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# Perception of pre-service teachers about their competence in biology applications

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## Abstract

This study examined the perception of pre-service biology teachers about their competence in biology applications. The study was conducted on senior students who took all application courses since the first year of the university. Totally 150 senior students participated in the study in 2003-2007 period. In the scope of the study, students were asked “As a pre-service teacher, how competent you find yourself in using effectively the instruments in the biology laboratory, teaching the subjects covering laboratory techniques and methods, ensuring maintenance of the instruments in the biology laboratory and establishment of a biology laboratory in a secondary education institution”. The answers were grouped in a 5-point Likert type scale, ranging from 5: Quite competent to 1: not competent. The study results showed that pre-service teachers found themselves “partially competent” in “using effectively the instruments in the biology laboratory” and “teaching the subjects covering laboratory techniques and methods” (respectively  $\bar{X}=3.33$ ;  $\bar{X}=3.29$ ). Moreover; a significant, positive relationship was found between pre-service teachers’ scores related to “using effectively the instruments in the biology laboratory” and “teaching the subjects covering laboratory techniques and methods” ( $p=0.01$ ,  $r=0.73$ ).

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## 1. Introduction

As a discipline of science, biology includes many concepts that have complex relationships with each other. Experiments and observations are two indispensable components that are necessary for shaping biology concepts and relating these concepts to each other. Therefore, experiments and observations, which are necessary information production tools for biology science, are also indispensable for the teachers giving biology course to any grade (Berck 2001). In this scope and as a necessity of their profession, biology teachers have to develop not only methodological competences related to experiments and observations but also competences related to the laboratory equipment used in implementing these methods. As a matter of fact, “teacher competence” can be defined as having the professional knowledge, skills and attitudes required for the performance of duties unique to teaching profession.

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“General Competences for Teaching Profession” which is prepared by Ministry of National Education (MoNE) should be considered in first place in the scope of teacher competence (MoNE, 2006). “Learning and Teaching Process” is one of these competences and it includes some performance indicators such as “a competent teacher takes into consideration the usage principles of the related tools and materials while organizing the learning environment”, “takes measures to ensure safe use of tools and materials” and “ensures maintenance of course tools and materials, keeps them ready-to-use”. These performance indicators show that biology teachers are expected to have a sufficient level of knowledge and skills related to use of laboratory equipment. On the other hand, new curriculum reviewed within the scope of constructivist approach focus on the active participation of students in the course and underline student activities. Teachers are expected to be more active in guiding students and making more experiments and activities. This new approach raises the issue of “re-questioning the application-based skills and competences of teachers”. Due to its nature, biology is an area open for experiments and activities. For instance, it is sometimes possible to teach a subject by using only a microscope (Killermann and Rieger, 1996). Studies emphasize the importance of laboratory applications in not only biology but also in science education (Wenglinsky, 2000; Wenglinsky and Silverstein, 2007).

Present study examined the perception of pre-service biology teachers about their competence in biology applications. Participant pre-service teachers were selected among the students who took “general biology, systematic botany, plant morphology and anatomy, invertebrates, vertebrates, histology, parasitology and microbiology laboratory” courses throughout their university education. Having required competences in biology applications and being well-equipped at the time of graduation is of great importance for pre-service biology teachers who will start professional life soon. The problem this study was based on was about the perception of pre-service teachers about their competence in biology applications after successfully graduating from the university.

## 2. Method

This study was conducted on senior students who took all application courses since the first year of the university. Totally 150 senior students participated in the study in 2003-2007 period. The study was based on “teacher competences” presented in the Secondary Education Biology Applications Guide prepared for biology teachers by Higher Education Council (YOK) and only “laboratory safety” component was added to these competences (Ohlsson and Ergezen, 1997). Accordingly, by using 61-item questionnaire, students were asked how competent they found themselves as pre-service teachers in “using the instruments in the biology laboratory”, “teaching the subjects covering laboratory techniques and methods”, “ensuring maintenance of the instruments in the biology laboratory” and “establishing a biology laboratory in a secondary education institution”. The answers were grouped in a 5-point Likert type scale: 5: Quite competent, 4: Very competent, 3: Partially competent, 2: Barely competent and 1: Not competent. The relationship between pre-service teachers’ scores related to “using laboratory equipment” and “teaching the subjects covering laboratory techniques and methods” was determined by using Pearson correlation coefficient.

## 3. Findings

This part presents the findings obtained from the competence questionnaire administered to pre-service teachers to determine their competence in biology applications. Scores related to “using laboratory equipment” and “teaching subjects covering laboratory techniques and methods” are presented in Table 1 and Table 2, respectively.

Examining Table 1, it is observed that pre-service biology teachers found themselves most competent in using “microscope” among the instruments listed in Table 1. It is also found out that the pre-service teachers who found themselves “Quite competent” and “Very competent” in using laboratory equipment such as pipette, thermometer, scale, tape measure, buret and pH meter found themselves “Partially competent” in using barometer, volumetric flask and spring balance. Pre-service teachers finding themselves “Barely competent” in using distillation apparatus and egg incubator found themselves “Partially competent” in terms of all laboratory equipment.

Table 1. Competence perception scores of pre-service teachers about “using laboratory equipment”

Biology Laboratory Equipment	N	$\bar{X}$	SD
Microscope	150	4.71	0.54
Pipette	150	4.62	0.63
Thermometer	150	4.47	0.96
Scales (mechanical or electronic)	150	4.29	0.85
Tape measure	150	4.22	0.98
Burette	150	4.16	0.91
Spirit and Bunsen burner	150	3.74	1.02
pH meter and pH paper	150	3.57	1.30
Water bath	150	3.50	1.31
Dissecting set	150	3.19	1.25
Autoclave	150	3.10	1.07
Connecting and running tubes or air gas	150	3.10	1.27
Spring balance	150	2.96	1.45
Incubator	150	2.95	1.18
Volumetric flask	150	2.86	1.50
Barometer	150	2.75	1.24
Egg incubator	150	2.29	1.33
Distillation apparatus	150	2.12	1.09
Cutting and shaping glass rods and pipes	150	2.07	1.23
Total	150	3.33	0.60

Table 2. Competence perception scores of pre-service teachers about “teaching subjects covering laboratory techniques and methods”

Teaching of Laboratory techniques and methods	N	$\bar{X}$	SD
Cross-sectioning	150	4.27	0.76
Laboratory safety	150	4.15	1.05
Accurate measurement and weighing	150	4.10	0.89
Sterilization	150	3.95	0.99
Preparation of preparats	150	3.90	1.13
Culture medias	150	3.79	0.94
Simple microbiology	150	3.61	1.08
Biological staining	150	3.39	1.16
Preparation of sterile liquid	150	3.31	1.17
Preparation of permanent and temporary preparats	150	3.25	1.16

Chemical solution	150	3.25	1.07
Reservation of animals and plants	150	2.98	1.08
Use and storage of chemical substances	150	2.85	1.19
Serial dilution	150	2.66	1.19
Molar, percentage solutions	150	2.46	1.16
Simple embryological techniques	150	2.37	1.26
Chromatography	150	1.55	0.86
Total	150	3.29	0.64

Table 2 shows that pre-service teachers regarded themselves most competent in teaching subjects of “cross-sectioning, laboratory safety and accurate measurement and weighting” and “Very competent” in teaching subjects of “sterilization, preparation of preparats, culture medias and simple microbiological techniques”. Chromatography is the only subject pre-service teachers found themselves “Not competent” in teaching. Pre-service teachers found themselves “Partially competent” in teaching the subjects of “biological staining, preparation of sterile liquid, preparation of permanent preparats, use and storage of chemical substances, serial dilution, molar and percentage solutions and simple embryonic techniques”. Table 3 lists the results of the correlation analysis between the competence of pre-service teachers in “using laboratory equipment” and “teaching methods and techniques”.

Table 3. The relationship between the competence perception of pre-service teachers about using laboratory equipment and about teaching laboratory methods and techniques

	Laboratory Equipment	Teaching Laboratory Methods and Techniques
N	150	150
Mean	3.33	3.29
St. Deviation	0.60	0.64
Correlation coefficient (Pearson)	0.73**	

\*\*  $p < 0.01$

Looking at Table 3, a positive relationship (at significance level of 0.01) can be detected between the scores related with “using laboratory equipment” and the scores related with “teaching students the laboratory methods and techniques”. Table 4 lists competence perception scores of pre-service biology teachers about “organizing living environments required for enabling some living things to survive and making some observations”.

Table 4. Competence perceptions of pre-service biology teachers about organizing living environments

	N	Mean	St. Deviation
Growing plants in a pot	150	4.32	0.89
Aquarium	150	3.67	1.25
Terrarium	150	1.83	1.13
Total	150	3.27	0.86

Table 4 shows that pre-service teachers found themselves “Barely competent” in establishing a terrarium within the scope of the competence in organizing and maintaining some living environments to enable some observations; however, they found themselves “Quite competent” in growing plants in a pot and “Very competent” in building an

aquarium. Table 5 lists the findings related with the competence of pre-service teachers in isolating from nature and reproducing some simple organisms.

Table 5. Competence perceptions of pre-service teachers about isolating from nature and reproducing some simple organisms

	N	Mean	St. Deviation
Bacteria	150	3.21	1.16
Protozoa	150	3.18	1.22
Fungi	150	2.98	1.16
Algae	150	2.67	1.12
Total	150	3.01	0.95

According to Table 5, pre-service biology teachers found themselves “Partially competent” in isolating from nature and reproducing microscopic living things such as bacteria, protozoa, fungi and algae (Table 5).

Table 6 presents findings related with the competences of pre-service teachers in keeping some animal groups alive under laboratory conditions.

Table 6. Competence perception of pre-service teachers about keeping some animal groups alive under laboratory conditions

	N	Mean	St. Deviation
Birds	150	3.36	1.32
Insects	150	3.07	1.33
Amphibians	150	2.76	1.28
Reptiles	150	2.75	1.29
Total	150	3.01	1.11

Table 6 reveals that pre-service biology teachers found themselves “Partially competent” in keeping alive under laboratory conditions the animal groups such as birds, insects, amphibians and reptiles (Table 6).

Findings related with competence perceptions of pre-service teachers about using teaching technologies are given in Table 7.

Table 7. Competence perceptions of pre-service teachers about using teaching technologies

	N	Mean	St. Deviation
Overhead projector	150	4.69	0.51
Video player-TV	150	4.51	0.78
Camera	150	4.49	0.74
Cassette player	150	4.39	0.95
Computer	150	4.18	0.88
Slide machine	150	4.00	1.06
Total	150	4.38	0.56

According to Table 7, pre-service biology teachers found themselves “Very competent” in using camera, computer, overhead projector, slide machine, cassette player, video player and television (Table 7).

In addition, the study also revealed that pre-service teachers found themselves “Very competent” in establishing a secondary education biology laboratory and in ensuring maintenance of the instruments in such laboratory (respectively  $\bar{X}=3.66$ ;  $\bar{X}=3.73$ ).

#### 4. Conclusion

In the light of the findings obtained at the end of the study, it has been found out that pre-service biology teachers who participated in the study found themselves “partially competent” or “barely competent” in using half of the instruments in a biology laboratory of a secondary education institution. This may result from the fact that laboratory courses are given theoretically or via demonstration method. Similarly, another study on the examination of the competences of pre-service teachers in using laboratory equipment and applications within science education showed that pre-service teachers could develop only half of the required competences (Korkmaz 2000). Moreover, the study conducted by Koseoglu and Soran (2004) on biology teachers employed in Ankara Province revealed that teachers found themselves “partially competent” or “barely competent” in using laboratory equipment. In another study on the competences of pre-service science teachers in using laboratory equipment for the right purposes and in the right manner, it was found out that pre-service teachers had wrong or imperfect information and they were not competent in using laboratory equipment for the right purposes and in the right manner (Costu et al., 2005). A study conducted on pre-service science teachers measured the interest and motivation of pre-service teachers towards science laboratory by using “science laboratory environment inventory” and showed that pre-service teachers had low level of competence in using laboratory equipment ( $X=2.82$ ) (Hacieminoglu et. al. 2008).

Present study showed that pre-service teachers found themselves “Partially competent” in teaching various laboratory methods and techniques. Taking into consideration the possibility that this result may be related to the results about the use of laboratory equipment; the relationship between the competence of pre-service teachers in using laboratory equipment and their competence in teaching laboratory techniques was examined and a positive relationship (at the significance level of 0.001 ( $r=0.73$ )) was determined (Table 3). Taking as basis this relationship, it can be suggested that pre-service teachers should be quite competent in using laboratory equipment to be able to teach methods and techniques of biology applications to students in an effective manner. Studies underline the importance of laboratories in science education. In the study conducted by Killermann and Rieger (1996), teaching via microscope was compared with teaching via video player. Nearly 80% of the students who have participated in that study preferred microscope to video player and students who were taught the subject with the help of a microscope were found to be significantly more successful in understanding the content than those who were taught with the help of a video recorder. In his study, Wenglinsky (2000) discovered that students educated by the teachers competent in laboratory-related issues, giving applied courses and using teaching technologies were more successful than the students educated by teachers lacking such features. On the other hand, it was revealed that the students of the teachers who took laboratory courses in universities for their professional development were more successful at the end of academic year and participated in the science projects and organizations more frequently than the students of those teachers who did not take such courses (Wenglinsky & Silverstein 2007). In another study conducted on two groups of elementary teachers trained according to two different education programs, the teachers in the group who have taken applied science education were found to have significantly higher self-efficacy in teaching science course than the teachers in the group which did not (Andersen et. al. 2006).

In this study it was determined that pre-service teachers found themselves “very competent” in using teaching technologies. Such result brings the mind the possibility that pre-service teachers encountered these instruments during their education or used these instruments in the courses. On the other hand, pre-service teachers may have gained experience about some of these instruments thanks to out-of-school applications. Unlike the pre-service teachers included in the present study, a study conducted on biology teachers showed that teachers found themselves incompetent in using teaching technologies (Koseoglu and Soran, 2004). It shows that, as technology continuously develops and changes, teachers did not deem themselves competent by only depending on the pre-service education they received and they were in need of more trainings. A study conducted on biology teachers about teachers’ expectations put forward that most of the teachers needed in-service training on innovations about both instruments and the content (Altunoglu and Atav, 2005).

As revealed by the present study and previous studies, existence of teachers and pre-service teachers who find themselves incompetent in biology and science applications is an indicator of the insufficiencies resulting from university education. To eliminate insufficiencies, teacher education institutions should be reviewed particularly in terms of application component.

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