta (2007), Ünsal (2007) and Eşgi (2005) argue that blended learning approach contributed more to academic achievement than face-to-face approach. Furthermore, in a study, Robison (2004) underlined the effectiveness of blended learning environments and recommended it for extensive use in undergraduate courses. Consequently, given the positive contributions of the blended learning model to critical learning outputs such as attitude, satisfaction, academic achievement and retention of information, it is clear that certain measures should be taken for the extensive use of this learning model in the system of education.

2. Generally speaking, the students have medium critical thinking dispositions and levels. A literature review reveals some research findings suggesting that critical thinking has a linear effect on student's academic performance (Kaasboll, 1998; Kökdemir, 2003). Given the importance of critical thinking, medium critical thinking dispositions and levels should not be considered as sufficient for students.

Titiz (2001) highlights the fact that memorizing is the greatest problem of current systems of education. Similarly, Yıldız (2003) also state that memorizing is one of the important problems of Turkish education system. The results of a study conducted by Akbulut (1999) demonstrates that questions asked by teachers are largely at the knowledge level; while only to a small extent at the comprehension level and none at the application level and higher levels. As a result, students are expected to make a habit of taking what they read as unquestionable facts without any recourse to critical evaluation. It could be suggested that such habits undermine the power of critical thinking disposition. Consequently, such applications inhibiting the improvement of critical thinking dispositions and levels should be carefully revised. It is important that education programs should be properly updated and instructors should be informed about the importance of critical thinking and how to improve it.

3. When compared to the traditional instruction method, the blended learning model contributes more to critical thinking dispositions and levels of students. Examining the sub-dimensions of critical thinking, this contribution is manifested particularly at the sub-dimensions of open-mindedness and truth-seeking.

It is further emphasized that open-mindedness refers to tolerance to divergent views and self-monitoring for possible errors, and the basic idea behind this trait is an individual's consideration of not only his/her own opinions but also those of others while making a decision (Kökdemir, 2007). Moreover, truth-seeking refers to the tendency to take into account the alternatives or differing opinions, and individuals with high scores in this subscale are more likely to have higher skills of truth-seeking, question-asking and display more objective behaviors even in the face of new information inconsistent with his/her own views (Kökdemir, 2007).

The available literature suggests that blended learning requires students to have control on their own learning processes, and in turn improves their critical thinking and cooperative learning skills (Dziuban, Moskal & Hartman., 2004). Similarly, with regard to online courses allowing students additional time for reflective thinking and processing information, Rovai and Jordan (2004) state those students can process information better in online learning environments where they would be forced to analyze themselves what they learn, instead of decisions and interpretations of others. The additional time created for processing information also contributes to critical thinking skills of students and helps them develop further insight into their responses (Rovai & Jordan, 2004). Furthermore, Garrison and Kanuka (2004) suggest that the high-quality interactive communication enjoyed in blended learning environments could facilitate critical thinking as well as high-level learning, and blended learning also improves the critical thinking skills of students since it promotes independence and internal control. In their study, Lynch and Dembo (2004) also stressed the importance of internal control and argued that critical thinking skills and cognitive and metacognitive learning strategies might be useful in improving internal control in students; and online learning environments could also make crucial contributions to improving internal control. Consequently, it could be suggested that blended learning model helps students improve their ability to control their own learning processes, and thus, add to their critical thinking dispositions and levels.

4. There is a positive correlation between student attitudes towards geography course and their critical thinking dispositions and levels. In other words, the more positive the student attitudes towards the geography course, the higher their critical thinking dispositions and attitudes. As a discipline analyzing and synthesizing the information collected in the context of human-natural environment interaction, geography requires students to structure the acquired information by questioning it using these criteria at all stages. Thus, they improve their critical thinking skills through a questioning and synthesizing approach. In this context, students with positive attitudes towards geography course are expected to have high critical thinking dispositions and levels.

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