THE DETERMINATION OF SCIENCE TEACHER CANDIDATES' IDEAS ON CELL SUBJECT THROUGH DRAWING METHOD**

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Abstract: Though science teacher candidates know the cell subject in theory, they cannot connect the relation between the cell and its organelles exactly. With this study, using drawing method to ascertain the ideas of the teacher candidates about cell subject, the importance of the use of the drawing method in assessments will be emphasized. In the study it is aimed to determine the science teacher candidates' ideas on cell subject through drawing. The study was carried out with 62 teacher candidates that study science teaching department second grade in 2012-2013 academic year fall semester. In the study survey method was used, which is one of the descriptive research methods. In the study the drawing test (Drawing Test Regarding Cell Subject) which was developed by researchers was used as data gathering tool and developed rubric was used for data analysis. According to the findings obtained from the study it can be said that teacher candidates generally have sufficient performance on cell subject. Although science teacher candidates know the basic parts of the cell they have misunderstandings about the places, shapes and the connections of the organelles. Besides, it can be expressed that the teacher candidates have inadequate information about the nucleus. In this context although teacher candidates know the cell organelles, they have lacking knowledge regarding the shape-place-connections of the cell. In this study it is understood that they drew the nucleus at the right place however they do not know some parts or relatively know the parts of the cell.
Key words: Cell, Drawing, Idea, Science, Teacher candidate

INTRODUCTION

In order to sustain a regular and a healthy life individuals must know the nature and the living and must be sensitive towards them. As Gunes and Gunes (2005) suggest that the whole organic and inorganic environment that contain humans affect their daily life, development and health and realizing all these can be possible through learning biology subjects. The field of biology that searches the humans and the whole organic-inorganic beings is one of the science fields that have developed most and it affects human life a lot (Ekici, 2002). As a matter of fact biology is the life study that requires careful observation and explanation (Dempsey and Betz, 2001). In this context, it can be said that biology subjects have great importance in people's learning and acquiring basic life skills. Considering the fact that the foundation of the biology subjects is laid in primary school introduction to science and secondary school science courses, the importance of these lessons is increasing.

In science course, it is aimed to teach students basic science concepts, scientific process skills and acquire basic skills such as life skills. In this context, in science teaching it is aimed not only to acquire knowledge but also to develop the strategies that will help students in the process of the development of relations between concepts and sub-concepts (Calik, Ayas and Unal, 2006). In any case conceptual learning is one of the important parts of science teaching (Joung and Gunstone, 2010). In order to actualize this, students need to understand the concepts and rewire them in their minds. In constructivist approach and inquiry based learning that take place in science studies, a philosophical understanding in which information is generated by students, participators are active and take responsibility in learning process is based (Kahveci, 2010). Within this concept together with the active learning approaches that students will learn through research in the process their conceptual learning will occur as well. Through conceptual approaches students form images and models relating the events and concepts in their minds. Individuals' mental and cognitive model creation is based on their past experiences, current ideas and pre-knowledge in order to explain and interpret the events in the world (Moseley, Desjean-Perrota and Utley, 2010). Especially while learning abstract science concepts, it is very important to form true images, if students have not formed an image about a subject in their minds yet it means they have not identified that concept (Kavak, 2007). In this context it is significant to form images in students' minds relating concepts and to help them make connection between concepts.

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When the secondary school science course curriculum is observed 'Living Things and Life', 'Substance and its Evolution', 'Physical Events' and 'The Earth and The Universe' consist of learning areas (MEB, 2013). It can be said that 'Living Things and Life' learning area consists of biology subjects such as the basic structure and diversity of the living, structure, organs and systems in organisms. Some of these subjects are understood easily by students, however some subjects that contain abstract concepts are perceived difficultly. As Kete, Horasan and Namdar (2012) state one of the determined problems in teaching biology is that abstract concepts and some events may not be perceived easily by students. In this concept it is thought that the subjects that contain abstract concepts in biology must be paid attention on. It is stated that the number of studies relating how students rewire their biology knowledge is rare and contradictory (Teixeira, 2000). In this concept it is thought that the study relating how students restructure the cell subject, which is taught and perceived difficultly in science lesson, is significant in terms of literature.

When the subjects that take place in biology, it is seen that subjects like photosynthesis, respiration, cell, genetics are perceived difficultly. In their studies in Scotland, Bahar, Johnstone and Hansell (1999) stated that water transfer in plants and genetics are some of the subjects that participators have difficulty in biology. Atilboz (2004) states that since mitotic and meiosis division happen at microscopic level students may have difficulty in imagining it in their minds perceptibly and configuring these concepts. Also Flores, Tovar and Gallegos (2003) expresses that, the cell is a theme that is explained difficultly for students at different education levels. Because, the complex and microscopic nature of the cells makes it difficult for students to separate the cells and their contents (Maras and Akman, 2009). On the other hand, in the event that the cell subject is understood and perceived, the other subjects of biology will be perceived generally (Tasdelen and Guven, 2012). Within this context it is considered important to determine how the cell subject is perceived by students and how they connect the relations, in terms of laying foundation of biology subjects. In the study it is aimed to determine the ideas of science teacher candidates considering the cell subject and to use the drawing method for this purpose.

The drawing method is a method that enable students express themselves freely without any constraints and allow the conceptual structure in their minds with its details therefore makes it possible to gather information at first hand (Tokiz and Sasmaz Oren, 2011). Drawings aim to reveal the hidden knowledge and beliefs of students in order not to remain them limited with words (Ayas, 2006, 103). In other words the purpose of drawings is to bring out the ends positions on word-diagram searching an understanding deeply (Aydin, 2011). Considering the fact that the drawing will be productive for students in terms of permanence, it can be used both for the lecturing and the evaluating part (Çelikler and Topal, 2011). Though many students dislike answering questions they consider the drawings as an easy, enjoyable and fast way that they can fulfill (Kara, 2007; Kose, 2008). In addition drawings are used as the reflector and pointer of personal identities for years (Weber and Mitchell, 1996) and provide convenience in comparisons at international level (Prokop and Faneovieova, 2006).

Drawings are used in many ways in order to search to understand science (Dove, Everett and Preece, 1999). When the literature is observed it is seen that the drawings are used to determine the ideas, views and knowledge of participators on the subject of carbon hydrate and water cycle (Celikler and Topal, 2011), light (Kara et al. 2008), Newton's laws (Kara, 2007; Uzunkavak, 2009), microorganism (Saka and Ayas, 2002), scientist (Kaya, Dogan and Ocal, 2008; Korkmaz and Kavak, 2010; Unver, 2010), human body (Cerrah Ozsevgec, 2007; Patrick and Tunnicliffe, 2010; Prokop and Faneovieova, 2006; Reiss and Tunnicliffe, 2001; Reiss et al. 2002), digestive system (Rowlands, 2004; Teixeire, 2000), animal skeletal system (Tunnicliffe and Reiss, 1999), animal inner structure (Prokop, Tunnicliffe and Diran, 2007), environment (Moseley et al. 2010), biological legacy (Chin and Teou, 2010) and water/water cycle (Dove et al. 1999). As it is understood it is seen that the drawing method is used in order to determine the ideas of students on different subjects of science.

When the studies on cell subject in literature are checked there are some studies in which the knowledge, understandings and misconceptions of the participators about the cell division (Atilboz, 2004; Dikmenli, 2010; Emre and Bahsi, 2006; Harman, 2012), genetics/gene (Bahar, Johnstone and Sutcliffe, 1999; Lewis, Leach and Wood-Robinson, 2000; Lewis and Wood-Robinson, 2000) subjects/concepts are determined. In literature there are some studies in which understanding cell concept and the effects of different programs (computer supported education, touch technology) are analyzed (Jones et al. 2006; Minogue et al. 2006). Moreover, there are studies in order to determine the understandings of the participators about cell genetic (Wood-Robinson, Lewis and Leach, 2000) and their misconceptions about the cell subject (Gencer, 2006; Kete et al. 2012; Storey, 1991). Also in literature there are some studies intended to determine the understandings of plant and animal cell subject (Topsakal and Oversby, 2012), the cell and its functional relations (Flores et al. 2003; Maraş and Akman, 2009) the cell-organelles-their locations (Yorek, 2007; Sahin and Ugulu, 2010). As it is seen although there are studies on cell subject in international literature, in Turkey there are few studies on this matter. Within this

context it is thought that a study which will be done with a sample that takes place in Turkey about the cell subject will be significant in terms of national and international literature. Besides these is not any study that determines the ideas of participators in-deeply about the cell subject. Therefore in order to see the relations between the ideas of the participators about the cell subject and cell-organelles-nucleus the drawing method was used. In this context in the study it is aimed to determine the ideas of science teacher candidates who will teach cell subject in secondary school.

METHOD

In the study since the purpose was to analyze the ideas of science teacher candidates about the cell subject in-deeply, survey method was used. The survey method is a type of research which is practiced to detect the current situation (Cepni, 2010; 65). Survey method is a method used for obtaining much data from people in large numbers generally in a statistical form (McNeil and Chapman, 2005). In the study within this context the survey model was considered appropriate since it was aimed to detect current situations of teacher candidates in cell subject.

Participants

The study was performed in Dokuz Eylul University Faculty of Education, which is located in Turkey's East region, in 2012-2013 academic years. 62 teacher candidates that study science teaching department second grade participated the study. While choosing the teacher candidates it was taken note of that they had taken 'General Biology I' and 'General Biology Laboratory I' classes. In this context the participators were chosen purposefully. Purposeful sampling generally as well as being a feature of qualitative researches, researchers are determined depending on certain required specifications or their own decisions (Cohen, Manion and Morrison, 2007). 55 of the teacher candidates who participated in the study are female and 7 of them are male. Also while 32 teacher candidates attend formal education, 30 of them attend evening education.

Data collection

The drawing test (Drawing Test Regarding Cell Subject) which is developed by researchers was used in the study as the data gathering medium. In this context it can be said that open-ended questionnaires were used in the study. As Dawson (2002) states open-ended questionnaires as well as being used in qualitative researches do not include tick boxes, instead there are blanks given to write answers. In the drawing test the teacher candidates were asked to choose one of the plant or animal cell and to draw this cell on the paper given. In addition the teacher candidates were asked to write the names of the parts and the organelles next to the drawing. In the process of data gathering firstly the students were announced what to do, it was expressed that the beauty of the drawing did not matter but how to draw what-how-where was important. The practice was performed during 'General Biology' lesson and took 15-20 minutes.

Data analysis

In the analyze of the data rubric (Drawing Test Rubric Regarding Cell Subject) which is developed by researchers was used. While rubric was being developed firstly the studies that take place in literature were examined and the dimensions of the rubric were decided. In this context the rubric was decided to consist of basic parts of the cell, organelles and nucleus dimensions and also every dimension to consist of sub-dimensions of part-place-shape connection. The point of each of these dimensions as well as being different from each other the highest point was given to the organelle dimension and the lowest point was given to the nucleus dimension. The points that participators took from each dimension were defined with four different levels as: 'insufficient, limited, sufficient and perfect''. The highest point to be taken from this rubric is 100, the lowest point is 25. Rubric takes place in Table 1.

Table 1: Drawing test rubric regarding cell subject

Dimension	Sub-Dimension	Insufficient Performance (1p)	Limited Performance (2p)	Sufficient Performance (3p)	Perfect Performance (4p)
The Basic Part of the Cell (8)	The part of the cell (2)	No drawing	1part	2 parts	3 parts
	The places of the parts (2)	Stated in the right places with 3 missing	Stated in the right places with 2 missing	Stated in the right places with 1 missing	All stated right place
	The shapes of the parts (2)	Missing in the drawing of the shape of 3 parts	Missing in the drawing of the shape of 2 parts	Missing in the drawing of the shape of 1 part	All parts stated drawn correctly
	The inter partial connection (2)	Missing in 3 connections	Missing in 2 connections	Missing in 1 connection	All connections indicated clearly
Cell Organelles (12)	The organelles (3)	0-2 organelles	3-4 organelles	5-6 organelles	7 organelles
	The place of organelles (3)	Stated in the right place with 5 or more missing	Stated in the right place with 3-4 missing	Stated in the right place with 1-2 missing	All stated in the right places
	The shapes of organelles (3)	Missing in drawing of the shape of 5 or more organelles	Missing in drawing of the shape of 3-4 organelles	Missing in drawing of the shape of 1-2 organelles	All organelles indicated well drawn
	Inter organelles connections (3)	Missing in 5 or more connections	Missing in 3-4 connections	Missing in 1-2 connections	All connections indicated clearly
Nucleus (5)	The parts of the nucleus (2)	0-1 part	2 parts	3 parts	4 parts
	The places of the nucleus (1)	Stated in the right places with 3 or more missing	Stated in the right places with 2 missing	Stated in the right places with 1 missing	All stated in the right places
	The shapes of the nucleus' part (1)	Missing in the drawing of 3 or more parts' shape	Missing in the drawing of 2 parts' shape	Missing in the drawing of 1 part's shape	All parts indicated drawn correctly
	The inter partial connection of the nucleus (1)	Missing in 3 or more connections	Missing in 2 connections	Missing in 1 connection	All connections indicated clearly

The data gathered in the study was analyzed using the developed Drawing Test Rubric Regarding Cell Subject. As a result of the analyze samples were included in order to determine the ideas of the teacher candidates regarding the use of the rubric and cell subject. Also in consequence of the analyze points like minimum-maximum values, arithmetic average were evaluated.

FINDINGS

The findings of the study consist of two basic titles as 'findings regarding the analyze of the drawings of the teacher candidates considering cell subject' and 'samples from the drawings of the teacher candidates regarding cell subject'.

Findings regarding the analyze of the drawings of the teacher candidates considering cell subject

In this section the qualitative and quantitative findings gained from the analyze are included respecting the science teacher candidates' drawings considering cell subject. In Table 2 the findings regarding the points that the teacher candidates took from the cell basic parts sub-dimension of Drawing Test Rubric Regarding Cell Subject.

Table 2: Findings regarding the points that teacher candidates took from the basic part of cell sub-dimension of rubric

Sub-dimension	N	Min	Max	Ort	SS
The basic part of the cell (8)	62	6	8	7.23	0.98
The places of the parts (8)	62	4	8	6.94	1.19
The shapes of the parts (8)	62	4	8	7.00	1.13
The inter partial connection (8)	62	4	8	7.13	1.12

As it is seen in Table 2 while the teacher candidates took 7.23 points from the cell parts, they took 6.94 points from the places of parts sub dimension. Maximum point that can be taken from the sub-dimensions of the basic parts of the cell is 8 and it is understood that some of the teacher candidates took these points. In this context, it can be expressed that science teacher candidates take part between the sufficient and perfect performance regarding the parts, places, shapes and connections of the cell. The findings regarding the points that science teacher candidates took from cell organelles sub-dimension of Drawing Test Rubric Regarding Cell Subject are included in Table 3.

Table 3: Findings regarding the points that teacher candidates took from the cell organelles sub-dimension of rubric

Sub-dimension	N	Min	Max	Ort	SS
The organelles (12)	62	6	12	9.05	2.34
The place of organelles (12)	62	3	12	7.89	1.90
The shapes of organelles (12)	62	3	9	5.90	2.17
Inter organelles connections (12)	62	3	12	6.58	2.09

When Table 3 is observed it is seen that science teacher candidates took 9.05 points from cell organelles sub-dimension, 7.89 from organelle place sub-dimension, 6.58 from inter organelles connection sub-dimension, 5.90 from shape of organelles sub-dimension. Maximum point that can be taken from each sub-dimension of cell organelles dimension is 12. Within this context it is understood that the teacher candidates have sufficient performance in cell organelles sub-dimension, sufficient and limited performance in organelle place sub-dimension, limited performance in inter organelles connection and organelles shape sub-dimension. The findings regarding the points that science teacher candidates took from nucleus sub-dimension of Drawing Test Rubric Regarding Cell Subject are given in Table 4.

Table 4: Findings regarding the points that teacher candidates took from the nucleus sub-dimension of rubric

Sub-dimension	N	Min	Max	Ort	SS
The parts of the nucleus (8)	62	2	8	4.48	1.97
The places of the nucleus (4)	62	1	4	2.23	.97
The shapes of the nucleus' part (4)	62	1	4	2.15	.94
The inter partial connection of the nucleus (4)	62	1	4	2.23	.97

When we look at Table 4 it is seen that teachers took 4.48 points in average from cell parts dimension, 2.23 points in average from cell parts place and inter partial connection sub-dimensions, 2.15 points in average from the parts' shape sub-dimension. When the rubric is examined it is seen that teacher candidates can take maximum 8 points from cell parts sub-dimension and 4 points from other sub-dimensions. Within this context it can be said that participators have limited performance in all sub dimensions of rubric's nucleus dimension. The findings regarding the points that teacher candidates took from Drawing Test Rubric Regarding Cell Subject are given in Table 5.

Table 5: Findings regarding the points that teacher candidate took from the sub-dimension of rubric

Sub-dimension	N	Min	Max	Ort	SS
The basic part of the cell (32)	62	20	32	28.29	4.05
Cell organelles (48)	62	18	42	29.42	6.91
Nucleus (20)	62	5	20	11.08	4.75
Total (100)	62	50	86	68.79	9.73

When Table 5 is analyzed as well as the maximum point that can be taken from the cell's basic parts dimension is 32, it is understood that teacher candidates took 28.29 points in average and showed perfect-sufficient performance. In cell organelles dimension the highest point that can be taken is 48 and the average point that science teacher candidates took was 29.42. In this context it can be stated that teacher candidates are between limited and sufficient performance. In the nucleus dimension of the rubric teacher candidates took 11.08 points. The point that can be taken in this dimension is 20 and teacher candidates have limited performance. In total of the rubric teacher candidates took 68.79 point in average. Within this context it can be said that teacher candidates have sufficient performance considering the cell subject. The findings regarding cell kind that teacher candidates prefer are given in Table 6.

Table 6: Findings regarding cell kind that teacher candidates prefer

Cell Kind	N	%
Animal Cell	46	67.7
Plant Cell	16	32.3

As it is seen in Table 6 while 46 of the teachers preferred to draw animal cell, 16 of them chose to draw plant cell. Within this context it is understood that science teacher candidates prefer animal cell more than plant cell. The findings regarding the organelles take place in the drawings of teacher candidates are given in Table 7.

Table 7: Findings regarding the organelles take place in the drawings of teacher candidates

Animal Cell			Plant Cell		
Organelles	f	%	Organelles	f	%
Ribosome	46	100.0	Endoplasmic Reticulum	16	100.0
Endoplasmic Reticulum	46	100.0	Golgi Apparatus	15	93.8
Mitochondria	44	95.7	Mitochondria	13	81.3
Vacuoles	43	93.5	Vacuoles	13	81.3
Golgi Apparatus	33	71.7	Plastid	11	68.8
Lysosome	28	60.9	Ribosome	11	68.8
Centrosome	24	52.2	Lysosome	4	25.0

When Table 7 is examined all of the 46 teachers who chose to draw animal cell drew ribosome and endoplasmic reticulum organelles. While 95.7% of science teacher candidates drew mitochondria 93.5% of them drew vacuoles animal cell. None the less, the fewest organelles drawn by teacher candidates are lysosome (f=28) and centrosome (f=24). All of the science teacher candidates who preferred to choose plant cell drew endoplasmic reticulum however, 15 of them drew golgi apparatus. On the other hand only 4 teacher candidate drew lysosome as an organelle of the plant cell. In addition 11 teacher candidates drew plastid but only chloroplast was indicated as plastid. Moreover 2 teacher candidates drew centrosome in the plant cell.

Samples from the drawings of teacher candidates regarding cell subject

In this section some samples from the animal and plant cell drawings of teacher candidates are presented.

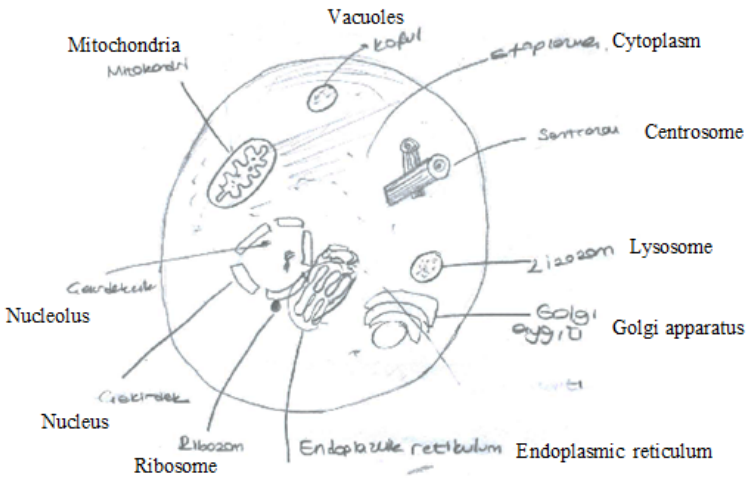

Figure 1: An example of an animal cell drawing 1

When Figure 1 is observed it can be expressed that teacher candidate preferred to draw animal cell and almost exactly drew the basic parts of the cell. However it is seen that the shape of the cell membrane is drawn absently and the pores among them were not presented. Besides, although all of the organelles that take place in an animal cell were drawn by the teacher candidate it can be said that there are some mistakes in the drawings of some of the size and places of organelles. For instance, while centrosome organelle should be located close to the nucleus it was drawn to a place away from the cell. Also while endoplasmic reticulum should lain to the cell membrane starting from the nucleus, it starts from the nucleus but does not reach out to the cell membrane in the drawings of teacher candidate. In the nucleus part only nucleolus was stated, nuclear membrane-chromatin thread-cytoplasm were not included.

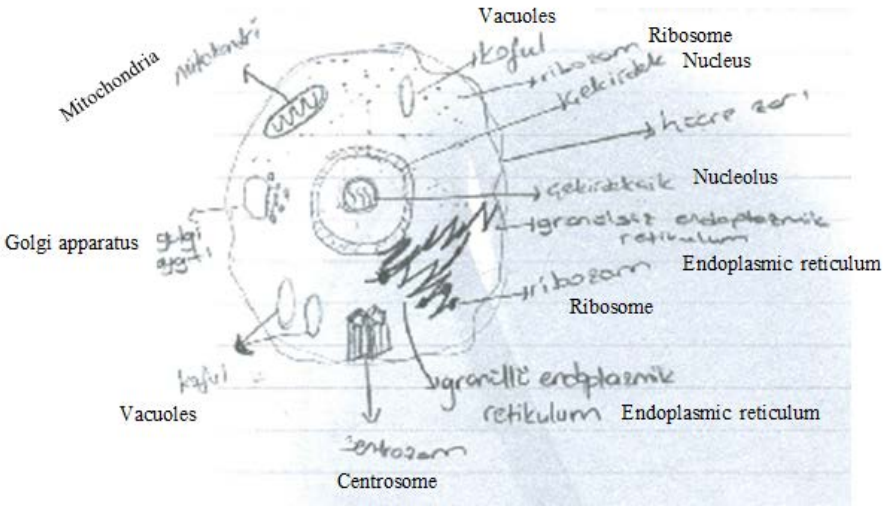

Figure 2: An example of an animal cell drawing 2

When we look at the Figure 2 it is seen that teacher candidate prefer to draw animal cell which is drawn round. Considering the organelles that take place in animal cell, it is understood that the teacher candidate drew every organelle except for lysosome. The teacher candidate drew the vacuoles small, showed the ribosome as a point and indicated the cristae matrix parts of the mitochondria. The endoplasmic reticulum was separated as granulose and agranulated and was drawn between the nucleus and cell membrane however, the shape of the endoplasmic reticulum was indicated inaccurately. In the nucleus part only the nucleolus was stated and cell membrane-chromatin thread-cytoplasm was not included.

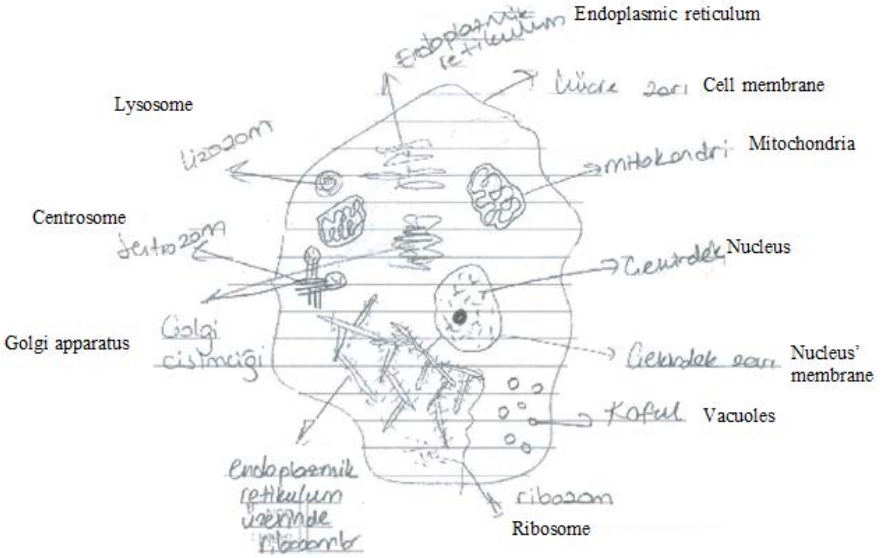

Figure 3: An example of an animal cell drawing 3

In Figure 3 it is seen that animal cell was drawn and cell membrane and nucleus were indicated however, cytoplasm was not stated by science teacher candidate. It is understood that only cell membrane was drawn in the nucleus part and the other parts were not drawn. The teacher candidate stated all the organelles in the animal cell however, it can be said that the size of the organelles and the connections between them have some inaccuracies. For instance, though mitochondria, centrosome and golgi apparatus do not have the same size, they were drawn at the same size. Whereas endoplasmic reticulum-golgi-lysosome generally should be drawn close to each other teacher candidate drew them at far points.

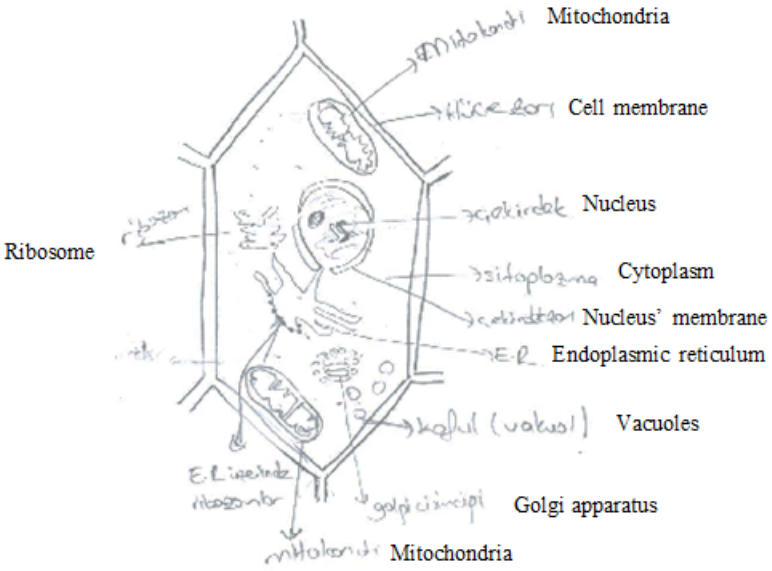

Figure 4: An example of a plant cell drawing 1

When Figure 4 is observed it is seen that the teacher candidate preferred to draw plant cell and drew it in an angled structure. Near the cell membrane cell wall was drawn but not expressed by teacher candidate. In the nucleus part only the nuclear membrane was indicated nucleolus-chromatin thread-cytoplasm was not included. Among the organelles mitochondria, ribosome, vacuoles, endoplasmic reticulum, golgi apparatus were drawn but lysosome and plastids were not shown. Although vacuoles are fewer and bigger in plant cell they were drawn smaller by teacher candidate.

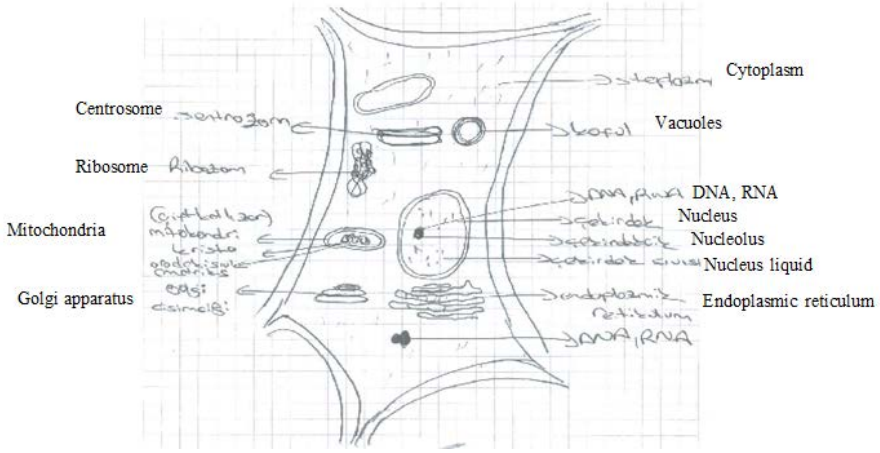

Figure 5: An example of a plant cell drawing 2

In Figure 5 it is seen that teacher candidate drew plant cell. Although cell membrane and cell wall were drawn they were not stated, and cytoplasm and nucleus were drawn appropriately. Even though all the organelles taking part in the plant cell were drawn except for plastids and lysosome, there are some deficiencies in their shapes. For example the connections of endoplasmic reticulum were not made and the size of the vacuoles was wrong etc. In addition centrosome organelle which does not exist in plant cell was drawn by teacher candidate. In nucleus part it can be said that other parts were drawn except for nuclear membrane.

DISCUSSION AND CONCLUSION

Cell is among the complicated subjects that are perceived difficultly by secondary school students and it might not be understood since it is a subject at micro level. The subjects that are difficult to understand for students become a handicap while understanding next subjects. In this context the determination of science teacher candidates' ideas on cell subject gains importance in terms of how they will teach the subject in the future. In the study it is aimed to determine the ideas of science teacher candidates regarding cell subject.

According to the findings obtained from the study it is understood that science teacher candidates prefer to choose animal cell more than plant cell. Similar results were taken in Yorek (2007) and Yorek et al. (2010)'s studies as well. It is thought that this situation results from the fact that in books and basic resources generally

animal cell example is given. Also considering the fact that human cells are made up of animal cell it is quite normal for participators to draw animal cell when they are told to draw a cell.

In the study science teacher candidates take place between sufficient and perfect performance respecting parts, place, shape and connections of the cell. Within this context it can be said that teacher candidates showed perfect- sufficient performance in the dimension of basic parts of the cell. As it is known teacher candidates start to learn the cell subject beginning from the secondary school and process it at different levels of education. Within this context it is an expected result for teacher candidates to have perfect-sufficient knowledge and understanding respecting the basic parts of the cell. When the literature is observed in Yorek (2007)'s study it is confirmed that the place of the nucleus is comprehended well, but the locations of the cell membrane and cell wall are mistaken.

As a result of the findings gained from the study it is understood that science teacher candidates have sufficient performance in the cell organelle sub-dimension. However teacher candidates have sufficient and limited performance in cell place sub-dimension, and they have limited performance in inter organelle connection and organelle shape sub-dimensions. As it is understood it can be expressed that, teacher candidates take place between limited and sufficient performance in cell organelle sub-dimension. In this context although teacher candidates know the cell organelles, they have lacking knowledge regarding the shape-place-connections of the cell. Kete et al. (2012) in their studies stated that the students have incomprehensibility about the location and structure of endoplasmic reticulum among other cell organelles. In our study teacher candidates generally drew the organelles round and put it randomly between cell membrane and nucleus. In similar studies in literature (Yorek, 2007; Yorek et al. 2010) it is determined that students memorize the names of the organelles rather than comprehending the structure and function of the organelle and put them randomly between nucleus and cell membrane. In Maras and Akman (2009)'s studies it is determined that students learn the names of the cell organelles easily however the students find it quite complicated to relate the cell organelles with their functions.

In the study it is understood that science teacher candidates mostly drew endoplasmic reticulum and mitochondria in both animal and plant cell. Besides in animal cell; ribosome and in plant cell; golgi apparatus are among the organelles drawn mostly. In Yorek (2007)'s study the most indicated organelles by 9. and 11. grade students were nucleus, cell membrane, cell wall, vacuoles, endoplasmic reticulum, mitochondria and ribosome. It is thought that mitochondria takes charge in producing energy and it is an important organelle for the cell affected teacher candidates. In addition due to the fact that endoplasmic reticulum has an interesting name makes it easier for teacher candidates to remember its name.

In the study teacher candidates preferred to draw lysosome organelle, both in animal and plant cell. Moreover, in animal cell; centrosome, in plant cell; ribosome and plastid were drawn by fewer teacher candidates. Because, it is thought that centrosome only exists in animal cell and plastid only exists in plant cell. Also teacher candidates only drew chloroplast as plastid. In addition to this, some teacher candidates drew centrosome in plant cell. These can be considered as mis-learning and misunderstandings that teacher candidates have. Other studies in literature (Emre and Bahsi, 2006; Harman, 2012) indicate that students have missing or wrong information about cell divisions.

According to the findings obtained from the study teacher candidates have limited performance in all sub-dimensions of rubric's nucleus dimension. Yorek et al. (2010)'s studies it is ascertained that participators drew the location of the nucleus correctly. In this study it is understood that they drew the nucleus at the right place however they do not know some parts or relatively know the parts of the cell.

As a result of the study it can be expressed that teacher candidates have sufficient performance in cell subject. Although science teacher candidates know the basic parts of the cell, they have misunderstandings about the place, shape, connections of the organelles. In addition, it can be said that teacher candidates have lacking knowledge about the nucleus. In the studies of the literature (Gencer, 2006; Maras and Akman, 2009) it is understood that the participators have difficulties in comprehending the cell subject. As Gunes and Gunes (2005) suggest, it is determined that the students that are at the level of finishing secondary school, have difficulties in understanding or they never understand the basic subjects of biology (such as cell division, plant or animal tissues, chromosome and genes, the bio-incidents and ATP energy).

RECOMMENDATIONS

According to the findings obtained from the study it is confirmed that the cell subject, which is one of the basic subjects of biology, is difficultly understood by students and teacher candidates. In order to determine the ideas of teacher candidates drawing method was used. Tasdelen and Guven (2012) stated that the drawings that are

used in cell biology class helped students understand the subjects better. In this context, it is thought that there is a need for studies to confirm the fallacies in comprehending, knowledge and conceptions of the students at different levels using the drawing method.

According to the results taken from the study it can be stated that the understanding of teacher candidates in cell subject is at intermediate level. In order to increase the understanding level of teacher candidates it is thought that it will be appropriate to use methods and approaches that appeal to visual based constructivist approach. In the studies of the literature Dogan (2008) suggests that project based learning and Onder (2011) states that constructivist 5E learning model is effective in cell subject. Within this context, it can be said that the studies in which the ideas for cell subject will be determined and the effect of visual based methods will be confirmed, are going to contribute to the literature.

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