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A descriptive analysis of prospective science teachers' beliefs and expectations about laboratory course

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Abstract

This study investigated prospective science teachers' beliefs and expectations about chemistry laboratory course at the beginning and the end of the semester. 27 freshmen participated in this study. They carried out 11 experiments and had a metacognitive training by filling reflective forms, which were developed by the authors, and making pre- and post-discussions throughout a semester. The participants were administered pre- and post-course reflective forms, before and after the treatment, respectively and filled pre- and post-performance forms, at the beginning and the end of each lesson, respectively. They prepared reports of each experiment and received feedback for both their performance during the lessons and their reports. At the end of each lesson the students were asked authentic research questions related to the topic of the experiment and sometimes asked to design a new experiment. Students' answers to the pre- and post-course reflective forms were analyzed and coded. The frequencies of these codes were presented and discussed. The analysis of pre- and post-course reflective forms showed that the diversity of the students' responses about laboratory course increased throughout the course period. The results also indicated the increase in the use of metacognitive skills and the outcome expectations, especially self-efficacy beliefs of prospective science teachers.

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1. Introduction

Teachers' attitudes towards science are important in influencing students' attitude in every grade levels (Talsma, 1996). Teachers' beliefs are also significant for their attitude. According to Fishbein, beliefs affect attitudes, and these attitudes affect intentions and behaviors (Weinburgh & Englehard, 1994). In the light of these views, it is very logical to anticipate that the more positive attitude, beliefs, and expectations the teachers have the more effective they teach.

A considerable number of research points out elementary children's poor achievement in negative and attitude towards science. The reasons of this situation are shown to be content deficiencies, ineffective instructional strategies and negative attitudes towards science on the part of the teacher (Fones, Wagner, & Caldwell, 1999).

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Literature also emphasizes on teachers' low confidence and self-efficacy beliefs in science and in teaching science (Appleton, 2002; Garcia, 2004; Mulholland & Wallace, 1999; Taylor & Corrigan, 2005).

Although some research points out the positive effect of metacognitive guidance (Tien, 1998; Zion, Michalsky, & Mevarech, 2005) and giving positive feedback (Schunk, 1988; Schunk, 1991; Smith, 2001; Taylor & Corrigan, 2005) on learning outcomes, many of these studies does not examine both metacognitive guidance and motivation. Besides seldom of these studies focus on prospective science teachers' views about laboratory course. This research aims to investigate the beliefs and expectations of prospective science teachers' beliefs and expectations about laboratory course before and after a semester.

2. Method

27 freshmen, who enrolled in General Laboratory-I course in Primary Education, Science Education Program at a public university in Turkey in the spring semester of 2008-2009, participated in this study. 10 of the participants were male and 17 were female.

The study presented here is a part of a larger study (Saribas & Bayram, 2009). This paper presents 27 prospective science teachers' beliefs and expectations before and after a metacognitive training in a motivating course. The pre- and post-course reflective forms, given prior to and after lab courses, were analyzed for a detailed investigation of the students' metacognitive skills, motivation and attitudes towards the course. For this purpose, the answers the students gave were coded and categorized for each question in these two forms. They carried out 11 experiments and had metacognitive training by filling reflective forms, which were developed by the authors, and making pre- and post-discussions throughout a semester. All of the students were administered pre- and post-course reflective forms, before and after the treatment, respectively. The participants filled two additional kinds of reflective forms searching students' beliefs and expectations about each experiment and the topic of the experiment, at the beginning and the end of each lesson, respectively, which we termed as pre- and post-performance forms. These two forms were used to improve their metacognitive awareness, while pre- and post-course reflective forms were used for a descriptive analysis of students' beliefs and expectations about lab course before and after treatment. The process implemented in this study was a guided inquiry in which the students made discussions to propose a method for the solution of the problem or question and interpreted their results. The lessons carried out in this group began with an authentic problem or research question following the pre-performance form. The students discussed their ideas about this problem or question. During these discussions the researcher (first author) asked additional questions to narrow the research area and oriented the students toward the design and the content of the experiment to be performed. After the consensus on the design, students performed the experiments in small groups (each consisted of 3 or 4 students). During performing the experiments, the instructor (first author) always walked around the classroom in order to be available for students' questions and she always gave positive feedback to the students' abilities and efforts (such as "You are doing well!" or "You are good at this!"). Following the experiment, the students made post-discussions to let the groups share their results and interpret these results in the whole class. Following the post-discussions, the researcher asked the students new research questions and sometimes design a new experiment related to the topic of the experiment and wanted them to answer in their reports. Finally, they filled the post- course reflective form. The students prepared a report of the experiment they performed in which they answered the questions written in their lab manual as well as the ones the researcher asked. They submitted these reports one week later and they received feedback to their reports, which not only included positive statements, such as "Well done!", but also indication of their mistakes without discouraging them.

Data was gathered through pre- and post-course reflective forms developed by the researchers. Pre- and post-reflective forms consisted of 4 and 7 open-ended questions, respectively. The responses given to the questions of each form coded by each researcher in turn and both of the researchers agreed on the codes they generated. The categories emerged from the responses were analyzed as frequencies and percentages.

3. Findings

The first question in each form was the same that asked why students thought they entered this course. Four categories emerged from the answers students gave in the pre-course reflective form, given at the beginning of the study while these four categories remained but three additional categories appeared in the post-course reflective

form, given at the end of the study. In the pre-course reflective form some students' answers, concerned with acquiring knowledge, comprehension or application of the acquired knowledge, were classified as *cognitive gain*. The second category, in which the answers about using the chemicals and materials took place, was denominated as *psychomotor skills*. The answers that reflected lab course was essential for the future, when they would become a teacher were coded in the third category, *professional attainment*. Some students expressed that they took the lab course for *verification* of the true knowledge, which constituted the fourth and last category emerged from the first question of the pre-course reflective form. The fifth category, *observation*, represented the answers given to the first question of the post-course reflective form. A student thought that lab instruction is necessary for *scientific* work, while another student expressed that the experiments were enjoyable and she took that course for *pleasure*.

The second question in both of the forms asked the students what kind of knowledge and skills the lab course should make them acquire. Students' responses in the second question of the pre-course reflective form were classified in four categories; cognitive gain, psychomotor skills, professional attainment, and verification, as mentioned in the first question of the pre-course reflective form. The fifth and the last category of the second question was observation.

The answers of the second question of the post-course reflective form were classified again in these five categories but two more category was developed from the answers, one of which was the lab courses prompted them for *inquiry*. The last category of the second question of the post-course reflective form was *team work*, in which the answers that stressed lab courses make students work in groups were classified. The number and the percentage of the answers in all the categories of the first and the second questions of the two forms are presented in Table 1.

Table 1. Categories of questions 1 and 2

	Pre (%)		Post (%)	
	Q1. Reason (n=27)	Q2. Knowledge-skill (n=27)	Q1. Reason (n=27)	Q2. Knowledge-skill (n=27)
Cognitive gain	19 (70)	17 (63)	26 (96)	21 (78)
Psychomotor skills	7 (26)	17 (63)	5 (19)	14 (52)
Professional attainment	11 (41)	4 (15)	8 (30)	0
Verification	4 (15)	1 (4)	2 (7)	1 (4)
Observation	0	1 (4)	3 (11)	4 (15)
Scientific	0	0	1 (4)	0
Pleasure	0	0	1 (4)	0
Inquiry	0	0	0	4 (15)
Team work	0	0	0	1 (4)

Comparing to the pre-course reflective form, given before lab course, one can conclude that diversity of the students' answers increased in the post-course reflective form. Considering the categories of cognitive gain, observation, inquiry, scientific and team work, it is evident in Table 1 that student responses in each category increased and students emphasized the gains of lab course that they had not mentioned before the study. This result showed that students have more metacognitive awareness of the benefits of lab instruction after the lab course than did they before. Comparing to the pre-course reflective form, it can also be concluded that after the treatment, students de-emphasized the psychomotor skills the lab courses let them gain, necessity of lab courses for their professional career, and verification of scientific knowledge by experiments.

According to the third question of the pre-course reflective form, the students were asked whether they believed they would perform the experiments easily or not, 17 responses were positive while 10 students hesitated. 8 students out of 10 thought that they could have had difficulties when performing the experiments because of personal factors, such as deficiencies, mistakes or dislike of lab courses i.e., *internal factors (personal factors)*. Among these students, 7 participants seem to have had low self-efficacy beliefs about intelligence level of themselves or performing experiments, while only one student thought he could not perform the experiments that he did not have pleasure. 2 students who thought the experiments would be challenging for them expressed *external factors*, such as waste of time during taking and weighing of the chemicals or insufficiency of the materials.

All of the participants, except for 2 students, responded positively to the question whether they performed the experiments easily in the post-course reflective form. One participant expressed that he had difficulties in the experiments needed tactful handling and required for observing color change. The other participant based his difficulties in the experiments upon insufficient preparation for the lesson. Both of these students seem to attribute

their learning to personal factors. Given these findings, the students' self-efficacy beliefs seem to have been enhanced after the treatment. Frequencies of students' responses are presented in Table 2.

Table 2. Categories of question 3

	Pre (%)			Post (%)		
	Difficulty (n=27)		No difficulty (n=27)	Difficulty (n=27)		No difficulty (n=27)
	Internal	External		Internal	External	
Performing experiments	8 (30)	2 (7)	17 (63)	2 (7)	0	25 (93)

At the beginning of the lab course, 15 students wrote down external factors, such as insufficient material, noise, other students' annoying talks and behaviors, in terms of the obstacles for their learning. 3 students mentioned internal (personal) factors, while 4 students stated both internal and external factors. Internal factors expressed by students were personal unwillingness, difficulties in writing reports, difficulties in focusing, problems in communicating others, etc. 5 students thought that they did not believe there would be an obstacle. It was interesting that only one student believed that the solution of the problem was dependent on his own effort.

Student responses that they did not face any obstacle were 19 in the post-course reflective form. 8 students stated that they were sometimes distracted, one of whom showed personal factors for the obstacles and emphasized on paying attention. The other 7 out of these 8 students pointed out external factors, such as noise, other students' annoying talks and behaviors, etc. and believed they should have warned their friends. Frequencies of the responses of this question in each form are presented in Table 3.

Table 3. Categories of question 4

	Pre (%)				Post (%)		
	May exist		Internal + External	Cannot exist	Existed		Did not exist
	Internal	External			Internal	External	
Obstacles	3 (11)	15 (56)	4 (15)	5 (19)	1 (4)	7 (26)	19 (70)

All of the students defined the experiments they performed were instructive. A participant sometimes and another one generally had pleasure of performing the experiments. One student wrote that the experiments were enjoyable unless they were challenging and another student commented the reflective forms, which they were obligated to fill every course, as boring. All the other participants found the experiments enjoyable.

Four different answers arose from the last question of the post-course reflective form. 14 students reflected that the feedbacks the teacher gave to their reports contributed to their learning. 10 students stated that the forms motivated them. 2 students pointed out both contribution to learning and motivating attribution of these feedbacks. A participant was hesitant about that issue and answered "I don't know".

4. Discussion

The analyses of pre- and post-course reflective forms showed that the diversity of the students' responses about laboratory course increased throughout the course period. Some of the students used the terms of inquiry, team work, scientific work and pleasure of the lab work which they did not mention in the pre-course reflective form. The analysis of these forms also showed that the students' outcome expectations, especially self-efficacy beliefs enhanced after the treatment. All of the students expressed that the experiments they performed was instructive and enjoyable. Considering the participants' responses to the reflective forms, one can conclude that the lab course carried in this study motivated students and improved their metacognitive awareness. However, students were unwilling to fulfill the reflective forms and always stated their dislike of filling these forms. This situation may have negative effect on their motivation and attitude towards laboratory course.

5. Conclusions and Recommendations

The results of this study indicate positive effect of metacognitive prompts embedded within a motivating lab on prospective science teachers' metacognitive skills and motivation. Pre- and post-discussions and feedbacks seems to have been beneficial in terms of metacognitive and affective outcomes. However, the obligation of filling reflective

forms does not seem to have a positive effect on participants' motivation and attitude towards lab course. Despite the suggestions of self-recording and self-reflective techniques (Smith, 2001; Zion, Michalsky & Mevarech, 2005), it is hard to conclude that these techniques are always effective regarding student attitude and motivation. This situation may arise because of cultural differences. Further investigation in different cultures focusing on self-reflective techniques may be needed.

Regarding the laboratory instruction, the results of experiments are less important than the process of scientific investigation. So students should plan and design their own procedures and every step should be discussed throughout a lab lesson (Mertoglu & Akgul, 2009). The findings of this study show the significance of giving students the opportunity to have control over their procedures and conclusions in terms of their attitude and motivation.

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