



What Do Turkish Students at Different Ages Know About Their Internal Body Parts Both Visually and Verbally?

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ABSTRACT

The study aimed to seek the students understanding of their internal bodies. It was carried out in the East Black Sea Region of Turkey in two junior high schools. All data were gathered from 55 grade 6 students (aged 12) and 57 grade 8 students (aged 14). The students were given an outline of body map and asked to draw which organs they have in their bodies. Once completed they to write the function of each organ. The drawings of the organs were analyzed according to their accurate characteristics such as presence, location, shape and function. The findings showed that the students of both grades had problems about the functions of the organs and other body structures.

Keywords: Biology Education, Understanding, Body Structures, Drawings

INTRODUCTION

Although the reforms of post 50's in science education focuses on students' understanding rather than knowing large number of scientific facts (AAAS, 1993; NRC, 1996), the studies about children's learning problems in science reveal that they have large number of erroneous ideas even after receiving formal instruction. As in other areas of science like physics and chemistry, many alternative conceptions have been reported in biology. The topics studied extensively are; cells (Doğru, 2000), respiration and photosynthesis (Anderson, Sheldon & Dubay, 1990; Seymour & Longden, 1991), and genetics (Pashley, 1994; Lewis, Leach & Wood-Robinson, 2000). Recent studies have also showed that students have problems in understanding key topics of biology such as internal organs, organ systems and processes of their own bodies (Yip, 1998a; Lazarowitz & Penso, 1992; Bahar, Johnstone & Hansell, 1999; Tekkaya, Özkan & Sungur, 2001). Students possess alternative conceptions or unscientific beliefs prior to instruction about a variety of science topic (Head, 1986). Teachers need to know their students' ideas to be able to help them be aware of their own views, as well as scientific views and also to plan effective activities to bridge the gap between students' ideas and the scientific facts

(Dickinson & Flick, 1997). The reason of low quality of understanding in science among students may vary from density of the curriculum to teacher education.

Why should children have knowledge about their internal bodies? It is a fact that we are all living beings. Maintaining a healthy life and understanding other living organisms' internal processes need to know about body (Steve & Kim, 1998; Science Textbook 6, 2002). If one knows the scientific knowledge with concrete experiences he/she may develop more positive attitudes toward science so that he/she may possibly become scientifically literate.

In the studies about the understanding of human body, drawings have been used mostly. Cuthbert (2000) asked the students aged 7-11 to draw their organs in to given body map and label them. His results indicated that children aged 7-11 represent little progression in their understanding of bodily systems. Reiss et al. (2002) examined what young people (aged either seven years or 15 years) from 11 different countries know what is inside them. Analysis of the data showed that the students aged 7 had a broad knowledge of their internal structures, being aware of a wide variety of organs. However had little appreciation of how organs exist as related structures within organ systems? 15 year-olds also had better knowledge of their internal organs, most of them revealed little understanding of their organ system. Other studies of organ systems also indicated valuable data. Texieria (2000), studied about children's conceptions of the structure and function of the human digestive system. Mintzes and Arnaudin (1985) reported that the students' alternative conceptions of the human circulatory systems. Toyoma (2000) planned a series of five experiments to evaluate whether young children are aware of biological transformations associated with eating and breathing.

However, how knowledge of the various organs, their locations, shapes and also especially their functions, depends on age has not been extensively examined systematically and quantitatively in Turkey and other countries. Students' body knowledge is the necessity for scientific literacy. It is not a good picture in which a person had a pain in his stomach but he thinks that it is liver or many people suffer from the appendicitis but they do not understand it.

In this paper, it is also attempted to examine students' body knowledge. But different from previous studies in the literature, drawing with writing is used to research how students coded the organs visually and verbally. This paper examined the research question: How do students' understandings of internal body change in regard to grade?

METHODOLOGY

A variety of methods have been used by researcher to examine students' understandings and to detect alternative conceptions in science education such as multiple choice items (e.g. Odom, 1995), open ended questions (e.g. Themane, 1990), clinical interviews (e.g. Piaget, 1929), construction of concept maps (e.g. Novak & Gowin, 1984) and so on. In this study, drawing and writing were used to collect the data. These instruments provided that how children coded the internal body parts visually in their minds and which functions were ascribed to these drawn body parts. Drawings also provided to see the students' knowledge of connections between the related body parts.

a) Participants and Procedure

The study was carried out in the East Black Sea Region of Turkey in two junior high schools, (ages 12 to 14) which are in the center of the city of Trabzon. Grade 6 and grade 8 students were included in the study.

Each of systems (skeletal, digestive, circulatory, respiratory, excretory, nervous and endocrine) and their organs' function and locations are taught simply at grade 6. The grade 7, Science Curriculum comprises physics and chemistry subjects (e.g., atoms; force and motion). At the grade 8, the students also learn about the genital systems. They do not study any of body systems again until the high school (lycee). So that, this instruction about their anatomical structure and its processes that given in the junior high school may be first and last for the students if they don't choose science in the high school. In this case, students should be taught effectively to construct the best. And also their knowledge should be detected to plan better instruction for coming students in the next year. Therefore, junior high school students were selected as sample.

All data of this study were gathered 55 students from grade 6 (aged 12) and 57 students from grade 8 (aged 14). The students were given an outline of a body map, asked to draw which organs they have in their bodies and once they completed, also to write the functions of what they drew. The study was administered at the end of the second semester so the subjects of the body systems were completed. Students were told that this was not an examination but were not to copy others' drawings. Students were given 40 min to complete the task then the researcher collected papers.

After analyzing of the data, for some interesting cases students and teacher of them were interviewed.

b) Data Analysis

A total of 112 drawings were analyzed. Three experts independently analyzed the papers and the percent of the perfect agreement on scores was derived. The drawings of the organs were analyzed according to the accuracy of characteristics such as presence, location and shape and function, so that, a drawing was analyzed a total of three times; first once for the presence or absence of the organ, then for shape and location of the organ and lastly function of the drawn organ.

During the analyzing of the papers for the shape and location of the drawn organs, small details passed over. For example where was the stomach drawn? It must be on the left side but it does not matter it is just under the left lung on the other side it is imported that it is connected with esophagus. It mustn't be drawn bigger than the liver also spherical or triangular. In a minority of instances, where the students' answers for the function of the organs were contradictory, two lecturers who were experts of this subject assisted me. Students' responses for the functions of the organs were also grouped with percentages.

FINDINGS

The results were grouped according to presence or absence, correct shape and location and function of the drawn body parts.

a) Presence of the Organs in the Students' Drawings

Table 1 shows which body parts were drawn at two grades. The body parts, which had the percentage below the 10 in both grades, were not given in table.

Table 1. Percentage of Drawn Body Parts in the Students' Drawings

	Heart	Lung	Stomach	Liver	S.Intesine	L.Intestine	Kidneys	Esophagus	Trachea	Appendix	Pancrea	Urinary BI
Grade 6	91	96	78	76	71	64	56	47	22	18	15	11
Grade 8	98	80	68	75	54	54	51	42	49	14	14	0

Table 1 shows all drawn body parts comparing two grades. The organs most commonly seen in the drawings of different grades were heart. 91% of the grade 6 and 98% of the grade 8 students drew heart. Students hear about the heart from their parents, television and news from the early ages. So it was not surprising to see these ratios. The followings organs with high ratios were lungs, liver, stomach, small intestine, large intestine and kidneys respectively. While the minority (5%) of the grade 8 students drew the spleen none of the grade 6 students drew the spleen. Also, 4% of the grade 8 students drew gallbladder. Although it was not expected, surprisingly, appendix, gall bladder, liver, pancreas and spleen were drawn. These organs are not included, in the National Science Curriculum for junior high school, so that the science textbooks also do not have any information about them. Interviews with the students exposed that textbooks and courses for preparation to the high school entrance exam (LGS) inform the students about these organs. Because students mostly gain the examination practice in these courses, meaningful learning is not succeeded. This may explain why the scores of these organs were lower.

Other surprising data was the ratio of the testis. Although subjects were consisted of both boys and girls students, testis was drawn by the boys (5% in grade 6 and 2% in grade 8 students) but ovaries were not drawn. Socio-cultural factors may be effective on these ratios. Teachers also explained this situation like that “students especially girls are shaming while we are teaching this unit and sometimes boys are disturbing the girls by flouting.”

b) Students' Understanding of the Organs' Correct Location and Shapes

Students' drawings were analyzed second time to determine the students' understanding of the organs in the body; their connections and the data were given totally in Table 2.

Table 2. Percentage of Correct Location and Shape of the Students' Drawings

		Lung	Esophagus	Liver	Stomach	L.Intestine	S.Intesine	Kidneys	Trachea	Heart
Correct Location	Grade 6	65	45	33	29	24	20	24	13	13
	Grade 8	31	22	32	18	26	26	7	24	15
Correct Shape	Grade 6	18	40	13	18	5	2	18	4	-
	Grade 8	11	24	14	8	11	12	15	12	-

Table 2 represents the data for the position and the shape of organs drawn by the grades. Over half the students had problems of drawing correct location and shape of the organs. Approximately all of the students in two grades drew heart as it was shown in Table 1. However none of them were able to draw its shape accurately. The ratio of the lungs was the highest. Characteristics of the students' drawings were given in the following parts with respecting to the grades.

i) Characteristics of the Grade 6 Students' Drawings

In the grade 6 students, 24% of the students drew a valentine heart and 20% of them drew it spherical. And also it was placed, on the left lung (4%), on the right lung (2%), next to the left lung (15%) and in the middle of the lungs (47%).

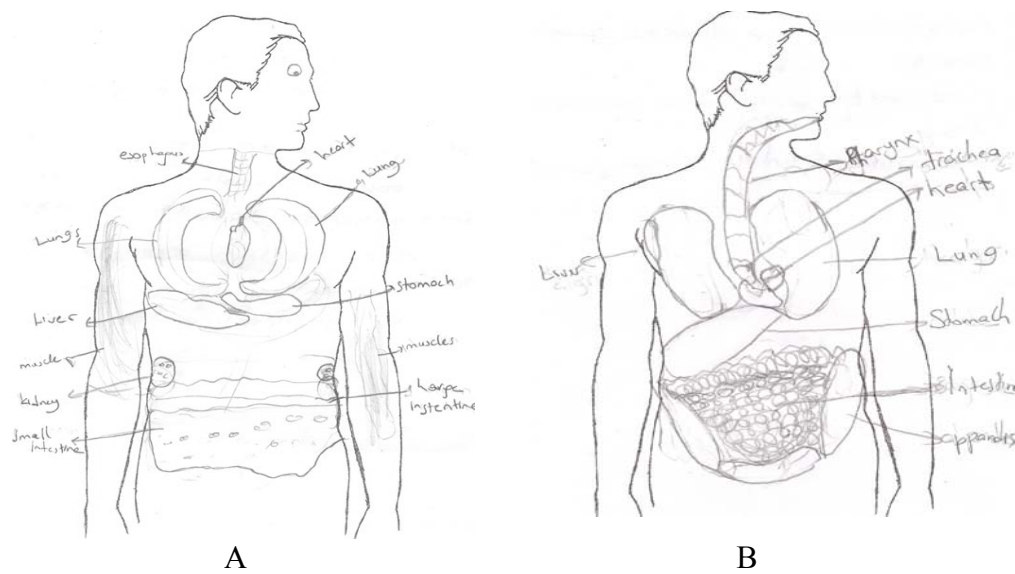


Figure 1. Drawings by the Grade 6 Students

As it is seen in the Figure 1, (A), most of the grade 6 students placed heart between the two narrow and arched (14.5%) or bean shaped *lungs* (B), which are not connected to the trachea. The lungs were generally drawn smaller (10.9%) than their normal shapes. Minority of the grade 6 students drew lungs, like balloon (3.6%), or long cylindrical (3.6%) or united (5.4%) or half circle (5.4%), and also free from each others (5.4%).

Students generally connected to the esophagus to the lungs (25.4%). In some of the drawings the esophagus was short and free. Minority of students connected esophagus to the stomach or intestines.

The location of the stomach was also problematic. It was located between kidneys (1.8%), under the liver (7.2%), at the right side (5.4%), upper of the lung (1.8%) and also middle of the thoracic region (7.2%). Most of the students drew the stomach small and spherical shape.

The majority of the students did not draw the right lung; the position of the liver was represented across the left lung (14.5%). 5.4% of the students located it in the middle of the abdominal region. While one of the students drew the liver between the kidneys, other one drew it double on the left and right kidney.

Although more than half the students drew the kidneys, they had problems about their correct location and shape. 7.2% of the students located them under the intestines. Some of them drew kidneys between the lungs and liver or on the stomach or between the

liver and stomach. Generally students attached the kidneys to the waist. One of the students drew the kidneys at the thoracic region.

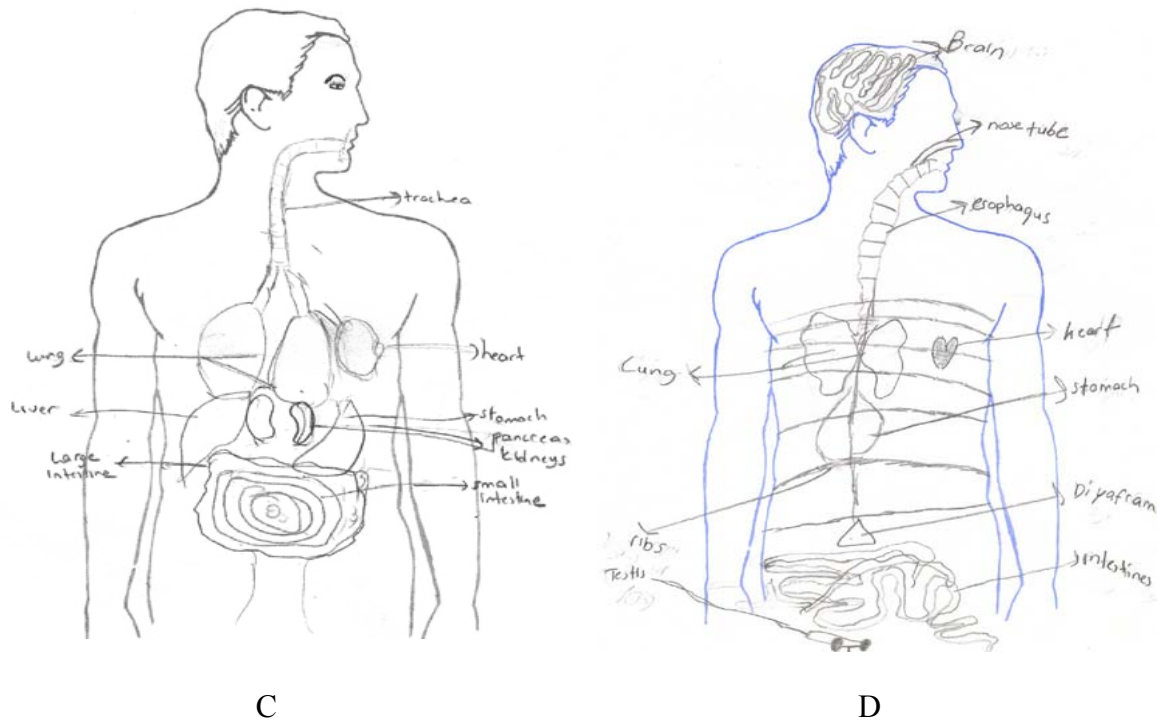


Figure 2. Other Examples of Drawings by the Grade 6 Students

The other problematic organs of the grade 6 students were small and large intestines. 10.9% of the students located small intestines as a free part under the large intestines. One student positioned it between the liver and kidneys. The students drew the small intestines bead like or tube like or as circles continuation of the large intestines. Large intestines were also drawn bead like or triangular or square shape. Also 10.9% of the students named only intestines as seen in the Figure 2 (D).

ii) Characteristics of the Grade 8 Students' Drawings

Eight grade students also had problems about the location of the heart. 17.5% of the students drew it on the left lung or in the middle of the two lungs. 7% of the students positioned the heart above the left lung. While one student located it above the right lung, 7% of the students drew it in the blank. 12.2% of the grade 8 students drew a valentine heart.

Seven percent of the students attached the left and right lung. Very minority of them drew the lungs free from each other and also unconnected to the trachea. One of the students connected one of the lungs to the trachea and connected the other lung to the esophagus. 5.2% of the students located the liver across the lungs.

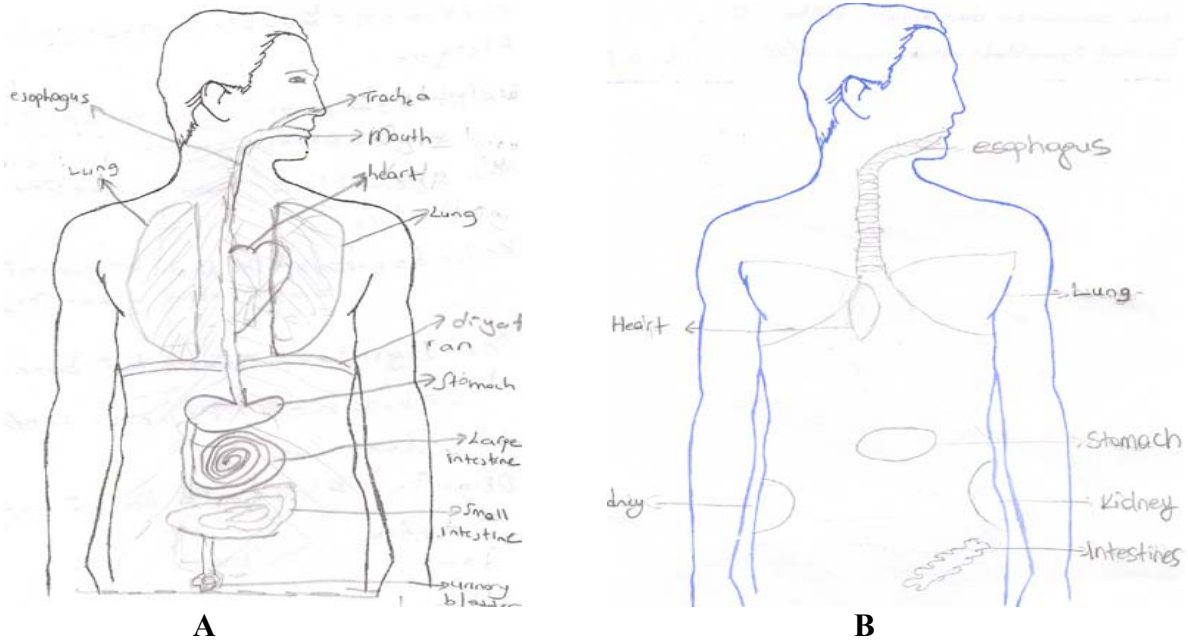


Figure 3. Examples of Drawings by the Grade 8 Students

10.5% of the students started the trachea from the mouth. While two of the students drew it a short free part, other two students started the esophagus and trachea side-by-side from the nose.

Like their peers grade 8 students located the stomach in different places such as between two lungs (5.2%) or below the liver (7%) or in the middle of the abdominal region. 5% of them drew stomach in the intestines. Liver was generally drawn across the lung (10.5%).

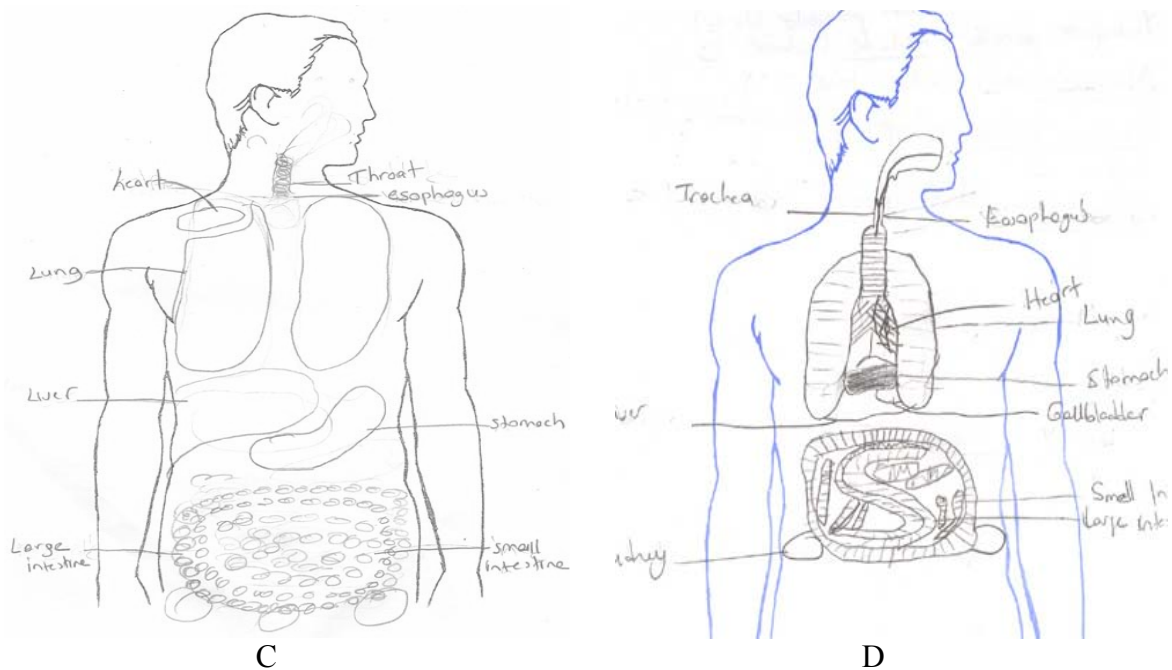


Figure 4. Other Examples of Drawings by the Grade 8 Students

10.5% of the students positioned the kidneys under the intestines. The others drew them under the stomach or lungs (5.2%), besides the intestines or attached to the waist

(5.2%). Small minority of the students drew only one kidney (1.7%) and 5.2% of them connected the kidneys to the esophagus.

10.5%- 12.2% of the students drew the small and large intestines bead-like. While small intestines shapes were represented as parallel lines or S shape or circles, large intestines were drawn as a square shape. Also some of the students drew small and large intestines free from each other. 26.3% of the students named them simply intestines.

Drawings of students revealed that the students of both grades had similar problems with the location and shape of the organs. Although it was expected better understanding from older students, there is not a difference. If it is taken into consideration that students are taught body systems in the grade 6 students, it may be normal forgetting the previous knowledge. On the other hand, students are carrying their nonscientific beliefs to the following grades without very small changing.

c) Understanding of the Organs' Functions across the Grades

10% of the sample did not write the functions of any organs. In contrast to drawings, students of the both grade failed to describe the functions of the organs. Table 3 gives the all data across the grades, which organs functions were written and which of them were correct. These data will be interpreted one by one for each organ in the following of this part.

Table 3. Percentage of the Students' Responses for the Function of the Organs

		Heart	Lung	Stomach	Esophagus	Kidneys	Liver	Trachea	S.Intesine	L.Intestine
Written Functions	Grade 6	78	64	58	56	36	30	24	19	15
	Grade 8	79	61	54	22	21	13	39	12	7
Correct Functions	Grade 6	41	30	31	51	16	6	16	12	2
	Grade 8	67	49	24	12	12	7	6	3	-

i) Heart

As it can be seen in Table 3, although the students of two grades had high ratios for writing function of the hearts, the percentages of the correct responses were not high. 41% of the grade 6 students and 54% of the grade 8 students were aware that *heart pumps the blood*. Other common response of the students, *heart keeps us alive* (24% of the grade 6 students 7% of the grade 8 students).

Only one grade 8 student wrote as *heart provides circulation of the blood*. Small minority (5%) of the grade 8 students also identified that *heart separates the clean and dirty blood*. Other students in grade 6 and grade 8 also ascribed additional functions to heart that were given in Table 4.

Table 4. Percentage of the Students' Ideas about the Functions of the Heart

	Grade 6	Grade 8
Pumps the food we eat to the all part of the body.	7	0
Cleans the blood.	7	0
Collects the clean blood.	4	0
Provides the breathing.	0	2
Controls the body as a control channel.	0	2

ii) Lungs

As it is seen in the Table 3, 64% of the grade 6 students and 61% of the grade 8 students wrote the functions for the lungs but half of them were correct. Most common responses in both grades were that *lungs help the inhaling and exhaling* (15% of the grade 6, 44% of the grade 8 students). Unlike their peers (%15 of the grade 6 students), %5 of the grade 8 students wrote that *the lungs clean the blood*. Primer function of the lungs is gas exchange but science teachers did not mention this situation and simply say that the lungs clean the blood. This may explain why students also did not write about the oxygen and carbon dioxide exchange. In both grades they also had alternative conceptions, which were given in Table 5.

Table 5. Percentage of the Students' Ideas about the Functions of the Lungs

	Grade 6	Grade 8
Provide pulmonary and systemic circulation.	2	0
Provide inhaling.	25	0
Take in and out the oxygen, makes it appropriate to the body.	0	2
Provide fresh air.	2	3
Provide exhaling.	0	5

Table 4 and Table 5 show that small minority of the students of the grade 6 students has confusion between lungs and heart functions. They indicated their functions interchangeably.

iii) Stomach

Table 3 indicates that, stomach was the third organ of which functions were written (58% of the grade 6 students and 54% of the grade 8 students). Like other organs their functions also described incorrectly. About half of these students showed that a good general understanding that stomach digests food (24% of the grade 6 students, 19% of the grade 8 students). The awareness shown by 7% of the grade 6 students and 5% of the grade 8 students that stomach stirs and mixes the food. However, significant minority of students (27% of the grade 6 students, 30% of the grade 8 students) also ascribed additional functions to the stomach that including; melting, burning, storing food, transferring the food to the energy and absorption of the food.

iv) Liver

As can be seen from Table 3, 29% of the grade 6 students and 12% of the grade 8 students drew liver and wrote about it, although the function and structure of the liver are not present in the national science curriculum. I asked them where they learn about it. They said the reason of this as school course for Lycee Entrance Exam. Only 6% of the grade 6 students described its function as *liver regulates glucose level*. On the other hand 7% of the grade 6 students identified its function as it *helps digestion*. Students' alternative conceptions about the liver were given in Table 6.

Table 6. Percentage of the Students' Ideas about the Functions of the Liver.

	Grade 6	Grade 8
Stores the glucose.	11	0
Cleans the blood.	2	2
Brings the food to the heart.	9	0
Exhales the dirty air.	2	0
Stores the food and if it is necessary send the food to the stomach.	0	2
Red and white blood cell present and breathing starts in it.	0	2

As seen from Table 6, there was some confusion between the lungs and liver. This also explains why students located the liver opposite instead of left or right lung.

v) Kidneys

As can be seen from Table 3, although 36% of the grade 6 students and 23% of the grade 8 students wrote functions for the kidneys 23% of the grade 6 students and 9% of the grade 8 students made correct explanations. 16% of the grade 6 and 5% of the grade 8 students described the kidneys' function as *filtration of the blood* and small minority of the students in both grades (5% grade 6 students, 2% grade 8 students) identified that *kidneys provides urine formation*. 5% of the grade 8 students also wrote that kidneys *clean the blood*. However, 2% of the grade 6 and 7% of the grade 8 students gave additional explanation such as *helping digestion*. This may be the reason why students drew kidneys connected with esophagus.

vi) Intestines

As seen from Table 3, totally 34% of the grade 6 and 12% of the grade 8 students wrote about the small and large intestines. On the other hand 20% of the grade 6 and 26% of the grade 8 students who labeled intestines without representing small and large intestines, described intestines' functions as *filtering vitamins*, *excretion*, *separating foods as useful and harmful*.

In both grades the minority of the students (5% in grade 6 students, 3% in grade 8 students) identified that *the digested food absorbed from the small intestines* and also only 7% of the grade 6 students wrote about the *digestion in the small intestines*.

On the other hand students in both grades also had lack of understanding about the functions of large intestines. Only 2% of the grade 6 students described the function of it as *water absorption*. Their alternative conceptions about the large intestines were given in Table 7.

Table 7. Percentage of the Students' Ideas about the Functions of the Large Intestines.

	Grade 6	Grade 8
From the large intestines food passes the heart.	5	0
Waste products stayed here for a while and then they are excreted.	0	7
Passes the food to the small intestines.	5	0

Responses of the grade 6 and the grade 8 students illuminated that they had conceptual conflict about 'excretion' and 'elimination'. They use the excretion concept for both the process of getting rid of the metabolic wastes and the process of getting rid of the digestive wastes. The science teachers should pay attention to these points.

vii) Other Structures

With very small ratios the students described some of the other organs and body structures' functions such as gallbladder, diaphragm, pancreas, appendix and urinary bladder. Students' ideas for these organs were like that gallbladder *collects the harmful substances, which go to the stomach* (3% in the grade 8 students); *diaphragm is a muscle that helps inhaling and exhaling* (7% in the grade 6 students; 5% in the grade 8 students); *pancreas secretes insulin and glucagons hormones* (3% in both grades); *appendix collects the harmful substances in the body* (4% in both grades); *urinary bladder gets rid of the food wastes* (5% in the grade 6 students). Although spleen, muscles and testis were present in the drawings of the students, they were not written about them.

With same small ratio (4%) students of both grades drew triode and salivary gland. Although goiter is very common sickness in the Black Sea Region because of their diet, they do not have knowledge about it.

DISCUSSION and SUGGESTIONS

In this study students at different ages were asked to draw their internal organs and to write their functions. Analysis of the data revealed that the students mostly were aware of a wide variety of organs. However, they had little understanding of how these organs are related to the each other within an organ system. They also had lack of understanding about their location, shape and function. Unfortunately, older students and even pre-service biology teachers did not also had a good general understanding of their internal organs and organ systems (Yip, 1998b).

Generally, students know the names of the organs but they had problems about their functions, locations and the shapes. In both grades, the heart was the mostly drawn organ and lungs followed. Most organs were drawn small and freely suspended within the body cavity or their connection with other related structures were drawn incorrectly, which are the same as the results of Cuthbert (2000). Furthermore, only capillaries were drawn as thread-like lines from the vascular system and muscles were drawn only in the elbow. On the other hand, none of the sample drew the brain. A study carried out in eleven countries also revealed that students in all over the world had similar problems understanding organ systems (Reiss *et al.*, 2002).

Analysis of data by ages showed that students in the grade 6 students mostly higher percentages than the older ones that contradict the findings of the Tunnicliffe and Reiss (2001). Human systems are covered in the grade 6 science curriculum and also no chance is provided by the timetable of the science curriculum to repeat these topics in the grade 7 or the grade 8 students. This may cause forgetting previous knowledge in following grades. This means that retention of the knowledge could not be succeeded. However it should be emphasized that the grade 6 students also did not show a good general understanding. The students of the both grades had alternative conceptions about the functions of the organs such as *heart cleans or stores or controls blood*, which also was revealed in by Mintzes and Arnaudin (1985). This may be explained that the students memorize the name and function of the organs during lessons. In this case teacher factor should be interrogated such as teachers' content knowledge, pedagogic content knowledge and teachers' assessment techniques. Teachers mostly teach the organs by using a didactic method on a human body maquette.

Students' terminology for the identification of the organs' functions were also problematic. Students used "clean or dirty blood" instead of "oxygenated or deoxygenated blood" when describing the function of the heart. They used that 'excretion of the foods' instead of "elimination of food". Because the students use their teachers' terminologies, teachers should pay attention their words used in their lessons. Students' daily life experiences also cause the alternative conceptions. Generally it is used that "my stomach did not melt what I eat" or 'I have burning feeling in my stomach' in vernacular. The grade 6 students also ascribed to the stomach, *melting or burning food*.

This study reports that students basic knowledge about their internal body parts is not expected level. This ineffective learning may be caused from the teacher who had little content knowledge, textbooks, students' daily experience and prior knowledge.

Teachers must be informed about these student understandings and they should design their science lessons according to these points. Organs were taught individually, but it must be emphasized that these organs are parts of systems or as it was mentioned in the study of Reiss *et al.* (2002) it is started that teaching whole organ systems and then

going into more detail. Body is a big machine and all parts of this machine related with each other.

Teachers also should be informed about different teaching methods depending on the students' active learning. In addition to these, they should pay attention to the terminology they use and carefully direct their students' terminology. Students especially in these years are affected by their teachers much more than upper graders.

Teachers should assess what students have learned at the end of the lesson, using different techniques such as writing, concept tests, concept map etc. Teacher may also use drawing technique as an assessment tool. To encourage meaningful learning and to minimize the students' alternative ideas about the explanation of complex physiological body processes, teachers especially should recognize the importance of assessment.

REFERENCES

- American Association for the Advancement of Science (AAAS, 1993). **Benchmarks for Science Literacy**. New York: Oxford University Press.
- Anderson, C., W., Sheldon, T., H., & Dubay, J. (1990). The Effects Of Instruction On College Nonmajors' Concept Of Respiration And Photosynthesis. *Journal of Research in Science Teaching* 27: 761-776.
- Bahar, M., Johnstone, A., H., & Hansell, M., H. (1999). Revisiting Learning Difficulties in Biology. *Journal of Biological Education* 33: 84-87.
- Cuthbert, A.J., (2000). Do Children Have A Holistic View of Their Internal Body Maps? *School Science Review* 82: 25-32.
- Dickinson, L., V., & Flick, B., L. (1997, March). Children's Ideas in Science: How Do Students and Teachers Perspectives Coincide? Paper Represented at the *Annual Meeting of the National Association for Research in Science Teaching*, Student Ideas in Life Science And Their Implications For Teaching Strand, Oak Brook.
- Doğru, D. (2000). *Development and Application of the Sample Materials in the Instruction of Basic Unit of the Living Things, The Cell Unit*. Master Thesis, Karadeniz Technical University, Trabzon, Turkey.
- Head, J. (1986). Research into 'Alternative Frameworks': Promise And Problems. *Research in Science & Technological Education* 4 (2): 203-211.
- Lazarowits, R., & Penso, S. (1992). High School Students' Difficulties in Learning Biology Concepts. *Journal of Biological Education* 26: 215-224.
- Lewis, J., Leach, J., & Wood-Robinson, C. (2000). What's in a Cell?- Young People's Understanding of Relationship Between Cells, Within an Individual. *Journal of Biological Education* 34: 129-132.
- Mintzes, J., J., & Arnaud, W., M. (1985). Students' Alternative Conceptions of the Human Circulatory System: A Cross-Age Study. *Science Education* 69: 721-733.
- National Research Council (1996). **National Science Education Standards**. Washington, DC: National Academy Press.
- Novak, J., D., & Gowin, D., B. (1984). **Learning How to Learn**. Cambridge University Press, New York, USA.
- Odom, A., L. (1995). Secondary and College Biology Students' Misconceptions About Diffusion and Osmosis. *The American Biology Teacher* 57: 409-415.
- Pashley, M. (1994). A-Level Students: Their Problems With Gene and Allele. *Journal of Biological Education* 28: 120-125.
- Piaget, J. (1929). **The Child's Conception of the World**. London, UK: Routledge and Kegan Paul.
- Reiss, M.J., Tunnicliffe, S.D., Moller Anderson, A., Bartoszeck, A., Carvalho, G.S., Chen, S., Jarman, R., Jonsson, S., Manokore, V., Marchenko, N., Mulemwa, J., Novikova, T., Otuuka, J., Teppa, S., & Rooy, W.V. (2002). An International Study of Young Peoples' Drawings of What is Inside Themselves. *Journal of Biological Education*. 36(2), 58-63
- Seymour, J., & Longden, B. (1991). Respiration-That's Breathing Isn't It? *Journal of Biological Education* 25: 177-183.
- Science Textbook (2002). *Primary Science Education Textbook 6*. National Education Publication, Istanbul, Turkey.
- Steve, J., O. & Kim, B. N. (1998). What is the Purpose of Biology in Education? *School Science & Mathematics*, 98: 268-272.

- Teixeira, M., F. (2000). What Happens to the Food We Eat? Children's Conceptions of the Structure and Function of the Digestive System. *International Journal of Science Education* 22: 507-520.
- Tekkaya, C., Özkan, Ö., & Sungur, S. (2001). Biology Concepts Perceived as Difficult By Turkish High School Students. *Journal of Hacettepe University Education Faculty* 21: 145-150.
- Themane, W. (1990). Pupils' Understanding of Osmosis and Diffusion. *B. Sc. Research Report*. Department of Botany, University of Witwatersrand, Johannesburg, South Africa.
- Toyoma, N. (2000). What are Food and Air Like Inside Our Bodies?: Children's Thinking About Digestion And Respiration. *International Journal of Behavioral Development* 24: 220-230.
- Tunnicliffe, S., & Reiss, M. (2001). Students' Understanding About Human Organs and Organ Systems. *Research in Science Education* 31: 383-399.
- Yip, D., Y. (1998a). Children's Misconceptions on Reproduction and Implications for Teaching. *Journal of Biological Education* 33: 21-27.
- Yip, Y., D. (1998b). Teachers Misconceptions of Circulatory System. *Journal of Biological Education* 32: 207- 216.