PROSPECTIVE SCIENCE TEACHERS' LEVELS OF UNDERSTANDING AND EXPLANATION OF ANIMAL AND PLANT CELLS: DRAW-WRITE

Huriye Deniş Çeliker

Abstract. *Understanding science concepts and being able to explain them is important for science teachers. The perception of students about the concepts of science is related to teachers who use these concepts. In this study, it was aimed to determine prospective science teachers' (n=152) levels of conceptual understanding and ability to explain animal and plant cells by drawing and written explanations. In the study, descriptive survey design has been used. As for the outcome of the research, the conceptual understanding of prospective science teachers regarding plant and animal cells was not adequate. In addition, prospective science teachers' level understanding and explanation the animal cells and plant cells was found out to be associated with each other. Prospective teachers' writing and drawing scores are remarkably in favor of writing and significantly differ. The majority of prospective teachers had difficulty over drawing concepts. Recommendations are presented on the basis of these results.*
Key Words: *cell, explanation, prospective science teachers, understanding*

Introduction

Science is a dynamic and human activity that tries to define and explain physical, chemical and biological processes. Through this activity, information that can be tested objectively and consistently has been generated and continues to be generated (Victor & Kellough, 1997; Kaptan, 1999; İşman, Baytekin, Balkan, Horzum & Kıyıcı, 2002; Doğru & Kıyıcı, 2005; Ministry of National Education, 2005; Topsakal, 2005; Banasiak & Beimer, 2007).

Another dimension of science is biology. Biology teaching is one of the more effective ways that can be used for people to gain some knowledge by transferring the information obtained regarding the occurrence and order of the events in nature to their lives thanks to biological research. In biology lessons, students are able to encounter a lot of information and concepts related to themselves or their environments (Berkant, 2002). Concepts are abstract units involved in people's thought systems. They facilitate communication between people by classifying information (Saka & Akdeniz, 2004; Saka, Akdeniz, Asilsoy & Bayrak, 2005). In science the importance of the concept is great. The reasons why students are successful or unsuccessful in learning concepts are the prominent issues in educational research for effective learning (Kurt, 2013). To internalize the ideas that the concepts symbolize and to consider the meaning of these concepts correctly, and to assimilate in the mind beyond simple memorizing are the necessities to reach the upper steps of science teaching (Eyidoğan & Güneysu, 2004). Although the most important objective of science is conceptual understanding, difficulties in understanding science concepts are observed in all student age groups (Noh & Scharmann, 1997). Educators need a good starting point and it is important for teachers to know the level of students' conceptual understanding (Pittman, 1999).

The field knowledge of those who are guiding the learning process in assimilating the concepts correctly is important. Especially when considered in terms of abstract science concepts, it is expected that the prospective sci-

Huriye Deniş Çeliker
Mehmet Akif Ersoy University, Turkey

Journal of Baltic Science Education, Vol. 14, No. 4, 2015

PROSPECTIVE SCIENCE TEACHERS' LEVELS OF UNDERSTANDING AND EXPLANATION OF ANIMAL
AND PLANT CELLS: DRAW-WRITE
(P. 501-512)

ISSN 1648–3898

ence teachers who will lead future generations have correct knowledge about the subject field. On the other hand, when considering that prospective teachers may come to university with scientifically incorrect perceptions on some topics, it is inevitable that they transfer these misunderstandings to their students and this incorrect learning process continues in the next generations. Thus, to identify the lack of subject knowledge and misconceptions of prospective teachers and efforts to eliminate them are crucial in teacher training (Bak, Ayas & Devecioğlu, 2005).

Field Qualifications of Prospective Science Teachers

The field qualifications of prospective science teachers and science teachers are very important. As teachers can be a major source of children's informal ideas in science, their incompetence in subject matter knowledge will affect students' basic understanding of science concepts (Mak, Yip & Chung, 1999). A source of misconception comes from teachers who are less competent in subject-matter knowledge (Yip, 1998). In the 2013 Public Staff Selection Examination that science teaching graduates attended, the arithmetic average of the Science Test, which consisted of 50 questions on the area of Science, was 15.00. In 2014, the average was 13.00 (Student Selection and Placement Center, Turkey, 2013; 2014). These results indicate that the knowledge of the area of the prospective teachers graduated from university is not adequate. In addition, the research carried out on prospective science teachers in recent years has shown that the field knowledge of prospective teachers is not sufficient. There has been missing and incorrect learning, they have misconceptions and they have low levels of conceptual understanding. It has been identified that the prospective science teachers have misconceptions on such topics in the field of chemistry, physics and biology.

It has been identified that the prospective science teachers have misconceptions on such topics as states of matter (Aydın & Gödek Altuk, 2013), the relationship between boiling point and vapor pressure (Akgün, Gönen & Yılmaz, 2009), solution, dissolution, and the structure and the conductivity of mixtures (Akgün, Gönen & Yılmaz, 2005) in the field of chemistry. In the field of physics, it has been determined that prospective teachers have misconceptions on such topics as force and motion (Demir, Uzoğlu & Kasap, 2004; Kurt & Akdeniz, 2004), work (Erduran Avcı, Kara & Karaca, 2012), waves (Küçüközer, 2010), and astronomy (Emrahoğlu & Öztürk, 2013; Küçüközer, 2007). And it has been identified that they have misconceptions in the field of biology subjects such as diffusion (Akgün, 2010; Yıldırım, Nakipoğlu & Sinan, 2004), photosynthesis and respiration in plants (Köse, Ayas & Uşak, 2006), proteins, enzymes and protein synthesis (Sinan, Yıldırım, Kocakülah & Aydın, 2006), cell division (Emre & Bahşi, 2006) and greenhouse effect (Bal, 2004).

In most of this research, it has been concluded that prospective teachers have difficulty in the explanation of topics and concepts that are difficult to learn and embodying the abstract concepts learned (Çelik, Yılmaz, Şen & Sarı, 2013). When an abstract concept is not embodied, an individual is forced to memorize these concepts without internalizing them (Yapıcı, 2004).

Cell Concepts in Science Teaching

One of the important abstract concepts in science teaching is the topic of cells. The concept of the cell is not related to daily life. Students do not have a reference where they can find out for themselves what cells are or where they are (Zamora, Silvia & Guerra, 1993). It is very complex for students who have not integrated into the whole picture to establish the relationship between structure and function of the cell (Flores Tovar & Gallegos, 2003). Understanding the structure of cell biology is among the topics that are the most difficult to learn (Storey, 1990). Cavas and Kesercioğlu (2010) indicate that understanding of cell functions is important in learning about the functioning of multicellular organisms. The difficulty of embodying this topic causes a decrease in prospective teachers' interests in the topic. The structure, functions and organelles of cells are difficult to understand and abstract topics (Saygın, Atılboz & Salman, 2006). Emre and Bahşi (2006) have shown in their research that prospective science teachers have misconceptions about cell division. They have stated that interrelated concepts and the memorization of these concepts cause misconceptions. Kaya and Gürbüz (2002) have taken the views of high school students on the course of biology and have concluded that most of the students describe it as a course that is based on memorization and is unpractical. Yörek, Aydın and Kete (2005) have insisted that it is required to have students better comprehend it, as the topic of the cell is one of the basic structures of biology. Uşak (2009) found in his research on the pedagogical knowledge of prospective science teachers about cells that the prospective teachers are not successful in using specific teaching methods, are teacher-centered in terms of teaching approaches and have high

Journal of Baltic Science Education, Vol. 14, No. 4, 2015

ISSN 1648–3898   PROSPECTIVE SCIENCE TEACHERS' LEVELS OF UNDERSTANDING AND EXPLANATION OF ANIMAL
AND PLANT CELLS: DRAW-WRITE
(P. 501-512)

self-confidence about knowledge of the field. Öztaş and Özay (2004) examined the problems faced by teachers in biology teaching in their study on biology teachers and stated that most of the teachers had not received enough biology education in their school life; therefore, they used schemes more than models while teaching. The fact that teachers mostly use methods such as lecture, question-answer, and discussion instead of student-centered and practical methods can be considered as one of the reasons that affects achievement negatively (Yaman & Soran, 2000; Ekici 2001). Therefore, studies conducted in order to increase the interest of students in biology courses and to provide a conceptual understanding by providing configurations in their own minds instead of memorizing the concepts are important (Saygın, Atılboz & Sayman, 2006).

The Present Research

Flores, Tovar and Gallegos (2003) stated that there have been very few studies on the students' concept statements. Prospective teachers studying in faculties of education are supposed to have field information. It seems that there is little research on cells, which is one of the basic subjects in Biology. Uşak (2009) suggested that the field information a teacher has is important but what is more important is how much of this information a teacher or a prospective teacher can transfer to the students in accordance with their interests, necessities and levels.

The topic of cells is one of the basics in Biology and it is a prerequisite concept in learning Biology subjects such as the living, the inanimate, tissue, organ and system. It is a subject that takes place from middle school to secondary education and for prospective science teachers' until the bachelor degree. Considering that the conceptual understanding levels of future teachers regarding this subject will reflect on their professional life and the seriousness of its consequences, it is necessary to determine the conceptual understanding on this subject.

Drawing is one of the methods that can be used to reveal the levels of conceptual understanding of students, their observational skills and their discernment (Dove, Everett & Preece, 1999; McNair & Stein, 2001; Pridmore & Bendelow, 1995). Drawings, which provide an opportunity for international comparison, are easily applied research tools (Reiss et al, 2002). They reveal the hidden knowledge and beliefs of students without being limited by words (Ayas, 2006). Drawing is used increasingly in research regarding the environment and science teaching (Angell, Alexander & Hunt, 2015; Shepardson, Niyogi, Choi & Charusombat, 2009). This method can be used for many ages and development groups, thus it provides an understanding of the individual's knowledge, conceptual understanding and the feelings of their inner world (Bahar, Uzel, Protop & Uşak, 2008; Bartoszeck, Machado, & Amann-Gainotti, 2008; Dove, Everett & Preece, 1999; McNair & Stein, 2001; Nyachwaya, Mohamed, Roehrig, Wood, Kern & Schneider, 2011; Prokop & Fančovičová, 2006; Prokop, Fančovičová & Krajčovičová, 2015; Prokop, Prokop & Tunnicliffe, 2008; Prokop, Prokop, Tunnicliffe & Diran, 2007; Prosser, 1998; Sasmaz-Ören & Ormanci, 2014).

Thus, the aim of this study is to determine prospective science teachers' level of conceptual understanding and ability to explain the structure of animal and plant cells. It was intended to find answers to the following questions in accordance with these aims;

What level is the science teachers' conceptual understanding of plant and animal cells?

What level is the science teachers' conceptual description of plant and animal cells?

Is there a significant difference between the scores they receive from writing and drawing of prospective science teachers in plant and animal cells?

How often do prospective science teachers express the structure of plant cells and organelles in their drawings and explanations?

Methodology of Research

Research Design

In the study, descriptive survey design has been used for determining prospective science teachers' levels of understanding and explanation of animal and plant cells. Survey research provides a quantitative description of trends, attitudes, or opinions of a population by studying a sample of that population (Creswell, 2013). The survey

Journal of Baltic Science Education, Vol. 14, No. 4, 2015

PROSPECTIVE SCIENCE TEACHERS' LEVELS OF UNDERSTANDING AND EXPLANATION OF ANIMAL
AND PLANT CELLS: DRAW-WRITE
(P. 501-512)

ISSN 1648–3898

studies can be descriptive or analytic. Descriptive surveys simply describe data on variables of interest, whilst analytic surveys operate with hypothesized predictor or explanatory variables that are tested for their influence on dependent variables (Cohen, Manion & Morrison, 2011).

Participants

The participants of the research consisted of 152 students (female=113, male=39) registered at a state university in Turkey. The mean age of the participants was 23.2 (SD=1.08, range: 21 - 26). Purposive sampling was used to select the participants. In the purposive sampling procedure, the researcher decides what needs to be known and sets out to find people who can and are willing to provide the information by virtue of knowledge or experience (Bernard, 2002). The applications were done after the participants received all the courses (General Biology-I-II, General Biology Laboratory-I-II, Human Anatomy and Physiology, Genetics and Biotechnology, Special Topics in Biology) they would get during their study period. In particular, the course of General Biology-I that is taken in the second grade and consists of the topics of "cell, the structure and function of cell, cell membrane, cytoplasm and organelles, cell nucleus". Participants were seniors studying at the Department of Science Teaching in the Faculty of Education. Therefore, the sample of this study was appropriate.

Data Collection Tool

Prospective science teachers participating in the study were asked to draw and explain in writing the structure of animal and plant cells. To ensure that students could freely express their knowledge on this subject, no pattern was asserted and it was stated that every kind of drawing and writing could be used. The students were given 40 minutes for this application. Prospective science teachers did not receive private tutoring in this matter. Draw-Write Form regarding animal and plant cells was applied at the end of 2013-2014 school year fall semester.

Data Analysis

It was anticipated that the prospective science teachers would make the drawings and the explanations that they would use when they practice their profession. In this respect, the subject content of "the resemblances and differences between animal and plant cells", which is in Science Teaching Program (Ministry of National Education, 2013) 6th Grade 'The Systems of Our Body' unit were examined. In the assessment of the prospective science teachers' drawings and explanations, the shapes and explanations that are in the 2013 science course curriculum and in the 6th grade course book (Öcal, 2014) that science teachers use in their classes were taken as the base. The determination of prospective science teachers' levels of conceptual understanding of animal and plant cells was made by domain experts consisting of two people according to the scoring scale developed by Ormancı and Şaşmaz (2010) and is used in the assessment of drawing questions given in Table 1 and the scoring scale whose instructions are given in Table 2. The percentage of agreement between the experts regarding the assessment of drawing and explanations was measured at 0.91.

Table 1.   **The scoring scale used in the analysis of drawing questions.**

Assessment Criteria	Score	Scoring Criteria
Clear Understanding	5	Drawings that are fully scientifically correct
Partial Understanding	3	Drawings containing scientifically a part of the answer or drawings containing misconceptions along with the right answer
Not Understanding	0	containing total misconceptions, (b) scientifically wrong, (c) irrelevant or incomprehensible drawings, (d) leaving blank

Journal of Baltic Science Education, Vol. 14, No. 4, 2015

ISSN 1648–3898   PROSPECTIVE SCIENCE TEACHERS' LEVELS OF UNDERSTANDING AND EXPLANATION OF ANIMAL
AND PLANT CELLS: DRAW-WRITE
(P. 501-512)

Table 2.   The scoring scale used in the analysis of writing.

Assessment Criteria	Score	Scoring Criteria
Correct Explanation	5	An explanation that is scientifically correct
Partially Correct Explanation	3	An explanation that is scientifically correct but cannot be expressed in all its parts
Wrong Explanation	0	(a) an explanation that is scientifically incorrect, (b) explanation irrelevant to the question, (c) explanation consisted of misconception, (d) explanation in which the expression in the question is repeated, (e) leaving empty, (f) expressing not knowing, (g) leaving empty

Data on both the plant and animal cells related to affidavits and drawings were not normally distributed (Kolmogorov-Smirnov tests, both p <0.05). Thus, for teachers drawings of plant and animal cells, a comparison of the post-level 3x2 Chi-Square test (c^2) (King and Minium, 2003) was used. Drawing and Spearman rank correlation to determine whether the relationship between the written expression result, the Wilcoxon in order to test the significance of the difference between the drawings and written expression results, a Signed Rank test was administered and values with p <0.05 were accepted as significant. Organelles provided from drawings and reports were laid out to be calculated as percentage (%) and frequency (f).

Results of Research

Levels of Understanding

The frequency and the percentage distribution of the drawing levels of prospective science teachers regarding the structure of animal and plant cells and the results including The Chi-Square test are given in Table 3.

Table 3.   Animal and plant cell drawing levels of prospective science teachers.

Categories of Analysis	Animal Cells		Plant Cells	
	N	%	N	%
Not Understanding (U-1)	126	82.9	106	69.7
Partial Understanding (U-2)	22	14.5	40	26.3
Clear Understanding (U-3)	4	2.6	6	3.9
Total	152	100.0	152	100.0

Examining Table 3, a large majority of participants had very poor understanding of both plant and animal cells.

The level of difference between prospective teachers of understanding plant and animal cells was found to be significant (chi-square test, χ^2 (2) = 7.35, p = 0.025). In other words, there was a significant relationship between teachers' level of understanding of plant and animal cells.

Description Levels

The frequency and the percentage distribution of the explanation levels of prospective science teachers regarding the structure of animal and plant cells and the results including the Chi-Square test are given in Table 4.

Journal of Baltic Science Education, Vol. 14, No. 4, 2015

ISSN 1648–3898

PROSPECTIVE SCIENCE TEACHERS' LEVELS OF UNDERSTANDING AND EXPLANATION OF ANIMAL
AND PLANT CELLS: DRAW-WRITE
(P. 501-512)

Table 4.   The levels of prospective science teachers regarding the structure of animal and plant cells.

Categories of Analysis	Animal Cells		Plant Cells	
	N	%	N	%
Wrong Explanation (E-1)	72	47.4	40	26.3
Partially Correct Explanation (E-2)	56	36.8	84	55.3
Correct Explanation (E-3)	24	15.8	28	18.4
Total	152	100.0	152	100.0

Examining Table 4, the vast majority of participants is at the level of description wrong explanation for animal cells, and partially correct explanation level for the plants. There is a significant relationship over prospective teachers to explain levels of plant and animal cells (chi-square test, $\chi^2 (2) = 15.05$, p = 0.001)

Comparison between the Levels of Drawing and Writing

Comparison between the Levels of Drawing and Writing Spearman rank correlation results are given in Table 5 in order to determine the relationship between the drawing and writing scores over plant and animal cells of participants.

Table 5.   Drawing and Spearman rank correlation between the results of drawing and writing.

Drawing	Explanation								
	Plant Cells			Animal Cells			Total		
	r	p	n	r	p	n	r	p	n
Plant Cell	0.288	0.001	152						
Animal Cell				0.135	0.096	152			
Total							0.242	0.001	304

Wilcoxon Signed Rank test results applied to determine whether there is a significant difference between prospective teachers' writing and drawing related to animal and plant cells are given in Table 6.

Table 6.   Drawing and writing test scores Wilcoxon signed rank test results.

	Drawing-Writing	n	Mean Rank	Sum of Ranks	z	P
Animal Cell	Negative Ranks	72	45.83	3300.00	6.41*	0.001
	Positive Ranks	14	31.50	441.00		
	Ties	66				
Plant Cell	Negative Ranks	78	41.58	3243.00	7.37*	0.001
	Positive Ranks	4	40.00	160.00		
	Ties	70	-	-		
Total	Negative Ranks	150	86.82	13023.00	9.74*	0.001
	Positive Ranks	18	65.17	1173.00		
	Ties	136	-	-		

*Based on positive ranks.

Journal of Baltic Science Education, Vol. 14, No. 4, 2015

ISSN 1648–3898   PROSPECTIVE SCIENCE TEACHERS' LEVELS OF UNDERSTANDING AND EXPLANATION OF ANIMAL
AND PLANT CELLS: DRAW-WRITE
(P. 501-512)

Analysis results indicate that there is a significant difference between drawing and writing levels of teachers who participated in the research related to plant and animal cells. As the difference in average scores (mean rank) and row totals (sum of ranks) are observed, the difference is negative hence it is determined to be in favor of writing scores. When the evaluation criteria of these levels are considered, it can be suggested that the explanations of animal and plant cells of prospective science teachers are more successful than their drawings.

The frequencies of stating cell structure and its organelles in the drawings of prospective science teachers are given in Table 7.

Table 7.   The frequencies of stating cell structure and its organelles in the drawings of prospective science teachers.

Organelles	Drawing of a Plant Cell		Drawing of an Animal Cell		Explanation of Animal and Plant Cells	
	F	%	f	%	f	%
Nucleus	119	77.6	108	71.0	88	57.8
Cell Wall	106	69.7	10	6.5	88	57.8
Vacuole	96	63.1	38	25	114	75.0
Mitochondria	82	53.9	38	25	128	84.2
Chloroplast	80	52.6	2	1.3	96	63.1
Cell Membrane	78	51.3	82	53.9	86	56.3
Ribosome	72	47.3	50	32.8	114	75.0
Endoplasmic Reticulum	68	44.7	34	22.3	82	53.9
Lysosome	68	44.7	42	27.6	86	56.5
Golgi Apparatus	62	40.7	38	25.0	116	76.3
Centrosome	20	13.1	46	30.2	78	51.3

It is remarkable that even though there is a similar structure instead of a lysosome in plant cells, 44.7% (f=68) of the prospective science teachers drew this organelle. Similarly, even though there isn't a centrosome organelle in plant cells, 13.1% (f=20) also drew this organelle.

Even though there isn't a cell wall and a chloroplast in an animal cell, it is seen that 6.5 % (f=10) of the prospective science teachers drew the cell wall and 1.3% (f=2) drew the chloroplast.

Discussion

There is a lot of work for science teachers to determine the level of conceptual understanding. In this study, it was aimed to determine the level of understanding and ability to explain concepts via drawing and writing descriptions for science teachers who will teach animal and plant cells in near future.

The results are discussed below in order to conclude the level of prospective science teachers regarding their understanding and explanations of animal and plant cells concepts.

Levels of Understanding

From the analysis of the vast majority of science teachers' drawings, it might be said that both animal and plant cells are not at the understanding level. This is followed by the Partial Understanding level. Very few teachers' drawings being at the Clear Understanding level is noteworthy. Prospective teachers seem to be a relationship between the understanding of plant and animal cell levels (Table 3).

It is seen that the knowledge levels of prospective teachers regarding animal and plant cells are low and the number of prospective teachers who have wrong and imperfect data is high. In his studies where he examined prospective science teachers' pedagogical field knowledge about cells, Uşak (2009) determined that the prospective teachers' field knowledge specific to the subject was demonstrably imperfect.

Journal of Baltic Science Education, Vol. 14, No. 4, 2015

PROSPECTIVE SCIENCE TEACHERS' LEVELS OF UNDERSTANDING AND EXPLANATION OF ANIMAL
AND PLANT CELLS: DRAW-WRITE
(P. 501-512)

ISSN 1648–3898

Similarly, Mestre (2002) mentioned that university students are insufficient in physics conceptual understanding, Sinan, Kose, Aydin and Gezer (2007) that science teachers are insufficient at enzymes and protein synthesis, and Brown and Schwartz (2009), that prospective teachers have conceptual understanding problems over photosynthesis and in cellular respiration. Fančovičová and Prokop (2014) stated that the anatomy knowledge of prospective biology teachers was weak.

Acquisition of conceptual understanding is influenced by prior knowledge (Driver, Asoko, Leach, Mortimer and Scott, 1994). Moreover use of higher level strategies contributes to substantially different indicators of conceptual understanding (Alao and Guthrie, 1999). Especially in the teaching of biology questions and answers (Kumbıçak, Atılboz and Salman, 2006), the narrative method (Karamustafaoğlu, Bayar and Kaya, 2014) has been found to be the most often used. The inefficiencies of the teachers in their field knowledge might cause them to use materials in a way that will give them wrong information about the subject (Canbazoğlu, Demirelli and Kavak, 2010).

Description Levels

According to the results obtained from the article, it was observed that the level of prospective science teachers' explanation of animal cells is Wrong Explanation level, and teachers' level of explaining of plant cells is Partially Correct level. There seems to be a correlation between the level of description of plant and animal cells of prospective teachers (Table 4).

Comparison between the Levels of Drawing and Writing

It has been determined that there was no relationship between animal cell drawing and writing but a positive and statistically significant low level relationship was found between plant cell drawing and writing and total drawing and writing of plant and animal cells (Table 5). Similarly with animal cell drawing and writing results Prokop and Fančovičová (2006) failed to find significant relationships between students' writings and drawings about the human body.

Analysis results indicate that there is a significant difference between the levels of prospective science teachers in writing and drawing plant and animal cells. It is observed that this difference was in favor of writing scores (Table 6).

Examining animal and plant cells it is seen that for each of them, the levels of the written statements are higher than those of drawings. This might be the result of prospective teachers' memorizing the information rather than configuring it in their minds. Most of the prospective teachers didn't include the cell organelles they explained in their drawings. Ormancı and Şaşmaz Ören (2010) suggested that when the students are asked questions which they are required to answer in writing, there is a possibility that they will write by heart but when they are asked to draw the subject, the students need to have full knowledge to make a drawing. It is understood that students cannot transfer what they know into drawings. A similar result has been suggested by Saka and Akdeniz (2004) in their study in which they examined prospective science teachers' different progression levels regarding the topic of genetics with surveys and drawings.

Also, it is seen that the prospective teachers tried to answer in their written statements instead of leaving blank even if the answer was wrong. It is determined that this is less done in drawings. Kara, Erduran-Avcı and Çekbaş (2008) reached a similar result in their study in which they researched the prospective teachers' levels of knowledge regarding the concept of light with drawings. This might be the result of knowledge based learning. Also, it can be interpreted as prospective teachers' having difficulty in the visualizing process.

Frequencies of Stating Cell Structure and Its Organelles

Examining the written statements of the prospective teachers' regarding the organelles in animal and plant cells, it was seen that mitochondria organelle is the most explained. The majority of the prospective teachers explained the vacuole and ribosome and most of them explained the nucleus, cell wall, cell membrane and lysosome. The organelle the prospective teachers have the most difficulty in explaining is the centrosome (Table 7).

Examining the prospective teachers' drawing of the organelles in a plant cell, most of them showed the cell nucleus and cell wall by drawing. Even though there isn't a centrosome organelle in a plant cell, the prospective

Journal of Baltic Science Education, Vol. 14, No. 4, 2015

ISSN 1648–3898   PROSPECTIVE SCIENCE TEACHERS' LEVELS OF UNDERSTANDING AND EXPLANATION OF ANIMAL
AND PLANT CELLS: DRAW-WRITE
(P. 501-512)

teachers' drawing of this organelle is a good example of lack of conceptual understanding. It draws attention to the fact that this result is parallel to the findings of Yörek (2007) in the study he conducted with 9th and 11th graders.

Examining the drawings of animal cells, it is seen that most of the prospective teachers drew the nucleus and cell membrane. It shows that even though there is no cell wall or chloroplast in an animal cell they are still drawn.

Conclusion and Implications

The current study shows that prospective science teachers' conceptual understanding and explanation of plant and animal cells is not sufficient. This study also revealed that prospective science teachers' understanding of animal cells and plant cells is associated with the level of understanding and explanation. In addition, prospective teachers' writing and drawing scores are remarkably in favor of writing and significantly differ. The majority of the prospective teachers have difficulty while drawing.

Multiple-choice exams based on memorization, the decline of the scores that decrease each year in the education faculty entrance exam, (insufficient information levels at the start of university), the prevalence of teacher-centered implementation, insufficient performance of interdisciplinary work, and courses being studied without field educators might be some of the reasons and recommendations might be proposed accordingly.

Firstly, this result may be seen as the natural effect of prospective teachers to settle in to university and after graduating from the university, such as the Public Personnel Selection Exam, which is a multiple-choice, central examination based on knowledge. Individuals with a time limitation in this exam focus on solving without in-depth thinking but rather with eliminating techniques (Unal Coban, 2010). University students prefer memorizing test solving techniques to understand science in order to settle issues conceptually. Employment concerns and lack of required preconditions of education faculties and base condition scores decreasing each year lead to university teachers with insufficient preliminary information regarding the area.

The second reason could be the teaching methods used in the course. To solve the problem of learning wrongly and imperfectly, which is the case of prospective teachers' knowledge about the topic of cells, it might be suggested that student centered methods and techniques such as examination of animal and plant cells under a microscope, research and question based learning, problem based learning and project based learning in which they will actively participate should be used. Also, in different studies, experimental and quasi experimental research can be conducted on the effectiveness of study leave that is supported by different student centered methods and techniques for students to gain knowledge of this subject in middle school, secondary school and higher education.

The third reason might be associated with science concept drawings and the lack of interdisciplinary studies on the development of three-dimensional materials. An interdisciplinary study could be conducted with visual arts classes in teaching the subjects that take place in middle school science class especially in biology and teaching biology subjects in secondary school. In higher education, it is necessary that the subjects are understood by visualizing. The drawing process should be concentrated on in the study leave in the course books.

The fourth reason might be that training courses are given by trainers instead of field educators. Although these trainers know about education in the sciences, they are not specialists in each field.

Considering the conceptual understanding and explaining levels of prospective science teachers regarding animal and plant cells, it might be suitable for science education experts to conduct research into Teaching Technology and Material Design, Science Technology Program and Planning and Special Teaching Methods I-II courses that require both field and education knowledge. Also, in these courses prospective teachers should participate in activities in which they can apply their field knowledge. By increasing the number of Teaching Application and School Experiment courses, prospective teachers should be given more chance to perform an application. Also, by giving information about conceptual understanding and explaining to the school counselors in practice schools the prospective teachers attend, they can be supported in making progress.

This research conducted on animal and plant cells can be repeated with the draw and write method by including the structures of protists (e.g. paramecium, ameba, and euglena) in further studies. Also, to determine the levels of conceptual understanding and explaining of prospective teachers on different subjects, data diversification can be achieved by having interviews and observations.

Moreover, as a follow up study, more research has to be done for prospective teachers to understand and explain the different concepts of both cells and improving the levels. The findings of this research might help to create a foundation for the development of this level.

References

Akgün, A. (2010). The relation between science student teachers' misconceptions about solution, dissolution, diffusion and their attitudes toward science with their achievement. *Education and Science*, *34* (154), 26-36.

Akgün, A., Gönen, S., & Yılmaz, A. (2005). Misconceptions of pre service science teachers regarding the structure and conductivity of mixtures. *Hacettepe University Journal of Education*, *28* (1), 1-8.

Akgün, A., Gönen, S., & Yılmaz, A. (2009). Science teacher candidates' misconceptions and lack of knowledge about the relation between boiling point and vapor pressure. *E-Journal of New World Sciences Academy (NWSA)*, *4* (1), 13-24.

Alao, S., & Guthrie, J. T. (1999). Predicting conceptual understanding with cognitive and motivational variables. *The Journal of Educational Research*, *92* (4), 243-254.

Angell, C., Alexander, J., & Hunt, J. A. (2015). 'Draw, write and tell': A literature review and methodological development on the 'draw and write' research method. *Journal of Early Childhood Research*, *13* (1), 17-28.

Ayas, A. (2006). *Learning concepts. Science and technology education (Editor: S. Çepni)*. Ankara, Pegema publishing.

Aydın, A., & Altuk, Y.G. (2013). Turkish science student teachers' conceptions on the states of matter. *International Education Studies*, *6* (5), 104-115.

Bahar, M., Ozel, M., Prokop, P., & Usak, M. (2008). Science student teachers' ideas of the heart. *Journal of Baltic Science Education*, *7* (2), 78-85.

Bak, Z., Ayas, A., & Devecioğlu, Y. (2005). Determination of misconceptions about heat and temperature of prospective teachers, *XIV. National Educational Sciences Congress,* Pamukkale University Faculty of Education, Denizli, Retrieved from http://www.pegem.net/Akademi/kongrebildiri_detay.aspx?id=100763

Bal, Ş. (2004). Determination of the misconceptions about the greenhouse effect of science teachers. *Eurasian Journal of Educational Research*, *17*, 102-111.

Bartoszeck, A. B., Machado, D. Z., & Amann-Gainotti, M. (2008). Representations of internal body image: a study of preadolescents and adolescent students in Araucaria, Paraná, Brazil. *Ciências & Cognição*, *13* (2), 139-159.

Berkant, H. G. (2002). Development based on the biological causality of secondary biology courses, *V. National Science and Mathematics Education Congress, ODTÜ, Ankara,* Retrieved from http://old.fedu.metu.edu.tr/ufbmek-5/b_kitabi/PDF/Biyoloji/bildiri/t13d.pdf

Bernard, H. R. (2002). *Research methods in anthropology: qualitative and quantitative methods.* 3rd edition. AltaMira Press, Walnut Creek, California.

Brown, M. H., & Schwartz, R. S. (2009). Connecting photosynthesis and cellular respiration: preservice teachers' conceptions. *Journal of Research in Science Teaching*, *46* (7), 791-812.

Canbazoğlu, S., Demirelli, H., & Kavak, N. (2010). Investigation of the relationship between pre-service science teachers subject matter knowledge and pedagogical content knowledge regarding the particulate nature of matter. *Elementary Education Online*, *9* (1), 275-291.

Cavas, B., & Kesercioglu, T. (2010). A qualitative study on student' understanding and misconceptions regarding the living cell. *e-Journal of New World Sciences Academy Education Sciences*, *5* (1), 321-331.

Cohen, L., Manion, L., & Morrison, K. (2011). *Research methods in education* (7th Ed.). New York: Routledge Publishing.

Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.

Çelik, H., Yılmaz, G., Şen, Ö. F., & Sarı, U. (2013). Analyzing science teacher candidates' scenario-forming capabilities aimed at constructivist approach. *Journal of Research in Education and Teaching*, *2* (3), 75-83.

Demir, Y., Uzoğlu, M., & Büyükkasap, E. (2012). To compare the effectiveness of multiple-choice questions with cartoons which use to determine prospective science teachers' misconceptions about force and movement. *Journal of Research in Education and Teaching*, *1* (1), 88-102.

Doğru, M., & Kıyıcı, T. (2005). *The necessity of science education*. M. Aydoğdu ve T. Kesercioğlu (Editor), Teaching science and technology in primary education (1-24). Ankara: Anı Publishing.

Dove, J. E., Everett, L. A., & Preece P. F. W. (1999). Exploring a hydrological concept through children's drawings. *International Journal of Science Education, 21* (5), 485-497.

Driver, R., Asoko, H., Leach, J., Scott, P., & Mortimer, E. (1994). Constructing scientific knowledge in the classroom. *Educational researcher*, *23* (7), 5-12.

Ekici, G. (2001). Examination of the theoretical knowledge of teaching methods of biology teacher qualification. *Contemporary Education, 274*, 40-46.

Emrahoğlu, N., & Öztürk, A. (2013). A longitudinal research on the analysis of the prospective science teachers' level of understanding the astronomical concepts and their misconceptions. *Çukurova University Institute of Social Sciences Journal*, *18* (1), 165-180.

Emre, İ., & Bahşi, M. (2006). Misconceptions of science teacher candidates about cell division. *Eastern Anatolia Region Studies*, 70-73.

Erduran-Avcı, D., Kara, İ., & Karaca, D. (2012). Misconceptions of science teacher candidates about work. *Pamukkale University Journal of Education*, *31* (1), 27-39.

Eyidoğan, F., & Güneysu, S. (2002). *Examination of the misconceptions of elementary science books. V.* Science and Mathematics Education Congress, Ankara. Retrieved from http://old.fedu.metu.edu.tr/ufbmek-5/b_kitabi/PDF/Fen/Bildiri/t72d.pdf

Fančovičova, J., & Prokop, P. (2014). The effects of 3d plastic models of animals and cadaveric dissection on students' perceptions of the internal organs of animals. *Journal of Baltic Science Education, 13* (6), 767-775.

Journal of Baltic Science Education, Vol. 14, No. 4, 2015

ISSN 1648–3898   PROSPECTIVE SCIENCE TEACHERS' LEVELS OF UNDERSTANDING AND EXPLANATION OF ANIMAL
AND PLANT CELLS: DRAW-WRITE
(P. 501-512)

Flores, F., Tovar, M. E., & Gallegos, L. (2003). Representation of the cell and its processes in high school students: an integrated view. *International Journal of Science Education, 25* (2), 269-286.

İşman, A., Baytekin, Ç., Balkan, F., Horzum, M. B., & Kıyıcı, M. (2002). Science education and constructivist approach. *The Turkish Online Journal of Educational Technology, 1* (1), 41-47.

Kalvaitis, D., & Monhardt, R. M. (2012). The architecture of children's relationships with nature: a phenomenographic investigation seen through drawings and written narratives of elementary students. *Environmental Education Research, 18* (2), 209-227.

Kaptan, F. (1999). *Science Education.* İstanbul: National Education Press.

Kara, İ., Erduran-Avcı D., & Çekbaş, Y. (2008). Investigation of the science teacher candidates' knowledge level about the concept of light. *Mehmet Akif Ersoy University Faculty of Education Journal, 16*, 46-57.

Karamustafaoğlu, O., Bayar, A., & Kaya, M. (2014). An investigation of science teachers' teaching methods and techniques: Amasya case. *Journal of Theoretical Educational Science, 7* (4), 436-462.

Kaya, E., & Gürbüz, H. (2002). The views of the high schools and vocational high schools students on the problems of biology teaching. *Erzincan Journal of Education, 4* (2), 11–21.

King, B. M., & Minium, E. W. (2003). *Statistical reasoning in psychology and education.* John Wiley & Sons Incorporated.

Köse, S., Ayas, A., Uşak, M. (2006). The effect of conceptual change texts instructions on overcoming prospective science teachers' misconceptions of photosynthesis and respiration in plants. *International Journal of Environmental & Science Education, 1* (1), 78-103.

Kumbıçak, Ü., Atılboz, N. G., & Salman, S. (2006). The issues encountered in teaching biology subjects involved in science lesson at elementary school. *Milli Eğitim Dergisi, 172*, 211-224.

Kurt, H. (2013). Determining biology teacher candidates' conceptual structures about energy and attitudes towards energy. *Journal of Baltic Science Education, 12* (4), 399-423.

Kurt, Ş., & Akdeniz, A. R. (2004). Misconceptions about the concept of force in students at different levels, XII. Educational Sciences Congress, Gazi University Institute of Educational Sciences, Ankara, Proceedings, Volume III, 1931–1950.

Küçüközer, H. (2007). Prospective science teachers' conceptions about astronomical subjects. *Science Education International, 18* (2), 113-130.

Küçüközer, A. (2010). Prospective science teachers' misconceptions about the wave. *Journal of Turkish Science Education, 7* (2), 66-75.

Mak, S. Y., Yip, D. Y., & Chung, C. M. (1999). Alternative conceptions in biology-related topics of integrated science teachers and implications for teacher education. *Journal of Science Education and Technology, 8* (2), 161-170.

Mestre, J. P. (2002). Probing adults' conceptual understanding and transfer of learning via problem posing. *Journal of Applied Developmental Psychology, 23* (1), 9-50.

Ministry of Education. (2005). *Elementary science and technology course (6, 7 and 8 classes) curriculum.* Ankara: Talim ve Terbiye Kurulu Başkanlığı.

McNair, S., & Stein, M. (2001). *Drawing on their understandings: using illustrations to invoke deeper thinking about plants.* Proceedings of the 2001 Annual International Conference of the Association for the Education of Teachers in Science. Costa Mesa, CA: Association for the Education of Teachers in Science.

Noh, T., & Scharmann, L. C. (1997). Instructional influence of a molecular level pictorial presentation of matter on students' conceptions and problem solving ability. *Journal of Research in Science Teaching, 34* (2), 199-217.

Nyachwaya, J. M., Mohamed, A. R., Roehrig, G. H. Wood, N. B., Kern, A. L., & Schneider, J. L. (2011). The development of an open-ended drawing tool: an alternative diagnostic tool for assessing students' understanding of the particulate nature of matter. *Chemistry Education Research and Practice, 12* (2), 121–132.

Ormancı, Ü., & Şaşmaz-Ören, F. (2010). A scoring study on the use of concept cartoons, drawings, word association test and concept maps for assessment-evaluation purposes. International Conference on New Horizons in Education, Famagusta (23–25 June 2010) INTE–2010 Proceedings Book, 487-499.

Ormancı, Ü., & Şaşmaz-Ören, F. (2011). An analysis of pre-service teachers' drawings about the digestive system in terms of their gender, grade levels, and opinions about the method and subject. *International Journal of Biology, 1* (1), 1-22.

Öcal, C. (2014). *Secondary science-6.* İstanbul: Fen-Bil Publishing and Trading A.Ş.

Öztaş, H., & Özay, E. (2004). Problems biology teachers encounter in biology teaching. *Kastamonu Education Journal, 12* (1), 69-77.

Pittman, K. M. (1999). Student generated analogies: another way of knowing? *Journal of Research in Science Teaching, 36* (1), 1-22.

Pridmore, P., & Bendelow, G. (1995). Images of health: exploring beliefs of children using the 'draw-and-write' technique. *Health Education Journal, 54*, 473-488.

Prokop, P., & Fančovičova, J. (2006). Students' ideas about the human body: do they really draw what they know? *Journal of Baltic Science Education, 2* (10), 86-95.

Prokop, P., Prokop, M., & Tunnicliffe, S. D. (2008). Effects of keeping animals as pets on children's concepts of vertebrates and invertebrates. *International Journal of Science Education, 30* (4), 431-449.

Prokop, P., Prokop, M., Tunnicliffe, S. D., & Diran C. (2007). Children's ideas of animals' internal structures. *Journal of Biological Education, 41* (2), 62-67.

Prokop, P., Fančovičová, J., & Krajčovičová, A. (2015). Alternative conceptions about micro-organisms are influenced by experiences with disease in children. *Journal of Biological Education*, 1-12.

Prosser, J. (1998). *Imaged based research.* Bristol, PA: Falmer Press.

Journal of Baltic Science Education, Vol. 14, No. 4, 2015

PROSPECTIVE SCIENCE TEACHERS' LEVELS OF UNDERSTANDING AND EXPLANATION OF ANIMAL AND PLANT CELLS: DRAW-WRITE
(P. 501-512)

ISSN 1648–3898

Reiss, M. J., Tunnicliffe, S. D., Andersen, A. M., Bartoszeck, A., Carvalho, G. S., Chen, S. Y., Jarman, R., Jonsson, S., Manokore, V., Marchenko, N., Mulemwa, J., Novikova, T., Otuka, J., Teppa, S., & Rooy, W. V. (2002). An international study of young peoples' drawings of what is inside themselves. *Journal of Biological Education*, *36*, 58-64.

Saka, A., & Akdeniz, A. R. (2004). Changes according to different levels of misconceptions of genetics. *Sakarya University Faculty of Education Journal*, *7*, 188-209.

Saka, A., Akdeniz, A.R., Asilsoy, Ö., & Bayrak, R. (2005). Investigation of "*energy conversion in living" unit which located in high school biology textbook-3 and development an activity according to 5e model*. XIV. National Educational Sciences Congress, Pamukkale University Faculty of Education, *1*, 112-116.

Sasmaz-Ören, F., & Ormanci, U. (2014). Exploring pre-service teachers' ideas about the digestive system by using the drawing method. *Journal of Baltic Science Education, 13* (3), 316-326.

Saygın, Ö, Atılboz, N. G., Sayman, S. (2006). The effect of constructivist teaching approach on learning biology subjects: The basic unit of the living things-cell. *Journal of Gazi Education Faculty, 26* (1), 51-64.

Shepardson, D. P., Niyogi, D., Choi, S., & Charusombat, U. (2009). Seventh grade students' conceptions of global warming and climate change. *Environmental Education Research*, *15* (5), 549-70.

Storey, R. D. (1990). Textbook errors & misconceptions in biology: Cell structure. *The American Biology Teacher*, 213-218.

Sinan, O., Köse, S., Aydın, H., & Gezer, K. (2007). Prospective science teachers` conceptual understanding about proteins and protein synthesis. *Journal of Applied Sciences*, *7* (21) 3154–3166.

Sinan, O., Yıldırım, O., Kocakülah, M. S., & Aydın, H. (2006). Preservice primary science teachers' misconceptions about proteins, enzymes and protein synthesis. *Journal of Gazi Education Faculty, 26* (1), 1-16.

Student Selection and Placement Center. (2013). 2013- Public Personnel Selection Examination A-Group and Education Results. Retrieved From http://dokuman.osym.gov.tr/pdfdokuman/2013/KPSS1/2013-KPSS%20A%20GRUBU%20ve%20%C3%96%C4%9ERETMENL%C4%B0K.pdf

Student Selection and Placement Center. (2014). 2014- Public Personnel Selection Examination A-Group and Education Results. Retrieved from http://www.osym.gov.tr/belge/1-21924/2014-kpss-ogretmenlik-alan-bilgisi-oabt-sinavi-sonuclar-.html

Şencan, H. (2005). *Social and behavioral measurement reliability and validity*. Ankara: Seçkin Publishing House.

Topsakal, S. (2005). *Science and technology education.* Ankara: Nobel Publications.

Uşak, M. (2009). Preservice science and technology teachers' pedagogical content knowledge on cell topics. *Educational sciences: Theory and Practice*, *9* (4), 2033-2046.

Unal-Coban, G. (2010). The scientific understanding level of prospective science teachers. *Journal of Baltic Science Education, 9* (3) 237–254.

Victor, E., & Kellough, R. D. (1997). *Science for the elementary and middle school eighth edition*, Prentice Hall, Inc.

Yaman, M., & Soran, H. (2000). Evaluation of biology teaching in secondary schools in Turkey. *Hacettepe University Faculty of Education Journal, 18*, 229-237.

Yapıcı, M. (2006). Appropriateness of textbooks used in elementary schools in terms of students' levels. *International Journal of Human Sciences*, *1* (1), 1-9.

Yıldırım, O., Nakiboğlu, C., & Sinan, O. (2004). Prospective science teachers misconceptions regarding the diffusion. *BAÜ Journal of the Institute of Science*, *6* (1), 79-99.

Yip, D. Y. (1998). Identification of misconceptions in novice biology teachers and remedial strategies for improving biology learning. *International Journal of Science Education*, *20* (4), 461-477.

Yörek, N. (2007). Determination of student conceptual understanding of cell using student drawing at grades 9 and 11. *Dokuz Eylul University Faculty of Education Journal, 22*, 107-114.

Yörek, N., Aydın, H., & Kete, R. (2005). *Investigation of conceptual understanding level in cells of secondary school students*. XIV. National Educational Sciences Congress, Pamukkale University Faculty of Education.

Zamora, M., Silvia, E., & Guerra, M. (1993). Misconceptions about cells. Technical Report, Universum, Universidad Nacional Auto´noma de Me´xico, Me´xico. Retrieved From http://www.mlrg.org/proc3pdfs/Zamora_Cells.pdf.

Huriye Deniş Çeliker	PhD, Assistant Professor, Science Education Department, Faculty of Education, İstiklal Campus, Mehmet Akif Ersoy University, 15030, Burdur , Turkey. Fax: +90 248 213 41 60 E-mail: huriyedenis@mehmetakif.edu.tr, denishuriye@gmail.com Website: http://abs.mehmetakif.edu.tr/huriyedenis