Effects of the Asynchronous Web-Based Course: Preservice Teachers’ Achievement, Metacognition, and Attitudes towards the Course

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ABSTRACT
This present study aimed to investigate the effects of the asynchronous web-based “General Teaching Methods” course conducted based on direct or indirect instructional methods on pre-service teachers’ achievement, metacognition, and attitudes towards web-based course. Two groups, a total of 63 third grade elementary science and mathematics education pre-service teachers, attended to one of the aforementioned web-based courses. The results indicated that the group exposed to the web-based indirect instruction significantly outperformed the group exposed to the web-based direct instruction in the final exam but not in the midterm exam and in the metacognitive questionnaire. On the other hand, the group exposed to the web-based direct instruction had significantly higher attitudes towards web-based course than the one exposed to the web-based indirect instruction.

Keywords
Direct instruction, Indirect instruction, Web-based course, Achievement, Attitude, Metacognition

Introduction
Considerable evidence exists to support the claim that web-based direct instruction (WBDI) or web-based indirect instruction (WBII) compared to the face-to-face (F2F) learning environment promotes students’ achievement (e.g. Matuga, 2001; Pevato, 2003), attitudes toward courses (e.g. Hislop, 2000; Richardson & Price, 2003), and metacognition (e.g. McLoughlin & Luca, 2002; Norton, 2005). The important inflection point for a web-based instruction (WBI), however, is determining which methods are best for a given subject matter (Merisotis & Phipps, 1999). Therefore, there has been an upsurge in publications (Gagne & Shepherd, 2001; Russell, 1999) on the need for instructional theories and their validation in web-based environment as in the F2F learning environment. Having established these facts, the aim of this study is to investigate the effects of the instructional methods (direct or indirect) in the asynchronous web-based course on the pre-service teachers’ achievement, metacognition and attitudes towards web-based course (WBC). Specifically, the study sought to address the following research questions: (1) What is the effect of the asynchronous WBII and WBDI on the pre-service teachers’ achievement in the “General Teaching Methods” course?; (2) What is the effect of the asynchronous WBDI and WBII on the pre-service teachers’ attitudes towards WBC?; and (3) What is the effect of the asynchronous WBDI and WBII on pre-service teachers’ metacognition?

Jonassen (2000) proposed that there were four primary instructional goals of WBDI. These are presenting course content in a manner that it hierarchically structures the sequence of information, obtaining student feedback to ensure accuracy of understanding, providing opportunities for students to question the instructor in order to ensure accuracy of understanding and, lastly, creating opportunities for students to communicate with each other in order to share their understanding of course content.

In contrast to the WBDI, Jonassen (2000) proposed that the primary instructional goals of WBII are: Presenting a problem-solving situation in a realistic context, providing opportunities for learners to collaboratively construct knowledge based on multiple perspectives, discussion, and reflection, providing opportunities for learners to articulate and revise their thinking in order to ensure the accuracy of knowledge construction, and, lastly, creating opportunities for the instructor to coach and facilitate construction of student knowledge.
The Effects of Asynchronous WBI on Achievement

Student achievement in a learning environment is an important learning outcome often examined by researchers. The effect of WBDI (Keller, 1997; Manathunga, 2002; Manuel, 2001; Miller, 2000; Pevato, 2003; Ryan, 2000) or WBII (Gagné & Shepherd, 2001; Jonassen, 2000; Matuga, 2001; Sener & Stover, 2000; Serban, 2000; Tam, 2000; Wegner, Holloway, & Gordon, 1999; Willis, 1995) compared to F2F on educational major students achievement has been investigated widely by researchers.

Studies conducted on comparing WBDI with F2F revealed that WBDI groups performed significantly higher than did F2F groups (Pevato, 2003). The reasons for this significant effect were reported as the highly structured and easily reached content of the course. In other studies, no significant difference was found on students’ achievement exposed to either WBDI or F2F environment (Keller, 1997; Manathunga, 2002; Miller, 2000; Ryan, 2000). These environments did not provide for students a perspective to outperform with respect to other as objectives guide development in both environments. Despite that linear structure of the WBDI course provided students with the feeling of control for their learning process and it caused high motivation to study harder though the students were separated from their teachers by space and time. Manuel (2001), however, reported that F2F group students outperformed better than WBDI group students, as WBDI group students did not significantly master the content due to a lack of experience in the web technologies and the non-interactive structure of the course.

WBII has been proposed as an effective instructional method by many theorists and researchers and assumed as the main stream in the web-based learning environment (Jonassen, 2000; Tam, 2000; Willis, 1995). Matuga (2001) reported in his study that students exposed to the WBII were significantly better than students exposed to the F2F instruction, as WBII encouraged students to think critically and provided students more interaction with their friends so that they felt the community of learning. Other studies (Gagné & Shepherd, 2001; Sener & Stover, 2000; Serban, 2000; Wegner et al, 1999) led to a conclusion of no significant difference between WBII and F2F instruction on student achievement. The core reason for this finding was that students needed strong metacognitive abilities in the WBII.

Although there are no studies that have focused on the effectiveness of WBII compared to WBDI in higher education, the bulk of the evidence in the studies above led us to predict that students using the WBII would score significantly higher on the achievement measures than those who study the course in WBDI.

The Effects of Asynchronous WBI on the Attitude towards WBC

Another important outcome often examined by researchers is students’ attitudes towards WBC (Fredericksen, Pickett, Pelz, Shea, & Swan, 2000; Hislop, 2000; Howland & Moore, 2002; Larson & Bruning, 1996; Lawless, 2000; Oliver & Omari, 2001; Richardson & Price, 2003; Taylor & Mohr, 2001; Weems, 2002). Generally speaking, students’ attitudes towards WBC are affected by their previous computer experiences, their familiarity with the web-based tools (Internet, email, forum, Listserv, etc.), their attitudes towards the course itself, instructional methods used in the course, the content of the course, and a lack of the physical existence of their friends.

Studies on educational major students’ attitudes towards WBC in WBDI environment reported various findings. Hislop (2000), Richardson and Price (2003), and Taylor and Mohr (2001) found that students’ attitude towards WBC increased as most of them expressed high level of satisfaction with the course, and improved confidence in present and future courses. In contrast, Larson and Bruning (1996), and Weems (2002) found that the students’ attitude towards WBC did not change significantly. The no significant change in these findings is due to the fact that the students could not interact with their friends sufficiently to build a learning community. Therefore they found the learning environment static and felt themselves less confident about the accuracy of their knowledge.

Studies on educational major students’ attitudes towards WBC in WBII environment reported that students might have or not have a positive attitude towards WBC, but their attitudes did not significantly change or develop throughout the course period. Howland and Moore (2002), and Fredericksen et al (2000) reported that students had positive attitudes about their online course experience. But, their attitude toward WBC did not change significantly through the course period. Although some students described their learning experience as rewarding but challenging,
others were overwhelmed with the need of relying on themselves. Similarly, the studies of Oliver and Omari (2001) and Lawless (2000) reported that students did not develop a significant positive attitude toward WBC because the course requirements were very challenging and time consuming.

The bulk of evidence in the studies above led us to predict that participants using the WBDI would score significantly higher on the attitude measure than those studying the course in WBII environment.

The Effects of the Asynchronous WBI on the Metacognition

Metacognition generally refers to the ability to understand, control, monitor, and manipulate individual cognitive processes (Brown, Bransford, Ferrara, & Campione, 1983; Reeve & Brown, 1984). The relations of the metacognition with autonomy and interaction push the attention of the researchers on the developments of the students’ metacognitive skills in the web-based learning environment (Tsai, 2004). There might be cyclic relations between some elements of the web-based learning environment and students’ metacognition (Moore, 2002). In other words, web-based learning environment tools and elements stimulate the use of the metacognitive skills and metacognitive skills depending on its levels facilitate interactions and meaningful learning in this environment.

Students can construct knowledge from various and vast store of information by the help of metacognitive knowledge, monitoring and control in the web-based learning environment (Schraw, 2000; Tsai, 2004). Besides, McLoughlin & Luca (2002) reported that web-based learning is likely to be more metacognitive and self-directed. For example, the question prompts and forum discussions in the web-based environment have been found effective to help students focus attention and monitor their learning through elaboration on the questions asked (Norton, 2005). So Asynchronous WBC tools and elements (help functions (Renkl, 2002); pop-up windows (Thomas, 2002); forum discussions (Garrison & Anderson, 2003); preview windows (Cress & Knabel, 2003) might have effects on the development or improvement of the students’ metacognition whether or not instructional methods are direct or indirect.

Methods

Sample

The accessible population of the study was all third grade mathematics and science pre-service teachers in the department of elementary education at public universities in Turkey in which the medium of instruction is English. There are two such universities: Bogazici and Middle East Technical University, having altogether 133 third grade mathematics and science pre-service teachers.

Each university was invited to participate in the present study. Only Bogazici University responded positively to the invitation. Sixty-three pre-service teachers taking “General Teaching Methods” course in their third year of the educational program constituted the sample of this study.

The pre-service teachers were distributed identically to the two groups (WBDI group and WBII group) considering their grade point average (GPA), gender, age, and program (mathematics or science). The members of each matched pair were then assigned to the groups at random. The pre-service teachers distributed to the WBDI group (WBDIG) and WBII group (WBIIG) were 31 and 32, respectively. The 32 WBIIG were composed of 12 male and 20 female, whereas the 31 WBDIG were composed of 13 male and 18 female. The number of pre-service teachers from mathematics was 17 for WBIIG and 18 for WBDIG. The ages of the sample ranged from 21 to 25. The mean of the ages was about 22 for both groups. Of the pre-service teachers participated in the study, their GPA ranged from 1.63 to 3.74 with a mean of 2.41. The mean of the GPA of the WBDIG was 2.40 whereas that of the WBIIG was 2.41.

In analyzing pre-service teachers’ prior experience in computer, 92 % of the pre-service teachers had previously completed at least one computer related course, such as Introduction to Computer, or Computer-Assisted Instruction. Moreover, about three fourths of the pre-service teachers from both groups described themselves as having sufficient keyboarding skills.
Measuring Tools

Midterm and Final Exams of Teaching Methods Course

The midterm exam (ME) and the final exam (FE) required the participants to answer the questions related to the learning objectives addressed in the first five chapters and in the all ten chapters of the one-semester course, respectively. They served to measure the pre-service teachers’ achievement in the “General Teaching Method” course. The 32 questions for the ME and the 34 questions for the FE were submitted to a three-member validation panel, which was composed of the lecturer (the second researcher), who had taught this course for eight years and two English teachers, who had taken similar course previously and had ten years of teaching experiences. The lecturer assessed the questions regarding the appropriateness to the content of the related chapters in the course, the clarity, the correct usage of the language, and the cognitive levels measured whereas English teachers assessed the questions only for the correct usage of the language, their readability and clarity. Most of these questions were directly taken or were slightly adapted from different sources: item pools of the validation panel lecturer, teaching method books (Borich, 1997; Chambers & Sprecher, 1996; Clark & Starr, 1996; Cruickshank, Bainer, & Metcalf, 1995), and the Internet sources (some of the 24 sites are Cotton (2001, sections 1.3), Jarrett (2000). The recommendations of the panel were used to modify and to select the questions for the ME and the FE. Sixteen questions were chosen for the ME, whereas 21 questions were chosen for the FE. Twenty two percent of the FE questions were chosen from the first five chapters. In other words, they were from the content of the ME.

The questions in the ME and the FE were in the form of True/False (Three questions in the ME and four questions in the FE), Fill-in-the-Blanks (two questions in the ME and three questions in the FE), Matching (two questions in the ME and two questions in the FE), Multiple-Choice (five questions in the ME and five questions in the FE), and open-ended (four questions in the ME and seven questions in the FE). The variety of question types in ME or FE aims to measure achievement in the course properly, because each question type requires different cognitive levels and learning styles. By this way, researchers wanted not to leave any pre-service teachers outside the measurement process. Besides, they wanted to increase the validity of the instruments. Specimen questions for each type from the ME and the FE are given in Appendix.

The first researcher scored all the answers except the ones given to the open-ended questions. True/false, Matching, Fill-in-the-blanks and multiple-choice items were scored out of two. On the other hand, two researchers scored answers for the open-ended questions separately and they looked for a consensus at their scoring with respect to pre-prepared answer key. They were scored out of six, eight or more with respect to their requirements of higher level thought, critical thinking and effort. For instance, the open-ended question in FE given in Appendix was eight points. Writing “dramatic enactment” truly was one point, finding “dramatic moments” truly was three points, writing “communication forms” truly was two points and writing “representation forms” was two points. The total score of the ME and the FE was 100. The Cronbach alpha values for the internal consistency reliability for the ME and the FE were calculated as .71 and .78, respectively.

Web-Based Course Attitude Scale

The Web-Based Course Attitude Scale (WBAS) (Ham, 2002) updated from the originally developed scale (Hiltz, 1994) was used to determine pre-service teachers’ attitude towards web-based course. WBAS is a five-point Likert-type scale consisted of 47 items measuring (1) Current Feelings about WWW (e.g. stimulating – dull; Fun-Dreary); (2) Online Course Support (e.g. I needed a lot of help to access course materials on the web); (3) Level of Communication (e.g. Online collaborative activities took too much of my time;) and (4) Perception of Satisfaction and Success (e.g. Taking a web-based course is more boring; I spent too much time surfing on the web instead of studying). The sum of the choices for each item yields a raw score ranging from 47 to 235. In addition, it includes
eight survey-type questions to obtain pre-service teachers’ feelings about the online course and their motivation level for the success.

Internal consistency reliability (alpha) estimates for the WBAS itself and its subscales calculated on the basis of the post-test scores were as follows:

- Current Feelings about WWW : .82
- Online Course Support : .70
- Level of Communication : .83
- Perception of Satisfaction and Success : .71
- WBAS total : .90

General Metacognition Questionnaire

The General Metacognition Questionnaire (GMQ) covering all the components of metacognition –metacognitive knowledge, metacognitive judgments and monitoring, and self-regulation, and control of cognition- without tightening them to any specific domain, such as mathematics, science, literature - was used to determine the level of the metacognitive abilities of the participants. GMQ is a five-point Likert scale developed by the authors. Students were asked to rate 30 statements on the perspective of the judgments about previous learning condition. The authors in a study of 221 pre-service teachers investigated the psychometric properties of the GMQ and found that it was sufficient for use in this study. An overall review of validity data (exploratory analysis extracts factor model and this model emerged from the exploratory analysis was confirmed by confirmatory factor analysis) suggests that the GMQ measures what it aims to measure. GMQ scores could range from 30 to 150. Higher scores indicate higher metacognition ability. Internal consistency reliability estimate of .79 was obtained for this questionnaire on the basis of the posttest scores. Examples of items related to each component –metacognitive knowledge, metacognitive judgment and monitoring, self-regulation, and control- include respectively: (a) When I study, I practice saying to myself the important facts, principles and concepts in my cognition, (b) When a different idea comes into my mind instantaneously, while I am studying, I check it in a different condition, and (c) If I do not comprehend one point in a subject, I return to the related section or words.

Observation Checklist

To determine whether web-based asynchronous “General Teaching Methods” course conducted according to the described instructional methods or not, an observation checklist (OC) was developed by the authors. The items include the most important characteristics of the WBII and WBDI (Jonassen, 2000; Tam, 2000; Willis, 1995). Each of the items uses a five-point scale. Items contain instructor (four items), students (seven items) and medium (four items) related criteria. Examples of the items related to each criterion include (a) “Instructor acts as coach, not a content provider”, (b) “Students focus on knowledge building rather than knowledge reproduction”, (c) “Course site provides links related to the course content to stimulate recall for the prior learning”, respectively.

Data Collection and Analysis

Prior to the beginning of the treatment, GMQ and the first subscale, “Current Feelings about WWW” (CFW), of WBAS were posted to the pre-service teachers by email attachment to be returned in one-week time. The ME and the FE were administered in two different classrooms at the middle and at the end of the semester, respectively. One research assistant was present in each classroom. The instructor (the first researcher) acted as controller in the classrooms. WBDIG and WBIIG pre-service teachers were distributed randomly into the two classrooms considering that each classroom had equal number of pre-service teachers from the two groups. The WBAS and the GMQ were also administered by email attachment at the end of the semester.

The dependent variables of this particular design are pre-service teachers’ “Teaching Method Course” performance in ME, and in FE, their WBAS, their post current feelings about WWW (POSTCFW), and their post metacognition (POSTGMQ). These dependent variables were determined as continuous variables and measured on interval scale. The independent variables of the study were collected in two groups as covariates and group membership (main
effect); Block 1 and Block 2. Pre-service teachers’ age, gender, program, GPA and their pre feelings about WWW (PRECFW), their pre metacognitive ability level (PREGMQ) within Block 1 as covariates. Treatment (Methods of instruction) was included in Block 2 as main effect. The treatment and pre-service teachers’ gender and program were discrete variables and were measured on the nominal scale, whereas their GPA, PRECFW and PREGMQ were continuous variables and were measured on interval scale. The pre-service teachers’ gender was coded as zero for female and one for male. The program was coded as one for math education and two for science education. Lastly, treatment was coded as one for WBDI and two for WBII.

Statistical technique named multivariate analysis of covariance (MANCOVA) was used since it is an extension of analysis of covariance that incorporates two or more dependent variables in the same variables (Fraenkel & Wallen, 1996). The design of the study was a single-factor design. The treatment, independent variable; WBII and WBDI, had to levels. Variance due to the GPA, PRECFW, PREGMQ, gender, program, and age was removed prior to entry of the treatment variable. Block 1 (covariates) was entered first in the MANCOVA model. Block 2 (group membership-treatment) was entered second in the analysis while Block 1X2 (covariate*group interaction) was entered third to determine covariate*group membership interactions. This set must be statistically non-significant for MANCOVA model to be valid. Block 1X2 yielded non-significant increase in total variance for the overall MANCOVA model. Therefore, the interaction set was discarded from the inferential statistical analysis. After MANCOVA analysis, follow-up ANCOVA’s (Protected Univariate F Tests) were used for significant main effects. Step-down analyses were conducted for the significant main effects to remove the effects of the relation between them.

Treatment

“General Teaching Methods” web-based asynchronous course includes ten chapters. These are, in sequence, (1) Introduction to Course and The Effective Teacher, (2) Questioning in the Classroom, (3) Introduction to Methods and Direct Instruction, (4) Discovery Teaching, (5) Problem Solving, (6) Discussion, (7) Cooperative Learning, (8) Computer Assisted Instruction, (9) Project-Based Learning, and (10) Drama. Video clips were used for chapters 1, 5, 6, 7 and 8, and the episodes in terms of dialogs were used for the rest of the chapters as an ill-structured case. Each chapter lasted one week except the first one. The first chapter continued one and half weeks as the pre-service teachers got accustomed to the web-based asynchronous course environment and its tools.

Figure 1 and Figure 2 show the flow of the courses for each week in the WBDIG and WBIIG, respectively. The difference between WBDI and WBII was sourced from timing in the presentation of the lecture notes and the questions directed in the discussion forum. The numbers of periods, threads, and course topics were the same for both groups. In these groups, three or four threads were opened in the first two periods and under each thread three or four questions were directed to the pre-service teachers.

In WBDIG, lecture note related to each week was presented at the beginning of the week. In the first period, questions posed were centered on the lecture note to exemplify and to analyze it. In the second period, questions posed were centered on video clips or episode dialogs to allow pre-service teachers to focus on teaching processes, with the aim of improving students’ learning. For example, for the first chapter called “Introduction to Course and Effective Teacher”, the opened threads were: (1) some terms used in the course, (2) effective teacher, (3) teacher’s level of subject matter, and (4) psychological characteristics. Examples of questions posed for the second thread “effective teacher” in the first and second period of the week were: “Is this statement true: “Successful students will be effective teachers?” and “Is the teacher in the video clips an effective one?” respectively. In the last period, they prepared the summary of the forum discussions in the light of the lecture notes and discussions.

In WBIIG, lecture note related to each week, in contrast to WBDI, was not provided to the pre-service teachers at the beginning of that week. In other words, the content in WBDI was clearly on front of the pre-service teachers. They elaborated and discussed the content, and attempted to analyze examples. Questions in WBDI require restating the information in the lecture note whereas questions in WBII require sharing of experience and ideas. Instructor in WBDIG did not need to use encouraging prompts to provide collaboration between pre-service teachers on the content and pre-service teachers did not need help to acquire the necessary knowledge. On the other hand, pre-service teachers in WBIIG discussed guiding questions and they continuously needed help and collaboration to construct knowledge. WBII questions posed in the first period provided opportunities for learners to collaboratively
construct knowledge based on discussions and reflection, and to articulate and revise their thinking in order to ensure the accuracy of knowledge construction. The questions posed in the second period were centered on video clips or episode dialogs to allow pre-service teachers to focus on teaching processes, with the aim of improving students’ learning. For instance; for the first chapter called “Introduction to Course and Effective Teacher”, the same four threads were opened as in the WBDIG. Examples of questions posed for the second thread “effective teacher” in the first and second period were: “Recall both effective and ineffective teachers you may have had! To what extent did they seem to differ with respect to the knowledge of how to teach the subject, or knowledge of how people learn?” and “What would you do if you were in place of the teacher in the video clips?” Why or why not? In the last period, they constructed the lecture notes based on the forum discussions and research done through the periods on the Internet. Lastly, lecture notes prepared beforehand by the researchers were also opened at the end of the week.

![WBDI Course Flow for Each Week](image-url)

*Figure 1. WBDI Course Flow for Each Week*
In both groups, each pre-service teacher was required to participate at least three times to the discussions in total for the first two periods in each week. Each message of the pre-service teachers in the forum discussions was assessed by using the coding technique developed by McKinnon (2000). After coding the messages in the forum discussions, the instructor used a grading rubric developed by the researchers to score the pre-service teachers’ messages under these codes. The discussion scores of the pre-service teachers related to each week were announced on Sunday at that week. These scores constituted 25% of the course grade.

**Power Analysis**

An essential and primary decision in the power analysis is the determination of the population effect size before the study. Cohen and Cohen (1983) offered the following values; small, $ES = .20$; medium, $ES = .50$; and large $ES = .80$ 

[ES = (Mean of the WBII group – Mean of the WBDI group / standard deviation of WBDI group)]. As many studies
proposed, constructivist approach is appropriate to the nature of web-based learning environments (Jonassen, 2000; Keagan, 1997; Willis, 1995). Therefore, effect size was set to high ($f^2 = 0.33$ for variance and $0.8$ for mean difference) at the beginning of the study. During the analyses, the probability of rejecting true null hypothesis (probability of making type-1 error) was set to .05 as a priori to our hypothesis testing, as it is the mostly used value in educational studies. This study was conducted with 63 pre-service teachers considering nine variables. Then the power for that sample size and large effect size was calculated for nine variables. Power of this study was calculated as .85. Therefore, the probability of failing to reject the false null hypothesis (probability of making Type 2-error) was found as .15.

Results

Only one of the 63 pre-service teachers did not return PREGMQ. Missing PREGMQ data constituted 1.5 % of the whole data. Since this missing data constituted a range less than 5 % of the whole data, it was directly replaced with the series mean of the entire subjects as suggested by Cohen and Cohen (1983).

Determination of Covariates

Six covariates (age, program, gender, GPA, PRECFW and PREGMQ) were predetermined as potential confounding factors prior to conducting the MANCOVA. In order to limit the variables in the covariate set to a few reliably measured and highly correlated ones with the dependent variables (Cohen & Cohen, 1983), these potential covariates were correlated with the dependent variables (see Table 1). Gender, GPA, PRECFW and PREGMQ had significant correlations with at least one dependent variable. Therefore, they remained in the covariate set for the inferential statistics and the rest were discarded.

Homogeneity of Regression

To check the homogeneity of regression assumption, Multivariate Regression and Correlation (MRC) was conducted using enters method for each variable to test the significance of $R^2$ change for four interaction terms produced by multiplying the group membership with the covariates, separately. The contribution of interactions is not significant for the ME, FE, WBAS, and POSTGMQ [$F (6, 49) = 1.768, p = .125, F (6, 49) = .186, p = .980, F (5, 51) = .673, p = .672, and F (6, 49) = 1.074, p = .391$, respectively]. These results indicate that there are no significant interactions between covariates and the group membership; therefore the interaction set was excluded from further inferential statistical analyses.

| Table 1. Correlation Coefficients between Covariates and Dependent Variables |
|-----------------------------|-----------|----------|-----------|
| Covariates                 | ME        | FE       | WBAS      |
| Age                        | -.154     | -.143    | -.157     |
| Program                    | .059      | .156     | -.051     |
| Gender                     | -.274*    | -.305*   | .014      |
| GPA                        | .450*     | .391*    | .117      |
| PRECFW                     | -.026     | .086     | -.292*    |
| PREGMQ                     | .377*     | .282*    | -.264*    |

* Correlation is significant at the .05 level (2-tailed)

The MANCOVA Model

A MANCOVA model conducted revealed that there is a significant main effect for instructional methods (treatment), Wilk’s $\lambda = .509; F (6, 50) = 8.043; p < .05$ (See Table 2). Subsequent to the significant omnibus MANCOVA presented above, protected univariate F tests and step-down analysis were conducted to investigate the unique importance of each dependent variable in the model.
**Protected Univariate F Tests:** A univariate analysis of covariance (ANCOVA) conducted as follow-up tests of the MANCOVA indicated a statistically significant mean difference between groups for the FE in the favor of WBIIG \[F (1, 55) = 31.725, p < .05\] and for the WBAS in favor of the WBDIG \[F (1, 55) = 8.412, p < .05\]. On the other hand, there is no statistically significant difference for the ME and the POSTGMQ \[F (1, 55) = .080; p > .05, F (1, 55) = .011; p > .05, respectively\]. This means that pre-service teachers taught by the WBII got higher scores on the final exam than the pre-service teachers instructed by the WBDI. Moreover, the pre-service teachers in the WBDIG developed a more positive attitude towards web-based course than the pre-service teachers in the WBIIG. The descriptive statistics for each dependent variable are reported in Table 3.

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<th>Table 2. Multivariate Tests Results for the MANCOVA</th>
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**Step-down Analyses:** As there was a significant correlation between the FE and the WBAS (r = .01, p<.05), there was a need to proceed a step-down analysis for the FE as the dependent variable of highest priority, and the WBAS as the additional covariate. The results showed that the method of instruction had significant effect on the FE \[F (1.54) = 35.925, p= .000\]. This implies that after accounting its effect on WBAS, the effect of instructional method on pre-service teachers’ final exam is still significant.

**Treatment Verification**

The instructor followed all of the forum activities, emails, and other web tools and took notes based on the OC criteria about the flow of the lesson. Through the treatment period, he completed OC for six weeks (six chapters) in both groups by using the notes taken during the implementation. The instructor-completed observation was compared by those completed by the outside observers (one experienced teacher for each group) and the interrater reliabilities for the WBII and WBDI were .92 and .88, respectively.

To compare the two instructional methods, the six observations of the instructor for the two courses were used. For this purpose, t-test was conducted. The results revealed that there was significant difference between two instructions on each criterion of the OC except three criteria. These three criteria are related to online settings, which are valid for any proper web-based learning environment. So, it means that the two courses were administered significantly different from each other on the base of the instructional methods. According to these observation scores for each group and the implication from the t-test, it could be assumed that teaching methods course in both groups was conducted according to the treatment requirements.

**Conclusion and Discussion**

The main purpose of this study was to investigate the effects of the asynchronous web-based “General Teaching Methods” courses conducted based on direct or indirect instructional methods on pre-service teachers’ achievement, metacognition, and attitudes towards web-based course. The following conclusions are offered: (a) WBIIG was more
effective on the pre-service teachers’ achievement than WBDI did, (b) WBDI was more effective on pre-service teachers’ attitude towards WBC than WBII did, and (c) there was no significant difference between the WBIIG and WBDIG on metacognition.

The observed value of effect size was calculated for each dependent variable where significant difference was seen. The calculated eta squared was .512 for the total model, .383 for the FE and .142 for the WBAS. Olson and Wisher (2002) reported the results of the 15 studies between the years 1996 and 2002 about the effects of the web-based instruction on the students’ outcomes, such as learning, performance, and satisfaction. In their analysis, effect sizes ranged from -.16 to .40. The grand mean for all 15-effect sizes was .24. So, this study supported previous researchers’ findings. The effect sizes for the total model and the FE are large, whereas the effect size for the WBAS is medium. In other words, results for the FE and for the total model were of practical significance for similar populations.

The significant group differences on the FE support the hypothesis that WBII promotes the achievement. This result also replicate the achievement benefits in mathematics (Sorg, 2000), and educational courses (Goggin, Finkenberg, & Morrow, 1997; Johnson, 2001; Matuga, 2001; Pevato, 2003; Tsai, 2004) associated with WBII that has been observed in the undergraduate and graduate. Insignificant difference between groups on the ME is consistent with the findings of the previous studies (Chellman & Duchastel, 2000; Cyrs & Conway, 1997), which reported that the online learning environment has a novice effect on the students if they take the web-based course for the first time. Due to novice effect, the effect of the treatment remains in secondary level at the beginning of the class. As a matter of fact, novice effect was, especially, seen in the discussion forum. Participation in forum discussions and cohesiveness between threads for both groups improved with time. They investigated the links in the course site more, searched Internet more and sent rich and deep messages containing critical and creative thinking, and intensive interactions. Mean of the discussion scores increased from 5.2 to 7.8 in the WBIIG and from 5.6 to 6.4 in the WBDIG through the course. Similarly, mean of the interaction scores for the WBDIG were increased from 3.2 to 6.8 and that for the WBIIG were increased from 3.5 to 7.1 through the course. This might culminate in the high achievement in the final exam.

Another explanation for the question why WBIIG compared to WBDIG produced a higher performance on the FE might be that WBII required an active process within which students built on previous knowledge and developed personal connections to conceptual material. Indirect instruction paradigm reflects a position that knowledge is not independent of the learner but is internally constructed by the learner as a way of making meaning of experiences. As a result of that the facilitative questions in the WBII focused on the students’ experiences, readings about the concepts and exploring ill-structured cases (videos or episodes) rather than on the definitions and concepts in the lecture notes as in the WBDI. Questions on experiences and ill-structured cases were the heart of the forum discussions in WBIIG to facilitate discovering the concepts of the topic and pre-service teachers presented their ideas by focusing on them. WBII is a developmental process beginning from duality, moving to an understanding of multiple views, and finally acknowledging the context wherein the solution is given (Jonassen, Davidson, Collins, Campbell, & Haag, 1995). Therefore, although the same learning materials were used in both groups, the content of the questions as well as flow of instructions stimulated pre-service teachers differently.

The study found that there is a significant difference between WBIIG and WBDIG in the attitude towards web-based course. Consistent with previous studies (Manuel, 2001; Matuga, 2001), reaching the content easily and obtaining knowledge by spending less effort can explain the difference in attitude towards web-based course in favor of WBDI. The relatively low attitude towards web-based course of WBIIG might be caused by the need of more effort to acquire the content of the course than of the WBDI and it culminated in the need of more time for the familiarity. Familiarity with WBC, in general, was highly correlated with initial attitude towards WBC (Richardson & Price, 2003). As pre-service teachers had no previous experience about the web-based learning environment, the high amount of time-on-task about the challenging subjects caused frustrations. It is similar to the previous researches’ reports (Chellman & Duchastel, 2000; Cyrs & Conway, 1997). This finding was also supported by the WBII’s messages in the informal forum discussion of the course, such as “I studied this course as three times as any other course” or “If I study for any one of my course as much as for this course, I can certainly take a credit AA.” But, this high effort to acquire the content, in turn, produced high performance in the FE for WBII. By providing basic facts and principles without spoiling the flow of discussions in a timely manner in WBII, instructor or moderator might decrease cognitive loads on students. Depending on the students’ attitude, at the beginning lessons, WBDI can be conducted. Later, WBII can be conducted.
Another important finding of this study showed that there was no significant difference between the two groups with respect to general metacognition. It might be caused by the short period of the teaching/learning process or by the pre-service teachers’ high metacognition. Many studies on metacognition reported that they need longitudinal research to observe the change and development in the metacognitive strategies depending on training on them (Schraw & Moshman, 1995; Schraw, 2000). Consequently, activities or tasks might be embedded into online projects, readings, and threads in the online discussions in order to train students in terms of metacognitive abilities. The metacognition of the pre-service teachers in both groups were moderately high or high (only three for WBDIG and two for WBIIG were low). Therefore, future research is needed to be conducted in a more representative sample, which includes students in every metacognition levels. Additionally, research should also attempt to determine differences in the achievement and attitudes of the learners with high and low levels of metacognitive abilities.

There were several limitations to the findings of this study that merit attention. First, although the sample size provided sufficient power for the desired statistical analyses, it was smaller than ideal. Future studies could address this issue through larger and more representative samples and ideally using true experimental design. Although the experimental and control group was randomly assigned, the participants in both groups were administratively defined (already existed group).

An additional limitation comes from the self-report nature of the GMQ and the WBAS. Self-report measure of metacognition does not guarantee that the participants actually had and used the metacognitive abilities. Self-report measure of attitudes does not guarantee that the participants felt this way all through the course. Behavioral measures or think-aloud protocols during the treatment would have enabled more certainty as to whether participants were actually using metacognitive abilities and how they felt during the course of the experiment.

Another limitation of this study concerns the dealing of pre-service teacher belong to two different programs. This created difficulty focusing on deeply in mathematics and science. Additional research is needed to fill the gaps in our understanding of the pre-service teachers’ achievement and attitudes during the Asynchronous Web-Based Mathematics or Science Method Course. In this respect, scores obtained from online discussion forum should also be used to determine course achievement besides paper-based exams. It might positively affect both achievement and attitude towards web-based course.

The implication of this study for pre-service teachers involves the importance of indirect instruction on academic performance but not much on attitude.

References


Howland, J. L., & Moore, J. L. (2002). Student perceptions as distance learner in Internet based courses. Distance Education, 23 (2), 183-195.


Appendix

Example Questions from the Midterm Exam

1. “Who can tell me the cell division?” is a leading question.
   True                                           False

2. Focusing the subject on one idea at a time and presenting it so that learners can master a point before the teacher introduces the next point is the key of the --------------- method.

3. Directions: Match the description in column A with the correct method in column B. Write the matching letter in the blanks provided in column A. The items in column B may be used once, more than once, or not at all. Consider the primary characteristics of the method!

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>----- 1. Teaching how to deal with new situation</td>
<td>A. Questioning</td>
</tr>
<tr>
<td>----- 2. Helping students to evaluate their own progress</td>
<td>B. Problem Solving</td>
</tr>
<tr>
<td>----- 3. Providing students a structured presentation.</td>
<td>C. Discovery</td>
</tr>
<tr>
<td>----- 4. Helping students to organize and build.</td>
<td>D. Lecturing</td>
</tr>
<tr>
<td>----- 5. Helping students to monitor and regulate their action.</td>
<td>E. Expository</td>
</tr>
<tr>
<td>----- 6. Helping students to recognize their environment</td>
<td></td>
</tr>
</tbody>
</table>

4. Which one the following is NOT the primary limitations of the lecturing (a type of direct instruction)?
   A. Audience is passive   B. Learning is difficult to gauge
   C. Communication in one way  D. Time used for lecturing

5. First “Express 3/8 as a decimal” then draw the distinctions in the solution related to the different types of mathematical competence (Fact, skill, concept, strategy) possessed by an individual. (8 points)

Example Questions from the Final Exam

1. Project-based learning is an instructional method that aims at student engagement in real-world tasks to enhance learning.
   True                                         False

2. The question “How do single-celled animals reproduce themselves and divide up to create similar animal life that looks like themselves?” is an ineffective question because it is ---------------------question. It should be stated as: -------------- --------------------------------------

3. Directions: In the following exercise, column A contains description of students’ activities in team-oriented cooperative learning and column B names of three types of the team-oriented cooperative learning. Match each activity in column A with its corresponding type of team-oriented cooperative learning. Write the matching letter in the blanks provided in column A. Team-oriented cooperative learning types may be used one, or more than once.

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>----- 1. Students learn the content through the teacher presentation.</td>
<td>A. Students Teams - Achievement Division</td>
</tr>
<tr>
<td>----- 2. Students read the unique section of the text at the beginning of the class.</td>
<td>B. Jigsaw</td>
</tr>
<tr>
<td>----- 3. Students monitor teammate’s level of understanding.</td>
<td>C. Team-Assisted Individualization</td>
</tr>
<tr>
<td>----- 4. Students study through the assigned unit given by the student’s monitor.</td>
<td></td>
</tr>
<tr>
<td>----- 5. Students take worksheet and work on it with their team.</td>
<td></td>
</tr>
<tr>
<td>----- 6. Expert groups help the students by giving information about the content.</td>
<td></td>
</tr>
</tbody>
</table>

4. Which one of the following is NOT TRUE for the drama as a method?
   A) Experiential approach is used for learning
   B) Product is the major goal of the drama.
C) A variety of communication experiences are offered.
D) Teacher becomes a learner among the learners

5. Read the case below! Assume that the learning task is the organelles of an animal cell and the subject is explained by the drama. Each of the organelle is matched with a student.
   Student N- Nucleus
   Student M- Mitochondria
   Student G: Golgi apparatus

The students stand in the center of the class. Firstly, students introduce themselves. For instance; Student R says:” My name is ribosome. I’m the smallest cell and I’m responsible for the protein synthesis in the cell.” After students introduce themselves, they act the activities of the cell while it digests a harmful bacterium. The students show the relations between the organelles and display the functions.
Analyze the concepts below by using the drama example above.
   Dramatic enactment:
       Dramatic moments (At least two)
       Communication forms (at least two)
       Representation forms (at least two)