VIRTUAL CHEMISTRY LABORATORY: EFFECT OF CONSTRUCTIVIST LEARNING ENVIRONMENT

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ABSTRACT

The lab applications, which were started to be applied through mid 19th century, not only provide a new point of view but also bring about a new dimension to the lessons. At early times they were used to prove theoretical knowledge but lately they turned into environments where students freely discover knowledge as an individual or in groups. The activities that have come up with the recent form of labs substantially contributed to training ideal students for constructivist approach, who research, inquire, test, seek solutions, wear scientist shoes and deeply reason about the concept of concern. However, on the present stage of our educational system, these activities cannot be included in science lessons for several reasons. At that point virtual labs emerged as an alternative solution for the problems of the instruction in science courses. Thanks to virtual labs presenting different disciplines in a flexible manner, the interaction between the teacher and the learner become 7/24 independent from time and place. This article presents a study that provides insight in the appropriateness of Virtual and real laboratory applications on constructivist learning environment using interactive virtual chemistry laboratory (VCL) development was used in academic year of 2009-2010 for a six week period. The sample of this quasi-experimental study was 90 students from three different 9th grade classrooms of an Anatolian Secondary school in the center of Trabzon city. The student groups were randomly attained as one experimental and two control groups. The data collection tools of the study were; questionnaire of teaching philosophy (QTP), Semi-structured interviews and unstructured observations. The results showed that virtual chemistry laboratory software was just as effective as real chemistry laboratory and it positively affected the facilitating of constructivist learning environment. It was determined that the students in experimental group conducted the experiments as precise as the real ones; they felt themselves safe during the experiments; they could relate the experiments with daily life; they had the opportunity to investigate both macro-molecular and symbolical dimensions of the experiments. It was speculated that using virtual chemistry laboratories as a supportive complement in education will become an indispensable instructional material in terms of both the economy of the nation and the persistency of the learning.

Keywords: **virtual laboratory, constructivism, learning environments**

INTRODUCTION

Secondary education 9th class chemistry curriculum which was reorganized in 2007 has traces of constructivist learning approach which defends the idea that knowledge is constructed as a result of the active interaction of the individual in the activities (Baki, 2008; Tatli, 2011).

Constructivist approach suggest that active participation has crucial importance in students' learning process (Bernard et all., 2004; Edwards& Hammer, 2004)).

In constructivist learning approach, students construct actively their knowledge by thinking, doing, and interacting with the environment (Yildirim, 2009; Tatli, 2011). For this reason, laboratory has a great importance for chemistry teaching and learning (Leite & Afonso, 2002). The laboratory has been given a central and distinctive role in science education, and science educators have suggested that there are rich benefits in learning from using laboratory activities (Hofstein & Lunetta, 1982; Taşdelen, 2004). Beach and Stone (1988) state that the most effective teaching of chemistry can only be possible through the use of laboratory and they explain this situation with the irony "trying to teach painting without paint and canvas or trying to learn cycling from user's manual" (Tezcan & Bilgin, 2004).

Laboratory approach is based on the idea that experiments to prove the basic information about science must be done in laboratory by the students (8). Individual differences would be eliminated in laboratory studies in a way. Because, all equipments and methods used in doing experiments in laboratory studies are also elements of individual training (Tatli, 2009). In addition, use of laboratory as a method of teaching develops students' reasoning, critical thinking, scientific perspective and problem-solving abilities (Odubunni & Balagun, 1991; Ayas, Cepni & Akdeniz, 1994).With these skills, the students are encouraged to think, study and perform experiments like a scientist (Ayas, Cepni & Akdeniz, 1994, Bozdogan & Yalcın, 2004). It is often emphasized that the necessary importance for laboratory is not given (Glaserfeld, 1995; Saka, 2002).

Nowadays, science education focuses on educating young people who analyze the process to find out scientific knowledge and applications and have high problem solving ability (Yang & Heh, 2007). Teaching which is rapidly moving away from traditional methods, must determine the reasons of past problems and adopt new approaches to the needs of the modern information society (Rusten, 2004). For this purpose, well-developed computer-aided systems to assimilate the content of scientific knowledge and constructivist approach in computer science are needed. In the past, technical deficiencies, inefficient course hours to do experiments, security concerns and expensive equipments have been effective in reduction of lab hours for experiments in programs.

Computers, with the development of information technologies, have shown itself as the most powerful tool to develop students' ability to query and to support the teaching of science (Fetaji et all., 2007). Thus, the configuration of information required for the quality of training has been provided (Rusten, 2004). In this context, developments in the field of education in the last twenty years have a promising nature. To use technology in this defined process is not a privilege but has become a necessity. Individuals who seek information and have the ability of constructing their own knowledge and the teachers who integrate technology with their courses to train individuals are the needs of the new age (Pekdag, 2010). As the computer allows teacher to use and control different tools at the same time in teaching students' learning options has been extended and quality has possibly been increased (McCoy, 1991; Geban, Askar & Ozkan, 1992). Thus, children of the age of technology should use computers in their education effectively and by using them they should be able to construct their own knowledge (Cepni, 2009). In our country, with the increasing number of computers in schools, the need for virtual learning environments has been felt day by day. Virtual labs or materials, which allow training free from location and time, can rescue education from the walls of the class and spread it to all kinds of environments and thus applications are more dynamic with simulations (Yang & Heh, 2007).

Students demonstrate active participation while doing an experiment in a virtual environment; they may carry out the experiment individually or in collaboration with colleagues. This is the most important difference that separates virtual laboratories from traditional applications (Dede, Salzman & Loftin, 1994). In addition, thanks to the flexibility of virtual environments, abstract concepts that inevitable for chemistry become more concrete, daily life experiences can meet lessons and students can go ahead according to their personal learning pace and needs (Sanger, 2000; Stieff, Wilensky, 2003; Pekdag, 2010).

Virtual laboratories as a supportive factor to real laboratories enriches learning experiences of students and offers students to do experiment, to control materials and equipment, to collect data, to perform the experiment interactively, and to prepare reports for the experiment as well as developing experimenting skills.

Educational environments in which constructivist approach is adopted and implemented need to be enriched with collaborative and interactive facilities (Ayas, 1998). POE (predict-observation-explain) that is one of the constructivist approach proposed to enhance learning environments is among the most preferred strategies in recent years (White & Gunstone, 1992; Liew & Treagust, 1995; Palmer, 1995). In POE (predict-observation-explain) strategy, students make a prediction and interrogate the nature of situation they faced by combining their existing information with their experiences by using similar situations they faced in real world. Thus, students participate in the process actively (Palmer, 1995; Gunes, 2008). The basis of POE strategy bases on students' predictions about the event prepared by the researcher, observations on the event and explanations to eliminate the conflicts between their predictions and observations (Champagne, Klopfer & Anderson, 1980; White & Gunstone, 1992; Liew & Treagust, 1995; Palmer, 1995).

Based on the summary above, a virtual chemistry lab has been developed related to "chemical changes" unit in year nine chemistry curriculum by making use of the constructivist theory and fallowing POE strategy, including presentations in macro, micro (molecular) and symbolic levels, and relating it with daily life.. Investigation of similarities and differences of learning and teaching process in virtual and real environments (laboratory) is the basic problem of this study.

METHODOLOGY

Material and Method

In this study a quasi-experimental method was used.

Table: 1
The Process of This Study

Group	Process	QTP	Interview	Observations
EG	a*	X	X	X
CG-I	b*	X	X	X
CG-II	c*	X	X	X

EG: Experimental group; CGI: Control Group I; CGII: Control Group II
a: Doing experiments in the virtual laboratory.
b:Without any intervention to the teacher, conducting the course as its normal way (experiments should be done in actual chemistry labs in normal frequency).
c: Doing experiments in a real laboratory environment .
*: evaluation of the process by using a questionnaire of education philosophy.
While virtual chemistry laboratory software is developed, constructivist learning approach, and POE strategy are taken into account.

The students performed their studies in virtual laboratory compared with those who did the same experiments in real laboratory and those who continued their lessons as before were three groups one experimental and two control groups took part in this study.

A summary of application together with the measurement tools used in it study are indicated in Table: 1. In this context, reflections of constructivist approach and POE strategy to VCL software are given in Table 2 systematically.

Table: 2.
Reflections of Principles and Strategies in VCL to The Software

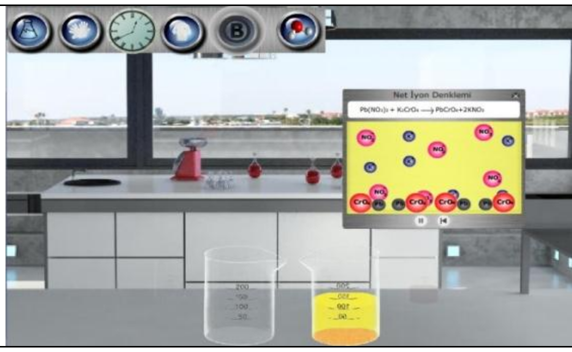
Steps	Reflections to VCL
Configuration information	Before the students start the experiment, their prior knowledge adapting real or virtual lab experiences to daily life are inquired. Free science experiments that can be done in class or at home using VCL.
Student-centered learning	Individual or group decision making experiments Ask an open-ended questions during an experiment Students can make experiments interactively inVCL environment
The role of the teacher	Start the experiment with an interesting question Dimensions of planning instruction, learning and teaching through nmultimedia Before begining an experiment, students should select the inventory in the stall and all equipment
Evaluation	Process evaluation/At the end of the experiment, comparison of the students' prior knowledge and result of experiment Students write down their predictions and record the data in the VCL
Steps in POE	Reflections to VCL
Predict	Before begining an experiment, students should select the prediction about subject and record the data in the VCL
Observation	Observe every details of the experimental process by playing an active role and recording the data by the students.
Explain	At the end of the experiment, a comparison of the students' prior knowledge and observation

Aspects of the software developed in the study and images related to these sections are provided in Figure 1.

The experiment tools selected by the student

Takes necessary safety measures before the start of the experiment

Before students start the experiment, VCL ask students to predict about subject



Systematic observation and experiment (macro-micro & sembolic levels)

At the end of the experiment, comparison of the students' prior knowledge and result of experiment

Warning "The laboratory is kept clean and uncluttered"

Figure: 1
Parts of VCL

Data Collection Tools

In the study, in CG-I, CG-II, and EG groups, observations were made during 11 lesson-hours each. In this process, the researcher has tried to record the student responses and teacher-student dialogues with unstructured observations. However, everything that goes on in the course cannot be written down, all lessons are recorded by audio recording device with teacher's consent. Observation data are transferred to the questionnaire of education philosophy that was developed by field experts (Gunes, 2008; Tatli, 2011). In this study, interviews with students and teachers are the data sources as well.

Analysis of Data Obtained from the Research

Observations made during "chemical changes" unit in control and experimental groups have been analyzed considering the characteristics of constructivist learning environment created by teachers. In each lesson, events in the classrooms were written down by the researcher, to examine the records again they were transferred to the computer environment.

Thus, events that were not noticed by the researcher during the observation could be taken into account. Sample situations that could be used as data to the study, in the observation notes and audio recordings were transferred carefully. Semi-structured observation form which was used to determine the practice teachers' teaching philosophies was scored in the form of "constructivist" (4), "close to constructivist" (3), "close to traditional" (2) and" traditional" (1) and was detailed with the notes that recorded in "the researcher comments" section under the observation form.

At the end of the observation, after determination of observation frequency of each category, these frequencies were multiplied with the corresponding teaching philosophy (Constructivist: 4, close to constructivist: 3, close to tradition: 2, traditional: 1).

Thus, the scores that teachers got were multiplied. However, both of teachers C and D were observed during 11 hours, in CG-I, CG-II, and EG, the periods of time were varied in classroom and laboratory among these teachers.

In Table: 3, periods of times that spent by the teachers C and D during the chemical changes unit in laboratory and classroom are shown.

Table: 3
Teachers Teaching Environments and Course Hours

Student group (teacher's)	Learning Environment		
	Laboratory	Class	Total
CG-I (C)	2*	9 *	11 *
CG-II (D)	3 *	8 *	11 *
EG (D)	5 *	6 *	11 *

*Hour.

Teacher C and D filled a "questionnaire of teaching philosophy" for each observed lesson during the Chemical Changes unit. All questionnaires were classified in two categories; filled in laboratory and in class. Total scores in the forms that classified in categories were divided by course hours and so an average score was gained (for example, 2 hours observed total score for laboratory environment were divided by 2 and so the score of that teacher about the constructivist teaching philosophy was found).

According to the ratings, to decide on teachers' teaching philosophy preferences, range points were found by adding range point values to the lower and upper ranges. In the calculation the score ranges; "Score Range = (Maximum value-Minimum value) / class interval" formula was used (Sumbuloglu & Sumbuloglu, 2002). The data gained from Semi-structured interviews made with the students and teachers in the scope of the study were analyzed descriptively. Because the descriptive analysis approaches make it possible that the data are organized according to the themes of the research questions and presented according to the questions and dimensions used in the interview (Birgin, 2008). At the end of each interview audio files recorded during interviews transferred to the computer by the researcher and then all the records were listened to be sure that there were no missing or damaged parts in these records after than they were written down. In Quotations real names of the participants is not preferred by the researcher, instead, code names given by the researcher were used. In this direction, names such as for the interview carried in CG-I group, the C1-M (interview order), for CG-II, C2-M (interview order) and for EG E-M (interview order) are used.

FINDINGS

To learn the appropriateness of VCL software in the learning environment to the constructivist approach, application process was observed and it was compared with the learning environment in the control groups. For this reason, during "the chemical changes" unit, all the lessons that Teacher C and D had with the control and experiment groups were observed. The data was used to find out the teachers' philosophy through the teaching philosophy questionnaire.

With the data from the findings and informal (their ideas about the constructivist approach and how to integrate this approach the process) interviews held with the teachers, a conclusion could be made about the teachers and their teaching philosophies were determined.

Two different form were prepared for the two different student groups according to learning process was in class or in laboratory. The results of these observations are given in Table: 4.
Table 4 shows teachers' teaching philosophies reflected in laboratory and the classroom environment. Accordingly, the teacher who has the highest score is the nearest to the constructivist approach. According to the data obtained from the survey, teachers were categorized in four groups. Categories correspond to the scores are below:

Between 24-41points: "traditional"
Between 42-59 points "close to traditional",
Between 60-77 points "close to constructivist"
Between 78-96 points "constructivist"

Table: 4.
Groups Learning Process

	Environment/Learning Philosophies		
Teacher	**Laboratory**	**Classroom**	**Mean**
Teacher C (CG-I)	**46.0 (CT)**	**38.5 (T)**	**42.2 (CT)**
Teacher D (CG-II)	**46.0 (CT)**	**76.0 (CC)**	**61.0 (CC)**
Teacher D (EG)	**93.6 (C)**	**69.3 (CC)**	**81.5 (C)**
Min-max level	**24-96 (T-C)**		

Based on the above table, it is seen that Teacher C is close to traditional. Teacher D is almost constructivist with the CG-II while he has close to constructivist perspective in EG. When the differences in teacher D with two student groups were investigated, it was seen that classroom aspect of the lessons in the two groups was close to constructivist but differences could be observed in laboratory sections. It is seen that teacher D's "close to traditional" with CG -II group in laboratory lessons, and "constructivist" with EG students in laboratory lessons.

This difference can be associated with the duration of the rate between classroom work/experimental work. Because Teacher D with students CG-II uses the most of the time in the lesson to prepare the experiment and make students ready for the experiments. The groups in doing experiments consist of at least 4-5 students. Therefore, the teacher D is often chose performing demonstration in teaching. The students are only do what the teacher shows them in this process, they cannot query the process. However, EG students use VCL software in information technology class and 2 or 3 students share 1 computer.

The students choose the necessary equipment for experiments from VCL and they establish experiment assembly by themselves. In this process, the experiment is done by the students with the provided software. Teacher D's role in EG is being a guide.

Findings from semi-structured interviews carried out with students are also presented below to find supportive evidences on the effect of VCL software. The questions asked to students from CG I and II, and EG and their answers are presented in the following Table 5.

Table: 5.
The Questions And Students' Responses Obtained from Semi-Structured Interviews

Categories	Examples of anwers	CG-I % (f)	CG-II % (f)	EG % (f)
Question: While you attending a laboratory session, were you participating in the laboratory activities?				
Always	When teacher shows us how to perform the experiment we can do (C1-M2)./Yes, we do all the experiments by ourselves (E-M1).	%25 (2)	%62.5 (5)	%100 (8)
Sometimes	When we do group work 1-2 of us are doing the experiment the rest is only observing, seldom we do experiment (C1-M8).	%37.5 (3)	%37.5 (3)	-
Newer	No, up to now only once we had chance to handle the equipments (C1-M6).	%37.5 (3)	-	-
Question: have you had any difficulty in doing experiments?				
No, never	The experiments we performed were not very difficult. In fact we did not have chance most of the time to handle equipments for experiments (C2-M6)./Since our teacher is carrying out the experiments or he tells us step by step what to do, we have no difficulty (C1-M2)./To use VCL is very easy, we face no difficulty (E-M8).	%62.5 (5)	%100 (8)	%100 (8)
Sometimes	When we learn something new either a tool or a matter we face some difficulty. (C1-M2)./Sometime, I scared to spill acids around or on my clothes (C1-M8).	%37.5 (3)	-	-
Question: Do you feel self-confidence when you need to perform an experiment?				
Yes	Yes, I can do experiments easily when I have the knowledge (C1-M4). /Yes, I can do but It is more enjoyable when I do it in VCL (E1-M6).	%37.5 (3)	-	%100 (8)
To some extent	If the experiment is set and I am told what to do than I can do (C2-M8)./ If everything is clearly written down I can (C1-M2).	%50 (4)	%100 (8)	-
No	No, I cannot (C1-M8).	%12.5 (1)	-	-
Question: Does your teacher talk about how the experiment is connected or related to daily life?				
Yes	Our teacher teaches us chemical concepts or topics by relating them to daily life. Thus, we can easily remember them (C2-M6)./When we perform any experiment in VCL we use the button "Relate it with Daily Life" and we were examining the connection with daily life. Also, the background music and art (pictures) were really enjoyable (E-M2).	%37.5 (3)	%50 (4)	%100 (8)
To some Extent	Sometime he does (C1-M7).	%50 (4)	%50 (4)	-
No	No, we do not make connections. In fact, we did not do many experiments. We have difficulty to finish experiment because of time limit (C1-M3).	%12.5 (1)	-	-

When we examine the students' ideas from we can easily noticed that EG students have had no difficulty to perform the experiments via VCL software, they were able to participate every step of virtual experiment, and they have the self confidence to carry out their work on VCL. Moreover, students in experimental group have had the chance to use "Relate it with Daily Life" button in VCL and they have enjoyed it.

CG-I students have indicated that their teacher has done most of the time the experiment as a demonstration (%62.5), sometime they had chance to do the experiment by themselves (25%). However, because teacher was a guide in experimenting they did not develop self confidence to perform the experiments (%50) and they had limited chance to relate the experiment with the daily (%50).

CG-II students had taken responsibility most of the time (%62.5) in performing experiments, but their teacher has directed them what to do. They also indicated that since they do the experiments under the supervision of their teacher they faced no difficulty in experimenting (%100). Thus they feel self-confidence "to some extent" to do experiments. The student in this group was diverged in their ideas about relating experiments with daily life.

DISCUSSION AND CONCLUSION

Chemistry curriculum in Turkey, which took its present form in 2007, has traces of constructivist approach (Baki, 2008). Constructivist approach gives student the duty of being active during learning process and it gives teachers the mission of organizing the process and guiding (Tatli, 2011). Teachers who adopt the constructivist learning approach organize the knowledge around problems, questions and concepts and organize activities that will help students to develop new perspectives and build up connections with their previous learning.

It is important that they make experiments, ask questions and answer the questions (Atasoy, Kucuk & Akdeniz, 2011). Past knowledge constructions, beliefs, value judgments and tendencies of students should be considered within these activities developed, mistakes of students could be used as an opportunity to tell them the structures of thought and forms of constructing new knowledge (Ari, 2008). In other words, knowledge gained at school by students depend on the previous knowledge they had before coming to this environment and the things provided to them by the teaching-learning medium. For this reason, if previous knowledge of students is incorrect, the knowledge constructed over it could also be incorrect (Hewson & Hewson, 1984; Senemoglu, 1997). It is important that activities considering the previous learning of the learner be organized for effective learning (Driver, 1998; Grayson, Anderson & Crossley, 2001).

It is recommended that the lesson should start with a good problem in order that the learning takes place in constructivist teaching. Dewey mentioned that a problematic situation should be at stake and the importance of conducting a cooperative teaching, on the other hand. Cunningham focused on showing how a logical interpretation could be made rather than showing them they should know something exactly (Sahin, 2007). For that reason, teacher's POE strategy that forms learning process of student with questions that could reveal previous knowledge of student has an important place in teaching of chemistry concepts. In prediction stage of this method, students are informed about the concept and they are required to predict the result of the experiment or the reasons of their prediction. During the observation phase, students perform the experiment which they predicted about and than they observe the process (Sahin, Calik & Cepni, 2009; Tas, Apaydin & Cetinkaya, 2011).

Appropriate environment need to be prepared for students to take notes during their observations and the experiment is renewed if necessary. During the stage of explaining, contradictions between their observations and predictions are discussed if there are any. POE method will achieve its goal if the teacher guides students instead of explaining them the contradictions that occur and help them make alternative interpretations considering all probable thoughts (White & Gunstone, 1992; Karaer, 2007). Virtual chemistry laboratory developed in this study is prepared with an understanding that it is based on student interaction and appropriate to constructivist method as well as POE strategy.

However, each student is in interaction with the teacher and his/her friends because he/she is not hidden in a bell jar. VCL gives the student the opportunity using the software to make a prediction about the experiment, to make the experiment as a result of active interaction and compare his/her previous knowledge and present knowledge at the end of the experiment. In this research, experimental group teacher was requested to conduct in his lessons in accordance with the constructivist method. Software is good tool in this process of conducting lessons in accordance with the constructivist method. Lessons of CG-I, CG-II and EG students were observed during the unit "chemical changes" and the lessons performed in each class and the laboratory were observed using teaching philosophy survey and laboratory observation form. At the end of the study it was seen that the applications of the C teacher in the classroom were in accordance with "traditional" and his applications in the laboratory were in accordance with "close to traditional" approach.

Teacher C taught the lesson by using the method of lecturing the subject first and dwelled on question solution after that. It was observed in lessons in which questions solved that students' development were not given importance but when students stated an answer as incorrect they were given no feedback but given immediately a correct explanations. No matter how meaningless or incorrect answers the students gave they should be given importance and feedback need to be provided (Brooks & Brooks, 1993). According to traditional approach learning takes place when an appropriate reaction is given for a specific warning. The important thing is only the behaviors of students (Ertmer & Newby, 2008; Azar, 2010). It was seen that teacher C behaved close to traditional approach and was generally dominant in the class and he determined the rules in the class. For that reason, students who want to express their thoughts or want to be active have no opportunity for both in class and in the laboratory sections. It was seen that while teacher C was preparing the experiment in chemistry laboratory, a student asked "Can I ask something sir?" and he replied, "No, you can't". It was also observed that CG-I students did not make any guesses about the experiment conducted during the laboratory hours and they could not follow the experiment process completely. It was seen that CG-I students mostly did not understand what happened at the end of the experiment they made and the explanation about the result of the experiment was done in the next lesson by the teacher. Students are active only in a part of the observation process and they are passive at other times. During the interview with teacher C, he explained his way in the process as "... I want the students to be active during the process. It is not important they make noise or argue in the class. However, when an administrator passes in front of the door of the classroom he opens the door and checks if the teacher is there or not. When the situation is just like that, you have to carry on the traditional way.

Also, teacher D stated that university exam was very important for his students and his school so solving end of unit questions or problems has to be given more importance in teaching.

It was understood that teaching approach has become an obligation rather than a choice for teachers because of university entrance exam (YGS). In a similar way (Kang & Wallace, 2005) observed three science teachers and try to define which teaching approach they use to conduct their lessons. They defined that same teacher doesn't behave in the same manner in different lessons; they use different teaching approaches according to the different lessons and different classes. They think that this is because of the relationship between teachers' epistemological believes with the target topic and instructional purposes.

It was observed in CG-II that Teacher D wanted to keep the control in his hand every time, sometimes intervened the students in the lessons and students studied in crowded groups in laboratory environment. Teacher only said the name of the experiment before the experiment and provides tools to students for use in experiment in many times. It is detected in the study that during the laboratory applications, teacher said the necessary steps to the students directly, never created a situation for student to make some predictions or comments; during the observation aspect of the experiment students were partly active, to discuss the result of the experiment students did not have enough time in many cases. In an interview with a student in group CG-II, student said that he did not know the goal or result of the experiment and he added "…we add something to something. Then a solution in yellow appeared. But I did not know the solutions used in the experiment or I did not know what happened at the end…". Traditional classes are generally defined as the teacher-centered environments (Appleton; 1997). In this situation, it is believed that there is some knowledge that students need to know, so the content of the lesson is designed before the lesson and lessons are planned according to this formation. Students' improvement in this process is not taken into account (Bennett & Pilkington, 2001; Ozden, 2003; Josephsen, Kristensen, 2006).

There is some stable and definite knowledge that students must know and this knowledge is transferred to the students in an environment where teacher is active whereas students are passive. Less interaction and few questions by students are often observed in traditional teaching environment (Glaserfeld, 1995; Appleton, 1997; Edwards & Hammer, 2004; Fetaji et all., 2007; Tatli, 2009). Teacher D explain why these kinds of educational situation happen as"….tools and chemicals are not enough in laboratory, students must finish the experiment without making a mistake. So I must say students what they must to do in many times. For example, there is no silver nitrate so we couldn't do the silver-plating experiment. And also I can't arrange the experiment before the lessons, because we lose too much time. Time is very important for Anatolia High School as ours. So I prefer to do experiment as a demonstration or I prefer not to give students much independence…" and we refer from here not learning but finishing the topics are more important.

On the other hand, the role of teacher in constructivist environments is to organize knowledge around problems, questions and concepts in order to attract students and help students to develop new perspectives and make connections with their previous learning's. The teacher does not transfer the knowledge directly; on the contrary he presents environments where students can construct their own knowledge and facilitates learning. In this process students are presented activities through which he can construct his own knowledge about the outer world and he can interpret the knowledge he gained (Sahin, 2007). Activities organized are student centered and the students are encouraged to ask their own questions, make experiments and to reach results (Appleton, 1997; Bennet & Pilkington, 2001; Ozden, 2003; Josephssen & Kristensen, 2006; Bakar & Zaman, 2007; Winberg & Berg, 2007; Akbulut & Akdeniz, 2008; Ari, 2008; Falvo, 2008; Korakakis et all., 2009; Koray, Koksal & Hazer, 2010).

It was seen that teacher D undertook the role of a constructivist teacher in laboratory applications with EG students. Teacher D conducted his teaching in groups of 2-3 students contrary to other classes in his applications. He had the students to make a prediction about the result of the experiment to be made by bringing them to Information Technology room before teaching the subject mentioned in the experiment and entered this prediction to the screen with its reason and made them record it.

In observation part of experiments, students performed the experiment by trying all the alternative situations (if there is any) and compared the result they have reached with their first prediction on the screen. In that stage, students discussed the result they obtained first within the group and later between the groups and they requested help from their teacher at the final point where they could not handle. All the students in EG performed all the experiments in the unit at least two times. It was observed that the teacher allocated at least 10 minutes at the end of each lesson for discussing the experiment done. It was observed that the teacher guided the students during the process and organized the process very well and tried to help students construct their own knowledge. Teacher D who stated that VCL facilitated his work, also said the software helped him about creating a constructivist learning environment and that he could easily organize the time and the process. Also EG students were permitted to use VCL software only within chemistry lessons and applications lessons. When the success of students in a limited time period is considered, it is thought that higher success rates will be achieved by permitting virtual environments to be used out of classes with their character of learning environment independent of time and space. Teacher D stated that he presented sections of "relate this guess with daily life" or concepts he forgot in some lessons with sound and image, and after this application students were curious about what the relation was with the daily life and searched and discussed. During observations it was seen that EG students were active in application process and worked in cooperation, researched macro, micro and symbolical displays with interest and joy, tried to construct their own knowledge and undertook the role of a scientist within the process.

It is a requirement of constructivist approach that students use their own knowledge and create them with their unique method (Subramanian & Marsic, 2001; Limniou & Papadopoulos, 2009). During the practical sections each student had the opportunity to compare his previous knowledge with his later learning and discussed the result he/she obtained with his/her peers and teachers. The role of teacher is more difficult and indirect in constructivist approach because it focuses on student's construction of knowledge. The teacher should focus on the thought of the student rather than the correct answer. The teacher should encourage student to think (Glaserfeld, 1995; Kang & Wallace, 2005; Yang & Heh, 2007; Bakar & Zaman, 2007; Ertmer, 2008; Atasoy, Kucuk & Akdeniz, 2011).

As a conclusion, it can be indicated that VCL software helps teacher in creation of a constructivist learning environment and laboratory sections that takes the student at center and makes the student be active within the process (Appleton, 1997).

The use of computer technology is important in development of activities that are appropriate to implement constructivist teaching in the schools. Another study's finding supports this idea that "virtual learning environments have positive effect on independent and cooperative learning" (Bennet & Pilkington; 2001). Other virtual laboratory applications examined in the literature was also seen to support the learning environments appropriate for constructivist approach (Dede, Salzman & Loftin, 1994; Subramanian & Marsic, 2001; Fetaji et all., 2007; Pekdag, 2010; Tatli, 2011;).

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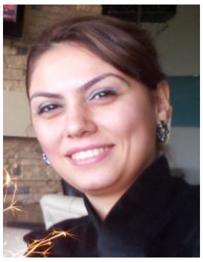

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