PROSPECTIVE TEACHERS' MISCONCEPTIONS ABOUT CLASSIFICATION OF PLANTS AND CHANGES IN THEIR MISCONCEPTIONS DURING PRE-SERVICE EDUCATION

**Selami Yangin,
Sabri Sidekli,
Yasin Gokbulut**

Abstract. *This study reported herein aimed to reveal prospective teachers' misconceptions about classification of plants and the effect of pre-service education program on their correct conceptions of this biological issue. Prospective teachers majoring in Elementary School Classroom Teacher Education constituted the target population of this study during the fall semester of the 2012-2013 academic years from Turkey. In order to reveal the difference between the misconceptions of prospective teachers who are at the beginning and at the end of their university education, the research was conducted as a cross-sectional study (78 first and 84 fourth class). The results showed that the prospective teachers in both groups have misconceptions and considerable confusion over the concepts of without-seed plants, seedy plants, vascular plants, non-vascular plants, gymnosperm plants, angiosperm plants, fruit and vegetable. In addition, the pre-service education did not seem to have an important effect on correction of prospective teachers' misconceptions about classification of plants. In this context, prospective teachers are graduated with misconceptions about classification of plants.*

Key words: *biology, classification of plants, misconceptions, prospective teachers.*

Introduction

Students often have difficulty learning classification of living worlds and one reason is due to misconceptions. In broad terms, misconceptions correspond to the concepts that have peculiar interpretations and meanings in students' articulations that are not scientifically accurate. In the literature, misconceptions are also referred to as alternative conceptions (Arnaudin & Mintzes, 1985), naive beliefs (Caramazza, McCloskey & Green, 1981), pre-conceptions (Hashweh, 1988; Ga1legos, Jerezano & Flores, 1994), alternative frameworks (Driver, 1981), erroneous ideas (Fisher, 1985; Sanders, 1993), multiple private versions of science (McClelland, 1984), personal models of reality (Champagne, Gunstone & Klopfer, 1983), spontaneous reasoning (Viennot, 1979), spontaneous knowledge (Pines & West, 1986), common sense concepts (Haloun & Hestenes, 1985), underlying sources of error (Fisher & Lipson, 1986) and children science (Gilbert, Osborne & Fensham, 1982). Although the term misconception is dominant in the literature, some researchers (e.g., Abimbola, 1988; Gilbert & Swift, 1985; Wandersee, Mintzes & Novak, 1994) now prefer the term alternative conception or misunderstandings. The characteristics of misconceptions are summarized by Adeniyi (1985) and Fisher (1985). They tend to be pervasive (shared by many different individuals), stable, well embedded in individual's cognitive ecology, often resistant to be changed at least by traditional teaching methods and remain intact throughout the university years and into adult life. Several reasons for lack of understanding were listed including lack of reasoning ability, lack of links between concepts, technical words without explanations, expository teaching and too much dependence on textbooks, rote learning and poor lesson planning

Selami Yangin
Recep Tayyip Erdogan University, Rize, Turkey
Sabri Sidekli
Mugla Sitki Kocman University, Mugla, Turkey
Yasin Gokbulut
Gaziosmanpasa University, Tokat, Turkey

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(Johnson & Lawson, 1998). Inadequacy of a teacher in content knowledge is a major cause of student misconceptions in biology (Cakir & Crawford, 2001; Tekkaya, et al. 2001). There are important roles and responsibilities of teachers.

Misconceptions tend to be very resistant to instruction because learning entails replacing or radically reorganizing student knowledge. Hence, conceptual change has to occur for learning to happen. This puts teachers in the very challenging position of needing to bring about significant conceptual change in student knowledge. Generally, ordinary forms of instruction, such as lectures, labs, simple discovery learning, or simply reading texts, are not very successful at overcoming student misconceptions. For all these reasons, misconceptions can be hard nuts for teachers to crack. However, several instructional strategies have been found to be successful at achieving conceptual change and helping students leave their misconceptions behind and learn correct ideas or theories. Therefore, in order to avoid misconceptions, most current and reliable scientific information should be sought.

Biology education should provide pupils with knowledge and skills that help them to understand everyday life in nature. The importance of biology education currently increases either due to the strong impact of modern technologies on everyday life of all people (Lappan, 2000) or due to the increase of environmental problems that negatively influence people lives. Biology course is one of the courses that students experience difficulty with. To date, several studies have investigated students' misconceptions of biological concepts in different countries: Evolution (Garner, 2003; Yates, 2011), natural selection (Richard, 2004; Weeks, 2013), biological membranes (Ecarma, 2010), cell (Marek, 1986; Dreyfus & Jungwirth, 1988), living things (Arnold & Simpson, 1979), photosynthesis (Bell, 1985; Haslam & Treagust, 1987; Waheed & Lucas, 1992; Amir & Tamir, 1994), respiration (Sanders, 1993), genetic (Kargbo, Hobbs & Erickson, 1980; Clough & Wood-Robinson, 1985; Fisher, 1985; Stewart & Dale, 1989; Stewart, Hafner & Dale, 1990; Cavello & Schafer, 1994; Pashley, 1994; Lewis, Leach & Wood-Robinson, 2000), ecology (Griffiths & Grant, 1985; Munson, 1994), phylogenetic systematics (Bei, 2011), classification (Trowbridge & Mintzes, 1985; Braund, 1998; Meir et al., 2007; Doug, 2011), the circulatory system (Yip, 1999), vertebrate and invertabrate (Braund, 1998), mammals (Bell & Barker, 1982; Trowbridge & Mintzes, 1985; Kubiatko & Prokop, 2007), plants (Bell, 1981) and energy (Boyes & Stanisstreet, 1991). There also has been an interest in determining students' misconceptions concerning various biological concepts (Tekkaya, Sen & Ozden, 1999; Capa, 2000; Tekkaya, Capa & Yılmaz, 2000; Tekkaya, Ozkan & Ascı, 2001; Ozkan, 2001; Sungur, Tekkaya & Geban, 2001; Gallop, 2002; Bahar, 2003; Ozay & Oztas, 2003; Firat, 2008). These studies revealed that regardless of the age and the level of schooling misconceptions are also prevalent among high school and university students.

There are few studies conducted with prospective teachers (Adeniyi, 1985; Griffiths & Grant, 1985; Stewart & Dale, 1989; Boyes & Stanisstreet, 1991; Tekkaya, Sen & Ozden, 1999). Researching into elementary prospective teachers' misconceptions about classification of plants, Yangın (2013) found that almost all of the participants in their study confused fungi with plants and related some gymnosperm plants with angiosperm plants. Misconceptions can be gained by pupils' own experiences in life, even before they started school or through media, films, parents, and people around them, school books, and poor teaching in the classroom or from teachers who are less competent in subject matter knowledge (Yip, 1999; Tekkaya, Sen & Ozden, 1999; Köse, Ayas & Usak, 2006). If science education aims to educate students who are knowledgeable about biological concepts such as livings world, plants, animals, microorganisms, and take responsibility for the management and policymaking decisions about the problems facing the planet (Brown, 1992; Bybee, 1993), then it is essential to reveal their misconceptions about these issues and to plan curriculum and instruction that builds on or challenging their existing perceptions (Driver, Leach & Millar, 1996).

Presently many studies in science education area deal with the misconceptions related to science subjects taught in schools in the world. Students seem to have difficulties to learn conceptions in science courses including biology subject (Treagust, 1988; Bloom, 1990; Kinchin, 2000). There would be several reasons that students can hold misconceptions and the beginning of holding misconceptions could go to the first school years (Bell, 1981; Pines & West, 1986). Misconceptions held by students were not easily changed throughout of the school years and also, stall meaningful learning of new concepts and make connections with other concepts as well as achievement of students in science courses (Strike &

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Posner, 1982). Studies showed that elementary and secondary school students have problems in the classification and diversity of living organisms (Kellert, 1985). For example, Trowbridge and Minszes (1985 and 1988) found that students have difficulties on the understanding of diversity of animals. There are several reasons students have misconceptions related to science courses. To solve this problem, there are some ways, one of which is concept maps helping students to make connections with sub-concepts related to the main concept and to find relations with the concepts (Kinchin, David & Adam, 2000). Although, the concepts of classification are frequently addressed in the printed books and documentary programs and students are taught these issues in their schools and at related education lessons, there are still some alternative learnings, misconceptions and confusions about the issues as identified by many research studies (Trowbridge & Mintzes, 1985; Braund, 1998; Meir et. al., 2007, Doug, 2011). Most of these studies researching into misconceptions of students about classification and systematic related issues have been conducted with students at elementary and secondary schools. A common finding of the studies was that students' perceptions about these concepts did not coincide with the expert scientific knowledge. The main misconception reported in these studies is that students relate some without-seed plants with the seedy plants, the vascular plants with the non-vascular plants and gymnosperm plants directly with the angiosperm plants.

Thousands of plants cover our earth. Classification is a system of grouping things based upon shared characteristics such as structure or appearance. Classification can be useful for describing relationships or identifying objects. Plants are divided into vascular and non-vascular groups. The vascular plants (pines, ferns, corn, oak, etc.) have tubes called the xylem and phloem to carry water and food throughout the plant. In contrast, the non-vascular plants (mosses and liverworts) lack these tubes and transfer food and water from cell to cell. The vascular plants are further divided into three major groups: angiosperms, gymnosperms, and ferns. The angiosperms have seedproducing fruits and flowers, the gymnosperms have the seed making parts in cones (ie. pine trees), and ferns are the third major type of vascular plant and they have no flowers, fruits, or seeds. Angiosperms are flowering plants like flowers and deciduous trees. Gymnosperms include primitive non-flowering plants such as conifers, ferns and horsetails. The ferns produce spores that grow into new plants. Also when looking at the concept of fruits and vegetables, fruit is a term given to the meat structure that occured as a result of the development of the carpel in flowering plants. Accordingly, if the flowers, fruits and seeds of the plants are eaten, that is fruit. In contrast, if the root, stem and leaf portions of the plants are eaten, that is vegetable. For example, tomato is a fruit eaten fleshy structure that grew as a result of the development of flowers. However, the vine plant is a vegetable because its leaves are eaten. In addition, the same plants can be fruit as well as vegetables. It should be used "fruit and vegetable" terms according to eaten portions. When the leaves of the vine plants are eaten, they are vegetable. But, when the grapes growing from the same plant are eaten, they are fruit.

In order for students to build a bridge between misconceptions and accurate science conceptions they need to experience a situation that would bring about conceptual change. However, according to constructivism learning theories, science learning requires determining students' existing cognitive understandings and building new understanding through modifying or restructuring (Glynn & Duit, 1995; Mintzes, Wandersee & Novak, 1998). Thus, revealing learners' existing knowledge will pave the way to plan curriculum and instruction that challenges and further develops their cognitive understandings. At this point teacher education has an important role in terms of educating future teachers. If prospective teachers have any misconceptions about such important biological concepts they may spread this confusion and misconceptions to their future students. Thus, it is important to reveal and correct any misconceptions prospective teachers may have before they start their teaching post. Hence, the study reported herein aimed to reveal prospective teachers' misconceptions about classification of plants.

The research questions of the study are:

1. What are the prospective teachers' misconceptions about classification of plants?
2. Is there any difference between the misconceptions of prospective teachers who are at the beginning (first class) and at the end (fourth class) of their pre-service (university) education?

In context, this study is important for several reasons. First is that as indicated above most of the

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studies investigating conceptions about other biological concepts, and the concepts related to it are with elementary and secondary school students and there are few studies conducted with prospective teachers at universities. This study investigated the misconceptions of elementary school prospective teachers about classification of plants. Second, most of the studies in the literature employed closed-ended response surveys to collect data while the present study used open-ended questionnaire to receive qualitative data which provided deeper insights into the prospective teachers' accounts of aspects of the concept of plant systematic. Finally, this study is also important as it is a developmental study researching into the misconceptions of prospective teachers at the beginning (first class) and at end (fourth class) of their pre-service education.

Methodology of Research

The research aimed to find out about prospective teachers' misconceptions of classification of plants as well as to reveal if pre-service education had any impact on their conceptions. In order to reveal the difference between the misconceptions of prospective teachers who are at the beginning (first class) of their university education and at the end (fourth class) of their pre-service education, the research was conducted as a cross-sectional study. Cross-sectional studies involve studying groups of students in different age groups at the same point in time (Cohen, Manion & Morrison, 2007). According to deVaus (2001), a cross-sectional design is ideal for descriptive statistics. Data is collected in a single time period in a cross-sectional design, rather than longitudinally. The cross-sectional design was most appropriate for the study because it did not require follow up or repeat data collection.

Sample

The sample of this study consists of 162 prospective teachers having education in Department of Elementary School Classroom Teaching in Recep Tayyip Erdoğan University Faculty of Education in fall semester of 2012-2013 academic year. This study was conducted with prospective teachers at the beginning (class 1/ 78 prospective teachers) and at the end (class 4 / 84 prospective teachers) of their pre-service education (see Table 1). We conducted with two third of the prospective teachers in each classroom. Participation was voluntary. Therefore, no sample selection was needed since this study was conducted directly on the population. Prospective teachers who agreed to participate in the research were given the questionnaire. They completed the questions individually. The identity of the participants remained anonymous.

Table 1.   Distribution of prospective teachers participating in research.

Class	Sex	N	%
Class 1	Female	34	43,24
	Male	44	56,76
Class 4	Female	39	46,15
	Male	45	53,85
General Structure	Female	73	44,74
	Male	89	55,26
Total		162	100,0

Research Tool

In order to reveal prospective teachers' misconceptions about classification of plants, an open-ended questionnaire was developed. The use of questionnaire was found to be useful as it added scope

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and breadth to the study by allowing for gathering information from more prospective teachers. Using only individual interviews to collect data from the same number of prospective teachers would make completing the research unrealistic. In addition, open-ended nature of the questions provided deeper understanding of prospective teachers' accounts of aspects of the concept of classification of plants. The questionnaire consisted of 8 open-ended questions on the meaning and types regarding to the classification of plants, and the relationship between the without-seed plants, the seedy plants, the vascular plants, the non-vascular plants, gymnosperm plants, the angiosperm plants, fruits and vegetables. The questions were designed to give prospective teachers the opportunity to provide extended answers related to the biological concepts in classification of plants.

Data Analysis

The open ended questionnaire provided qualitative data in this research. The content analysis was conducted in an inductive manner in order to identify concepts and patterns in the written responses. Content analysis is a widely used qualitative research technique (Patton, 2002). In this study, summative content analysis was used. In a summative approach to qualitative content analysis, data analysis begins with searches for occurrences of the identified words or sentences by hand or by computer. According to Morgan (1993), word or sentence frequency counts for each identified term are calculated, with source or speaker also identified (cited. Hisieh & Shannon, 2005). Throughout the paper, each prospective teacher is identified as PT (prospective teacher) followed by two numbers; one is for the order of the prospective teacher and the other is to indicate at which year group the prospective teacher was. For example, PT8-1 means that the order of the prospective teacher is 8 and that the prospective teacher was at Class 1.

Results of Research

The concept of classification of plants is defined as activity of separation plants into groups according to their biological similarities and differences. In this study, the responses of the prospective teachers were analyzed by adhering to this definition. The analysis of the prospective teachers' accounts in the open-ended questionnaire showed that 38 (45.2%) of the Class 4 and only 12 (15.4%) of the Class 1 prospective teachers could provide a definition close to the expert definition given above. Nevertheless, their answers were either too general or not completely correct.

One of the Class 4 prospective teachers' response below exemplifies this; "Pine is a plant without seeds" (PT 35-4). A Class 1 prospective teacher said; "Plants without seeds are plants with or without a big trunk, hard, spiny, living in various habitats, not having a colourful flower thus not having seeds" (PT 10-1). The accounts of the other prospective teachers from both groups contained various unempirical conceptions. Besides, their responses were not consistent, a prospective teacher whose response to one question coincided with the scientific view could provide an explanation that is not scientific as a response to another question. This may mean that the prospective teacher did not have a good conception of the subject matter (classification of plants). The unempirical conceptions held by the prospective teachers that participated in this study are categorized into eleven groups and they are presented in Table 2 according to the class groups. The accounts of the prospective teachers in both groups involved misconceptions and considerable confusion over the morphological, structural and other biological relationships between the concepts of without-seed plants, seedy plants, vascular plants, non-vascular plants, gymnosperm plants and angiosperm plants, fruits and vegetables. Considerable number of prospective teachers from both groups tended to mix some without-seedy plants with today's popular concept of seedy plants. The belief that pine is a plant without seeds was a more widespread misconception among prospective teachers. As much as 56 (71.8%) of the Class 1 and 53 (63.1%) of Class 4 prospective teachers actually wrote that pine defined as a plant without seeds because of its great size, woody structure, not having flowers made up of colourful petals and sepals, being in a spiny structure and a fern-like morphology and its habitat. In fact, it was clear from the overall analysis of their responses as a whole that they were of the impression that the pine was a seedy plant. One of the Class

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1 prospective teacher indicated; "Plants with seeds are plants with a big or a small trunk, circular or oval plump leaves, living in various habitats and having colourful flowers thus seeds" (PT 56-1). Similarly, a Class 4 prospective teacher said; "Mushrooms are plants without seeds and have not significant roots, stems and flowers" (PT 72-4). Such assumption, that 'the mushrooms' structures are similar to plants without seeds is a false assumption. Also, many of the prospective teachers in Class 1 and Class 4 who included mushrooms into the plant kingdom discussed this kingdom in the plants without seeds. This is not surprising since fungi were classified as plants without seeds, because of their cell walls, until the early 1960's. In 1950, Robert H. Whittaker became the first biologist who proposed adding the fifth kingdom, Kingdom Fungi, based on fungi's unique method of obtaining food (cited. Encarta, 2007).

Another unempirical conception that was revealed in terms of the relationship between the seedy-plants and without-seed plants. More than half of the prospective teachers in both groups indicated plants without seeds such as *lycopodium clavatum* and *lungwort* in the class of plants with seeds. A typical response to the question of "Can you describe to me the difference between seedy and seedless plants' properties?" was "use of reproductive structures like seed, chin, flower and fruit…. If we continue to classify seedy plants through using seed, chin, flower and fruit, we will classify these plants more easily." (PT 22-4).

Table 2.   Prospective teachers' misconceptions about classification of plants.

Conceptions	Class 1 (n=78)		Class 4 (n=84)	
	N	%	N	%
Pine is a plant without seed.	56	71.8	53	63.1
Plants with seeds are plants with a big or a small trunk, circular or oval plump leaves, living in various habitats and having colourful flowers thus seeds.	52	66.6	46	54.8
Mushrooms are plants without seeds.	62	79.5	60	71.4
Tomato, pepper, eggplant, cucumber and pumpkin are vegetables.	74	94.9	75	89.3
Vegetables can be seedless plant, not because their seeds.	47	60.3	42	50.0
Plants without seeds such as algae, lungwort, lycopodium clavatum and fern were non-vascular.	54	69.2	58	69.04
Pine, fir tree, spruce, wheat, corn and peanut are plants without seed.	62	79.5	64	76.2
Plants such as wheat, apricot, horsebean and pea are gymno-sperms.	58	74.4	61	72.6
Peanut is an angiosperm plant.	72	92.3	59	70.2
Corn is a dicotyledon plant.	63	80.8	66	78.6
Apple and apricot are monocotyledons.	64	82.1	68	80.9

Clearly, the prospective teachers' ideas that plants in our environment contribute to classification not because they contained different conception from learning, but because they are confronted with different ideas and circles, as well as concrete examples of lessons learned in school are not consistent with their environment. This life style was also evident in prospective teachers' comments related to their cognitive structures of increasing misconceptions about important biological concepts. More than 89% of each group of prospective teachers indicated that tomato, pepper, eggplant, cucumber and pumpkin are vegetables. One of the Class 1 prospective teachers indicated; "raw eaten foods are fruit, but most of the vegetables grow in the soil." (PT 62-1). It was also evident in both Class 1 and Class 4 prospective

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teachers' conceptions that they confused fruit concept with the vegetable concept. Over 85% of Class 1 prospective teachers and 75% Class 4 prospective teachers indicated that the prospective teachers have not distinction between the concepts of fruits and vegetables. Below account is the representative of most of these prospective teachers; "Vegetables can be a seedless plant, not because their seeds. In addition, the foods we use in our everyday lives and cooking are also vegetable." (PT 31-4). Vegetable and fruit concepts were the least mentioned and also mostly misunderstood concepts by both Class 1 and Class 4 prospective teachers. None of the Class 1 and only 3% of the Class 4 prospective teachers used the term "generative (reproductive) and vegetative (vital) organs" in their definitions of the fruit and vegetable. In addition, the questionnaire asked; "Do you think there is a relationship (similarities and differences) between the fruit and vegetable? If yes, please explain. Do you think that vegetables are seedless plants?". More than half of the prospective teachers did not respond to this question and sub-questions. Sixty-seven (85.9%) of the Class 1 prospective teachers wrote that there was no biological similarity between the two concepts.

The responses of those who answered the question indicated that none of them really knew what fruit and vegetable was. The main assumption behind their accounts about the fruit and vegetable concepts were that it was completely an their environmental experiences rather than a naturally occurring school or out of school learning process. None of the prospective teachers' accounts showed an indication of the awareness about the real meaning of the fruit and vegetable concepts. The responses of the prospective teachers regarding the fruit and vegetable fall into two groups. First group consisted of 14 (17.9%) of the Class 1 prospective teachers and 9 (10.7%) of the Class 4 prospective teachers who believed that the vegetables are plants without-seeds. The second group, mostly Class 1 prospective teachers believed that the tomato, pepper and eggplant was a vegetable. One said; "Everyone around me says that tomatoes, peppers and eggplants are vegetables." (PT 26-1). As it is clear from the above accounts of the prospective teachers, there were two common misconceptions in the prospective teachers' accounts in this group. One is that they defined vegetables as plants without-seeds. The second is that they were under the impression that everyone around their being considered tomatoes, peppers and eggplants as vegetables.

Conversely, some of the prospective teachers stated that plants without seeds such as algae, lungwort, lycopodium clavatum and fern were non-vascular. Also, samples that should have been included in plants with seeds but addressed by prospective teachers as a part of plants without seeds, such as pine, fir tree, spruce, wheat, corn and peanut were shown in the class of non-vascular plants without seeds. 61 (78.2%) of the Class 1 prospective teachers and 58 (69.04%) of the Class 4 prospective teachers provided responses that are not related to the concept of vascular or non-vascular. One of the Class 1 prospective teachers' comment below exemplifies this; "non-vascular plants without seeds are plants that do not have thin-long lines when examined with a microscope or with naked eye, without any reproductive organs differentiation such as flowers, fruit, and seeds, and sometimes without leaves" (PT 14-1). In addition, 54 (69.2%) of the Class 1 prospective teachers said that algae, lungwort, lycopodium clavatum and fern were non-vascular. One said; "In my opinion, there is no non-vascular plant. However, nowadays the level of the climatic factor is more different than before. Ferns and mosses disappeared due to the evolutionary process." (PT 28-1). Samples such as pine, fir tree, spruce, wheat and corn, which should have been included in plants with seeds but included in plants without seeds by prospective teachers were shown in the class of vascular plants without seeds. On the whole, the findings showed that both groups of prospective teachers at Class 1 and Class 4 had unempirical conceptions about vascular and non-vascular plants without seeds.

Prospective teachers offered misconceptions about the class of angiosperms, which is included in the phylum of plants with seeds. 72 (92.3%) of Class 1 prospective teachers and 59 (70.2%) of Class 4 prospective teachers considered peanut as an angiosperm. On the other hand, it was observed that there were some Class 1 and Class 4 prospective teachers who considered samples such as wheat, apricot, horsebean and pea as partly gymnosperms. Prospective teachers also offered alternative conceptions about the classification of monocotyledons in the class of angiosperms. In addition, most of Class 1 and Class 4 prospective teachers were seen to consider corn as dicotyledon even though it is monocotyledon. Prospective teachers offered various definitions about dicotyledons, which are in the

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class of angiosperms as well. In this step, they considered corn as a dicotyledon. In addition, it was found that most of prospective teachers thought samples such as apple and apricot as monocotyledons even though they are dicotyledons.

Discussion

This study aimed to reveal prospective teachers' misconceptions about classification of plants and the effect of classroom teacher education program on their awareness of this biological issue. In order to reveal the difference between the misconceptions of prospective teachers who are at the beginning and at the end of their university education, the research was conducted as a cross-sectional study.

The level of knowledge and the correct conception of Class 4 prospective teachers seems higher than those of Class 1 prospective teachers. This may mean that teacher education program made a difference; but, obviously, not sufficient as the prospective teachers who will soon graduate still have important unempirical accounts. This finding is important as the subject of the study are teachers of the next generation. The classification of plants is a part of elementary school science and technology lesson curriculum and the prospective teachers are expected to teach it when they start their teaching post. If they do not know what vascular and non-vascular plants without seeds is how can one expect them to teach it to their learners. Likewise, if their misconceptions are not revealed or corrected they may convey them to their students. Thus the results of this reserach present important implications for teacher education courses at both pre-service and in-service levels.

Misconceptions are stable and resistant barriers to acquiring scientific perspectives. Because of the fact that these misconceptions are strong predictors of pupils' achievement in science discipline, the research that identifies these misconceptions at the university level can help teachers be aware of their pupils' prior knowledge. The results of this study showed that prospective teachers' conceptions about the classification plants seems to be limited.

Prospective teachers were more likely to consider a fungus to be a plant if it possessed specific characteristics or parts. As for mistaking the members of the fungus kingdom, especially mushrooms, for plants, this was a very common misconception in this study. This finding is consistent with the scientific study of Barman et al. (2003).

The accounts of the prospective teachers in both groups involved misconceptions and considerable confusion over the concepts of without-seed plants, seedy plants, vascular plants, non-vascular plants, gymnosperm and angiosperm plants, fruits and vegetables. The belief that pine is a plant without seeds was a more widespread misconception among prospective teachers. They believed that pine, fir tree, spruce, wheat, corn and peanut are plants without seed. Prospective teachers defined pine as a plant without seeds because of its great size, woody structure, not having flowers made up of colourful petals and sepals, being in a spiny structure and a fern-like morphology and its habitat. This statement is completely false. This may mean that the prospective teacher did not have a good conception of the subject matter. This finding is based on the prospective teachers to learn by memorizing the information written in the books. This is not meaningful and an accurate learning process. Students memorize a lot of information like that. However, they do not know what it meant. The beliefs about nature of science can support alternative learning, because students depend on the knowledge described by the teacher, books and other documents. Students can see this information in the real and constant. This also leads students to alternative learning or misconceptions. The majority of prospective teachers indicated that tomato, pepper, eggplant, cucumber and pumpkin are vegetables. In this research, Class 1 and Class 4 prospective teachers have not distinction between the concepts of fruits and vegetables. The responses of those who answered the question indicated that none of them really knew what fruit and vegetable was. The responses of the prospective teachers regarding the fruit and vegetable fall into two groups. First group; prospective teachers who believed that the vegetables are plants without-seeds. The second group; prospective teachers who believed that the tomato, pepper and eggplant was a vegetable. According to the researchers, there are two important sources of misconceptions of students; 1) daily life and 2) formal learning events (Strauss, 1981; Osborne & Cosgrove, 1983; Soyibo, 1993; Hanif, 1995; Rickinson, 2001; Shephardson et al., 2009). According to Rickinson (2001), television is the main source

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of information for students on environmental issues through nature programs, documentaries and movies. The language used in everyday life affect students' concept of biology learning. Everyone in society recognizes tomato, pepper and cucumber as vegetables. Family and social environment, and even the teacher uses the same language. This causes students to recognize these plants as a vegetable. Since knowledge of one concept is built on that of another, misconceptions in one area can impact the learning of other concepts.

Thus, the prospective teachers' erroneous idea about plants is the main cause of television programs, daily life or the media, as well as instruction in schools which integrates the concepts of seedy plant and seedless plant. However, several studies showed that students might gain misconceptions about biology concepts from their teachers (Tekkaya, et al 2004; Schoon & Boone, 1998; Yip, 1999).

Former studies also reported similar misconceptions that learners had in relation to the classification of living things (Trowbridge & Mintzes, 1985; Braund, 1998; Tekkaya, Capa & Yılmaz, 2000; Türkmen, Cardak & Dikmenli, 2002; Türkmen, Dikmenli & Cardak, 2003; Meir et al., 2007; Yakısan, Selvi & Yürük, 2007; Doug, 2011). However, an important point that should be born in mind here is that the subjects of most of these studies were pupils in schools while the subjects of the study reported herein were prospective teachers who will soon be teaching pupils these concepts. Thus, they should have known the meaning of classification of plants and other related concepts. This finding presents important implications for pre-service education. Obviously, there is an urgent need to review the contents of instruction and textbooks in schools and in the pre-service classroom teacher education courses in terms of the teaching of the concept of classification of living things and related biological issues. As insufficient formal instruction and textbooks can be sources of misconceptions, those who are responsible for designing curriculum and instruction as well as teaching should take care of the research results and design the content and methods of teaching accordingly.

Conclusions

According to the results of the study, the prospective teachers in both groups did not show an accurate conception about classification of plants and its relationship with the concepts of seedless plants, seedy plants, vascular and non-vascular plants, gymnosperms, angiosperms, monocotyl and dicotyl plants, fruit and vegetables. They had various misconceptions and concerns, but they were more evident in the Class 4 prospective teachers' conceptions than those of Class 1 prospective teachers.

On the whole, comparing the two groups based on their misconceptions, it can be said that Class 4 prospective teachers had more knowledge and less misconceptions than Class 1 prospective teachers. This result is expected as prospective teachers take the modules of "The Special Issues In Biology", in which the topic of classification of plants is covered in their fourth year of pre-service education program. However, this research showed that pre-service teachers' pre-conceptions might not correct a lot biological concepts about classification of plants. And, teachers may not be aware of student's misconceptions. All of the prospective teachers in this study with different levels of academic achievement had almost the same types of misconceptions. Even the most successful prospective teacher in this study had many misconceptions before university education. However, although Class 4 prospective teachers had taken these modules, most of them still do not know what classification of plants really is. At this point, one can say that pre-service education contributed to the prospective teachers' conceptions about classification of plants but, obviously, not sufficiently. Hence, the content and instructional methods of these modules should be reconsidered and prospective teachers' misconceptions should be corrected before they start their teaching post so that they do not transfer those misconceptions to their students and grow as environmentally conscious teachers.

However, there are limitations as to the validity of this study in determining the correct interpretation of the prospective teachers' misconceptions. First, this study followed only with a total of 162 prospective teachers. In this context, a similar study can be conducted in different education levels and in different subject areas in the future. Further studies can be conducted with large samples from different universities. Also, 162 prospective teachers represent a very small part of all the prospective teachers in the world, so they cannot represent the full range of prospective teachers' misconceptions.

Thus, larger scale studies, examining prospective teachers' misconceptions regarding classification of living worlds and other units, are necessary. However, cross-sectional studies can be weak because they only provide a glimpse of the data at one point in time. As a result, they are not strong at the explanatory and causal analysis levels (deVaus, 2001). Extraneous variables were not investigated in this study. Further research examining extraneous variables would be beneficial. For this purpose, longitudinal studies can be carried out.

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Selami Yangın	Assistant Professor, Department of Elementary Science Teaching, Recep Tayyip Erdogan University, Education Faculty, Cayeli - Rize, Turkey. Tel.: +90 0 464 5328454 / 2354. Fax: +90 0 464 5328612. E-mail: selami.yangin@erdogan.edu.tr Website: http://www.rize.edu.tr/akademisyen/akademisyen.asp?id=288
Sabri Sidekli	Assoc. Professor, Department of Elementary Classroom Teacher Training, Mugla Sitki Kocman University, Faculty of Education, Mugla - Turkey. E-mail: ssidekli@mu.edu.tr Website: http://www.mu.edu.tr/personel/-AA00000729
Yasin Gokbulut	Assistant Professor, Department of Elementary Classroom Teacher Training, Gaziosmanpasa University, Faculty of Education, Tokat - Turkey. E-mail: yasin.gokbulut@gop.edu.tr Website: http://uis.gop.edu.tr/CV/CV.asp?ID=656