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Developing Activities Based on the Constructivist View of Learning and Investigating of Their Effectiveness

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SYPNOSIS

Introduction

According cognitive scientists, learning is a mental process and is to occur by giving a meaning to knowledge reaching to mind (Cüceloğlu, 1997). This basic idea agreed with the constructivist view of learning extensively accepted. This view suggested that persons could make sense of new phenomena encountered by using their existing prior knowledge and experiences (Wittrock, 1974; Hand & Treagust, 1991; Duffy & Jonassen, 1991). Bodner (1986), one of the most important advocators of this view, suggested that knowledge is constructed in the mind of the learner and is seldom transferred intact from the mind of the teacher to that of the students (Bodner, 1990). For this reason, it is very important to provide students with learning environments in which students constructs their concepts. This new approach requires teachers to act as a researcher in class environment and to actively participate in process of development and implementation of teaching program (Yiğit & Akdeniz, 1997; Özmen, 2002; Demircioğlu, 2003).

According to the constructivist view of learning, the knowledge develops by growing from a state of equilibrium to another in the mind of the learner. If your experiences are consistent with what you expected, then they make sense. You need only to add to your new experiences to your fund of information. But if your new experiences are unexpected, you really have three choices: (i) you can ignore new experiences. (ii) you can change them in your mind so that they fit. (iii) you can change the way you think so that the unexpected fits in once again. Learning has been expected to occur as in (iii) (Baker & Piburn, 1997; Çepni, Akdeniz & Keser, 2000).

Although a lot of studies, congresses, and seminars based on the constructivist view of learning in developed countries have been done, studies in our country are not many (Nakiboğlu, 1999; Çepni, Şan, Gökdere & Küçük, 2001). For this reason, studies based on the constructivism are needed in the country.

Purpose

The purpose of this study was to develop activities based on the 5E, which is instructional model for the constructivist view of learning, about the topic "Factors Affecting the Solubility Equilibrium" in lycee-2 chemistry curriculum and to investigate their effectiveness in real classroom environment.

Method

In the study, it was used a nonequivalent pretest-posttest control group design (Robson, 1988; Karasar, 1999). The study was conducted in a high school in the city of Trabzon. One chemistry teacher having 20 years of teaching experience and 46 students, 22 of which were in treatment group and 24 were in control group, participated in the study. While the students in the experimental group were taught by using the prepared activities, the students in the control group were taught with teacher-centered approach (teacher's expression, question and answer, writing, etc.). Both the students' preconceptions and achievement after the treatment were determined using the Concept Achievement Test.

Instruments

In the study, data was gathered from two instruments that were The Concept Achievement Test (CAT) and interviews.

The Concept Achievement Test (CAT): This test consisted of 15 questions, 10 of which were multiple-choice and the rest were open-ended questions. The questions in the test were prepared based on literature review and objectives of the subject matter. A commission involving three experienced chemistry teachers and three professors examined the test for the validity of it. The test was piloted with 40 students. The reliability of the multiple-choice section of CAT computed from the results of the pilot study using Kuder-Richardson 21 was found 0,79.

Interviews: In this research, it was conducted semi-structured interviews with the class teacher and five students who were randomly selected from the experimental group after the treatment. The interview took about 15-20 minutes for each student. On the other hand, the teacher interview lasted for 30 minutes. All of the interviews were audio taped and transcribed verbatim by the researchers.

Analysis of Data

In the multiple-choice questions of the test, frequencies and percentages of distribution of the students' responses to the options were determined. In the open-ended questions, the students' answers were separated into four categories consisting of correct, partial correct, wrong, and no response. Then percentages of each category were calculated. Multiple-choice questions were graded as 0 or 6 (0 for wrong, 6 for right answer). In open-ended questions, 6 point for correct answer, 3 point for partial correct answer, and 0 for wrong answer of each item were scored. Thus, the highest score of the test was found 90. The results of the pre-tests and post-tests were compared using t test.

The Development and Implementation of the Activities

There have been different learning models based on constructivist view of learning such as four sequences, five sequences (5E), and seven sequences (7E) to implement in school environment. In this study, it was used 5E model. This model was developed by Roger Bybee who was a BSCS group' researcher (BSCS, 2001). The model consisted of five sequences. They were: Engage, Explore, Explain, Elaborate and Evaluate. The researchers prepared five activities based on this instructional model. While preparing the activities, they benefited from the ideas of three academicians and four experienced chemistry teachers. The activities were first piloted in a tenth class. During the pilot study, informal students and teacher interviews and classroom observations were carried out. Based on the results, the activities were revised.

The treatment lasted for six class periods (6x45 minutes) in the each group. The teacher was introduced to the activities and 5E model for two hour. In addition, the researchers held meetings as often as needed to discuss the overall matters encountered during the teaching in the experimental group. The both experimental and control groups were observed during the implementation of the activities.

Results

The results from the pre-tests were compared with t-test. As seen in Table 3, no statistically significant mean difference was found between the two groups with respect to chemistry achievement (t = 0,332, df = 44, $p > 0,05$). As there were no significant differences between experimental group and control group in terms of the pre-test scores, the post-tests scores of the groups were compared using an independent t-test.

Table 3. *The results of the t-test on pretests and posttests scores of experimental and control group students*

Tests	Group	N	Mean	Standard deviation	Degree of freedom (*df*)	*t*	P
Pre-test	**Experimental**	22	29	11,2	44	0,332	0,882
	Control	24	30,2	10,7			
Post-test	**Experimental**	22	73,4	12,6	44	5,09	0,000
	Control	24	53,7	13,5			

Table 4. *The results from the multiple-choice section of the post-test*

Question Number	Group	A		B		C		D		E		No Answer	
		f	%	f	%	f	%	f	%	f	%	f	%
1	Experimental	-	-	-	-	-	-	-	-	22	100*	-	-
	Control	-	-	-	-	-	-	-	-	24	100*	-	-
2	Experimental	-	-	-	-	-	-	22	100*	-	-	-	-
	Control	-	-	6	25	-	-	18	75*	-	-	-	-
3	Experimental	-	-	-	-	22	100*	-	-	-	-	-	-
	Control	2	8	-	-	16	67*	6	25	-	-	-	-
4	Experimental	-	-	7	32	-	-	15	68*	-	-	-	-
	Control	10	42	2	8	-	-	3	13*	9	38	-	-
5	Experimental	-	-	-	-	-	-	-	-	22	100*	-	-
	Control	3	13	3	13	-	-	2	8	16	67*	-	-
6	Experimental			3	13	1	5	6	27	12	55*	-	-
	Control	-	-	6	25	4	17	4	17	7	29*	6	25
7	Experimental	-	-	22	100*	-	-	-	-	-	-	-	-
	Control	-	-	18	75*	2	8		-	-	-	2	17
8	Experimental	-	-	-	-	21	95*	1	5	-	-	-	-
	Control	1	4	-	-	14	58*	6	25	-	-	3	13
9	Experimental	-	-	-	-	-	-	5	23	17	77*	-	-
	Control	7	29	-	-	-	-	-	-	14	58*	3	13
10	Experimental	1	5	2	9	-	-	7	32	10	45*	2	9

	Control	1	4	3	13	-	-	7	32	12	47*	1	4

A significant difference was found between the experimental group (M= 73.4, SD= 12.6) taught by using the activities developed and the control group (M= 53.7, SD= 13.5) taught by the conventional approach with respect to chemistry achievement, t = 5,09, df = 44, $p < 0,001$ (Table 3).

The answers the students in both groups gave to the questions in the multiple-choice section of the post-tests are given in Table 4 and the answers the students gave to the open–ended questions are given in Table 5.

In the multiple-choice section of the test, while the percentage of the correct answers given by the students in the experimental group range from 55 % to 100 %, that of the students in the control group range from 13% to 100%, as shown in Table 4.

Table 5. *The results from the open–ended section of the post-test*

Question Number	Group	CATEGORIES							
		Correct		Partial Correct		Wrong		No Answer	
		f	%	f	%	f	%	f	%
11	Experimental	19	86	-	-	3	14	-	-
	Control	14	58	1	4	9	38	-	-
12	Experimental	18	82	-	-	3	14	1	5
	Control	17	71	2	8	5	21	-	-
13	Experimental	20	91	-	-	2	9	-	-
	Control	7	29	-	-	10	42	7	29
14	Experimental	16	73	2	9	4	18	-	-
	Control	8	33	3	13	11	46	2	8
15	Experimental	4	18	17	77	-	-	1	5
	Control	-	-	18	75	4	17	2	8

Discussion

In this study, the effects of the activities based on 5E model on students' understanding about the topic "Factors Affecting the Solubility Equilibrium" were determined. The results of the pre-tests and the post-tests indicated that the students taught by using the activities were more successful than the students taught with the traditional approach. This result was not surprising because the students in the experimental group were provided opportunities to link the events to the daily life, to think on their friends' and his/her own understandings, to doing experiment, to participate in the arguments that aimed to determine their preconceptions. The students in the experimental group showed quite low achievement in some questions of the test. The most important reason for this was that students were not curious about the questions asked in the excite stages of the some activities. Further, the students immediately wanted to see answers for questions the teacher asked in some activities. This may result from our teaching system based on the hidden assumption that knowledge can be transferred intact from the mind of the teacher to the mind of the student.

In the light of the interviews can be conducted by the teacher it can be said that teachers were not adequately aware of new developments in education, and new learning theories. Therefore, they needed for in-service training courses.

The results from the student interviews showed that the students found the study very effective and useful, and changed some misconceptions they held into scientifically conceptions. For instance, "*I don't know that the dissolving of the lime is endothermic. So, I always put the tap water into the iron. After this course, I learned the dissolving of the lime is exothermic* (student B)." The student B changed the way you think to adopt the new experience (Baker & Piburn, 1997; Çepni, Akdeniz & Keser, 2000). The students in the experimental group thought that the things they learned during the study were more permanent than that in the other courses. For instance, "*I think my knowledge is more permanent when we did the* experiments for ourselves and studied the topic by using the group and class discussions (student C)" and "*I think that the examples related to the daily life increased permanency of my knowledge* (student D)." This is an expected result.

Conclusions and Suggestions

In the posttests, a statistically significant difference was found between the experimental group and the control group with respect to chemistry achievement. This showed that the teaching with activities based on 5E model was more successful than traditional teaching. The developed activities not only increased the students' achievement in the experimental group but also helped them to recognize and remedy their misconceptions.

That this model can be successful is directly related to students' skills on doing investigation and reasoning. It was seen that the students in the experimental group had not got these skills during the implementation of the activities. The results showed that the developed activities were more effective for students with lower and medium achievement to improve their interest and success on the concepts studied than students with higher achievement.

This type of studies should be conducted in other topics and presented to teachers for their use. In addition, the teachers should be given in-service courses concerning how to develop and to teach such activities. Because most teachers do not have enough competence regarding this type of activities

Teachers should be aware of students' prior knowledge and misconceptions, because they are strong predictors of student achievement in science. Pre-service and practicing science teachers should be introduced to constructivist ideas of teaching and learning. Relevant research results concerning students' conceptions should be communicated to teachers, and curriculum developers.