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The effects of organic chemistry laboratory activities on students' attitudes, perceptions and achievements[1]

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Abstract: *Laboratory instructions in teaching organic chemistry are essential to preservice teachersstudying at chemistry education institutions in terms of theoretical knowledge provided and also experiments done. Within organic chemistry laboratory process, experiments specifically enable not only the learning of organic chemistry topics but also their rein for cement throughvisual aids and integration in to teaching skills. This study aimed to determine to what extent the process based chemistry laboratory instructions affected preservice teachers' organic chemistry knowledge levels along with how much these experiments contributed to their positive attitudes and perceptions over laboratory instructions. Pre-test post-test control group design out of the experimental research designs was employed for the study. Nonparametric statistical tests were used to evaluate the differences between the achievement, perceptions, attitude pre-test post-test and mean scores of the experimental and control groups. The sampling of the study consisted of 30 preservice teachers taking Organic Chemistry Laboratory course at the Chemistry Teaching Program of Hacettepe University, Faculty of Education. The Attitudes and Perceptions Toward Science, Chemistry and Laboratory Questionnaire and the Separation and Purification Achievement Test were used as data collection tools in the study. It was found out that post-test scores of the preservice teachers in the experimental group following the treatment based on the process-based instruction are statistically different from the pre-test scores. Furthermore, Attitudes and Perceptions toward Science, Chemistry and LaboratoryQuestionnaire pre- and post-test scores of preservice teachers in the control group were statistically significant. It is clear from the findings of the study that post-test scores ofpreservice teachers in the experimental group following the treatment through process-based instruction model are statistically different from the pre-test scores. Also, it is pointed out that pre- and post-test scores of preservice teachers in the control group are statistically significant.*

Keywords *-Process based instruction, organic chemistry laboratory,attitude, perception, achievement.*

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I. INTRODUCTION

Laboratory practices integrated to regular classes are of great importance for learners of all levels and taking the organic chemistry course, especially for the teacher trainees in the chemistry departments of education faculties, to learn the notions in organic chemistry in an easier and more meaningful way. Organic chemistry practices conducted in chemistry student labs of education faculties make tremendous contributions to teacher trainees' process of using their knowledge of organic chemistry effectively. These practices allow teacher trainees to run a number of tests that involves different chemicals containing organic matters in labs. Therefore, they come up with an objective interpretation of what they have already learnt in relation to both organic chemistry and other subjects in chemistry. Similarly, they become more and more capable of using their basic laboratory skills that they have got acquainted with in other chemistry labs. Organic chemistry laboratory practices are crucial for teacher trainees in that they not only enable learners to improve their higher order lab skills but also provide a learning setting in which they can link their knowledge of organic chemistry with prior chemistry knowledge of them comprehensively (Graham, Schaller, Johnson, & Klassen, 2002; Keiser, 1988; Freedman, 1997; Cooper, & Kerns, 2006; Sevinç, 2008; Bilir, 2009; Menzek, & Çavdar, 2011). The use of labs in teaching science has been widely accepted as a must since the midst of 19th century (Wheatley, 1975; Çepni, Akdeniz & Ayas, 1995). Laboratory practices in chemistry education is prevalently known to be the creator of the expected change in the learner behavior since teacher trainees experience a meaningful learning process through learning by doing (Ayas, Karamustafaoğlu, Sevim & Karamustafaoğlu, 2002). Besides, in a lab setting they have the chance to observe, apply and as a matter of course learn the most fundamental knowledge in a reasonably effective way. Accordingly, they can easily try out the available experimental setup or set some others up themselves, make syntheses of some materials and observe directly the process of many organic

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reactions by doing (Erdik, Obalı, Öktemer & Pekel, 2001). In other words, organic chemistry laboratory practices play a significant role in chemistry teacher trainees' process of developing such essential skills as recognizing various organic compounds, practicing reactions and syntheses, learning resolution and purification methods.

As one of the active instruction models, process-based instruction adopts the understanding and principles of constructing teaching and learning process on a learner centered design through cognitive consciousness control procedures (Duman, 2007). Process-based instruction techniques require the knowledge to be constructed by the learner and the teaching to be learner-centered. They involve a shared responsibility of learning, increased cooperation during group work, a socially interactive and communicative learning environment (Duman, 2007). Henceforth, baring such qualities, laboratory practices adopting the principles of process-based instruction are believed to have a positive impact upon learners' attitudes towards and achievements in organic chemistry.

Organic chemistry laboratory instructions have a crucial role in equipping preservice chemistry teachers with the skills to have numerous attainments. Organic chemistry laboratory activities supported with process-based instruction model also have great importance in providing the preservice teachers with the ability to recognize a variety of organic compounds and to perform reactions. Based on this argument, the aim of the present study is to determine how effective the activities carried out in the organic chemistry laboratory course are on the chemistry knowledge levels of preservice teachers. It has also been aimed to reveal to what extent the experiments conducted during the organic chemistry laboratory instructions contribute to the attitudes and perceptions of preservice teachers regarding the laboratory instructions.

II. METHODOLOGY

Pre-test post-test control group design out of the experimental research designs was employed for the study. While the experiments determined within the scope of the study were conducted in the organic chemistry laboratory through process-based instruction model in the experimental group, traditional method was applied in the control group. The current research followed a path in which the preservice teachers designed the steps of the experiment, completed the experiments within the process they identified, and conducted the experiments by each one taking his/her own responsibility.

Table 1. Pre-test post-test control group design

Groups	Pre-Test	Instructions	Post-Test
Experimental Group	Achievement TestAttitudes and Perceptions Toward Science, Chemistry and Laboratory Questionnaire	Process Based Organic Chemistry Laboratory Instructions	Achievement TestAttitudes and Perceptions Toward Science, Chemistry and Laboratory Questionnaire
Control Group	Achievement Test Attitudes and Perceptions Toward Science, Chemistry and Laboratory Questionnaire	Traditional Laboratory Instructions	Achievement Test Attitudes and Perceptions Toward Science, Chemistry and Laboratory Questionnaire

Sample of Research

The sampling of the study consisted of 30 preservice teachers taking Organic Chemistry Laboratory course at the Chemistry Teaching Program of Hacettepe University, Faculty of Education.

Data Collection Tools

Attitudes and Perceptions Toward Science, Chemistry and Laboratory Questionnaire (APSCLQ): To determine the attitudes of preservice chemistry teachers toward the organic chemistry laboratory and how they perceive the importance of laboratory course, the APSCLQ developed by Anket, Tümay (2001) and modified by Sevinç (2008) was used. The questionnaire consisted of 25 items based on responses with a 5-point Likert-Type ranging from strongly agree (5) to strongly disagree (1) structure.

Achievement Test: An achievement test was developed by researchers for the study to determine the achievement levels of the preservice teachers on The Separation and Purification. The test consisted of 18 structured questions.The point biserial of the test was assessed through a value of 0.63.

Data Analysis

Nonparametric statistical tests were used to evaluate the differences between the achievement, perceptions, attitude pre-test post-test and mean scores of the experimental and control groups. Mann Whitney U test was applied to reveal whether the scores gained from two independent samples for the comparisons between the experimental and control groups are statistically significant. Also, Wilcoxon test was used to measure the significance of difference between the scores of paired samples for the pre- and post-test score comparisons of the experimental and control groups. For the statistical analysis of the data gathered for the study, SPSS program was utilized.

III. RESULTS

Nonparametric test analyses were conducted using the mean ranks of students' scores obtained from the APSCLQ and the achievement test. There was no statistically significant difference between the average pretest scores of the control and experimental group achieved in the APSCLQ and Achievement Test. [APSCLQ: U(15)= 103, p>.05 Achievement test: U(15)= 105.5, p>.05]. This finding suggests that students of the two groups were at similar levels in terms of their attitudes and perceptions toward science, chemistry and laboratory and achievement. The findings of the post tests are this played on the followings tables.

Table 2. Comparison of post-test scores of experimental and control groups

Groups	N	Mean Rank	Sum of Ranks	U	p*
Experimental	15	16.19	273.5	102.5	.015*
Control	15	15.06	191.5		

*p< .05

The findings of the study indicate that there are significant differences between the Attitudes and Perceptions toward Science, Chemistry and Laboratory Questionnaire post-test scores.

Table 3. Comparison of pre- and post-test scores of experimental group

	N	Mean Rank	Sum of Ranks	z	p*
Negative Ranks	3	8.5	25.5	-1.96*	.040
Positive Ranks	12	7.8	95.0		
Ties	0				

*Based on negative ranks

Attitudes and Perceptions toward Science, Chemistry and Laboratory Questionnaire pre- and post-test scores of the experimental group were compared through Wilcoxon singed-rank test. It was found out that post-test scores of the student teachers in the experimental group following the treatment based on the process-based instruction are statistically different from the pre-test scores [z=- 1.96, p<.05].

Table 4. Comparison of pre- and post-test scores of control group

	N	Mean Rank	Sum of Ranks	z	p*
Negative Ranks	4	8.0	32	-1.59*	.111
Positive Ranks	11	8.0	88		
Ties	0				

*Based on negative ranks

Furthermore, Attitudes and Perceptions toward Science, Chemistry and Laboratory Questionnaire pre- and post-test scores of student teachers in the control group were not statistically significant [z= -1.59, p>05]. It is clear from the findings of the study that post-test scores of prospective teachers in the experimental group following the treatment through process-based instruction model are statistically different from the pre-test scores. Also, it is pointed out that pre- and post-test scores of student teachers in the control group are statistically significant.

Table 5. Comparison of pre- and post-test scores of experimental and control groups

Groups		N	Mean Rank	Sum of Ranks	z	p*
Experimental	Negative Ranks	1	4.0	4.0	-3.057*	.002
	Positive Ranks	13	7.7	101.0		

	Ties	1				
Control	Negative Ranks	1	1.50	1.50	-2.81*	.005
	Positive Ranks	10	6.45	64.50		
	Ties	4				

*Based on negative ranks

With Table 5 shows that there is a statistically significance in the achievements of student teachers in the experimental group following the process-based laboratory practices [z=- 3.057 p<.05]. Considering the data in Table 5 It is salient that statistical significance was detected in the achievements of prospective teachers in the control group with the application of traditional laboratory activities [z=- 2.81 p<.05]. It is proven that the student teachers in the experimental group have become more successful thanks to the process-based laboratory practices.

IV. CONCLUSION AND DISCUSSION

Teacher trainees can make sense of and then put into practice the knowledge, skills, attitudes and habits they have been exposed to as long as they can have a voice over their own learning process. As stated by Glaser earning is genetically coded in our brain just as fun is; thus learning in chemical labs should be fun and let the learners self-actualize. The use of appropriate instruction models in chemistry labs plays a valuable role in improving the cognitive procedures of the learners by setting the lab courses free from the traditional experiment report-basis way of teaching and let the learners make use of their own skills and knowledge.

In the current study, activities through process-based instruction model were carried out to ensure effective learning in the organic chemistry laboratory. The research was designed and carried out to identify the effects of process-based organic chemistry laboratory instructions on the achievement and attitudes-perceptions of preservice teachers. In the study conducted with experimental and control groups with this aim, while the laboratory instructions were performed through process-based learning-teaching model in the experimental group, the control group followed the traditional laboratory instructions. Significant differences were found in the attitudes and perceptions of preservice teachers in the experimental group after the instructions through the process-based laboratory activities. It was revealed that preservice teachers in the experimental group developed more positive attitudes and perceptions toward science, chemistry and laboratory. This comes from the fact that the Process-based Teaching Model is a learning model thatallows students to construct their own knowledge, problems and behaviors by relating them to daily life situations in terms of their own thinking and perceptions (Duman, 2008).No statistically significant differences were found in the control group preservice teachers' attitudes and perceptions toward science, chemistry and laboratory after the traditional laboratory activities. The learners with various skills, competences and motivational beliefs need to be mediated consciously in the classroom or laboratory environments. In this way, positive effects are supposed to occur on their existing skills, competences, beliefs and attitudes.

Moreover, there was a statistically significance in the achievements of preservice teachers in the experimental group following the process-based laboratory instructions. In other words, it is proven that the preservice teachers in the experimental group have become more successful thanks to the process-based laboratory instructions. Findings of the studies in the literature on Process-based Teaching have displayed the increase in the achievement levels of the students (Rosenbluth, 1990; Schatteman, Carette, Couder & Eisendrath, 1997; Walraven & Reitsma, 1992, Duran, 2008; Koçak, 2013).It is salient that statistical significance was detected in the achievements of preservice teachers in the control group with the application of traditional laboratory activities. The results of the study highlight that organic chemistry laboratory instructions had positive effects on the academic attainment levels of both the experimental group which followed the process-based instruction and also the control group pursuing the traditional methods.

However, teacher trainees in the experiment group are found out to change their attitudes and perceptions in a positive way, whereas no positive change is seen in the attitudes and perceptions of the teacher trainess in the control group. Thus, process-based instruction model is believed to have created this impact on the affective characteristics of the teacher trainees. As future teachers, teacher trainees are supposed to have positive attitudes and perceptions in relation to laboratory practices so that they could make their learners love chemistry and the lab, as well. Therefore, organic chemistry practices provided by chemistry teaching departments of the universities should have a deeper and more comprehensive basis and instruction should be carried out in a more dynamic and effective way. This could, at large, be achieved through organic chemistry laboratory practices having the essence of the process-based instruction model.

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