SECONDARY SCHOOL STUDENTS' ACHIEVEMENT AND ATTITUDE TOWARDS CHEMISTRY WITHIN COMPUTER SIMULATION ASSISTED INQUIRY-BASED CHEMISTRY TEACHING: CASE OF FINOTE SELAM TOWN

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ABSTRACT

Both inquiry and simulation teaching methods are active teaching methods that used the frame work of social constructivist teaching approach. This research was designed to examine the combined effect of inquiry and computer simulation teaching chemistry on secondary students' chemistry achievement and attitude towards chemistry. All secondary school students enrolled in Finote Selam Town were the population of the study. From these all three secondary schools were selected as a sample using compressive sampling technique. From the three schools 90 students were sampled using stratified random sampling method and those randomly assigned to a controlled and two experimental groups. Chemistry achievement test and attitude test were prepared to use as a pretest and posttest. One-way ANOVA was used to analyze the data and from the data analysis, the pretest result of both chemistry achievement (X, M=12.17, EG1, M=11.47, EG2, M=11.17, F=0.618, P>0.05) and attitude test (X, M=2.86, EG1, M=2.74, EG2, M=2.85, F=1.008, P>0.05) were not significantly different among the three groups. But there was significant difference in the posttest result of the three groups (X, M=12.27, EG1, M=14.5, EG2, M=16.6, F=17.05, P<0.05) and attitude test (X, M=2.83, EG1, M=3.24, EG2, M=4.04, F=39.8, P<0.05). From the data analysis inquiry-based blended with simulation teaching method was better than both teacher center and simple simulation method. *[African Journal of Chemical Education—AJCE 12(1), January 2022]*

INTRODUCTION

Background of the Study

Education is a very socially oriented activity and traditionally quality of education has been related with strong teachers having high degrees of personal contact with learners. Using technology-based teaching in teaching science also have un limited role in education lends it to more student-centered learning settings. Effective use of technology-based teaching, along with ICT use in the teaching learning process can enhance quality and accessibility of education, learning motivation and learning environment [1].

According to [2] a web-based computer simulation is used for teaching chemistry, using the assumption that it helps students in understanding the abstract and difficult concepts in the content. Simulations can help students to develop their own understanding of chemistry concepts and help them to be independent problem solvers.

Science in general and chemistry in particular is an essential tool for nations' progress and development [3] [4]. Students should be given opportunity to discover and invent for the rapid expansion in science and technology. Chemistry as science has made great impact in the development of nations and its importance warrants the need to expose chemistry students to innovative methods like computer assisted instruction (CAI) and inquiry methods.If chemistry students are exposed to appropriate methods of teaching, they will be able to apply knowledge, communicate effectively, and be analytical, critical thinkers, inquisitive and imaginative [5]. Once

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an individual acquires the right skills and attitude through appropriate teaching methods, they can independently learn by themselves. Studies like those of [6], indicated that many teachers prefer the traditional, expository/lecture method of teaching and afraid away from innovative methods like inquiry, computer assisted instruction, inquiry discovery and laboratory approaches to teaching.

Researches such as [4] [6] have pointed out that despite the thirty years existence of learning style theories (detailing how people learn), most teachers still present information using traditional lecture methods without regard to students' learning abilities. These traditional teaching methods are theoretical, extremely didactic and teacher centered, instead of being activity based and learner centered to enhance learning. Several research reports indicate that students achieve poorly in secondary school science subjects [2]. Several factors were identified as influencing against students' attainment of the objectives of science instruction. These include inappropriate and uninspiring teaching approaches adopted by science teachers. These researchers express the view that teachers fearfully away from activity-oriented teaching approaches which are known to be more effective. They rely most on teaching approaches that are easy but most of the times inadequate and inappropriate. A lot of innovative instructional methods including discovery, cooperative learning, inquiry concept mapping computer assisted instruction have been suggested for teaching science and they demonstrated to be effective [7].

A great deal of research has been conducted during the 1970s, and early 1990s on the effects of computer use on students' achievement, attitudes, and other variables such as learning rate.

Inquiry approach on the other hand is a teaching strategy which attempt to help learners ask questions and discover answers to their questions. Inquiry method permit student to observe an event recognize relevant and irrelevant questions, search out data and take complete responsibility for an entire process of obtaining organizing and interpreting data.

Research Questions

The studies mentioned above shown us that innovative (computer assisted instruction, inquiry methods, discovery, cooperative learning etc..) have a positive impact on students' achievement and attitude towards chemistry. To date, however, research studies have been conducted on the separate effects of inquire-based strategies or computer simulation teaching strategy on students' achievement and attitude in learning chemistry. Yet, existing studies provide limited empirical evidence on the interconnection between inquire-based strategies and computer simulation teaching strategy on students' achievement and attitude of chemistry learning. Therefore, this study specifically aimed to determine the combined effect of inquire-based strategies and computer simulation teaching strategies on Finote Selam secondary school students' chemistry achievement and attitude in learning chemistry. And so, to address the above objective, the researchers made four specific research questions:

1) Does the blended inquiry-based with computer simulation teaching strategy affect students' achievements in learning chemistry?

2) Does the blended inquiry-based with computer simulation teaching strategy affect students' attitude towards learning chemistry?

3) Is there a significance difference in retention of students who were taught using inquiry-based, blended inquiry-based with simulation and conventional teaching method in chemistry achievement test?

RESEARCH METHODOLOGY

Design of the study

In this study, experimental pretest-posttest comparison groups design was used. In a true experiment, participants are randomly assigned to either the treatment or the control group, whereas they are not assigned randomly in a quasi-experiment. In this study students are randomly assigned as experimental and controlled group using pre- test results. According to this research design, experimental group one students (EGS1) were taught through inquiry-based integrated with computer simulation teaching strategies, experimental group two students were taught through inquiry-based teaching only (EGS2) and the comparison group or controlled group students (X) were taught through the existing instruction or traditional teacher centered teaching method.

The Sample and Sampling Techniques

The researcher selected a total of 90 grade eleven students using random sampling method from three secondary schools in Finote Selam town and one chemistry teacher relatively well qualified and experienced in teaching was selected using purposive sampling method from Damot secondary school. Students are selected using stratified sampling method. Those 90 sampled students were 38 students from Damot one, 27 students from Damot two and remaining 25 students were from Gojjam Ber secondary schools and those students were randomly grouped in to three group: 30 students to EGS1, 30 students to EGS2 and remaining 30 to X.

Data Collection Instruments

In the study, for the purposes of this research, 20 multiple choice chemistry question were prepared by the researcher and 10 chemistry attitude scale Likert scale like questionnaires (five options) were adopted from [8] with some modifications. Chemistry achievement test and attitude skill questionnaire were used as data collection instruments. To check the validity of the questioner was checked by English college instructors for its face validity and the content validity was checked by two chemistry high school teachers.

To check the reliability of the questionnaire both the achievement test and attitude scale test was administered to non-sampled grade twelve student. The reliability coefficient of testes Cronbach alpha was found to be 0.78 and 0.81 respectively and it was high enough to use it as an instrument.

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Data analysis method

The data obtained from chemistry achievement test and chemistry attitude test questionnaire were analyzed using quantitative data analysis method. All the attitude test pretest and posttest questionnaire in the form of five-point Likert scale ranging from strongly disagree to strongly agree and students' chemistry achievement pre and post test results were collected. All the responses were loaded to SPSS software and being analyzed using one-way ANOVA. One-way ANOVA was used to check whether there is a significant difference in chemistry achievement and attitude towards chemistry between three different groups (X, EGS1 and EGS2) before and after the intervention. In this study, one way-ANOVA also used to check whether there is a significant difference in retention of chemistry achievement between the three groups due to intervention.

Procedures

During the first lesson, students in both experimental (EGS1 & EGS2) and controlled group administered to chemistry achievement test and chemistry attitude tests as a pre-chemistry achievement on two grade eleven selected topics namely acid - base equilibria, solution formation, and pre-chemistry attitude tests to learn chemistry.

Next the first experimental group one (EGS1) were introduced to the lessons through inquiry-based teaching method. During the lesson students were freely raised their questions to the teacher and to their friends and they freely discuss what they fell about the topic. Students in the second

experimental group two (EGS2) were taught by the same teacher but their inquiry-based teaching about their lesson were supported by simulation. in experimental group two (EGS2) students were actively inquire their lesson with their teachers and with their colleges. then the lesson is displayed with simulation. The controlled group were taught by the same teacher but using the traditional, teacher-centered approach involving a chalk-talk approach which is the dominant and usual teaching method in Ethiopia [9]. All those experimental groups and the controlled group were taught for 12 hours in three weeks.

After the intervention those all groups (experimental group one, experimental group two and the controlled group) were administered to chemistry achievement test and chemistry attitude test which was equivalent to the pre-test.

RESULTS, DISCUSSION AND INTERPRETATION

After assigning the students from the classes to the treatments and comparison groups, pre-test data were collected using achievement test and chemistry attitude questionnaire. Before analyzing the data, the data obtained from the pretest and posttest of chemistry achievement of the three group was feed to SPSS window and the normality and homogeneity of the data was checked. The pre-test and posttest achievement test in scale levels skewness should be checked whether the data is normally distributed or not so as to choose parametric or nonparametric test for groups. Parametric methods assume that the dependent (outcome) variable is approximately normally

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distributed for every group to be compared. The dependent variable, data obtained from the achievement test results (pretest and posttests) are homogeneous and normally distributed and it is ok to proceed the analysis.

Analysis of the pre- test results

To answer research question number one (does the blended inquiry-based with computer simulation teaching strategy and inquiry based teaching strategy affect students' achievements in learning chemistry?) and research question number two (does the blended inquiry-based with computer simulation teaching strategy and inquiry based teaching strategy affect students' attitude towards learning chemistry?), it is better to see whether there is a significance difference between pretest chemistry achievement & attitude towards chemistry and the achievement after intervention.

Table 1: *Summary on students' pre-test scores in chemistry achievement and chemistry attitude questionnaire among the three groups*

Dependent variable	Group	N	Mean	Std. Deviation	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Average pre-attitude towards chemistry	X	30	2.86	.42	2.70	3.01
	EGS1	30	2.74	.34	2.61	2.86
	EGS2	30	2.85	.33	2.72	2.97
	Total	90	2.81	.36	2.74	2.89
Pre-test chemistry achievement results	X	30	12.17	3.3	10.91	13.42
	EGS1	30	11.47	3.7	10.06	12.88
	EGS2	30	11.17	3.5	9.83	12.50
	Total	90	11.60	3.5	10.85	12.35

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Table 2. One-way analysis of variance summary table comparing the three groups on scores of pre-tests of chemistry achievement and chemistry attitude test scores

Dependent variables		Sum of Squares	df	Mean Square	F	Sig.
Average pre-attitude towards chemistry	Between Groups	.273	2	.136	1.008	.369
	Within Groups	11.779	87	.135		
	Total	12.052	89			
Pre-test chemistry achievement results	Between Groups	15.8	2	7.900	.618	.541
	Within Groups	1111.8	87	12.779		
	Total	1127.6	89			

Result of the one-way ANOVA analysis revealed that, there was no statistically significant mean difference between the comparison and treatment groups; means (12.17, 11.47, 11.17), F = 0.618, p = 0.54 for chemistry achievement test and means (2.86, 2.74, 2.81), F= 1.008, p = 0.369 for their attitude towards chemistry questionnaire.

It should be noted that the results of the pretest for both the treatment groups and the comparison or experimental groups are similar in their chemistry performance and attitude towards chemistry.

Analysis of Post-test Results

The effect of treatment on students' chemistry achievement

The first two research questions for this study were aimed to determine the combined effect of blended inquiry-based and simulation teaching strategy over inquiry-based teaching strategy and

traditional teaching methods on students' achievement in learning Chemistry as one subject of natural science and attitudes towards chemistry teaching.

As there were no statistically significant differences between the pre-test scores of the groups (see in Table 2), the post-test scores were compared using One-way ANOVA to explore whether there is a significant effect of those teaching methods on students' achievement and attitudes. Prior to conducting the one-way ANOVA, the assumption of normality and homogeneity of variance was evaluated. The results of outcome variable were found to be approximately normal distributed and equal variances are assumed based upon results of Levene's Test.

Table 3: *Means and standard deviations comparing the three groups on scores of achievement test*

Groups	Post-test chemistry achievement		
	N	Mean	Std. Deviation
Controlled group	30	12.27	3.930
EGS1	30	14.50	2.271
EGS2	30	16.60	2.044
Total	90	14.46	3.353

Table 4: *One-way analysis of variance summary table comparing the three groups on* post-test chemistry achievement

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	281.756	2	140.878	17.057	.000
Within Groups	718.567	87	8.259		
Total	1000.322	89			

As can be seen from table 4. There was a significance difference between the posttest chemistry achievement, mean (12.27, 14.5, 16.6), $F=17.057$, $P<0.05$, between the three groups.

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Thus, there is a significant result and concluded there is significant difference among students' levels of achievements between the three groups.

Post hoc analyses were conducted using Tuky HSD post-hoc test. Based on a Tuky HSD value the Achievement in the controlled (M = 12.27, SD = 3.9) is significantly less than experimental group one (M=14.5, SD=2.27) and experimental group one (M=14.5, SD=2.27) is significantly less than experimental group two (M=16.6, SD=2.02). The achievement of experimental group two was significantly better than both the controlled and experimental one groups.

Table 5: *Multiple comparisons of three groups on student's posttest Achievement test* Tukey HSD

(I) sample groups	(J) sample groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Controlled group	EGS1	-2.233*	.742	.009	-4.00	-.46
	EGS2	-4.333*	.742	.000	-6.10	-2.56
EGS1	controlled group	2.233*	.742	.009	.46	4.00
	EGS2	-2.100*	.742	.016	-3.87	-.33
EGS2	controlled group	4.333*	.742	.000	2.56	6.10
	EGS1	2.100*	.742	.016	.33	3.87

*. The mean difference is significant at the 0.05 level.

The effect of treatment on students' attitude towards learning chemistry

To determine whether the intervention (teaching methods) have effect on students' attitude towards learning chemistry, the researcher compared students post mean scores of the three groups using a one-way ANOVA. The results of the analysis are displayed in table 6 below.

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Table 6: *Means and standard deviations comparing the three intervention groups on scores of students* average post-attitude towards chemistry *towards learning chemistry*

Groups	Average post-attitude towards chemistry		
	N	Mean	Std. Deviation
Controlled group	30	2.8333	.43098
EGS1	30	3.2767	.48258
EGS2	30	4.0433	.65426
Total	90	3.3844	.72699

Table 7: *One-way ANOVA summary table comparing the three group levels on scores of students' average post-attitude towards chemistry towards learning chemistry*

Groups	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	22.484	2	11.242	39.833	.000
Within Groups	24.554	87	.282		
Total	47.038	89			

Table 8: *Multiple comparisons among the three groups on students' attitude scores* Tukey HSD

(I) sample groups	(J) sample groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Controlled group	EGS1	-.44333[*]	.13717	.005	-.7704	-.1163
	EGS2	-1.21000[*]	.13717	.000	-1.5371	-.8829
EGS1	controlled group	.44333[*]	.13717	.005	.1163	.7704
	EGS2	-.76667[*]	.13717	.000	-1.0937	-.4396
EGS2	controlled group	1.21000[*]	.13717	.000	.8829	1.5371
	EGS1	.76667[*]	.13717	.000	.4396	1.0937

*. The mean difference is significant at the 0.05 level.

A one-way between-subject ANOVA was run with number of groups as the independent

variable, and student attitude towards learning chemistry as the dependent variable. As can be seen

from table 7, there is a significant difference in attitude of students of three different groups (M=2.83,

M=3.28M=4.04, F=39.8, P=0.00). After establishing that there was a significant difference between groups (p<0.05) in their attitude towards learning chemistry, post-hoc analysis test of multiple comparison was employed to identify the group that were significant different from the other. As shown in the above table 8, the post-hoc analysis tests of multiple comparison shown that the attitude of students to learn chemistry of controlled group (M=2.83, SD=0.43, P<0.05) was significantly less than chemistry attitude experimental group one students (M=3.28, SD=0.48, P<0.05). Attitude of students learned through inquiry-based teaching method (experimental group one) also have significantly less attitude towards learning chemistry (M=3.28, SD=0.48, P<0.05) than students learned through both inquiry-based and simulation (experimental group two) students (M=4.04, SD=0.65, P<0.05).

The effect of treatment on students' chemistry achievement retention

To determine whether the intervention (teaching methods) have effect on students' retention ability in learning chemistry, the researcher compared the net achievement difference between students post mean scores and pre mean score of the three groups using a one-way ANOVA. The results of the analysis are displayed in table 9, 10 and 11 below.

Table 9. Means and standard deviations comparing the three groups on scores of average chemistry performance retention

	N	Mean	Std. Deviation	95% Confidence Interval for Mean	
				Lower Bound	Upper Bound
controlled group	30	12.70	2.548	11.75	13.65
EGS1	30	14.47	3.511	13.16	15.78
EGS2	30	17.23	1.633	16.62	17.84
Total	90	14.80	3.244	14.12	15.48

Table 10: *One-way ANOVA summary table comparing the three group levels on scores of students 'average chemistry performance retention*

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	313.267	2	156.633	21.869	.000
Within Groups	623.133	87	7.162		
Total	936.400	89			

Table 11: *Multiple comparisons among the three groups on students' average chemistry performance retention Tukey HSD*

(I) sample groups	(J) sample groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
controlled group	EGS1	-1.767*	.691	.033	-3.41	-.12
	EGS2	-4.533*	.691	.000	-6.18	-2.89
EGS1	controlled group	1.767*	.691	.033	.12	3.41
	EGS2	-2.767*	.691	.000	-4.41	-1.12
EGS2	controlled group	4.533*	.691	.000	2.89	6.18
	EGS1	2.767*	.691	.000	1.12	4.41

*. The mean difference is significant at the 0.05 level.

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A one-way between-subject ANOVA was run with number of groups as the independent variable, and students' chemistry achievement retention as the dependent variable. As can be seen from table 9 and 10, there is a statistically significant difference in chemistry achievement retention of three different groups (M=12.7, M=14.47, M=17.23, F=21.87, P=0.00). After establishing that there was a significant difference between groups (p<0.05) in their chemistry achievement retention ability, post-hoc analysis test of multiple comparison was employed to identify the group that were statistically significant different from the other.

As shown in the above table 11, the post-hoc analysis tests of multiple comparison shown that chemistry achievement retention ability of controlled group (M=12.7 SD=2.548, P<0.05) was significantly less than chemistry attitude experimental group one students (M=14.47, SD=3.511, P<0.05). Chemistry achievement retention ability of students learned through inquiry-based teaching method (experimental group one) also have significantly less chemistry achievement retention ability(M=14.47, SD=3.511, P<0.05) than students learned through both inquiry-based and simulation (experimental group two) students (M=17.23, SD=1.633, P<0.05).Chemistry achievement retention ability of students learned through blended inquiry-based with simulation (experimental group two) students was much better than both the controlled group (learned through tradition method) and students learned through inquiry-based teaching method.

CONCLUSIONS

The purpose of this study was to determine the effects of inquiry-based teaching integrated with simulation teaching method over only inquiry-based teaching on students' achievement and attitude towards learning chemistry. An attempt was made in the study to determine whether the students learned using inquiry-based integrated with simulation teaching method were better in achievement and attitude towards chemistry than students learned through only inquiry-based method and with traditional method.

There were clear differences between the groups in all the two dependent variables (Achievement and attitude), with the differences being in favor of the inquiry-based assisted with simulation teaching method than both the traditional and simple inquiry-based teaching method. It is true that microscopic and submicroscopic particles in chemistry are out of our imagination, then using simulation made the abstract clear and tangible to our sense and made students to more successful in their academic achievement and, in particular, develop positive attitude towards learning chemistry [10].

It is therefore recommended that students learned through integrated learning approach succeed in their chemistry achievement and develop positive attitude towards learning chemistry than students learned through traditional and single active teaching method. So, teachers should use integrated approach teaching method than single teaching method. It is better to use inquiry based

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integrated with simulation method or inquiry-based method of teaching chemistry than simple

lecture or traditional method of teaching chemistry to teach high school students.

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