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Research article

THE IMPACT OF ACTIVE LEARNIG RELATED TO ACIDS – BASES ON UNIVERSITY CHEMISTRY ACHIEVEMENTS AND ATTITUDES

MelakuMasreshaWoldeamanuel, Prof.HarisonAtagana, Dr.TemechegeEngida

E-mail:Sofonms@yahoo.com; sofon2ms@gmail.com

ABESTRACT

The main purpose of the research this paper is to investigate the influences of active learning related to learning chemistry at university level to the subject of "Acids and Bases" on freshmen's learning achievements and attitudes toward fundamentals of chemistry lesson. On this account, an active learning material based on constructivism was developed by considering students' misconceptions and learning difficulties, and its validity and reliability were determined. The effects of the material were assessed by participation of 136 freshmen from two Ethiopian universities who were randomly assigned to experimental ($N_{E_1} = 32, N_{E_2} = 40$) and control ($N_{c_1} = 26, N_{c_2} = 38$) groups. After remediation of students misconceptions and misunderstandings related to the basic concepts for learning "Acids and Bases", which were identified in the pre-test (KR-20=0.811), the subject of "Acids and Bases" was taught via active learning in the experimental, and via traditional format in the control groups. The results of "Acids and Bases Achievement Test" (KR-20=0.78) that administrated after the instructions, showed that active learning applications were affective on increasing students understandings and preventing misconceptions ($F_{(3-132)} = 74.71$, $p<0,05$). The results of Attitude toward Fundamentals of Chemistry lesson Scale ($\propto=0.82$) also reflected the significant increases of experimental group students' positive attitudes ($F_{(3-132)} = 55.18$, $p<0, 05$).

Keywords: ACTIVE LEARNING, LEARNING CHEMISTRY, UNIVERSITY, MISCONCEPTION,

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1. INTRODUCTION

During the recent years, researches have shown that teacher centered traditional approach fails to develop students' cognitive abilities, and this cause the lower learning achievement and also formation of misconception (Acar&Tarhan 2007, 2008; Bodner, 1986; Felder, 1996; Nakhleh&Krajcik, 1994). For this reason science educators have began to research new educational approaches and active learning that engage students in the learning process have received considerable attention (Meyers & Jones, 1993; Bonwell& Sutherland, 1996). Active learning provide students with the opportunities to engage in higher-order thinking skills and in processes of shared thinking which helps them to not only gain a better understanding but also to build on their contributions to develop new understandings and knowledge (Slavin, 1996). In this view, active learning is often contrasted to the traditional lecture where students passively receive information from the instructor. Researches show that students can develop scientifically incorrect conceptions as labeled 'misconceptions' during the traditional lessons (Jonassen, 1991: Sanger &Greenbowe, 1997). Because active learning is based on constructivism and constructivist learning theory clearly states that every learner actively builds or constructs their own private understanding, it has a great role on preventing misconceptions (Bodner, 1996).

As in the all field of science lessons, misconceptions adversely influence subsequent learning in the chemistry which is found as difficult, abstract and problematic lesson by students. the subjects of *'Acids and Bases'* which are the fundamental concepts in chemistry have been also regarded as problematic for students (Banerjee. 1991; Cros, Maurin, Amouroux, Chastrette&Leber, 1986; Demircioglu, Ayas&Demirciouglu, 2005; Hand &Treagust, 1991; Nakhleh&Krajcik, 1994). According to the literature review, it was found that although there are many studies on identification students' learning difficulties and misconceptions about acid and bases, research on preventing or remedying these misconceptions are limited (Demircioglu, Ayas&Demicioglu, 2005; sisovic&Bojovic, 2000). Therefore, researchers have been asserted that active learning applications should be developed and conducted according to constructivism to prevent misconceptions and provide higher learning achievement (Acar&Tarhan 2008; Ebenezer & Gaskell, 1995). Attitudes, like learning achievement, are also important outcomes of science education (Cheung, 2009). For this reason, in this study, it was aimed to investigate the affects of active learning material developed based on constructivism related to *'Acids and Bases'* on freshmen's learning achievements and attitudes towards fundamentals of chemistry lesson.

2. METHOD

2.1 SAMPLE

The sample of this study consisted of 136 freshmen attending in chemistry teaching and chemistry department in two universities cited in the west of Ethiopia. Freshmen were stratified randomly to experimental ($N_{E_1} = 32,\ N_{E_2} = 40$) and control ($N_{c_1} = 26,\ N_{c_2} = 38$) groups in each university. While freshmen in the experimental groups taught through active learning material, traditional teacher centered approach was used in the control groups.

2.2 INSTRUMENTS

The pre-test by twenty-two multiple-choice items was developed to identify students' per-knowledge and concepts that are basis for learning *'Acid and Bases'* such as solubility, periodic properties, chemical bonding, chemical reactions and equilibrium by considering students misconceptions in the literature (Ebenezer & Gaskell, 1995: Grifiths& Preston, 1992). The contents of the tests were validated by four chemistry educator in the universities, and then it was piloted with 237 university students to determine its reliability. After the item analysis the reliability coefficient (KR-20) of the test was found to be 0.81.

The *Acids-Bases Achievement Test* by twenty-five multiple choice including open-ended part was developed to identify students understanding of *'Acids and Bases*' by considering students' learning difficulties and misconceptions determined in the literature (Bradley and Mosimege, 1998; Cro& et all., 1986; Schmidt. 1991). For the content validation and reduction of errors, the items were examined by four chemistry educators in the universities. The test was piloted with 147 university students for the reliability. After the item analysis the reliability coefficient (KR-20) of the test was found to be 0.78.

To determine freshmen's attitudes toward the fundamentals of chemistry lesson before and after the instruction. 5-point Likert type Attitude toward Fundamentals of Chemistry Lesson Scale (ATCS) with 25 statements was developed by considering literature reviews related to the attitude toward science and chemistry (Berberoglu&Calikoglu, 1992; Freedman, 1997; Koballa, 1988; Salta &Tzougraki, 2004). The items were constructed by considering the attitude scale developed by Salta &Tzougraki (2004). For the validity, the scale was reviewed by seven educators in the different universities, and after the corrections the scale was applied on 195 university students for the reliability and the Cronbach's alpha reliability coefficient had found to be 0.82. The attitude scale was investigated in four dimensions; (1) Interest in chemistry lesson; (2) Understanding and learning chemistry; (3) the importance of chemistry in the life; and (4) Chemistry and occupational choice.

2.3 PROCEDURE

The active learning material including cooperative learning, problem based learning, brain storming, problem solving and laboratory activities, demonstrations and computer animations related to the *'Acids and Bases'* was developed according to constructivism by considering students learning difficulties and misconceptions determined in the literature and in the context of this study. By constructing the material, it was aimed to identify students' ideas and view, create opportunities for students to explore their ideas, provide stimuli for students to develop, modify and where necessary, change their ideas and views, help students recognize the conflict between their existing concepts and scientific concepts, and support their attempts to re-think and reconstruct their ideas and views as mentioned by Hodson (1996).

For the validity of the material, it was examined by four chemistry educators in universities. After the corrections were made according their comments, the material was piloted by participation of 28 university students attending chemistry teacher department for the reliability.

To assess the effects of active learning material, which was finalized after the pilot study, pre- and post testing control group design was used in this study. Before the instruction, the pre-test was applied to determine students' prior knowledge which are basis for learning 'Acids and Bases', and the results revealed that there were no significantly differences between means of groups($F_{(3-132)}$ =1.26, p>0,05). To remedy students' misunderstandings and misconceptions determined according to the pre-test, a four course hour preparatory lesson was conducted in all the groups. While instruction of *'Acids and Bases'*was accomplished with active learning material based on constructivism in the experimental groups, teacher cented traditional approach was used in the control groups. Experimental group students were stratified randomly assigned into their cooperative groups according to their first term chemistry achievements and social abilities determined according to the interviews with educators. The instructions were accomplished in twenty-four course hours in all the classes.

Before the instruction in the experimental groups, Educators gave an orientation lesson to the students about learning objectives, instruction process, rules of working in a cooperative group, roles and their responsibilities, and assessment strategies. Experimental group students were stratified randomly assigned into their cooperative groups according to their first term chemistry achievements and social abilities determined according to the interviews with educators.

3. RESULTS

In order to identify freshmen's pre-knowledge which are basis for learning *'Acids and Bases'*, the pre-test was applied. As seen in Table 1, the results of ANOVA showed that there were no significant differences among experimental and control groups in terms of pre-test ($F_{(3-132)}$ =1.26, p>0,05). Besides to the pre-test, 15 minute semi-structure interviews were accomplished to identify the reason of the students' answers and found that freshmen had some misconceptions related to the basic subjects for learning 'Acids and Bases' such as periodic table, electro negatively, chemical bonding, inter molecular forces, VSEPR theory, Lewis structure, chemical equilibrium.

Table 1:ANOVA Results of Pre-Test

Group	***N***	***Means*** $(\overline{X})$	***Standard Deviation (SD)***	***F***	***P***
Exp-1	32	62.01	14.17	1.26	0.29
Cont-1	26	64.56	13.70		
Exp-2	40	57.60	16.41		
Cont-2	38	60.75	14.18		
Total	**136**	**60.85**	**14.83**		

In order to identify students' understandings of 'Acids and Bases', the 'Acids and Bases Achievement Test' was applied on all the groups, According to the results of ANOVA, significant differences between experimental and control groups were found ($F_{(3-132)}$ =74.71, p<0,05; Table 2).

Table 2:ANOVA Results of Achievement Test

Group	***N***	***Means*** $(\overline{X})$	***Standard Deviation (SD)***	***F***	***P***
Exp-1	32	89.59	6.96	74.71	0.00
Cont-1	26	64.56	13.70		
Exp-2	40	85.65	8.54		
Cont-2	38	56.79	13.47		
Total	**136**	**74.48**	**17.74**		

The results of the achievement test and also 15 minute's individual semi-structured interviews reflected that freshmen in the experimental groups had lower misconception and lack of knowledge comparison with control groups. Totally forty nine misconceptions related to *acid and base theories. Strength of acids and bases, neutralization, pH-pOH, acid and base equilibrium, hydrolysis, buffer, indicator and titration* determined. Ten of those misconceptions were firstly indentified in this study.

To assess freshmen's attitudes towards fundamentals of chemistry lesson before and after the instructions Attitude toward Fundamentals of Chemistry lesson Scale (ATCS) was applied. As seen in Table 3, the result of ANOVA indicated that although there were no significant differences between experimental and control groups before the instruction ($F_{(3-132)}$ =1.00, p>0,05), significant differences were found between groups after active learning application ($F_{(3-132)}$ =55.18, p<0,05). The significant increases in the mean scores of experimental groups from 84.91 to 99.91, and from 82.68 to 97.25 displayed the development of university students' positive attitudes (p<0.05).

Table 3:ANOVA Results of per-and post- ATCS

Group	***N***	***Test***	***Means*** $(\overline{X})$	***Standard Deviation (SD)***
Exp-1	32	Per	84.91	5.16
		Post	99.91	4.75
Cont-1	26	Per	84.00	5.27
		Post	84.31	5.02
Exp-2	40	Per	82.68	7.80
		Post	97.25	7.83
Cont-2	38	Per	82.32	8.32
		Post	82.58	8.41
Total	**136**	Per	**83.35**	**6.99**
		Post	**91.30**	**10.29**

The ANOVA results also indicated that after the instructions, experimental groups' mean scores in the four dimensions increased significantly as; (1) Interest in chemistry lesson ($F_{(3-132)}$ =29.81, p<0,05); (2) Understanding

and learning chemistry ($F_{(3-132)}$ =20.06, p<0,05), (3) The importance of chemistry in the life ($F_{(3-132)}$ =10.31, p<0,05), and (4) Chemistry and occupational choice ($F_{(3-132)}$ =6.76, p<0,05), Results showed that over the 80% of the freshmen began to like chemistry and find the lesson as interesting. 80-90% of the freshmen also began to aware of the importance of learning basic concepts to understand chemistry, find chemistry as understandable easily and concrete. While over the 60% of the freshmen had positive attitudes towards the importance of chemistry in the life, this ration increased to 95% after the active learning application. However there are significant increases in the mean scores of the last dimension, it was also found that approximately 40% of freshmen who had still negative and inconsistent thoughts about occupational choice.

In addition to ATCS, 15 minute semi-structured interviews were also conducted with 26 freshmen to determine the reasons of their attitudes, According to the results. It was found that a minority of freshmen had negative attitudes. This minority did not:- like fundamentals of chemistry lesson and find the lesson as interesting (1); -understand chemical concepts and symbols, solve chemistry problems easily (2):- believe the importance of chemistry in the modern and daily life, and solving environmental problems (3):- find the jobs related to chemistry as interesting, and believe they will work in a business area related to chemistry and the department that they are attending help them to enhance their target carrier (4). The interviews reflected the reasons of negative attitudes, and it was found that freshmen commonly though; fundamentals of chemistry lesson is an expanded replication of high school chemistry lesson, some of the chemical concepts and subject are abstract, the lesson steer them to memorize. It was also determined that freshmen did not know the ways of acquiring the knowledge, had difficulties in associating the knowledge and deficiency in problem solving. The answers of freshmen also reflected the importance of instructional approaches used in the classroom on the attitude towards lesson. The obtained results showed that because only theoretical knowledge was taught and samples from daily life were not given in the lesson, they were unconscious about the development in the chemistry technology and did not use their knowledge in explaining the events in their life. They also indicated that because of university entrance exam, they did not attend their desired faculties, and had anxiety to be workless after graduation.

4. CONCLUSUION

The present study was an investigation of the effectiveness of active learning applications based on constructivism related to ‘Acid and Bases’ on freshmen’s learning achievements and attitudes towards fundamentals of chemistry lesson. The results in this study showed active learning instruction caused a significantly better acquisition of scientific conceptions than the traditional instruction. According to the findings of the achievements test, it was found that mean scores of experimental groups ($M_{E_{-1}} = 89.59,\ \ M_{E_{-2}} = 85.65$) were higher than control groups ($M_{c_{-1}} = 64.56,\ \ M_{c_{-1}} = 56.79$) and there were significant differences ($F_{(3-132)}$ =74.71, p<0, 05). This results and also individual interviews showed that active learning application in both the experimental group positively affected students’ understandings and prevented misconceptions. The obtained findings also reflected that analysis, making connections, synthesis, analytical thinking cognitive abilities of the experimental group students also improved. The

results of ATCS showed the positive effects of active learning material on freshmen's attitudes ($F_{(3-132)}$ =55.18, p<0, 05). This study is also an important evidence to assess the reasons of university students' attitudes towards chemistry.

In conclusion, it is very important to keep the continuity of development active learning applications based on constructivism, and encourage students to apply them in their classes.

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