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Diagnosing Student Misconceptions: Using Drawings as a Research Method

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Abstract: In recent years there has been considerable interest in misconceptions held by students of science. There are several ways for obtaining information about student's knowledge. Individual interviews, open-ended questions and/or two-tier multiple-choice on specific science topics may effectively elicit students' in-depth thinking, but they are difficult to quantify and some times subjective. Drawings have been considered as simple research instruments that enable easy comparisons at the international level. This study aims to investigate the effect of drawing method on determining university students' misconceptions concerning photosynthesis and respiration in plants. Data gathered from drawings of 156 students aged 20-25 from four classes and interview of 15 students. These drawings are analyzed and categorized into model types corresponding to five levels of understanding. Several misconceptions were found, some of them with both relationship between photosynthesis and respiration in plants and food and nutrition of plants. Some of these misconceptions were similarly previous studies and distributed across all age classes. Drawing method in conjunction with interviews have been successfully used to diagnose student's conceptual understandings and misconceptions about abstract concepts, e.g. 'photosynthesis and respiration'.

Key words: Biology education . photosynthesis and respiration in plants . drawings . university student . misconceptions

INTRODUCTION

One of the most important factors which prevent students' meaningful and permanent learning is the misconception. Misconceptions are what students themselves develop erroneously and different from scientifically accepted concept. That's why; it is necessary to determine the misconceptions that students already have. There are many methods for determining conceptual understanding and misconceptions. Open-ended questions [1], two-tier diagnostic test [2], concept mapping [3], prediction-observation-explanation [4], interviews about instances and events [5], interviews about concepts [6], drawings [7, 8] and word association [9, 10] can be given as the examples of these methods. Drawings have been considered as simple research instruments that enable easy comparisons at the international level [11]. While many children dislike answering questions, drawings can be completed quickly, easily and in an enjoyable way. Children's drawings provide a 'window' into their thoughts and feelings, mainly because they reflect an image of his/her mind [12]. As a technique for exploring ideas, drawing taps holistic understanding and prevents children from feeling constrained by trying to match their knowledge with that of the researcher [13]. It is also a useful alternative form of expression for children who have difficulty expressing their thoughts verbally [14].

Where drawings have been used to probe understanding in science, they have been used in a variety of ways. Drawing activities in conjunction with interviews have been successfully used to explore children's ideas about abstract concepts, e.g. 'technology' [14] and more specific ideas, e.g. 'evaporation' [15]. In other studies, drawing content has been quantified, as e.g. in research into children's drawings of a forest [16]. In another study, the children were asked to draw a person without being given any opportunity to practice beforehand [7]. Dove *et al*. [17], investigated children's drawings of a river basin, a concept linked to the water cycle. In another previous study, McNair & Stein, [18], fifth, eighth and eleventh grade students were asked to draw a plant and include plants part, functions and information about what plants need to grow in their drawing. Reiss and Tunnicliffe [19]; Reiss, Tunnicliffe and Andersen *et al*. [20]; Prokop and Fancovicová [11] used children's drawings to provide a reliable projection of what children know about the human body. Prokop *et al*. [8], used drawings

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to examine children's understanding about animal internal structure can be affected by several factors which are poorly understood by teachers. In this study, misconceptions about photosynthesis and respiration in plants using the method of drawing in combination with interviews are exposed.

Photosynthesis and respiration are an important scientific topics which are in the curriculum of many countries. Because of the importance and the difficulty of the subjects, it is important to determine university students' misconceptions. Thus, it is emphasized in many studies that one of the reasons for misconceptions of students is the teachers [21, 22].

When previous studies about photosynthesis and respiration in plants were examined, it is seen that for determining the misconceptions of university students' open-ended questions, multiple choice tests, two-tier diagnostic tests, concept mapping and interview are used for determining misconceptions among students and there's a scarce number of researches carried out on these subjects in which misconceptions are studied [3, 23-28].

Purpose: This study was conducted to investigate the effect of drawing method in combination with interview on determining Turkish university students' misconceptions concerning photosynthesis and respiration in plants.

MATERIALS AND METHODS

A total of 156 third year students studying pre-service primary school education from 4 different classes of Primary School Teaching Program of Pamukkale University Education Faculty participated in this study. The mean age of pre-service primary teachers was 21.5 year (range 20-25). The majority of pre-service primary teachers were females (115 of 156). But this study was not focused on gender differences. All participants had been previously studying general biology as a school subject in first year undergraduate. That's why; the backgrounds of teachers are accepted to be close to each other.

This research was conducted in "Science-II" lecture, which take place in the third grade of Primary School Teaching Program in May 2006. In this lecture, pre-service primary school teachers are informed about the instruction methods like concept mapping, conceptual change texts and drawings. Also some practices are applied about instruction methods.

Turkish university students' knowledge about photosynthesis and respiration in plants was examined by two different methods that are not mutually exclusive: 1) method of drawing 2) by individual interviews.

The application of the research was conducted with two phases. In the first phase, students were given information about the drawings, the aims of drawings and sample activities. Presentations were applied during a lesson hour (45 min.). In the next lesson, some drawings were made about the structure of animal cell and the place of some human organs and organ systems. Through the end of the lesson, students were asked to exchange their drawings and complete the missing parts of each other. Then, their drawings were re-changed. At the end of the lesson, the ready-made pictures were demonstrated and students were asked to compare their own drawings with them. By this way insufficiences of students on these subject are made up to be eleminated. In the second phase, the question "Draw what you think photosynthesis and respiration in plants are" was asked. Students were asked to draw what is photosynthesis and respiration in plants on a blank piece of A4-sized paper.

The researcher of the study determined the level of conceptual understanding for photosynthesis and respiration concepts [0] from students' drawings. Five levels of conceptual understanding were identified for this investigation: no drawing, non-representational drawings, drawings with misconceptions, partial drawings and comprehensive representation drawings. Although similar categories have been used in other studies [19, 29] these five categories proved to be useful for classifying students' responses in this study. Details of the levels are as follows:

Level 1: No Drawing: Students replied, "I don't know," or no response was given to the statement.

Level 2: Non-representational Drawings: These drawings were including identifiable elements of photosynthesis and respiration in plants. Also the answers, which include diagrams or formulations instead of the drawings, were evaluated in this category. This category is illustrated by examples in Fig. 1a, b.

Level 3: Drawings with Misconceptions: These typese of drawings showed some degree of understandings on photosynthesis and respiration concepts but also demonstrated some misconception; however, these drawings were misconceptions not understandings held by scientists or stated in science texts. The category is illustrated in Fig. 2a, b, c.

Level 4: Partial Drawings: The drawings in this category were demonstrating partial understanding of the concepts. Includes the drawings of photosynthesis elements like sun/light, carbon dioxide, rain/water, food/glucose/sugar/starch, oxygen, leaves; and the drawings of the respiration elements like food/glucose/sugar, oxygen, carbon dioxide, water, energy, leaves (Fig. 3a, b).

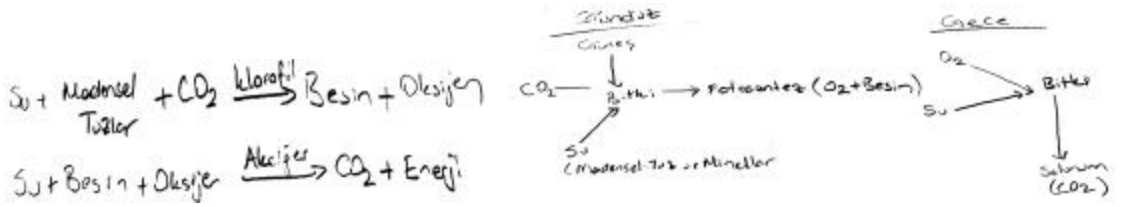

Fig. 1: a, b. Examples of level 2

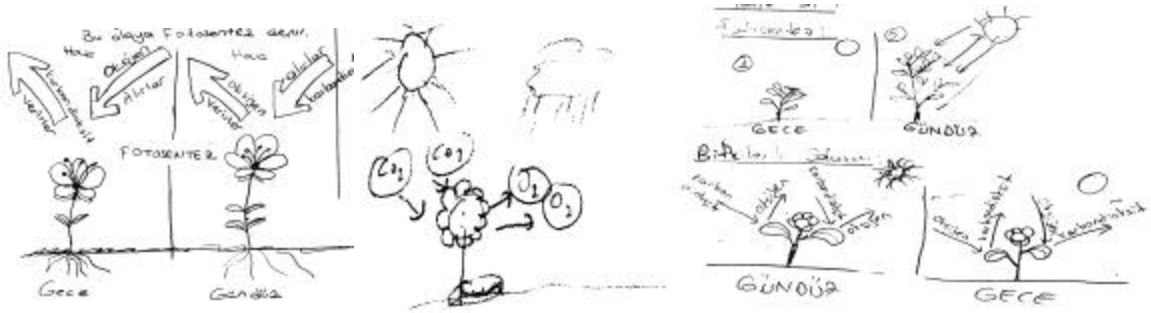

Fig. 2: a, b, c. Examples of level 3

Fig. 3: a, b. Examples of level 4

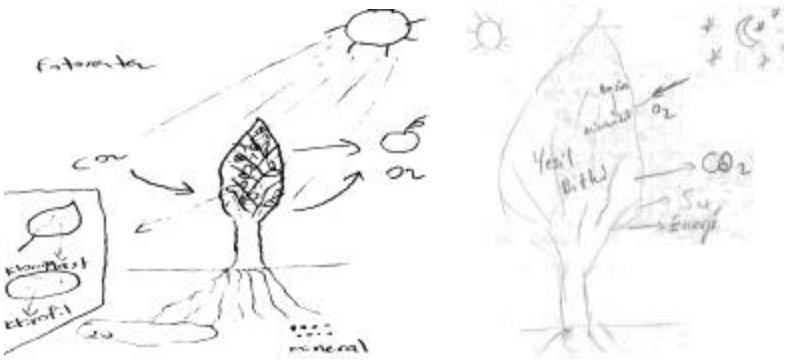

Fig. 4: a, b. Examples of level 5

Table 1: Definitions of process of photosynthesis and respiration in plants

Process in plants	The elements for photosynthesis and respiration in plants
Photosynthesis	Sun/light, carbon dioxide, rain/water, chlorophyll, leaves, roots, green branches, green stems, calyx, green fruit, food/glucose/sugar/starch, oxygen, minerals, soil
Respiration	Food/glucose/sugar, oxygen, carbon dioxide, water, mitochondria, energy, leaves, stems, roots, branches, fruits, flowers, soil

Level 5: Comprehensive representation Drawings: Drawings in this category were the most competent and realistic drawings of the photosynthesis and respiration in plants (Fig. 4a, b). Drawings showing sound understanding, contained seven or more elements of the validated response for that particular statement (Table 1).

After the drawings were evaluated according to the criteria above, individual interviews were conducted about the detailed subjects with randomly chosen 15 students (8 female, 7 male) who demonstrated misconceptions. The purpose was to check the validity of the interpretation of the drawings. In the interview, students were asked to answer the questions like what the photosynthesis and respiration are, when they occur, in which parts of the plants they take place, the basic duty of leaves, producer-consumer concepts, the relationship between the photosynthesis and respiration, what the nutriment of plants is and where they get it from. The obtained answers were given below by comparing with the drawings.

RESULTS

In this study, the application of the drawing method for determining students' misconceptions about photosynthesis and respiration in plants was conducted. In order to determine the conceptual understandings of students about photosynthesis and respiration the data have been evaluated according to the criteria given above and it has been demonstrated in Fig. 5.

Examining Fig. 5, it is seen that students intensify on the drawings with misconception (level 3) and there is almost no scientific knowledge about the respiration in plants. The rates of the misconceptions of students have were determined to be 40% for photosynthesis and 58% for respiration in plants. Besides, it is found that 32% of students left blank the question about the respiration in plants; 2% of them showed the respiration with partial correct drawing and only 1% of them showed it with exactly correct drawing. However, it appears that the students have more knowledge about the photosynthesis (Partial drawings: 26%, Comprehensive representation drawings: 17%).

The most frequent elements for photosynthesis drawn by students are presented in Table 2.

In Table 2, more than half of students concentrate on components like "sun/light, carbon dioxide, oxygen, leaf and soil" for their drawings about photosynthesis. Whereas, the chlorophyll pigment where photosynthesis take place, water and food components took place only in less than 50% students' drawings. It is striking that although about half of the participants draw the picture of one annual plant and showed its stem and branches, they didn't draw anything, which shows that the photosynthesis occurs in green stem and branches.

The most frequent elements for respiration in plants drawn by students are presented in Table 3.

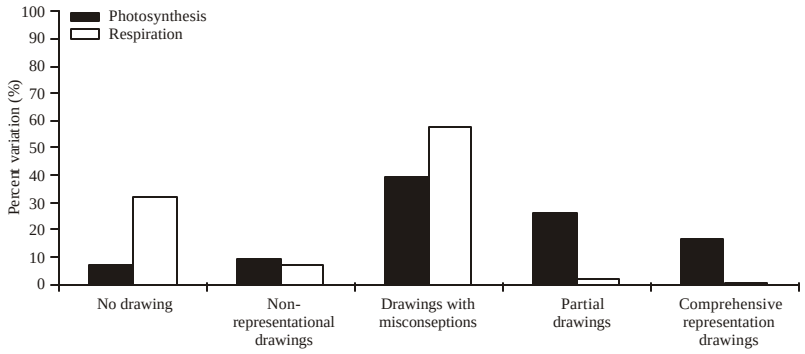

Fig. 5: Levels of university students' conceptual understanding for photosynthesis and respiration concepts

Table 2: The most frequent elements for photosynthesis drawn by students

	sun/light	carbon dioxide	rain/water	food	oxygen	leaf	chlorophyll	root	soil	mineral	green stem	green branch
N	126	89	67	62	94	116	27	65	110	38	75	51
%	81	57	43	40	60	74	17	42	71	24	48	33

Table 3: The most frequent elements for respiration in plants drawn by students

	food	oxygen	carbon dioxide	water	energy	leaf	mitochondria	root	stem	branch	flower	soil
N	19	62	59	8	2	56	2	16	59	32	40	54
%	12	40	38	5	1	36	1	10	37	21	26	35

Table 4: Students' misconceptions about photosynthesis and respiration in plants

Misconceptions	N	by previous researchers*
While photosynthesis in plants is the taking in of CO_2 and giving off of O_2 during the day, it is taking in of O_2 and giving off of CO_2 at night.	13	10, 11
Photosynthesis is the respiration of plants.	21	3, 6, 10, 11, 12
Photosynthesis occurs with the rise of the rains to the sky and after evaporation, their return to the ground.	2	new misconception
Photosynthesis is a gaseous exchange process during which CO_2 is taken in and O_2 is given off.	53	6, 7, 10, 11
Plants grow up by photosynthesis, which occurs during the day.	4	1, 2, 6, 11
Water moves into the leaves during photosynthesis.	8	1, 6, 7, 8, 11
Plant take in CO_2 and change it to O_2	2	4
Photosynthesis occurs in green plants all the time.	13	2, 6, 11
Photosynthesis is the production of energy for plant growth.	5	1, 2, 3, 4, 5, 6, 7, 10, 11,12
Photosynthesis is a type of respiration.	10	3, 5, 6, 11
Photosynthesis takes place mainly in the leaves.	58	2, 6, 7, 8, 9, 11, 12
When plants carry out photosynthesis, they not respire.	61	2, 3
Photosynthesis can take place to not use water.	54	6, 11
Photosynthesis can occur to not use sun light.	30	6, 11
The most important benefit to green plants when they photosynthesised is giving off oxygen.	52	6, 8, 11
Plants use CO_2 to carry out respiration and to produce O_2.	21	6, 11
Plants photosynthesise and animals respire.	27	2, 6, 7, 11
Plants use sunlight to live and grow.	5	2, 6, 11
Respiration occurs in no plant cells.	65	5, 6, 8, 10, 11
Respiration in plants does not take place in the presence light energy.	61	1, 6, 7, 11
Respiration in plants occurs only at night.	79	1, 2, 3, 6, 7, 9, 10, 11
Respiration in plants occurs only in their store roots.	3	new misconception
Humans are giving off CO_2 in respiration; plants are giving off O_2 in respiration.	24	4
While respiration in green plants is the taking in of CO_2 and giving off of O_2 during the day, it is taking in of O_2 and giving off of CO_2 at night.	21	6, 10, 11
Respiration in plants is a gaseous exchange process during which O_2 is taken in and CO_2 is given off	51	1, 2, 5, 6, 7, 10, 11, 12
Respiration in plants is the taking in of CO_2 and giving off of O_2 at night.	79	1, 2, 3, 5, 6, 7, 9, 10, 11, 12
Trees respire with the oxygen produced by the smaller green plants.	2	new misconception
Respiration in green plants takes place only during the day.	5	2, 6, 7, 8, 9, 10, 11
Respiration in plants takes place solely in the leaves.	75	1, 2, 6, 7, 10, 11, 12
Plants respire through the leaf's stomata.	11	6, 7, 10, 11
Photosynthesis and respiration are function in an opposite and contrasting manner.	53	2, 6, 7, 10, 11, 12
Photosynthesis and respiration in plants are only a gas exchange event	51	2, 7, 10, 11, 12
Plants eat minerals.	6	1, 4, 6, 7, 8, 9, 10, 11, 12
Plants feed on water.	7	1, 4, 5, 6, 7, 8, 9, 10, 11,12
The soil supplies water and food for plants.	5	1, 2, 3, 4, 6, 7, 10, 11, 12
Plants feed on the bacterial decompositions.	4	new misconception
Plants get their food from the soil through their roots	5	1, 4, 5, 6, 7, 8, 9, 11, 12
Plants are called as producers since they are food and oxygen sources for the other organisms.	9	7, 8, 12
Plants are called as producers since they give fruits and vegetables to humans	12	7, 8, 12
Leaves have special pores to exchange gases.	11	1, 2, 6, 7, 10, 11, 12
The leaves' main job is to capture the rain and the water vapour in the air.	8	1, 6, 7, 9, 11
The leaves' main job is to give off oxygen.	22	2, 6, 7, 11
The leaves' main job is to give off carbon dioxide.	17	1, 2, 6, 7, 11

*(1) Wandersee [30]; (2) Haslam and Treagust [2]; (3) Tamir [31]; (4) Anderson *et al.* [23]; (5) Songer and Mintzes [28]; (6) Hill [25]; (7) Çapa [32]; (8) Özay [33]; (9) Sensoy [34]; (10) Tekkaya and Balci [35]; (11) Köse [21]; (12) Çepni *et al.* [36]

When Table 3 was examined, it attracts attention that most of the students who make drawing don't show the food as the basic input of respiration and water and energy as the basic output in their drawing. However, only 2 students showed mitochondria, the place where respiration occurs, in their drawings. Although 25% of the participants on average showed root, stem, branch and flower in their drawings, there aren't any implications, which show that the respiration occurs there.

Students drew components of this process; both about the photosynthesis and respiration, at low rates, thus it is clear that they didn't learn the basic concepts about the subjects or they have many misconceptions about them. Forty-three misconceptions were determined from the students' drawings about the photosynthesis and respiration in plants. These misconceptions were demonstrated in Table 4.

Many misconceptions were determined in the interviews with fifteen people who were randomly

Table 5: Misconceptions about photosynthesis and respiration in plants obtained in the interviews

Misconceptions
Photosynthesis is a gaseous exchange process during which CO_2 is taken in and O_2 is given off.
Photosynthesis is a chemical process to obtain energy.
Photosynthesis occurs mainly in the leaves.
Photosynthesis is the respiration of plants.
Water moves into the leaves during photosynthesis.
The leaves' main job is to give off carbon dioxide.
The leaves' main job is to give off oxygen.
When plants carry out photosynthesis, they not respire.
Photosynthesis can take place to not use water.
The most important benefit to green plants when they photosynthesised is giving off oxygen.
Plants are called as producers since they give fruits and vegetables to humans.
Plants photosynthesize and animals respire.
Respiration in plants is a gaseous exchange process during which O_2 is taken in and CO_2 is given off
Respiration occurs in no plant cells.
Plants respire through their leaves because gas exchange occurs in the stomata in leaves.
Respiration in plants does not take place in the presence light energy.
Respiration in plants occurs only at night.
Humans are giving off CO_2 in respiration; plants are giving off O_2 in respiration.
Respiration in plants and in humans is different. When humans respire to provide energy, plants carry out to give off little CO_2 and use it.
Plants carry out anaerobic respiration at night.
Photosynthesis and respiration are function in an opposite and contrasting manner.
Plants photosynthesize during the day, which provide energy. They continue to photosynthesize with respiration at night.
Photosynthesis and respiration in plants are only a gas exchange event
Plants respire to digestive their food.
Plants get their food from the soil through their roots.
Salt, minerals, air and sun light is the plant's food.
Fertilizers is the plant's food
Plants feed on water.
Organic matters dissolve in water such as salt.
Inorganic matters not dissolve in water.
Plants feed on the bacterial decompositions.
Plants get their food from the soil through their roots.

chosen from the students whose drawings have misconceptions. The misconceptions that appear in the interviews are presented in Table 5.

It is seen that the obtained misconceptions determined in the interview overlaping with the drawings. In other words, the misconceptions in the drawings were confirmed through the interviews. While three of the students interview with, don't mention anything about the basic input of photosynthesis; water; two of them explained photosynthesis is a gaseous exchange process during which CO_2 is taken in and O_2 is given off and one of students reveals it as taking the clear weather in and leaving the filthy weather out. It was determined that since most of the students who took part in the interview have a misconception that the aim of photosynthesis is to produce energy, they haven't mentioned about the food, the basic output of photosynthesis. Besides, it is seen that they focus on the fact that the photosynthesis occurs only in the leaves and they don't say anything about the chlorophyll. It is possible to see this misconception in the drawings (Fig. 6). However, the students stated that they knew the minerals and water as the nutriments of the plants

Fig. 6: A drawing of misconceptions of photosynthesis occurs only in the leaves

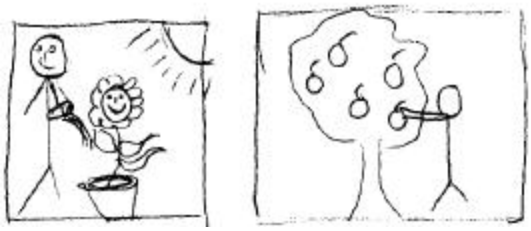

Fig. 7: A drawing of misconceptions of plants provide food and oxygen for the human beings and other creatures

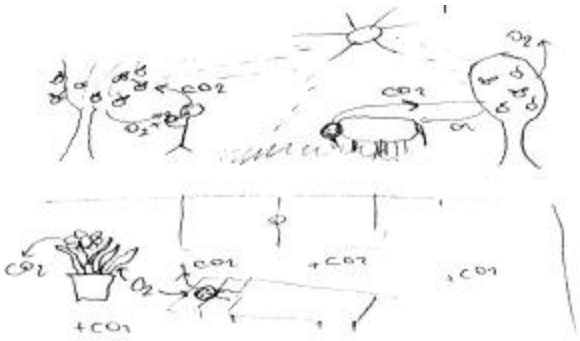

Fig. 8: A drawing of misconceptions of photosynthesis and respiration in plants

and they believed that the plants feed themselves by taking them from the soil through their roots. In addition to them, it was determined that the students have a common thought that the plants are named as producer since they provide food and oxygen for the human beings and other creatures. A sample drawing can be seen in Fig. 7.

It is seen that all the students in the interview gave information about human and animal respiration when they were asked about respiration in plants. It is notable that they think animal and plant respirations as different things. It is also determined that they do not know that plants also respire during the day. One of students even explained that "The plants take carbon dioxide in during the day and they give off oxygen. When there is not sun light at night, they do the vice versa. In primary school we learnt that we shouldn't keep plants in our bedrooms at night because they respire just like you at nights." It is possible to see all these mentioned things in the drawing of one of the students (Fig. 8). While twelve students explain the respiration in plants is a gaseous exchange process during which O_2 is taken in and CO_2 is given off, one of them states that the foods are burned with oxygen and this forms water and carbon dioxide, but he doesn't mention about the energy. One of the participants in the interview said that the plants respire with their roots, because the extra foods are stored here. The others stated that the leaves take carbon dioxide and give off oxygen.

DISCUSSION AND CONCLUSION

One of the reasons of students' present misconceptions is the misconceptions that teachers have [22]. That's why it is first priority to determine and prevent the misconceptions in order to raise following generations with scientifically correct knowledge. In this study the effect of drawing method is investigated to determine the university students' misconceptions about photosynthesis and respiration in plants. First of all, students were asked to express their opinions about the subjects with drawings and then interviews were conducted deeply with randomly chosen 15 people. The results of our study show that the knowledge of university students about photosynthesis and respiration in plants in Turkey is consistent. This was confirmed both by analysis of drawings of photosynthesis and respiration in plants and by individual interviews focused primarily on the function of photosynthesis and respiration.

Analyses of drawings show that students' conceptual understanding was poor especially in the case of the photosynthesis, respiration, relationship between photosynthesis and respiration in plants, food for a plant, nutrition of plants, autotrophy and the role of leaves. That's why, most of the students made drawings with misconceptions. It is even possible to see some misconceptions in each students' drawing. Most of the determined misconceptions exist in all the levels of school life; from primary education to university and they resemble the previous researches in the country and abroad. However; in this research some misconceptions, which were not determined before, were found (Fig. 9). These are: *"Photosynthesis occurs with the rise of the rains to the sky and after evaporation, their return to the ground", "Respiration in plants occurs only in their roots", "Trees respire with the oxygen produced by the smaller green plants* and *"Plants feed on the bacterial decompositions"*. These misconceptions can stem from education students received in the university. Studies made in Turkey [37, 38] emphasized that the lecturers in education faculties use the lecture method and the students graduate from the education faculties without being introduced with any other alternative instruction methods. If it is considered that these students will graduate in a year and become teachers that is apperant to see that to purify the misconceptions from university students is very important. University students must be educated in the way they are asked to educate others when they become teachers. That's why; university

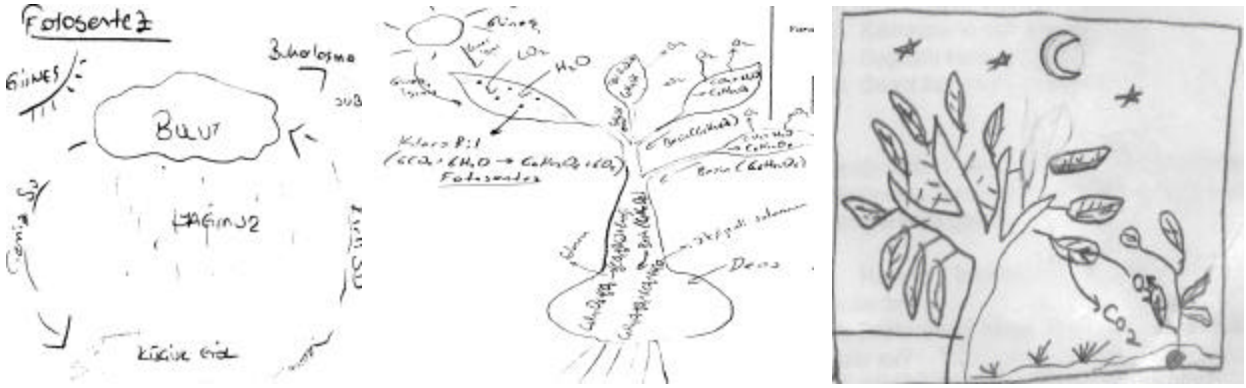

Fig. 9: Some misconceptions of determined in this study by drawings

students must be trained with efficient instruction methods which will prevent them from the misconceptions or common beliefs they have about the concepts. In this way, the transformation of teachers' misconceptions to following generations can be avoided, the instruction activities can be arranged by taking the prior knowledge of students into consideration and the lessons can be taught with modern instruction methods.

It is apparent that university students concentrate on the following misconceptions: *"Photosynthesis is a gaseous exchange process during which CO_2 is taken in and O_2 is given off, While photosynthesis in plants is the taking in of CO_2 and giving off of O_2 during the day, it is taking in of O_2 and giving off of CO_2 at night, The most important benefit to green plants when they photosynthesised is giving off oxygen, Photosynthesis takes place mainly in the leaves"*. The existence of similar misconceptions was determined to take place at every level of school life; from primary education to the university [32, 34]. Such misconceptions may have stemmed from many things from their previous school life; for example, since students are told that the forests and trees must be protected in order to have fresh air (O_2), that the forests/trees are the lungs of the world, the forests clean the filthy weather and in the course books [39] this subject is frequently emphasized, while the photosynthesis subject is presented only the plants are exemplified and only the leaves are mentioned as the place where photosynthesis occurs, while the photosynthesis subject is handled only the diagrams of leaves are used [40]. It was demonstrated in many researches that the misconceptions about the photosynthesis in course books leads students to have misconceptions [41, 42, 43, 44]. That's why; as mentioned in the science and technology curriculum, MNE, [45], it seems useful to teach the photosynthesis and respiration subjects over the food webs with concept maps. Besides, we can change the concepts in students' minds through the conceptual change texts which apparently show the conflict between the probable misconceptions of students and the scientifically right knowledge. However, it must not be forgotten that the misconceptions are resistant to change and they can not be removed easily [46-48].

Thirty two percent of the students leave the respiration in plants subject blank and 58% of them have misconceptions. These students concentrate on the misconceptions like "Respiration occurs in no plants cells, *Respiration in plants occurs only at night, Respiration in plants is a gaseous exchange process during which O_2 is taken in and CO_2 is given off, Respiration in plants takes place solely in the leaves"* (Fig. 10). Similar misconceptions also appear in the previous researches made by Wandersee [30], Haslam and Treagust [2], Hill [25], Çapa [32], Özay [33], Tekkaya and Balci [35], Çepni *et al*. [36], Köse and Usak [26]. As it is seen, the misconceptions go beyond the international limits like language and culture. Many things can be counted among the reasons which give way to misconceptions; for example in the university students' previous school lives, the respiration subject is mostly exemplified with animals, in respiration parts of the course books, the focus is mostly upon the respiration of animals and human beings [49], again in the course books, the diagrams of leaves are used for the expressions related with photosynthesis and there are explanations which state that the respiration in plants occurs solely in the leaves. At the same time, since the respiration in plants is not mentioned in the respiration subjects of course books [49] students can believe that the plants don't respire. Such false beliefs can be prevented if the students are educated from primary school that the plants are living creatures and they respire both day and night, during their respiration they take oxygen and give off carbon dioxide, they also obey the laws of respiration and if a special place is given to the subject of respiration.

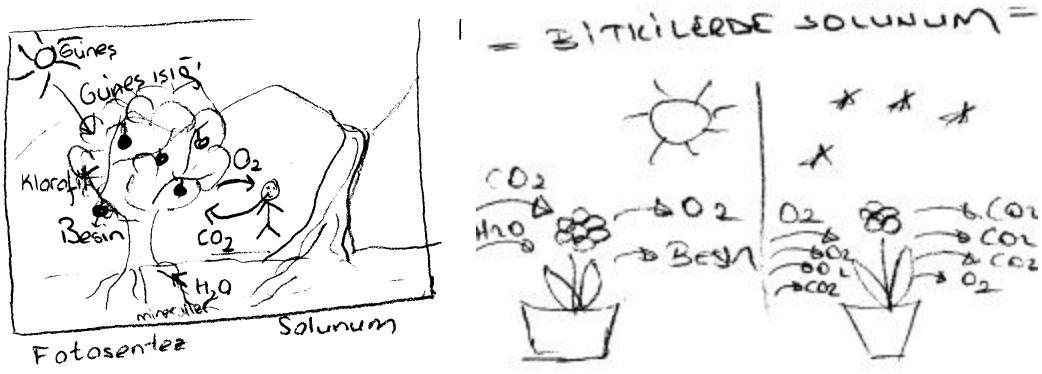

Fig. 10: Misconceptions such as "Respiration occurs in no plant cells; While respiration in green plants is the taking in of CO_2 and giving off of O_2 during the day, it is taking in of O_2 and giving off of CO_2 at night"

Students showed in some of their drawings that the plants feed themselves with matters they got from their environments just like the animals. It is seen that the students can not relate the materials they got from outer environment with the photosynthesis in plants. This gives way to the belief that the basic source of plants' food is the materials from soil and the plants feed themselves with these materials. The reason of this misconception is the natural observation of students. This is among the reasons of the misconceptions [50]. That's why; while forming the basic opinions of students about photosynthesis, the students' interest must be drawn by generating conceptual conflict related to where the plants and animals get their food in order to provide their energy even at the primary school level. Then the scientific knowledge about photosynthesis and respiration must be given by taking the conceptual change strategies into consideration.

In the interviews, conducted with students, it was determined that there are similar misconceptions like their drawings. That's why; the results obtained indicate that drawing method is effective in determining the students' misconceptions. One of the probable reasons of the determined misconceptions may be the difference between the scientific and daily language. For example; it is seen that the students use the "respiration" concept at the same meaning with "breathing"; the act of taking oxygen and giving off carbon dioxide. However, the two events are different from one another; the respiration is a chemical and breathing is a physical event. As stated in an example from the interview with students *"Don't keep plants in your bedrooms at nights, because plants respire at nights just like you"* another reason may be the daily experiences of students (Fig. 8). Another reason may be the close relationship between the subjects. In biology, understanding a subject can be effective for learning another subject. Students, who can not relate the subjects correctly, have difficulty in understanding some of the basic concepts and they have misconceptions. For example, since the photosynthesis subject has many sides like ecological, biochemical, anatomical-physiological and energy change, in order to learn this subject, the concepts related with each side must be learnt. Besides, we must have enough knowledge about the chemical reactions, energy, organic and inorganic molecules subjects in chemistry and physics. In order to understand the concepts in subjects like producers, consumers, transformation of material, foods chains, food webs; the photosynthesis subject must be learnt well.

From the results found in this study, it is clear that students also do not understand processes of photosynthesis and respiration in plants well. University students' representation drawings in this study indicated that there were lots of misconceptions. The teacher or pre-service teacher has a direct and important impact on the development of scientific concepts and must understand scientific phenomena at least one level beyond where their students need to go. If teachers or pre-service teachers are enacting the curriculum that is designed to address these topics, then it is clear that students are not developing a deep understanding of concepts involved.

Where drawings have been used to probe understanding in science, they have been used in a variety of ways. Drawing activities in conjunction with individual interviews have been successfully used to explore students' ideas about abstract concepts, e.g. 'photosynthesis' and more specific ideas, e.g. 'respiration in plants'. I believed that drawings are often an under-utilized research tool in primary classrooms. Drawings can provide valuable information for teaching and learning process and determining misconceptions and, more importantly, they provide an open-ended means for creative expression that is difficult to achieve with other assessment strategies.

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