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Design and development of a technology enhanced hybrid instruction based on MOLTA model: Its effectiveness in comparison to traditional instruction

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Abstract

Using the model for learning and teaching activities (MOLTA), a new technology enhanced hybrid instruction was designed, developed and implemented. The effectiveness of the hybrid instruction in regard to students' achievement, knowledge retention, attitudes towards the subject, and course satisfaction was evaluated in comparison to traditional classroom instruction. Experimental study with pre-test, post-test control group design was carried out. The sample of the study consisted of 50 university students enrolled in "Computer Networks and Communication" course. The control and experimental groups composed of 24 and 26 students respectively, and the experiment lasted 14 weeks. The findings of the study indicated no significant difference between the hybrid course and the traditional course in students' achievement, knowledge retention, satisfaction, and attitude.

Keywords: Distributed learning environments; Media in education; Interactive learning environments; Computer-managed instruction; Hybrid instruction; Blended learning

1. Introduction

Distance Education and specifically online learning reach students who otherwise would not have access to higher education. This population includes students who could not enter to a higher education program in one of the universities, and students with work schedules that preclude them from participating in a traditional classroom environment. Given a computer and an Internet connection, it is assumed that this portion of the population would be able to complete a degree program or take courses for professional development at leisure time. While these programs were solving some of the resource related problems, in the long term,

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they required logistic support, brought additional cost to the institutions, and could not meet all demands. Not to mention the pedagogical problems of traditional instruction, the idea of using the new technologies as media to overcome those problems and the question "if technology would increase learning" brought the need for online programs. However, early studies showed that technology can be a "double-edged sword" if not properly planned and implemented. Based on the research studies and discussions made on online instruction, the educators came to a conclusion that learning process does not change just because technology is integrated into the instruction (Achacoso, 2003). A carefully designed and well implemented online instruction can help students access more information faster, can give opportunity to use multimedia environments to reach multiple senses of students, and provide support in understanding the content.

The findings of previous research studies indicate that integrating technology into instruction certainly improves access to information. Nevertheless, it is not certain that technology improves learning (Ehrmann, 1999). Similarly, based on his examination of 355 comparative research studies in distance education, Russell (1999) argues that there is no compelling evidence to support the notion that technology improves learning. The discussion on the roles of technology in instruction, purely as a media that cannot support learning/teaching or inherent to the learning/teaching process that enables better learning, resulted in the common view that just focusing on the technology would be wrong, learning should be the center of the interest (Ehrmann, 1999; Jonassen, Campbell, & Davidson, 1994; Russell, 1999). For effective online teaching and learning environments, being aware of various technologies and exploring the abilities of new media are required but not enough. There is a need to understand how learning occurs in online environments (Matejka & Maguire, 2001). Technology should to be used in an appropriate way with the relevant methods. To put things in their right order, it is wise to repeat that technology has to support learning.

Related with the use of technology, Saba (1997) states that "technologies of the information age have the potential to bring education to each person by allowing individuals to take more responsibility for their learning and achieve independence of thought and action" (p. 6). He describes the technology-based teaching and learning process as more learner-centered, rather than teacher-centered; case-based, rather than content-based; contextualized, rather than abstract; and democratic rather than elitist (p. 6).

The inherent problems of online instruction and the pressure of resources like time, money, hardware, software have led to a new idea of mixing the good parts of online courses with the good parts of face-to-face courses. This new structure is given different names, such as hybrid instruction, mediated learning, blended learning, Web-enhanced instruction, and Web-assisted instruction. In general, these types of courses are referred to as hybrid courses. The hybrid approach to instruction is basically composed of face-to-face components like in-class discussion, group work, lecture together with web components like online contents, assignments, announcements, chat room and other online materials. This type of instruction is meant to maintain and increase the quality of the instruction by streamlining and rethinking the delivery of course content. The hybrid course design is different from Web-based instruction (WBI) in that it combines the advantages of face to face and online modes of instruction. Garnham and Kaleta (2002) and Sands (2002) provide some guidelines for hybrid course design and development. Some of the models proposed for designing effective WBI can also be used in hybrid course design. These models are developed by Reeves and Reeves (1997), Caladine (1999) (the model used in this study) and Welsh and Reeves (1997), and provide important guidelines for the designers of WBI.

Several studies show that a "mixed" course structure is preferred by the students, and that hybrid courses affect students' learning positively (Gunter, 2001; León de la Barra, León de la Barra, & Urbina, 1999; Sanders & Morrison-Shetlar, 2001). In their studies, Marques, Woodbury, Hsu, and Charitos (1998) and Jones, Cranitch, and Jo (2001) investigated students' perceptions of hybrid course mode. The findings of their studies indicated positive perceptions of hybrid courses. Studies on student achievement in hybrid courses for different educational levels, specifically high school and higher education, indicated that students were more successful in this type of courses than in purely web-based or traditional courses (Christmann & Badgett, 1999; Christmann, Lucking, & Badgett, 1997; Lilja, 2001; Persin, 2002; Tuckman, 2002). The literature also shows that students' course satisfaction is high, and student attitudes toward technology and technology integrated courses appear to be positive in hybrid courses (Black, 2002; Gray, 1999).

The literature generally points to positive attributes of the hybrid structure. However, there are limited number of detailed empirical studies that examine the effectiveness of the hybrid course in relation to achieve-

ment, knowledge retention, attitude and satisfaction. In this study, a hybrid model of instruction was designed and developed to deliver content of "Computer Networks and Communications" course by technological means. The purpose of this study is to investigate the effectiveness of the hybrid course in terms of students' achievement, retention, attitude and satisfaction in comparison to traditional instruction. The research questions that guided this study are: (1) Is there a significant mean difference between experimental (exposed to hybrid course) and control (exposed to traditional instruction) groups in achievement at the end of the experiment? (2) Is there a significant mean difference between experimental and control groups in knowledge retention one month after the experiment? (3) Is there a significant mean difference between experimental and control groups in attitudes toward computer networks subject at the end of the experiment? (4) Is there a significant mean difference between experimental and control groups in course satisfaction at the end of the experiment?

2. Method

2.1. Design of the study

A pre-test/post-test control group experimental design was used in this study. A hybrid course covering computer networks topics was designed and developed. The independent variable of the study was the treatment (hybrid course or traditional face-to-face course); the dependent variables were the post-test performance, retention test performance, course satisfaction, and attitudes toward the course. Below, detailed information on the participants, the instruments, the procedures followed, and the treatment (hybrid or traditional face to face instruction) are presented. The design of the study is summarized in Table 1.

2.2. The sample

The subjects of the study were 50 students taking the Computer Networks and Communications elective course in a public university in Turkey. A total of 60 students from different departments at the university, registered to the course at the beginning of the semester. The students were assigned to the hybrid course or traditional course by using the matched-pair technique. Registered students were paired based on the grade point average (GPA) and the department, and from each pair, one was assigned to control group the other assigned to hybrid group randomly. Equal representation in terms of students' achievement and students' department types was achieved. However, 8 students from a total of 60 students who made initial registration could not be matched or the students did not want to participate in the selected group and dropped the course in the beginning of the study. During the treatment, 2 students from the control group withdrew from the course. As a result, there were 24 students in the control group and 26 students in the experimental group, yielding 50 subjects participating in the study.

2.3. The hybrid course

The "Computer Networks and Communications" course was designed and developed as a hybrid course for the purpose of this study. The hybrid course required self-paced learning time since the course content

Table 1
Design of the study

	Pre-test	Treatment	Post-test	Retention
Control group	Attitude scale Achievement test	Traditional classroom instruction	Attitude scale Achievement test Course satisfaction form	Achievement test
Experimental group	Attitude scale Achievement test	Hybrid instruction	Attitude scale Achievement test Course satisfaction form	Achievement test

was online, creating a significant reduction in classroom lecture time. In designing the hybrid course, formal and informal data gathered from the students who already took the course were examined. Then the desired outcomes of the course in terms of goals and objectives were specified. Based on the course goals and objectives, the content, the practice items, the visual elements of the web site of the course, and the assessment instruments were determined. Because of internal validity concerns, the majority of the visual elements and the content were adapted from a commercially well-known information source with permission. As the third step, the graphical user interface of the web site was designed. As the last step of creating the web site, the content and the visual materials were coded. The web site of the course was developed by using Active Server Pages (ASP), Microsoft SQL Server 7.0, Dynamic HyperText Markup Language (DHTML), and Cascading Style Sheets (CSS), and it included course content, syllabus, announcements, assignments, forum comments and the cognitive tools (Highlight, Bookmark, Notebook, Pagenote, Search, Glossary, History, Sitemap and Note to Remember) parts (Fig. 1).

The web site included objectivist/instructivist and constructivist elements. Objectivist structure in terms of content presentation structure in the web site was supported with constructivist elements like cognitive tools and in classroom meetings such as group works, games, discussions and projects. The instructional/learning elements of the hybrid course were designed by using Caladine's (1999) model which he called "A Model for Learning and Teaching Activities" (MOLTA). This model was not restricted to online environments. It aimed to help teachers in embracing flexible delivery of material in a systematic manner. MOLTA classified teaching and learning activities into five elements. The differences between traditional and hybrid course with regard to MOLTA are summarized in Table 2.

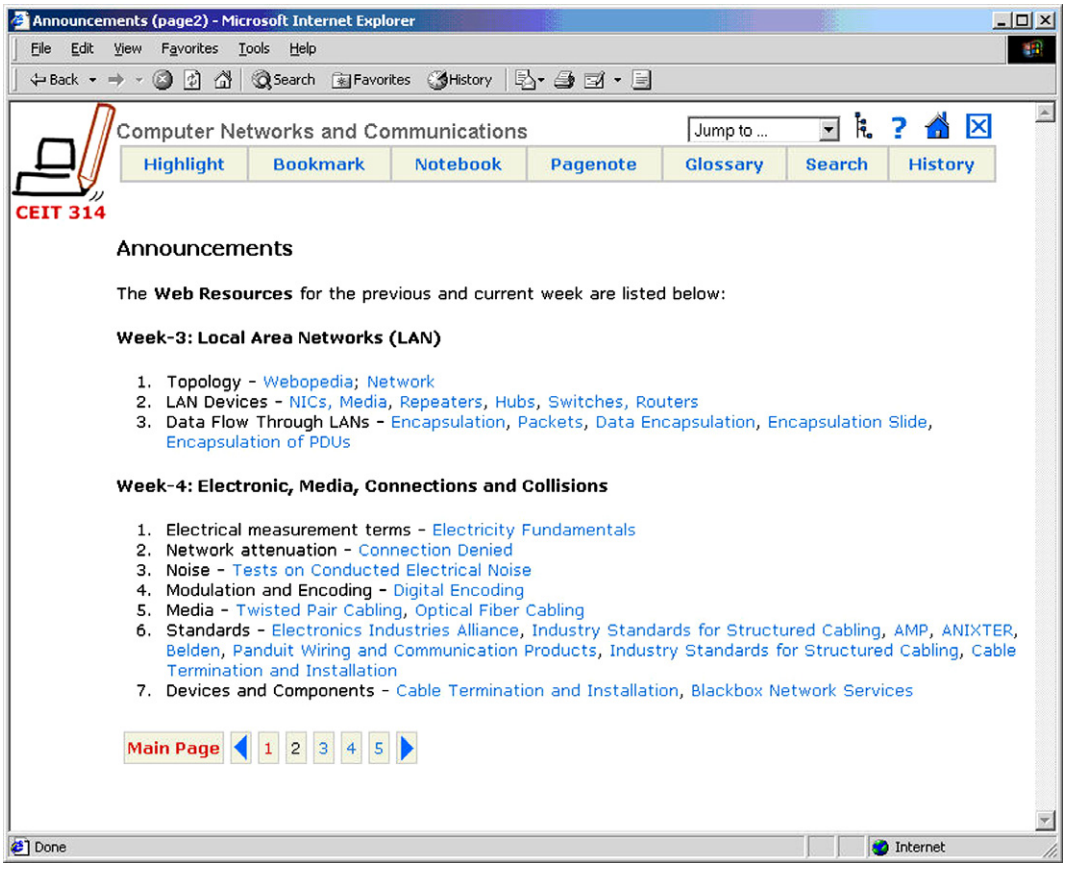

Fig. 1. The web site of the hybrid course.

Table 2
The elements of the hybrid instruction

Element	Traditional course (3 h of classroom meeting each week)	Hybrid course (1 h of classroom meeting each week)
Delivery of material	Lectures supported with PowerPoint presentation	Web-site, on-line materials
Interaction with materials	Text books, notes, library books, homework, quizzes, classroom activities	Multimedia, web browsing, cognitive web tools, homework, quizzes, classroom activities
Interaction with the teacher	Classroom discussion, face to face questions, consultation	Web announcements, forum, phone, face to face questions, consultation
Interaction between students	Group works, classroom discussions, projects, classroom games	Web forum, e-mail, group works, classroom discussions, projects
Intra-action	Classroom discussions, group works	Classroom discussions, group works, web forum

2.4. Data collection instruments

An achievement test, an attitude scale and a course satisfaction form were used to collect relevant data in this study. The achievement test on "Computer Network and Communications" subjects was used as pre-test to measure students' prior knowledge, as post-test to measure knowledge acquisition, and as retention test to measure students' knowledge retention on the course content. The achievement test was adapted from a commercially well-known information source with permission, and consisted of 60 multiple choice type questions. The test was examined by two subject matter experts for internal validity. After the revision, the test was piloted with 40 students who had taken the "Computer Networks and Communications" course in the previous academic year to examine the clarity of items, to understand the time required to fill out the test. The alpha reliability coefficient of the achievement test was .91.

The attitude scale that measured the students' attitudes toward "computer networks and communications" course had 37 five point-likert type items, which was adapted from Yildirim and Ozden (2001). There were positive and negative statements on the scale. The positive items were coded from 5 (strongly agree) to 1 (strongly disagree), and the negative items were coded from 1 (strongly agree) to 5 (strongly disagree) for each statement. The answers of the students were triangulated through at least two statements for each opinion about the subject. The alpha reliability coefficient of the attitude scale was .91 indicating that the instrument was highly reliable.

The course satisfaction form was developed to collect data on students' satisfaction about the hybrid course. It included 14 items in the type of five point-likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree). The form aimed revealing student satisfaction related to instruction and course design. Two experts' opinions were taken for the form. The form was given to the students at the end of the semester.

2.5. Procedures of the study

In the beginning of the study, the achievement test and the attitude scale were given as pre-tests to both control and experimental groups to measure their prior achievement in, and attitudes toward computer networks and communication course. Then the experimental group attended to the hybrid course (1 h of classroom meeting per week) while the control group was lectured in a traditional face to face course (3 h per week). The same content was covered in both courses, and the treatment lasted 14 weeks. The common activities of the traditional and hybrid courses are shown in Fig. 2.

At the beginning of the study, an orientation about how to use the online part of the course such as Internet address of the web site, navigation structures, use of cognitive tools, the security policies, how the site was functioning, and how to choose username and passwords was given to the students in the experimental group. Students were informed about, what was expected from them while using the online part of the course. Every student in the hybrid course had to visit the web site of the course and had to be active online for at least one hour each week. In order to be sure that all students in the experimental group used the web-site of the course, students' activities were recorded with a log-system, and each week, the duration and activities of each student

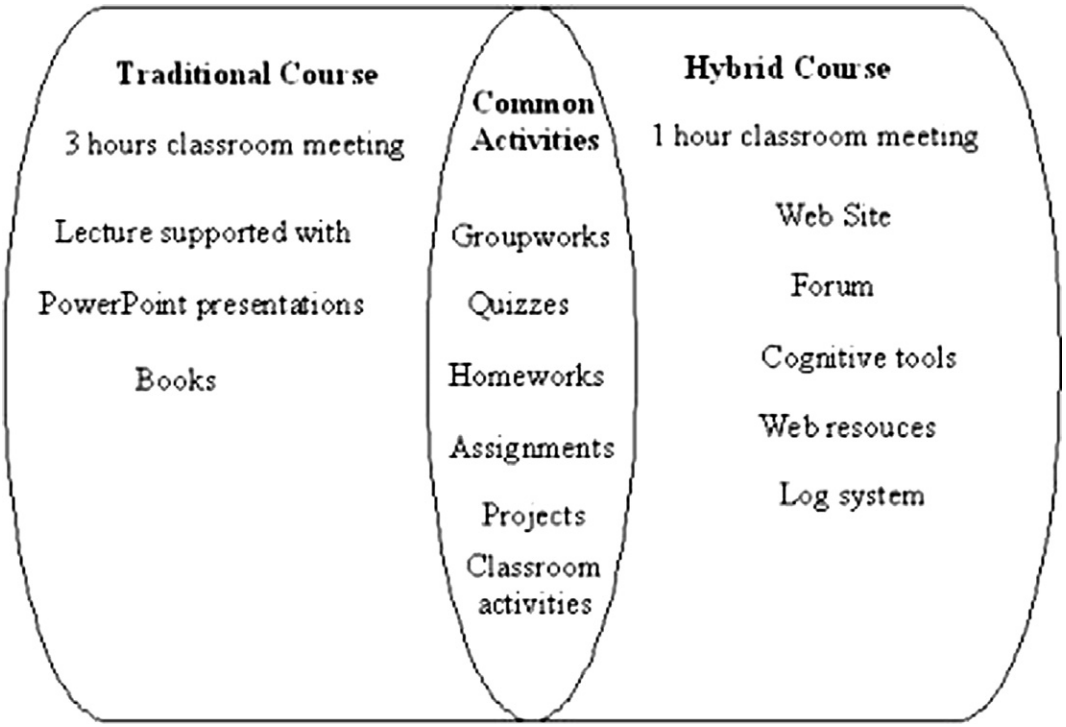

Fig. 2. Common activities of the traditional and the hybrid course.

were checked. The students could not just open the page and leave, since the system logged them out after a 5-min inactive time. During the one-hour classroom meeting, students were informed about their online participation.

When students met once a week for one hour in the class, no lecturing was done. Instead, class time was used for group and individual activities, educational games, discussions of home works and assignments, questions-answers about the subject, and discussions on term projects with the guidance of the instructor.

At the last meeting of the class, the course satisfaction form to measure the students' course satisfaction was given to the students in both groups. At the end of the study the same achievement test and attitude scale were implemented to both groups as post-tests. One month after the post-test implementation, the achievement test was given to both groups again as a retention test.

The data collected through the achievement test, attitude scale and course satisfaction scale were analyzed through descriptive and inferential statistics such as means, *t*-test and analysis of covariance (ANCOVA). Since the matched pairs no longer existed due to the drop outs, in order to check the difference between the experimental and control groups, their pretest scores on prior achievement and attitudes were compared through *t*-test.

3. Results

3.1. Difference between experimental (hybrid course) and control (traditional instruction) groups in achievement

To eliminate the effects of GPA and pre-test results on post-test achievement of the two groups, analysis of covariance (ANCOVA) with two covariates was conducted. A preliminary analysis evaluating the homogeneity-of-slopes assumption indicated that the relationship between the covariates (GPA and pre-test) and the dependent variable (post-test achievement scores) did not differ significantly as a function of the independent variable (treatment), $F(1,45) = 1.78$, $p = .189$, $2 = .038$. This result indicates that we can proceed to ANCOVA.

As it is provided in Table 3, the ANCOVA results showed no significant difference $F(1,46) = 2.426$ $p = .126$, $2 = .050$. Thus, after adjustment by covariates, post-test achievement of students did not differ significantly by the treatment. Both covariates, GPA and pre-test achievement were significantly related with the dependent variable (post-test achievement), $F(1,46) = 11.68$, $p < .001$ and $F(1,46) = 19.21$, $p < .001$, respectively.

Based on the findings, it can be concluded that there was no significant mean difference between the experimental (hybrid course) and the control (traditional instruction) groups in achievement.

3.2. Difference between experimental (hybrid course) and control (traditional instruction) groups in knowledge retention

To eliminate the effect of pre-test and post-test results on retention of the groups, analysis of covariance (ANCOVA) with two covariates was conducted. A preliminary analysis evaluating the homogeneity-of-slopes assumption indicated that the relationship between the covariates (pre-test and post-test) and the dependent variables (retention test scores) did not differ significantly as a function of the independent variable (treatment), $F(1,42) = 2.276$, $p = .115$, $2 = .098$. This result indicates that we can conduct ANCOVA.

As it is shown in Table 4, the ANCOVA results indicated no significant difference $F(1,46) = 1.825$ $p = .183$, $2 = .038$. Thus, after adjustment by covariates, retention of students did not vary significantly by the treatment. Only one covariate, the post-test achievement was significantly related with the dependent variable (retention), $F(1,46) = 65.33$, $p < .001$. The other covariate pre-test was not significantly related with the knowledge retention of students.

The findings indicated that there was no significant mean difference between the experimental (hybrid course) and the control (traditional instruction) groups in knowledge retention one month after the end of the treatment.

Table 3
Analysis of covariance of post-test achievement performance with GPA and pre-test as covariate

Source	Type III sum of squares	d.f.	Mean square	*F*	Significance	Eta squared
Corrected model	635.902	3	211.967	12.727	.000	.454
Intercept	772.200	1	772.200	46.366	.000	.502
Pre-test	319.933	1	319.933	19.210	.000	.295
GPA	194.440	1	194.440	11.675	.001	.202
Group	40.402	1	40.402	2.426	.126	.050
Error	766.098	46	16.654			
Total	109980.000	50				
Corrected total	1402.000	49				

Table 4
Analysis of covariance of knowledge retention with pre-test and post-test as covariate

Source	Type III sum of squares	d.f.	Mean square	*F*	Significance	Eta squared
Corrected model	1498.611	3	499.537	34.201	.000	.690
Intercept	6.074	1	6.074	.416	.522	.009
Pre-test	16.274	1	16.274	1.114	.297	.024
Post-test	954.204	1	954.204	65.330	.000	.587
Group	26.659	1	26.659	1.825	.183	.038
Error	671.869	46	14.606			
Total	101272.000	50				
Corrected total	2170.480	49				

Table 5
Analysis of covariance of post-attitudes towards computer networks subject with pre-attitudes towards computer networks as covariate

Source	Type III sum of squares	d.f.	Mean square	*F*	Significance	Eta squared
Corrected model	1.909E−02	2	9.545E−03	.047	.954	.002
Intercept	4.847	1	4.847	23.814	.000	.336
Pre-attitudes	1.959E−04	1	1.959E−04	.001	.975	.000
Group	1.816E−02	1	1.816E−02	.089	.766	.002
Error	9.567	47	.204			
Total	731.814	50				
Corrected total	9.586	49				

Table 6
Comparison of course satisfaction of control and experimental groups

Group	*N*	Mean	SD	*T* value	d.f.	Two-tail probability
Control	24	4.11	.48	.73	48	.470
Experimental	26	4.01	.51			

3.3. Difference between experimental group and control group in attitudes toward computer networks course at the end of the treatment

To eliminate the effect of pre-attitudes on post-attitudes of the groups, a one-way analysis of covariance (ANCOVA) was conducted. A preliminary analysis evaluating the homogeneity-of-slopes assumption indicated that the relationship between the covariate (pre-attitudes) and the dependent variable (post-attitudes of students) did not differ statistically significant as a function of the control and experimental groups, $F(1,46) = .265$, $p = .609$, $2 = .006$. This result indicated that we could proceed to ANCOVA.

As it is presented in Table 5, the ANCOVA results indicated no significant difference $F(1,47) = .089$, $p = .766$, $2 = .002$. The covariate of pre-attitudes toward ''Computer Networks and Communications'' course was not significantly related with post-attitudes toward the course. After adjustment by the covariate, the difference in the mean scores of control and experimental groups in post-attitude towards computer networks was not statistically significant ($p > .05$).

The results indicated that there was no significant mean difference between the experimental (hybrid course) and the control (traditional instruction) groups in students' attitudes towards ''Computer Networks and Communications'' course.

3.4. Difference between experimental group and control group in course satisfaction

To test the difference between the two groups' satisfaction, t-test was carried out. The experimental (hybrid course) and the control (traditional instruction) groups' mean scores on the course satisfaction scale were compared at a significance level of .05. As it is shown in Table 6, course satisfaction mean score ($M = 4.11$) of the control group was slightly higher than that of the experimental group ($M = 4.01$). The t-test result showed that this difference was not statistically significant at a significance level of .05. This result indicated that there was no statistically significant mean difference in course satisfaction between the experimental and the control and groups.

4. Conclusion and implications

The findings of the study indicated that the students in both experimental and control groups had similar levels of achievement and knowledge retention in ''Computer Networks and Communications'' course. The literature (Christmann et al., 1997; Christmann & Badgett, 1999; Lilja, 2001; Tuckman, 2002; Persin, 2002) indicates higher levels of achievement in hybrid courses. However, the findings of this study proved otherwise.

Marques et al. (1998), and Jones et al. (2001) pointed to students' positive perceptions of hybrid courses. Even though there were no significant difference in attitudes and satisfactions of the experimental and control

groups, both groups had positive attitudes toward computer networks subject, and had high levels of satisfaction in this study. It can be stated that this result is in line with the literature. One of the reasons for positive attitudes and high levels of satisfaction might be students' willingness to learn the "Computer Networks and Communications" subjects covered in the course. The course was not a compulsory course in the curriculum for the participants of this study, and they knew that they were to be assigned to either experimental (hybrid) or control (traditional) groups. Even though it was not included as a measured variable, internal motivation could be one of the reasons for the positive attitudes and high satisfaction levels. Another reason could be both traditional and hybrid courses addressed the students' needs in relation to the course, and resulted in positive attitudes and high satisfaction. It can be concluded from the findings that hybrid course in the area of "Computer Networks and Communications" was as effective as traditional course in regard to achievement, retention, attitudes and satisfaction.

In the literature, there are a limited number of research studies that examine students' achievements, satisfactions and attitudes in hybrid instruction. In that sense, the current study revealed valuable insights that could help and guide other instructors and designers in developing hybrid courses. Before highlighting the implications of this study, it should be noted that "what the ideal mix for a successful hybrid course" has not been clear yet. On the other hand, "mixing" seems to provide a bridge for new technologies to be integrated into instruction. However, it is essential to plan how much and what to "mix" based on the attributes of the course content, students' characteristics such as technology self efficacy, online learning readiness, prior knowledge and instructors/teachers' competencies in online technologies and instructional/learning strategies. What the hybrid course will look like at the end of the design and development depends on the understanding of how learning occurs and how learning will be supported. While hybridizing instruction, the focus should not be only on the technology to be used but also on the means for using technology to facilitate interactivity with the content for relevant and deeper cognitive processes. The design and development should be based on deeply rooted learning theories such as Gagne's (1985) "Nine Events of Instruction", and strong instructional design theories like Merrill's (1994) "Component Display Theory", Reigeluth's (1999) "Elaboration Theory" and Clark's (2002) "The new ISD" in order to apply cognitive strategies to instructional design. This could lead to a more successful and effective hybrid instruction.

Hybridizing of technical courses that require students to understand technical terms and abbreviations should be made with care based on students' prior knowledge. Students can be disoriented and break off easily when they are exposed to difficulty in technical and procedural knowledge that they have no background. Therefore, it is essential to provide students with orientation on the subject area that require prior knowledge, and to consider students' background during the hybrid course design.

The instruction type under investigation was a newly developed hybrid course. As indicated by Clark (2002), the hybrid/blended instruction is not a new paradigm. The use of alternative methods of course delivery has been brought into our attention several times through different means, and parallel to favorite media of the time. The effectiveness of these courses has been discussed for so long, but still they continue to accept students and deliver courses. The pedagogical problems are more related with the "broadcast" nature and one way communication feature of these courses. New technologies like e-mail, the Internet, chat and teleconferencing tools introduced new type of media which actually could contain all the others that were used in the past. Integrating such new technologies into hybrid/blended instruction may eliminate the problems of one way communication.

The main finding of the current study was that there was no significant mean difference in effectiveness between the hybrid and traditional courses. This result is promising since students having classroom seat time reduced by 2/3 were as successful as the students of traditional instruction. This means about 66% of seat time, teaching time and cost reduction. Can this finding be a solution for logistic problems and a key factor to deal with the high demand for university degree? That might be a generalization beyond the effect size of this study, but we can say that hybrid instruction "works" for "Computer Networks and Communications" course. To make more generalizations there is a need for further research studies in different subject area, at different students' levels, and with different design and development models. In the light of the findings, it can be concluded that there is no evidence against using hybrid course as an integral part of instructional design in higher education specific to "Computer Networks and Communications" course.

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