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Examining the relations between science attitudes, logical thinking ability, information literacy and academic achievement through internet assisted chemistry education

Hale Bayram[a*], Arif Comek[b]

[a]*Ataturk Faculty of Education, Marmara University, Istanbul, Turkey*

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Abstract

Homework is often assigned in Chemistry classes to facilitate students' learning. The main purpose of this study is to investigate the relations between students' science teaching attitude, logical thinking ability, information literacy self efficacy and academic achievement through internet assisted chemistry education. The study was carried out in the spring term of the 2006-2007 academic years for 10 weeks and 61 prospective science teachers enrolled in the science teacher education program at Marmara University constituted the study groups of the research. For this purpose, the students were randomly split into two groups. Group-1 (N=30) developed a teaching website for electrochemistry and Group-2 (N=31) prepared teaching portfolio for the same subject as homework. Data were collected by the Test of Academic Achievement, the Turkish version of the Science Teaching Attitude Scale II (STAS-II) revised by Moore and Foy, logical thinking ability test and information literacy self efficacy scale. Pearson Moments Correlation coefficient was used for the analysis of the data to specify the relations between the students' science teaching attitude, logical thinking ability, information literacy self efficacy and chemistry achievement. In addition to that, to obtain the most suitable regression equivalent in explaining the students' chemistry achievement, multiple regression analysis was used. At the end of the study for the first group; it was revealed that the students' chemistry achievement significantly correlates with their science teaching attitude ($r=0.663$; $p<0.01$) and logical thinking ability ($r=0.817$; $p<0.01$). But there is no correlation between the students' chemistry achievement and information literacy self efficacy ($r= -0.128$; $p>0.05$). Also, these variables significantly predict the students' chemistry achievement. The independent variables (science teaching attitude and logical thinking ability) explain about 78.4% of the total variance of the chemistry achievement. On the other hand for the second group, the students' chemistry achievement significantly correlates with their information literacy self efficacy ($r=0.480$; $p<0.01$). But there is no correlation between the students' chemistry achievement and science teaching attitude ($r=0.181$; $p>0.05$) and logical thinking ability ($r=0.293$; $p>0.05$). Also, information literacy self efficacy significantly predict the students' chemistry achievement and explains about 20.3% of the total variance of the chemistry achievement.

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Keywords: Chemistry education; homework; internet; information literacy self efficacy; logical thinking ability; science teaching attitude.

*Hale Bayram.
E-mail address: haleb@marmara.edu.tr

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1. Introduction

To expect that the manner in which students engage themselves with their homework is important. However, relatively little attention has been paid specifically to the mechanics of how students actually do homework outside the classroom (Kotas, 2002). Besides**,** homework is often assigned in Chemistry classes to facilitate students' learning.

The widespread use of information and communication technologies (ICT), and particularly the use of the World Wide Web (WWW), has made feasible many new forms of collaborative distance learning activities that take advantage of the capacity to integrate communications with information access and organization, within a commonly accessible hyper-linked environment (Collis, 1999; Khan, 1997). Research and development in the field of using internet for education have made rapid progress during the past years. There is an increasing amount of research directed at the affects of internet on learning. The internet provides the students access to the information at any time. This allows students to work at their own pace, on their own time, and extends their understanding of the related subject.

As recent progress suggest that Internet usage is becoming an integral part of the learning environment in higher education. There is a number of experimental studies on the Internet as a means of delivering course materials and as a way of enhancing communication with students all over the world. Internet is now widely used in most of the developed countries to promote the education and life-long learning in an effective way (Hirumi, 2002). One of the most common uses of the Web for teaching purposes is to use it as a tool of homework, and deliver it to the instructor online or place on the internet where it is accessible to current students, potential students, and to other interested people.

Results from the Rayburn & Rayburn study (1999) showed that students who consistently complete homework perform better on examinations. In addition, the use of homework positively impact students' retention and understanding of materials covered in the classroom (Cooper, 1989).

Türkmen and Bonnstetter (1999) studied Turkish preservice science teachers' attitudes toward science and science teaching by using a Turkish version of Science Teaching Attitudes Scale (STAS II) developed by Moore and Foy (1997). The sample size of the study was 612 freshman, sophomore, junior and senior science education major students of four different teachers colleges located in different parts of Turkey. Results of this study indicated that preservice Turkish science teachers have positive attitudes toward science and science teaching.

Many studies have indicated that elementary teachers' attitudes towards science teaching is important in determining both the quality and quantity of science taught to children (Schoeneberger & Russell, 1986; Wallace & Louden, 1992) since the attitude towards science teaching translate into effectiveness and time spent on teaching science.

Moreover teachers' beliefs, especially self efficacy beliefs, are indicators of teachers' instructional behavior in classroom. Self efficacy was found in social cognitive theory developed by Bandura (1977) who defined self-efficacy as "beliefs in one's capabilities to organize and execute the courses of action required to manage prospective situations" (Bandura, 1986, p. 3). Bandura (1997) proposed that efficacy beliefs were powerful predictors of behavior because they were ultimately self-referent in nature and directed toward specific tasks.

Information literacy can be defined as having information about how learning is, how information will be organized and about how information will be used in different ways. Information literacy can also be defined as learning to learn . An information-literate individual is someone who has learnt how to learn as s/he knows how information is organized and used. S/he also has the ability of life-long learning since s/he can always find the information that s/he will need in doing a job, solving a problem s/he meets or taking a decision (ALA, 1989). Students who are information-literate have various sources for the use and evaluation of information (Barton, 2000). On the other hand, as pointed out by Kenway (1995), possession of technological capital enables the Internet's users to become producers and distributors of their own products. So the students are in one way consumers and the other way producers and distributors of educational materials and knowledge.

The present study examines the effectiveness of online homework, one of the Web-based instructional tools, used to enhance traditional classrooms. The main purpose of this study is to investigate the relations between students' science teaching attitude, logical thinking ability, information literacy self efficacy and academic achievement through internet assisted chemistry education. It was tried to determine how the WBH and PPH affected the preservice science teachers' chemistry achievement.

2. Research Question

In this paper, the use of Internet for assignments in the teaching of chemistry is highlighted. The original idea for the study came from the desire to more effectively integrate the Internet in chemistry classes. This study assesses the effects of students' overall performance, when using web sites on the internet to as compared with traditional manually performed homework. To investigate the impact of the web-based homework on chemistry learning, the following question was addressed as the main research question:

Given that the same homework problems were assigned in WBH and PPH groups, what are the relations between preservice science teachers' science teaching attitude, logical thinking ability, information literacy self efficacy and academic achievement through internet assisted chemistry education?

3. Methodology

In this part of the study, the investigation model, performing the application, participants, collecting and analyzing data will be described. The research was designed according to pretest-posttest experimental model with control group. An experiment group and a control group are formed. The effect of the independent variables; science teaching attitude, logical thinking ability, information literacy self efficacy on the success of the students has been investigated.

During semester, the experimental web-based homework group (WBH) and the control traditional paper and pencil homework group (PPH) were both taught the subject by the same method. In both WBH and PPH groups, approximately 10 % who started the study did not complete the study; some did not take or did not complete the pretest or posttest. The instructor provided both groups with the same list of homework exercises for the entire semester.

This study employed quantitative measures in order to clarify the various effects of different variables on the students' academic performance. The study was carried out in the spring term of the 2006-2007 academic year for 10 weeks. At the beginning of the application, the success test was given as the pretest to the control and experiment groups. For both groups, the units were taught through internet assisted chemistry education. At the end of the study, both the experiment group and the control group were given the success test as the posttest and science teaching attitude scale II (STAS-II) revised by Moore and Foy, logical thinking ability test and information literacy self efficacy scale once. The result of these tests formed the database.

The study took place using the preservice science teachers' of the Ataturk Education Faculty at Marmara University and the sample group was formed by the students who attended the Selected-V: Computer assisted science teaching course. 61 prospective science teachers enrolled in the science teacher education program at Marmara University constituted the study groups of the research. For this purpose, the students were randomly split into two groups. Group-1 (N=30) developed a teaching website for electrochemistry and Group-2 (N=31) prepared teaching portfolio for the same subject as homework. All students were aware that they were participating in a study, and, although encouraged to take part, participation was voluntary. Indeed, a small number of individual students chose not to participate. Both groups were guided and taught by the researcher.

Before and after the application, the teacher candidates' chemistry achievements were defined by pretest and posttest. The experimental data were collected by the Test of Academic Achievement, the Turkish version of the Science Teaching Attitude Scale II (STAS-II) revised by Moore and Foy (1997), logical thinking ability test –PLT- (Almstrum,1996) and information literacy self efficacy scale (Kurbanoğlu and Akkoyunlu, 2001).

The Science Teaching Attitude Scale II (STAS-II) was originally prepared by Moore in 1973 as STAI and revised the test by the year 1997 (Moore & Foy, 1997). The STAS-II has 60 statements related to science and science teaching. These statements are rated using a Likert-type scale and consist of 30 positive and 30 negative statements. The statements are also evenly divided to measure attitudes toward science and toward science teaching. This attitude test was used for both groups once as posttest in order to measure and assess students' attitudes toward science and science teaching.

The Turkish version of the logical thinking ability test –PLT- (Almstrum, 1996) has 4 groups' statements and each group has 4 statements, so it has 16 statements, each has four choices, related to logical operators. It was used for both groups once as posttest in order to measure and assess students' logical thinking ability.

Information literacy self efficacy scale is a Likert-type scale and was prepared by Kurbanoğlu and Akkoyunlu, (2001) and was used for both groups once as posttest in order to measure and assess students' self efficacy about their information literacy.

4. Findings

Pearson Moments Correlation coefficient was used for the analysis of the data to specify the relations between the students' science teaching attitude, logical thinking ability, information literacy self efficacy and chemistry achievement. In addition to that, to obtain the most suitable regression equivalent in explaining the students' chemistry achievement, multiple regression analysis was used. Analyses were performed by using SPSS Regression. The regression equation is given below.

$$V = A - B_1X_1 + B_2X_2$$

The relations between science teaching attitude, information literacy self efficacy, logical thinking ability and chemistry achievement were examined by calculating Pearson Correlation values through correlation method for both groups.

Table1. The Correlation Between Chemistry Achievement, Science Teaching Attitude, Information Literacy Self Efficacy And Logical Thinking Ability For The First Group.

		Chemistry Achievement
Science Teaching Attitude	Pearson correlation significance (2-directional)	0,663
		0,000
	N	30
Information Literacy Self Efficacy	Pearson correlation significance (2-directional)	-0,128
		0,502
	N	30
Logical Thinking Ability	Pearson correlation significance (2-directional)	0,817
		0,000
	N	30

As it is seen Table 1, there is high a level positive and significant relation between the students' chemistry achievement, science teaching attitude ($r=0.663$; $p<0.01$) and logical thinking ability ($r=0.817$; $p<0.01$). But there is no correlation between the students' chemistry achievement and information literacy self efficacy ($r= -0.128$; $p>0.05$). Accordingly, students getting high scores from science teaching attitude scale and logical thinking ability test also get high scores from chemistry achievement test with WBH.

Also, these variables significantly predict the students' chemistry achievement. In order to identify the predictors of students' chemistry achievement scores multiple regression analysis was used. As a result, positive relations were detected between the students' chemistry achievement scores and the independent variables: science teaching attitude and logical thinking ability ($F=36,1$; $p<0.01$). There are 3 different independent variables and these two explain about 78.4% of the total variance of the chemistry achievement. The variables that significantly predict the students' chemistry achievement scores are science teaching attitude ($t=4,27$; $p<.05$) and logical thinking ability ($t= 6,97$; $p<.05$). Table 2 shows the results of the multiple regression analysis regarding the prediction of the students' chemistry achievement with WBH.

Table 2. The Results Of Multiple The Regression Analysis Regarding The Prediction Of The Students' Chemistry Achievement With WBH.

	B	St.Er.	βeta	t	p
Constant	-12,53	5,69	-	-2.2	0.037
Science Teaching Attitude	0,075	0,018	0,402	4,277	0,000
Information Literacy Self Efficacy	-0,006	0,016	-0,032	-0,366	0,717
Logical Thinking Ability	1,223	0,175	0,656	6,975	0,000

Regression analysis results presented above in Table 2. The score of the chemistry achievement was run as the dependent variable in the regression analysis where science teaching attitude, information literacy self efficacy and

logical thinking ability were independent variables. This analysis yielded a significant result (F=36,1; p<0.01). Independent variables explain about 78.4 % of the total variance.

The regression equation for the prediction of the chemistry achievement with WBH as per the results of the regression analysis is given below. Chemistry Achievement with WBH = -12,53 – (0,075 Science Teaching Attitude + 1,223 Logical Thinking Ability)

On the other hand for the second group, the students' chemistry achievement significantly correlates with their information literacy self efficacy (r=0.480; p<0.01). But there is no correlation between the students' chemistry achievement and science teaching attitude (r=0.181; p>0.05) and logical thinking ability (r=0.293; p>0.05). Accordingly, students getting high scores from information literacy self efficacy scale also get high scores from chemistry achievement test with PPH.

Table 3. The Correlation Between Chemistry Achievement, Science Teaching Attitude, Information Literacy Self Efficacy And Logical Thinking Ability For The Second Group.

		Chemistry Achievement
Science Teaching Attitude	Pearson correlation	0,181
	significance (2-directional)	0,331
	N	31
Information Literacy Self Efficacy	Pearson correlation	0,480
	significance (2-directional)	0,006
	N	31
Logical Thinking Ability	Pearson correlation	0,293
	significance (2-directional)	0,110
	N	31

In order to identify the predictors of students' chemistry achievement scores multiple regression analysis was used for the second group as the first. As a result, positive relations were detected between the students' chemistry achievement scores and information literacy self efficacy (F=3.54; p<0.01). There are 3 different independent variables but only one of them significantly predicts the students' chemistry achievement. The variable that significantly predicts the students' chemistry achievement scores is information literacy self efficacy (t=4,27; p<.05). Table 4 shows the results of the multiple regression analysis regarding the prediction of the students' chemistry achievement with PPH.

Table 4. The Results Of Multiple The Regression Analysis Regarding The Prediction Of The Students' Chemistry Achievement With PPH.

	B	St.Er.	βeta	t	p
Constant	-2,891	9,152		-0,316	0,754
Science Teaching Attitude	-0,003	0,041	-0,012	-0,068	0,946
Information Literacy Self Efficacy	0,058	0,022	0,452	2,601	0,015
Logical Thinking Ability	0,263	0,189	0,231	1,390	0,176

Regression analysis results presented above in Table 4. The score of the chemistry achievement was run as the dependent variable in the regression analysis where science teaching attitude, information literacy self efficacy and logical thinking ability were independent variables. This analysis yielded a significant result (F=3.54; p<0.01). Independent variable explains about 20.3% of the total variance.

The regression equation for the prediction of the chemistry achievement with PPH as per the results of the regression analysis is given below.

Chemistry Achievement with PPH = -2,891– 0,058 Information Literacy Self Efficacy

5. Conclusion

In terms of learning outcomes, the data suggests that, as a group, participants showed an increase from pre-test to post-test, statistically significant at the $p < 0.001$ level. This would suggest that the internet assisted education led to gains in chemistry knowledge.

The results displayed a positive correlation between chemistry achievement of the students in the first group and their science teaching attitude, and logical thinking ability. 78.4 % of the variance of chemistry achievement is explained by students' science teaching attitude, and logical thinking ability. It is an anticipated result in that the students who score high on the chemistry achievement test also have a high level of logical thinking ability and a positive attitude towards science teaching and. Internet offers a great opportunity to access information, to communicate and to keep up-to-date with innovations. That is why these students consider the internet as a homework tool. Moreover it is an effective learning tool for achieving their ideals which are of high importance to them.

Many studies to date have revealed that online homework is as effective as at least the traditional one. In one of the studies on the use of online homework, Allain & Williams (2006) investigate the use of online homework vs. non-graded offline homework. The study attempts to determine if the use of online assignments benefits the students' success more than offline, non-graded homework. A standardized pre and post test was used to measure students' conceptual knowledge. There were no significant differences in scores between students using graded online homework versus students not using it.

These results infer that the WBH can facilitate students construct knowledge and promote their comprehension in chemistry concepts. This study provides an insight to pre-service teaches' chemistry achievement. The important factors that influence teachers' chemistry achievement were found to be science teaching attitude and logical thinking ability for WBH group and information literacy self efficacy for PPH group. These findings can help researchers, teacher educators and program developers to have a better understanding of pre-service teachers and provide them best educational opportunities. Thus, they may feel comfortable using Internet in their teaching practices in the future.

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