EFFECTIVENESS OF CASE-BASED LABORATORY ACTIVITIES ON CHEMISTRY LABORATORY ANXIETY OF PRE-SERVICE SCIENCE TEACHERS

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ABSTRACT
This study aimed to investigate the effects of case-based laboratory activities in order to reduce the anxiety of pre-service science teachers during chemistry laboratory courses. The participants of the study consisted of 63 first year Science Education students from Mugla Sitki Kocman University. Experimental and control groups were formed randomly from these participants. In the experimental group, the laboratory courses were carried out with case-based activities for six weeks. In the control group the courses were implemented in a traditional way within the same period of time. For data collection the Chemistry Laboratory Anxiety Scale and open-ended questions were administered. The scale was administered to both groups as pre and post-test. The open-ended questions were administered only to the experimental group. In the experimental group where case-based lab activities were used sub-dimensions of the scale such as using equipment and chemicals, working with other students, collecting data, and having adequate time were observed. It was found that pre-service science teachers in the experimental group developed positive views towards the use of case-based activities in their teaching practices.

Keywords: Chemistry Lab, Anxiety, Science Education, Case-Based Activities, Pre-Service Teachers

ÖRNEK OLAY TEMELLİ LABORATUVAR UYGULAMALARININ FEN BİLGİSİ ÖĞRETMEN ADAYLARININ KİMYA LABORATUVAR KAYGILARI ÜZERİNE ETKİLİLİĞİ

ÖZET
Bu çalışma kimya laboratuvarı boyunca fen bilgisi öğretmen adaylarının kaygılarını azaltmada örnek olay temelli laboratuvar uygulamalarının etkililiğinin araştırılmasını amaçlamaktadır. Araştırmanın örneklemini Muğla Sıtkı Koçman Üniversitesi Fen Bilgisi Öğretmenliğinde öğrenim gören birinci sınıf 63 öğretmen adayı oluşturmaktadır. Deney ve kontrol grupları katılımcılardan tesadüfi olarak seçilmiştir. Deney grubunda kimya

laboratuvar uygulamaları örnek olay temelli olarak 6 hafta süreyle yapılmıştır. Kontrol grubunda ise laboratuvar uygulamaları geleneksel laboratuvar yaklaşımları ile eşit sürede işlenmiştir. Araştırmada veri toplama aracı olarak "Kimya Laboratuvarı Kaygı Ölçeği" ve "açık ve kapalı-uçlu sorular" kullanılmıştır. Ölçek her iki gruba ön test ve son test olarak, açık ve kapalı-uçlu sorular ise sadece deney grubundaki katılımcılara uygulanmıştır. Araştırma sonucunda, örnek olay temelli laboratuvar uygulamalarının öğretmen adaylarının kaygı ölçeğinin alt boyutları olan laboratuvar araçlarını ve kimyasal maddeleri kullanma, diğer öğrencilerle çalışma, veri toplama ve laboratuvar zamanını kullanma boyutlarındaki kaygılarını azalttığı ortaya konulmuştur. Ayrıca deney grubundaki öğretmen adaylarının örnek olay temelli laboratuar uygulamalarına yönelik olumlu görüşlere sahip oldukları sonucuna ulaşılmıştır.

Anahtar Kelimeler: Kimya Laboratuvarı, Kaygı, Fen Eğitimi, Örnek Olay Uygulamaları, Öğretmen Adayları

INTRODUCTION

The best way of learning chemistry effectively is by learning in the laboratory (Hofstein & Lunetta, 2004). The chemistry laboratory facilitates understanding chemistry issues and connects them with real life (Hodson, 2001; Lunetta, Hofstein, & Clough, 2007). Studying with concrete materials in chemistry laboratories helps students to understand the environment that they live in and get a feel of the events and cases (Jenkins, 1999). Moreover, laboratory activities present opportunities to students to understand scientific concepts by enhancing their mental development (Hofstein & Lunetta, 2004). In science teaching, the chemistry laboratory consists of experimental activities that students do by using chemicals and materials. Especially in laboratory activities students are expected to learn how to use proper laboratory materials and chemicals, experiment independently and do all these in a safe way.

As a result of the chemistry laboratory activities developed and implemented, students' ability in understanding concepts, scientific information related to chemistry, nature of science and chemistry (Hofstein, Nahum, & Shore, 2001; Lazarowitz & Tamir, 1994) will develop. Furthermore, students' ability in solving problems and development of scientific process skills and increasing positive attitudes, curiosity and interests towards chemistry will be ensured (Azizoglu & Uzuntiryaki, 2006). Most students, however, are afraid of chemistry laboratory activities (Jegede, 2007). This fear causes losing interest in chemistry by imposing pressure on students (Keeves & Morgenstern, 1992). Moreover, these kinds of fears affect students' learning chemistry and their performance negatively (Eddy, 2000). This condition can be considered to be students' anxiety towards particular chemistry topics. Anxiety towards chemistry is defined as fear of a chemistry course and chemicals (Eddy, 2000), resulting in inhibitions about chemistry (Turner & Linsay, 2003). According to Turner and Lindsay (2003), anxiety towards chemistry is related to a wide area of cognitive, psychological and behavioral problems and this anxiety causes students to avoid learning chemistry or end up learning and creating negative attitudes towards events and activities related to chemistry. That students think they will not be able to solve science problems and that they will fail in science exams causes this kind of anxiety. Expectations that students

whose parents are good at science should be more successful than the others and that girls should be more successful than boys are also sources of anxiety that exert pressure on students (Mallow & Greenburg, 1983). Moreover, not only students' parents and the environment, but also bad experiences in the past with science teachers, lack of a role model, gender and race effects, and the role of scientists in popular media are reasons for the cause of anxiety (Mallow, Kastrup, Bryant, Hislop, Shefner, & Udo, 2010).

Especially in laboratory learning activities, students' cognitive structures need to be addressed and also their needs, interests, aims and expectations need to be resolved because emotional and social factors are important as much as cognitive factors. In this regard, it will not be enough to determine anxieties of pre-service teachers when they are involved in chemistry laboratory activities. Studies related to this subject already show that students have anxiety about chemistry laboratory activities (Kaya & Cetin, 2012; Erokten, 2010; Kurbanoglu & Akin, 2010; Anilan, Gorgulu, & Balbag, 2009; Azizoglu & Uzuntiryaki, 2006; Eddy, 2000; Bowen, 1999; Wynstra & Cummings, 1993). Yet, a few studies, in which students have attempted to resolve those anxieties, have been found. According to these studies related to pre-service teacher education, the use of project-based learning process for self-learning in chemistry laboratory (Alkan & Erdem, 2013), spending a lot of time in the laboratory for performing experiments (Erokten, 2012), use of effective educational strategies (Kaya & Cetin, 2012), and also using strategies and methods in the laboratory such as argumentation and reflection based on the activities reduce anxiety toward the chemistry laboratory.

In this study, the case-based method which is a constructivist approach was used to reduce or eliminate anxiety of pre-service teachers toward chemistry laboratory because the case-based method involves learning by solving problems in the laboratory encountered in real life. Thus, students prepare themselves for living conditions by transferring the learning to their daily life problems (Acıkgoz, 2003). With this method, it can be ensured that students pay more attention to the lesson and laboratory, develop positive attitudes, become aware of their cognitive levels, apply the learned information to daily life situations and find alternative solutions to problems (Cakir, Berberoglu, & Alparslan, 2001). Especially, the case-based method enables pre-service teachers to realize the relevance of school and its environment and improves students' ability of interacting with their environment (Lourdusamy, Khine, & Sipusic, 2003).

Aims of teacher training programs are to ensure that pre-service teachers become the best in their subject area and fulfill professional standards by teaching to show how they can adopt their own knowledge to carry out "the best applications" by keeping pace with developments in education (Franz, Hopper, & Kritsonis, 2007). Being able to carry out these aims can be provided with the case-based method of teaching based on transferring real classroom experiences and specialist teacher behaviors because this method is one of the most suitable approaches that can be used to prepare pre-service

teachers for responding to complicated problems they may face after starting teaching (Tippins, Nichols, & Dana, 1999). Moreover, as teaching is a life-long learning process, pre-service teachers who will be teachers of the future need to have sufficient knowledge and necessary equipment. The study was made to reduce anxiety of pre-service teachers toward chemistry laboratory by resolving their lack of knowledge, implementation and evaluation in chemistry laboratory activities. In this regard, it was aimed that with case-based laboratory activities performed by pre-service teachers they would acquire information about the functioning of the process and gain experience that would help them in their careers.

So, the study aimed to investigate the effect of case-based laboratory activities on chemistry laboratory anxiety of first grade pre-service science teachers and to solicit their views about these activities.

The research questions were as follows:

(1) What is the effect of case-based laboratory activities on chemistry laboratory anxiety of pre-service science teachers?

(2) What are the views of pre-service science teachers about case-based laboratory activities carried out in the chemistry laboratory?

METHOD

Research Design

The study was carried out as semi-experimental study using pre and post-tests with experimental and control groups to investigate the effect of chemistry case-based laboratory activities on the laboratory anxieties of pre-service teachers. The semi-experimental pattern is the most commonly used pattern especially for researches in the field of education when it's not possible to control all the variables (Cohen, Manion, & Marrison, 2000). In this study, chemistry case-based laboratory activities were carried out with an experimental group; in the control group traditional laboratory activities were carried out in the traditional manner. Case-based laboratory activities and traditional laboratory activities used in the study are included as the independent variable. On the other hand, the dependent variable is chemistry laboratory anxiety levels of pre-service teachers. The pattern of the study is in the Table 1.

Table 1. Pattern of the study

Groups	Pre-test	Application	Post-test
Control	Chemistry laboratory anxiety scale	Traditional laboratory activities (6 weeks)	Chemistry Laboratory Anxiety Scale
Experimental	Chemistry laboratory anxiety scale	Case-based laboratory activities (6 weeks)	Chemistry Laboratory Anxiety Scale Open and close-ended questions

Participants

The sample of this study consisted of 63 first grade pre-service teachers studying in the Department of Science Education of Mugla Sitki Kocman University in the 2012-2013 academic years. The purposive sampling method was used in the study. There are two groups in the sample: control and experimental groups. The experimental and control groups were formed randomly. Activities in both groups were carried out by the same educator. The total number of participants was 63 (26 males, 37 females). The number in the control group was 32 (13 males, 19 females), and in the experimental group the number was 31 (13 males, 18 females). The mean age of the pre-service teachers was 20 years.

Research Instruments

The "Chemistry Laboratory Anxiety Scale" and "Open and Close-ended Questions" were used as data collection tools in the research.

Chemistry Laboratory Anxiety Scale (CLAS): This scale was developed by Bowen (1999) to measure chemistry laboratory anxieties of pre-service teachers, and was translated into Turkish by Azizoglu and Uzuntiryaki (2006). While the original form of the scale had 30 items in relation to laboratory anxiety, some of the items were removed in the Turkish form of the scale resulting in only 20. Five of these items were negatively worded. The items consisted of statements that required a response based on a five-point Likert-type scale ranging from '5' for strongly agree, '4' for agree, '3' for neutral, '2' for disagree, to '1' for strongly disagree. The anxiety scale consisted of four sub-dimensions. These are: using equipment and chemicals, working with other students, collecting data and having adequate time. The reliability of each dimension was calculated with Cronbach's alpha as a result of factor analysis. The Cronbach's alpha reliability coefficients of the sub-dimensions of the scales were 0.88; 0.87; 0.86 and 0.87, respectively (Azizoglu & Uzuntiryaki, 2006). It took 15 minutes for the participants to complete the scale. Some items in the scale were given in Table 2.

Table 2. Some items in chemistry laboratory anxiety scale

Items	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I am anxious when I use chemicals during lab.					
I feel anxious when I work with other students during lab.					
When preparing for lab, I am concerned about the time available for doing the experiment.					
When I get ready for chemistry lab, I get concerned about the chemicals we will use.					
I am comfortable with the amount of time available for doing the lab.					
…					

Open and Close-ended Questions: Open and close-ended questions were prepared to determine views of pre-service teachers on case-based laboratory applications by researchers. Open-ended questions are about favorite features over this application of pre-service teachers in experimental group and views on what this application contributes to them. Questions are like these; "What aspect of case-based laboratory applications do you like most in chemistry lab?" and "For you what are the contribution of case-based laboratory application to your academic development?". Close-ended questions are like "Were you satisfied with the case-based applications carried out in chemistry laboratory?", "Did you find these applications in the laboratory different?" and "Do you want these applications to continue in chemistry laboratory?"

Treatment

The study involved the topic "chemical rate and chemical equilibrium" in General Chemistry Laboratory. Before the laboratory activities started, the *CLAS* as a pre-test was administered to both groups. At the end of experimental procedures, the *CLAS* was administered as a post-test to both groups and the open and close-ended questions were administered to the pre-service teachers in the experimental group. The study was conducted over six weeks. The topics and cases that were used during the treatment process are presented in Table 3.

Table 3. Topics and cases used in treatment process

Weeks	Cases	Topics
First week	Bridge	Solubility
Second week	Zinc Ingot and Crushed Zinc	Contact surface
Third week	Why does chopping onions make us tear?	Temperature effect

Fourth week	Tooth and tooth decay, and equilibrium between them	Chemical equilibrium
Fifth week	Hiking	Chemical equilibrium
Sixth week	Airbag	Chemical equilibrium

In the experimental group in which case-based laboratory activities were conducted, case studies which were prepared by the authors were used. The case studies are about chemical rate and chemical equilibrium. For example, the case study of "why does chopping onions make us tear" is about the effect of temperature on reaction rate. Laboratory activities in the experimental group were carried out in the following way: the case studies were given at the beginning of the laboratory course to the pre-service teachers in the experimental group. The pre-service teachers were divided into small groups for laboratory activities. In these groups, discussions were held by reading the case study about the related issue. After that, the groups answered the questions about the case study. Each group carried out their experiments which are related to the case study which has certain preparation steps. In the final stage of the laboratory activities, groups discussed the findings of the case study.

For example, the following case study was presented in the chemistry laboratory to the pre-service teachers.

> *Demet observed her mother while she was cooking: She rinsed the onion with cold water for some time after peeling and dividing it into two. When she asked her mother why she did that, she couldn't get a satisfactory answer. Therefore, she decided to research this on the Internet. She found the following information on the Internet:*
>
> *In the onion cells there are chemical compounds that include sulfur. When an onion is cut, these cells fall into pieces and these chemical compounds transform into sulfur products which are more volatile. Sulfur products react with our tears by becoming airborne and form H_2SO_4 (sulfuric acid). In this situation the person feels burning in his/her eyes. At this moment, to decrease the effect of this acid which bothers our eyes, our brain makes our eyes produce more tears by activating tear ducts. In this way, the person who peels the onion cries automatically to protect his/her eyes from the acid.*

The groups discussed this case among themselves. Pre-service teachers usually had discussions on issues like which type of reactions occurred in this case, how sulfur products became airborne, whether acids damage our eyes, how eyes should be protected from this kind of acids? After that, they tried to answer the questions in the case study like "For you what is the purpose of Demet's mother doing this procedure?", "What would happen if the onion was cut in a warm atmosphere? (Would our eyes bring tears much more or less, nothing changes. etc.) Why?", "If the ambient temperatures were high, how would the time which is necessary for the reaction change?" Afterwards, the groups carried out the

experiment of 'the effect of temperature on reaction rate', which has certain preparation steps beforehand. In the final stage, the pre-service teachers made the necessary statements by associating the experiment with the case study.

However, in the control group traditional verification method was applied. The instructor, in laboratory activities which were carried out with this method, explained the problem which would be investigated by introducing the concepts, principles and theories in the laboratory activity to the pre-service teachers before starting to the activity. For example, in the experimental procedure of the effect of temperature on chemical equilibrium, the instructor expressed that the chemical equilibrium of cobalt chloride ($CoCl_2$) aqueous solution would be increased against the temperature and also the interaction of this solution with hydrochloric acid ($CoCl_2$) would be observed. Through this explanation, the instructor, who explained the experimental procedure in a detailed way, showed how the collected data were analyzed. After that, the pre-service teachers collected data by following the experimental procedure written on the laboratory sheet step by step, saved data and made the necessary calculations. Analyzing the collected data, pre-service teachers submitted a report which is related to the experiment they did one week later than laboratory activity. That is, in this experiment, the instructor asked the pre-service teachers to share the solution into the three different flasks. And then, the instructor helped the pre-service teachers heat one of the three flasks, cool down one of the three flasks in the ice bath, and leave the lat flask in the room conditions. Additionally, the instructor helped the pre-service teachers about how to add the concentrated HCl into each flask until the solution's colour changes. After then, the pre-service teachers noted observation data by observing the colour change of the heated and cooled samples. They stated their thoughts in the light of observed data and discussed whether or not the experiment outcomes support the scientific knowledge. In the last period of the experiment procedure, the pre-service teachers submitted their reports to the instructor, including the aim of the experiment, experiment procedure, results, and their comments.

Data analysis

Data analysis was done by using the SPSS 20 package program. In the analysis, using the groups (experiment and control) as independent variable; the "Chemistry laboratory anxiety scale" post-test scores of pre-service teachers who are in the group in which case-based laboratory applications are carried out were used as the dependent variable. On the other hand, covariance pre-test scores of the same scale were used. While the data was being analyzed, one-way ANCOVA was conducted to find out statistically whether there was a significant difference among the groups when there is one dependent variable, one or more than one co-variable (Kalayci, 2006). ANCOVA, excepting one factor or factors whose effects are tested in a study, is known as a technique which provides to control statistically a variable which has a relation with a dependent variable or variables (Buyukozturk, 1998). The reason why pre-tests were held as co-variable is that there is a doubt that there can be an effect of these pre-

tests on post-test scores which are dependent variables (Pallant, 2007). In this way, the problem of unequal groups was eliminated. On the other hand, pre-service teachers' views about the case-based laboratory activities were resolved by using descriptive analysis technique.

FINDINGS AND RESULTS

Effectiveness of the treatments on Chemistry Lab Anxiety

One factor covariance analysis (ANCOVA) was applied to study whether there is difference between pre-service teachers who are in the experimental group of case-based laboratory activities and pre-service teachers who are in the control group of traditional laboratory activities in terms of chemistry laboratory anxiety scores**.** At the beginning of analysis, normality, linearity, homogeneity of variances and homogeneity assumptions of regression tendency were determined. While the experimental and control groups were the independent variable, post-test anxiety scale scores were assigned as the dependent variable. The results of analysis are given in table 4.

Table 4. ANCOVA summary

Chemistry Laboratory Anxiety Scale	Source	Sum of Squares	df	Mean square	F	p
Using equipment and chemicals	Covariate pre-test	.573	1	.573	.046	.830
	Group	133.269	1	133.269	10.78	.002*
	Error	741.302	60	12.355		
Working with other students	Covariate pre-test	.001	1	.001	.000	.993
	Group	104.769	1	104.769	6.331	.015*
	Error	992.971	60	16.550		
Collecting data	Covariate pre-test	37.348	1	37.348	2.608	.112
	Group	66.059	1	66.05	4.613	.036*
	Error	859.299	60	14.322		
Having adequate time	Covariate pre-test	25.404	1	25.404	1.952	.167
	Group	82.982	1	82.982	6.377	.014*
	Error	780.783	60	13.013		

When table 4 is examined, it can be seen that statistically there is no meaningful effect of pre-test values of all sub-dimensions of the chemistry laboratory anxiety scale on groups [first dimension: F (1,60) = .046, p = .830; second dimension: F(1,60) = .000, p = .993; third dimension: F(1,60) = 2.608, p = .112; fourth dimension: F(1,60) = 1.952, p = .167]. Accordingly when pre-application scores are controlled, it can be seen that there is significant difference on chemistry laboratory anxiety scale along all sub-dimensions [first dimension: F(1,60) = 10.78, p = .002, partial eta square = .152; second dimension: F(1,60) = 6.331, p = .015, partial eta square = .095; third dimension: F(1,60) = 4.613, p = .036,

partial eta square = .071; fourth dimension: $F(1,60) = 6.377$, $p = .014$, partial eta square = .096]. Table 5 shows the groups for which these differences are favoured.

Table 5. Descriptive statistics of CLAS

Dimensions	Group	N	*M*	SD
Using equipment and chemicals	Experiment	31	24.00	4.20
	Control	32	21.06	2.61
	Total	63	22.50	3.76
Working with other students	Experiment	31	18.64	4.45
	Control	32	16.06	3.58
	Total	63	17.33	4.20
Collecting data	Experiment	31	23.45	3.43
	Control	32	21.03	4.18
	Total	63	22.22	3.99
Having adequate time	Experiment	31	18.96	4.07
	Control	32	16.65	3.14
	Total	63	17.79	3.78

According to Table 5, the difference in the sub-dimensions 'Using equipment and chemicals' in the chemistry laboratory anxiety scale ($M_{experiment} = 24.00$, $M_{control} = 21.06$), the 'Working with other students' ($M_{experiment} = 18.64$, $M_{control} = 16.06$), the 'Collecting data' ($M_{experiment} = 23.45$, $M_{control} = 21.03$) the 'Having adequate time' ($M_{experiment} = 18.96$, $M_{control} = 16.65$) are all in favor of the experimental group.

Views of Pre-Service Science Teachers About Case-Based Laboratory Activities

Distribution of answers to open and closed-ended questions which were used to determine pre-service teachers' views, about the activities which were carried out in the chemistry laboratory, is given in Table 6 and Table 7.

Table 6. Distribution of answers to closed-ended questions

Closed-ended Questions	Female	Male	Total	
	f	f	f	%
Question 1. Were you satisfied with the case-based activities that were carried out in the chemistry laboratory?				
Yes	14	10	24	78
No	4	3	7	22
Question 2. Did you find these activities in the laboratory different?				
Yes	12	11	23	74
No	6	2	8	26
Question 3. Do you want these applications to continue in the chemistry laboratory?				
Yes	14	11	25	81
No	4	2	6	19

When Table 6 is examined, it can be seen that 78% of pre-service teachers are satisfied with the case-based activities which are carried out in the chemistry laboratory, 74% of them find these activities as different and 81% want to continue these activities in the chemistry laboratory.

Table 7. Distribution of the answers to open-ended questions

Open-ended Questions	Some pre-service teachers' expressions
Question 1. What aspect of case-based laboratory activities do you like most in the chemistry lab?	*…associates the experiments which are done in laboratory with daily life* ($Ö_{14}$) *Provides real-life connecting in Chemistry* ($Ö_{11}$) *More than one point of view occurs in case studies* ($Ö_{27}$) *Some chemicals provide samples for where to use them… ($Ö_8$)* *…sharing knowledge occurs by providing working with group* ($Ö_{17}$) *…shows chemistry use in daily life (*$Ö_5$)
Question 2. For you what are the contributions of case-based laboratory activities to your academic development?	*…I learned how I can transfer my knowledge about chemistry into daily life ($Ö_2$)* *I understood the purpose of experiments in laboratory better ($Ö_9$)* *I learned to look cases statistically about chemistry in daily life from a different perspective. ($Ö_{30}$)* *I have more interest on chemistry laboratory. ($Ö_{13}$)* *I learned that the experiments in laboratories are not complex and they can be used easily in our daily life.* ($Ö_{25}$)

When pre-service teachers' answers to open-ended questions are examined, participants specified their most liked features like; case-based laboratory activities provide examples from daily life, they associate the experiments with daily life; they provide different points of view on cases and working collaboratively. Moreover, participants expressed how they could transfer their knowledge in chemistry into daily life, making concrete the purposes of experiments in the laboratory, look at the cases they face in their daily life in chemistry from different points of view and learn how to express and evaluate scientifically.

DISCUSSION AND CONCLUSION

At the end of the study which was carried out to investigate the effect of case-based laboratory activities to reduce anxieties of pre-service teachers in the chemistry laboratory, it was seen that the

case-based laboratory activities reduced pre-service teachers' anxieties of using equipment and chemicals, working with other students, collecting data and having adequate time.

Case-based laboratory activities were conducted with the experimental group in the chemistry laboratory. The pre-service teachers discussed both in groups and as whole laboratory. Moreover, the pre-service teachers had opportunities to recognize and use materials and chemicals by doing experiments in the laboratory about related topics. In the last section of the laboratory lesson, a relation was provided by associating the case study which was discussed in the laboratory with the experiment. In this way, the pre-service teachers had opportunity to discuss, apply and evaluate the cases related to chemistry that they might face in their daily life beforehand. Doing experiments with those kinds of materials and chemicals in the chemistry laboratory, discussing the case study with friends in groups, by collecting data and bringing daily life into the laboratory atmosphere and having enough time in a laboratory atmosphere may decrease pre-service teachers' anxieties about working in the chemistry laboratory. Moreover, pre-service teachers see that various kinds of chemicals are used in daily life and this situation may overcome their shyness and fears against to these chemicals in the laboratory. Also, studies which are done in groups in case-based laboratory activities not only help pre-service teachers work collaboratively but also provide a positive effect of the chemistry laboratory anxiety scale on anxieties of the "working with other students" dimension. Furthermore, pre-service teachers will have done preparation for understanding of a related experiment by being involved in discussions on case studies. This situation may support students using their laboratory time effectively.

The results show significant difference in the anxiety levels which grew in the chemistry laboratory that is compatible with the results of the studies which were conducted by Alkan & Erdem (2013), Erokten (2010), Kurbanoglu & Akin (2010), Anilan, Gorgulu & Balbag (2009), Saribas & Bayram (2009). In accordance with the results of the study, Erokten (2012), in her study, pointed out that pre-service teachers' anxiety decreased when they had more time in a laboratory atmosphere and did experiments. On the other hand, Kaya & Cetin (2012) highlighted in their study in which they examined chemistry laboratory anxieties of pre-service chemistry teachers that those anxieties would decrease when effective educational strategies were used. In this way, they pointed out that a more effective learning atmosphere could occur. According to Tan (2008) the use of educational strategies like argument which is based on laboratory activities, reflection, much more description, design and identification of duties decreased laboratory anxieties. In another study, it is pointed out that self-learning is also effective in decreasing pre-service teachers' laboratory anxieties (Alkan & Erdem, 2013). Moreover, Alkan & Erdem (2013) pointed out that self-learning in the laboratory and pre-service teachers' self-confidence in themselves, their beliefs in themselves and increasing their own readiness and their eagerness to take more responsibility are the reasons of observing an effective decrease in pre-service teachers' anxieties.

From the results of this study, it was seen that pre-service teachers were satisfied with case-based laboratory activities, thought that it was a different study and wanted to use this application continuously in the chemistry laboratory. Furthermore, pre-service teachers pointed out that they associated their knowledge in chemistry with daily life and this provides information transferring, it creates an experience for problem solving in chemistry which can happen in daily life, and it enables collaborative work by working in groups. Similar to these results, McWillian & Snyder (1999) pointed out that pre-service teachers can transfer theoretical principles into real situations. Moreover, in some studies, in which the case-based study was examined, it was seen that this kind of teaching contributed to pre-service teachers and students using knowledge in lessons and applying them into real classroom discussions (McCombie & Zimmer, 2007; Kurz, Llama, & Savenye, 2008), pre-service teachers improved their problem-solving skills in a real classroom problem solving (Choi & Lee, 2008), and they helped to develop positive attitudes towards working in the laboratory (Alpat, Uyulgan, Ozbayrak, & Alpat, 2011).

In accordance with the investigations about this issue, pre-service teachers have anxieties about the laboratory (Kaya & Cetin, 2012; Erokten, 2010; Kurbanoglu & Akin, 2010; Anilan, Gorgulu, & Balbag, 2009; Azizoglu & Uzuntiryaki, 2006; Eddy, 2000; Bowen, 1999; Wynstra & Cummings, 1993). Studies show that higher anxieties can negatively affect the level of achievement and their attitudes towards the subjects studied (Koballa & Glynn, 2007; Usher & Pajares, 2006, Osborne & Collins, 2000). However, the limited number of studies which show how to decrease and eliminate those anxieties (Alkan & Erdem, 2013; Erokten, 2012; Tan, 2008) make the results of this study valuable. Along with the identification of anxieties in the chemistry laboratory, we also need educational strategies which will reduce and eliminate these anxieties. For this reason, we need more research studies in this field.

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GENİŞ ÖZET

Giriş

Anlamlı bir şekilde kimya öğrenmenin en iyi yolu laboratuvarda öğrenmedir. Kimya laboratuvarı kimya konularının anlaşılmasını ve günlük hayat ile bağlantı kurulmasını kolaylaştırır. Ancak çoğu öğrenci kimya laboratuvar uygulama etkinliklerinden korkmaktadır. Bu korku öğrenci üzerinde bir baskı oluşturarak bu alanda ilgi kaybına sebep olmaktadır. Ayrıca bu tür korkular kimya öğrenimini ve öğrenci performansını olumsuz bir şekilde etkilemektedir. Bu durum öğrencilerin ilgili konu ve derse karşı göstermiş oldukları kaygı olarak nitelendirilebilir. Bu kaygılar öğrencilerin kimya öğreniminden kaçınmasına veya öğrenimi sonlandırmasına, kimya ile ilgili etkinlik ve faaliyetlere yönelik olumsuz tutum geliştirmesine neden olmaktadır.

Çalışmada öğretmen adaylarının kimya laboratuvarına karşı kaygılarını azaltmak veya ortadan kaldırmak amacıyla yapılandırmacı yaklaşım yöntemlerinden biri olan örnek olay yöntemi kullanılmıştır. Çünkü örnek olay yöntemi gerçek hayatta karşılaşılan problemlerin sınıf veya laboratuvar ortamında çözülmesi yoluyla öğrenmeyi sağlamaya çalışmaktadır. Böylece öğrenciler öğrenmeyi günlük yaşam sorunlarına transferini sağlayarak, yaşam koşullarına hazırlanmaktadırlar. Bu yöntem ile öğrencilerin derse veya laboratuvara karşı ilgilerinin artması, olumlu tutumlar edinmesi, bilişsel düzeylerinin farkında olması, öğrendikleri bilgileri günlük hayata uygulamaları ve sorunlara karşı farklı çözümler getirmeleri sağlanabilir.

Çalışmanın Amacı

Yapılan çalışma, öğretmen adaylarının kimya laboratuvar uygulamalarında bilgi, uygulama ve değerlendirme eksiklerini gidererek, kimya laboratuvarına karşı kaygılarını azaltmak amacıyla gerçekleştirilmiştir. Bu doğrultuda öğretmen adayları ile yürütülecek laboratuvarda örnek olay temelli laboratuvar uygulamaları ile öğretmen adaylarının sürece katılımları ve sürecin işleyişine ilişkin bilgi

sahibi olmaları ve meslek hayatlarında gerçekleştirecekleri örnek olay temelli laboratuvar uygulamalarına yönelik tecrübe kazanmaları hedeflenmiştir. Bu bağlamda çalışmanın amacı birinci sınıf Fen Bilgisi öğretmen adaylarının kimya laboratuvar kaygılarına yönelik örnek olay temelli laboratuvar uygulamalarının etkisini incelemek ve bu uygulamaya ilişkin öğretmen adaylarının görüşlerini belirlemektir.

(1) Fen Bilgisi öğretmen adaylarının kimya laboratuvar kaygıları üzerine örnek olay temelli laboratuvar uygulamalarının etkisi nedir?

(2) Kimya laboratuvarında gerçekleştirilen örnek olay temelli laboratuvar uygulamalarına ilişkin öğretmen adaylarının görüşleri nelerdir?

Yöntem

Araştırma, kimya laboratuvar uygulamalarının örnek olay temelli laboratuvar etkinlikleri ile işlenmesinin öğretmen adaylarının laboratuvar kaygılarına etkisini ve bu uygulamaya ilişkin katılımcıların görüşlerini incelemek amacıyla kontrol gruplu ön-son test modeline uygun yarı deneysel çalışma olarak gerçekleştirilmiştir. Araştırmada kimya laboratuvar uygulamaları deney grubunda örnek olay temelli olarak, kontrol grubunda ise geleneksel laboratuvar uygulamalarına göre gerçekleştirilmiştir.

Bulgular

Kimya laboratuvarı kaygı ölçeğinin tüm alt boyutlarında ön test değerlerinin gruplar üzerinde istatistiksel olarak anlamlı bir etkisinin olmadığı görülmüştür. Bu doğrultuda ön uygulama puanları kontrol edildiğinde, kimya laboratuvar kaygı ölçeği puanları üzerinde bütün alt boyutlarda iki uygulama arasında bir farklılık olduğu tespit edilmiştir. Kimya laboratuvar kaygı ölçeğindeki "Laboratuvar araçlarını ve kimyasal maddeleri kullanma" alt boyutundaki farklılık, "Diğer öğrencilerle çalışma" alt boyutundaki farklılık, "Veri toplama" alt boyutundaki farklılık ve "Laboratuvar zamanını kullanma" alt boyutundaki farklılık deney grubu lehinedir.

Ayrıca öğretmen adaylarının %78'inin kimya laboratuvarında gerçekleştirilen örnek olay temelli uygulamadan memnun kaldığı, % 74'ünün bu uygulamayı farklı bulduğu, % 81'inin ise bu uygulamaya kimya laboratuvarında devam etmek istediği görülmektedir.

Öğretmen adaylarının açık-uçlu sorulara verdikleri yanıtlara göre ise katılımcıların örnek olay temelli laboratuvar uygulamalarının gündelik hayattan güncel örnekler sunmasını, yapılan deneyleri gündelik hayat ile ilişkilendirmesini, olaylara farklı bakış açıları sağlamasını ve işbirlikçi çalışma imkânı vermesini en beğendikleri özellikleri olarak belirtmişlerdir. Ayrıca katılımcılar bu uygulama sayesinde kimya hakkında bilgilerini günlük hayata nasıl aktarabileceklerini, laboratuvarda yapılan deneylerin yapılış amaçlarını, kimya hakkında günlük hayatta karşılaşabilecekleri olaylara farklı açılardan bakabilmeyi ve bilimsel olarak açıklayıp değerlendirmeyi öğrendiklerini ifade etmişledir.

Sonuç ve Tartışma

Örnek olay temelli laboratuvar uygulamalarının öğretmen adaylarının kimya laboratuvar kaygılarını azaltmadaki etkisini araştırmak için gerçekleştirilen çalışmanın sonucunda örnek olay temelli laboratuvar uygulamalarının öğretmen adaylarının laboratuvar araçlarını ve kimyasal maddeleri kullanma, diğer öğrencilerle çalışma, veri toplama ve laboratuvar zamanını kullanma boyutlarındaki kaygılarını azalttığı görülmüştür. Öğretmen adayları laboratuvarda ilgili konu hakkında deneyler yaparak araç gereçleri ve kimyasal maddeleri tanıma ve kullanımı hakkında fırsatlar yakalama şansı bulmuşlardır. Laboratuvar dersinin son kısmında ise laboratuvarda tartışılan örnek olay ile yapılan deney arasında ilişki kurularak bağlantı sağlanmıştır. Böylece öğretmen adayları günlük hayatta karşılarına çıkabilecek kimya ile ilgili olayları önceden laboratuvar ortamında tartışma, uygulama ve değerlendirme fırsatı yakalamışlardır. Kimya laboratuvarında böylesine araç gereçlerle, kimyasal maddelerle deney yapıp, grup arkadaşlarıyla örnek olayı tartışıp veriler toplayarak günlük hayatı laboratuvar ortamına taşımaları ve laboratuvar ortamında yeterince vakit geçirmeleri öğretmen adaylarının kimya laboratuvarına yönelik kaygılarını azaltmış olabilir.

Bu çalışmanın bir diğer sonucunda ise, öğretmen adaylarının örnek olay temelli laboratuvar uygulamalarından memnun kaldıkları, bu uygulamayı farklı bularak kimya laboratuvarında devamlı kullanmak istedikleri görülmüştür. Ayrıca öğretmen adayları örnek olay temelli laboratuvar uygulamaları sayesinde kimya hakkındaki bilgilerinin gündelik hayat ile ilişkilendirilerek bilgi transferine katkı sağladığını, gündelik hayatta karşılarına çıkabilecek kimya ile ilgili problemlerin çözümüne yönelik bir deneyim oluşturduğunu ve gruplar halinde çalışarak işbirlikçi çalışmaya imkân sağladığını ifade etmişlerdir. Bununla ilgili yapılan çalışmalarda da öğretmen adaylarının örnek olay sayesinde kuramsal ilkeleri gerçek durumlara transfer edebildikleri, bu tür öğretimin öğretmen adaylarının ve öğrencilerin derslerdeki bilgileri kullanarak gerçek sınıf uygulamalarını tartışmalarına ve bilgi transferine katkı sağladığı, gerçek sınıf problemlerinin çözümüne yönelik problem çözme becerilerini geliştirdiği görülmüştür.