An Investigation of Primary Student Teachers' Drawings of the Human Internal Organs

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Received: March 21, 2018 Accepted: April 5, 2018 Online Published: May 28, 2018

doi:10.5430/ijhe.v7n3p107 URL: https://doi.org/10.5430/ijhe.v7n3p107

Abstract

The aim of this study is to investigate primary student teachers' drawings of the human internal organs, e.g. location, size and presence of organs (heart, lungs, stomach, liver, kidneys, pancreas and intestines etc.) This research was conducted with 104 primary teacher candidates studying in the Faculty of Education at Trakya University during the 2016-2017 academic year. The research data was obtained through the use of drawings and interviews with selected students. The findings revealed that, as expected, all students showed the heart, lungs and stomach in their drawings. The most frequently illustrated other human internal organs were intestines, liver, kidneys, pancreas and spleen, respectively. However, too many of them were not scientifically acceptable in terms of the location and size. The teacher candidates tended to usually draw the stomach, lungs and liver smaller than normal size. There are many points in the students' drawings that need to be underlined by teachers during the teaching-learning process in their classes.

Keywords: human internal organs, primary teachers, human body, drawings, organs.

1. Introduction

1.1 Theoretical Framework

Since late 1970s, constructivism, as a theory of knowledge and learning, has been dominant ideology in science education all over the World (Matthewss, 1992). Fensham (1992) states that the most noticeable psychological influence on curriculum development in science education is the constructivist approach. Today, science educators reject a transmission approach to teaching, and dominantly support the attempts and practices associated with constructivist view of learning (Richardson, 1997). It is common view that children develop their ideas about things around them before they are taught in schools. Therefore, they come to classroom with various personal beliefs about the scientific concepts or having personal understanding of scientific phenomena. Even though students' ideas are often not in accordance with the scientific view of things, they use their existing information as the starting point when making sense of new ideas in the school (Bennett, 2003; Colburn, 2000; Harlen, 2001).

It is a well-known fact that traditional approach does not improve the interaction between prior and new knowledge that are crucial for deep and meaningful understanding (Richardson, 1997). This has implications for teaching-learning process and student-centered pedagogies. As Harlen (2001) emphasized, "taking account of children's ideas has found a place in pre-service and in-service courses for teachers in many countries" (p.16). Teachers should be aware of their students' existing ideas and the principles of constructivist learning. There are a variety of techniques to gain access to students' own ideas about a scientific concept and then to replace them with scientifically acceptable ones, e.g. questioning, drawing, writing and discussing about what they think.

Even though there are many ways of collecting data about students' ideas of scientific phenomena (Grusche, 2017; White & Gustone, 1992), as Stears and Dempster (2017) emphasised, traditionally written answers, interviews, questionnaires and concept mapping are often preferred to find out students' conceptions. However, these methods do not always reveal an accurate understanding of scientific concepts. Furthermore, teachers ignore drawings in their classes. Therefore, in order to reveal student' own ideas, drawing as a research tool have received much attention recently. In this study, drawings as the eliciting instrument were preferred to reveal primary student teachers' ideas

about human internal organs. It is widely agreed that drawings are quite easy, practicable, and beneficial research instrument that helps easy comparisons at the national and international levels (Prokop & Fancovicova, 2006).

1.2 Literature Review

With regard to human internal organs, Gellert's (1962) study is one of the oldest and the well-known studies. Gellert investigated children's (aged 4 to 16) knowledge of the body organs in USA, by asking them in hospital to list what they have inside them. Gellert developed a questionnaire and asked children to indicate the size and location of a particular body organ on a blank human body outline. She aimed to identify developmental progressions in children's knowledge about the body. She found that there were small differences among the four to eight-year old children and among the thirteen to sixteen-year old group of children. The remarkable differences were available between the seven to eight-year old children and the nine to ten-year old children. This might probably be expected due to the child's increasing curiosity about the human body. While the young children identified approximately 3 things inside the human body, the others tended to draw 8 organs.

Aiming to investigate how students develop their understanding of the human internal organs, Reiss and Tunnicliffe (2001) studied with a total of 158 students in England from six different age groups (ranging from 4 to undergraduates). Students were instructed to draw what they thought was inside themselves on a blank paper. They found that student understanding of human organs increases with age, and older students have more knowledge about some organs and organ systems with compared to others. Although there were no considerable gender differences in the drawings, there were some interesting differences in the males and females' drawing of the reproductive organs. In a similar study, Reiss *et al.* (2002) explored what young people knows about what is inside them and how this knowledge depends on their culture. They used a cross-sectional approach and participants consisted of a total of 586 pupils (aged 7 or 15) from 11 different countries. They gave students a blank paper and instructed to draw what was inside the body cavity. The research results revealed that the students aged 15 had a better understanding of their internal organs, but they still hold some misconceptions. In another study, Cuthbert (2000) investigated children's (aged 7 to 11) knowledge of human internal body organs by giving a body outline. Most of the eight and nine years old children did not connect organs in their drawings. Many children drew the organs as small, unconnected and freely suspended. He concluded that children showed little progression in their knowledge of the body organs as the age increased.

Prokop and Fancovicova (2006) explored relationships between the level of understanding of first year primary teacher candidates' written responses about the function of body organs and their conceptions of the human body organs drawn on a separate paper. They found that students' written responses revealed a good understanding of their misconceptions about human internal organs. Furthermore, the drawings were useful to expose internal organs' sizes, shapes and locations. In their drawings, urinary, reproductive and nervous system were almost missing but the organs drawn were usually well located. In another study, Cerrah Özsevgeç (2007) explored sixth and eighth grade junior high school students' understanding of their internal bodies. Initially, the students were asked to draw the organs inside their bodies, and then to explain the function of each organ. She found that the students of both grades had a lack of knowledge about the structure and function of the organs.

Considering the common finding of previous research literature, children's internal body knowledge develops with age, Sterk and Mertin (2017) aimed to corroborate how much children know about their internal organs, after the increase in health and body information in school. They asked 189 children (aged 7 to 12) to draw the human internal organs on a body outline. They concluded that the developmental trends found were largely coherent with the previous literature on children's body knowledge. However, children's knowledge of the internal body parts seemed to be more developed than the previous studies but the resources of their knowledge of internal organs are still questionable.

In the Nordic countries, Oskarsdottir *et. al*. (2011) searched young children's ideas about the human body bones and organs. Participants consisted of twenty 6 years old children in each country. They were asked to draw and explain the bones and the organs in the body. The research results showed many similarities between the children's ideas and also some interesting differences. It was clear that the cultures of the countries such as cooking habits, characteristic foods, pictures in books and language expressions had an effect on children's ideas about bones and organs. In a similar study, Aydın (2016) investigated 244 high school students' familiarity with body organs and systems. He used the descriptive survey method. The findings showed that the heart, lungs, kidneys, and stomach were the best known organs. Students most frequently identified organs in the circulatory, respiratory, urinary, and digestive systems rather than other systems. Furthermore, there were no considerable differences between the ninth, tenth,

eleventh, and twelfth grade students' knowledge about organs. The majority of the students identified the small intestine, liver, pancreas, anus, and intestine as parts of the excretory system.

Given that children usually obtain their science knowledge through personal experience, Dempster and Stears (2014) explored seven-year-old South African children' understanding of their internal anatomy. They used drawings to determine young children's knowledge of systems and organs. Research results showed that children were able to draw individual organs but had difficulty in showing relationships between them. Not surprisingly, the informal knowledge children held about their organs appears to be acquired by informal experiences out of class. In a similar study, Stears and Dempster (2017) explored South African first grade (6-8 years) and ninth grade (14-16 years) children' intuitive understanding of their internal organs. They found out that there were significant differences between first and ninth grade students' understanding of human organ systems. Digestive, skeletal and gaseous exchange systems were more commonly represented in their drawings.

1.3 Importance of the Study

A brief review of the literature above indicates that there are several studies about students' understanding of the human internal organs at the pre-school, elementary and secondary levels (Osborne, Wadsworth & Black, 1992; Pfundt & Duit, 1994). However, there is still a dearth of research about the undergraduates' ideas of human internal organs. In order to fill in this gap in the literature, this study explores primary student teachers' understandings of their internal body organs as revealed by drawings. In this way, teachers might be aware that drawings could provide them quite valuable clues in order to use during teaching-learning process.

2. Method

2.1 Data Collection

Different methodologies reveal different features of a student's understanding of scientific concept. There are many ways of collecting data about students' ideas of scientific phenomena e.g. writing, talking, concept maps (Novak & Musonda, 1991), and each of these has its strengths and weaknesses. In this study, drawings were preferred because of the fact that the nature of research topic. Furthermore, drawings have advantages for individuals, who are bashful and shy in conversation, who lack some language skills and they also make easier international comparisons (Reiss & Tunnicliffe, 2001).

During the 2016-2017 academic year, a total of 104 primary student teachers (aged 19-23) studying in the Faculty of Education at Trakya University participated in this study. The students were given an A4 sheet of paper including a human body outline, and asked to draw what they thought was inside their bodies. The body outline provided made easier the placement of organs and possible comparisons between drawings. Almost all students seemed to be willing for their drawings and looked to enjoy. Just before the drawings, they were told not to feel any pressure when drawing the organs. Furthermore, it was told that there was no time pressure, this was not a test, not to copy from each other's drawings. Students were also instructed to label their drawings and to write at least their first name on the paper. They completed their drawings approximately in 15-20 minutes. Following drawings, the interviews were conducted with selected 16 students. All undergraduates had also completed 'General Biology' and 'Science and Technology Laboratory Practices' courses, in the first and second grades respectively. These courses included the human body and the organ systems topics. In this study, gender comparisons were not conducted because of the fact that a high number of the students were female.

2.2 Data Analysis

Students' drawings of the body organs were independently coded by the researcher and an MA student. Some differences between coders were resolved through negotiation and discussion. The intention in the analysis was to accurately judge the location and size of the organ rather than the quality of drawing. If the organ is roughly in the correct position, it was coded as correct or scientific. The criteria used about the size of the organs were normal, too small and too large. In order to clearly analyse the location of organs, the human body cavity was divided into parts as shown in Figures from 1 to 6 (Cakici, 2001).

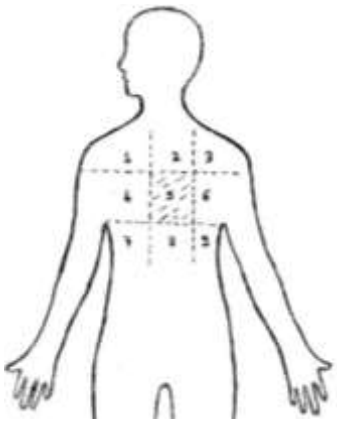

Figure 1. Heart location

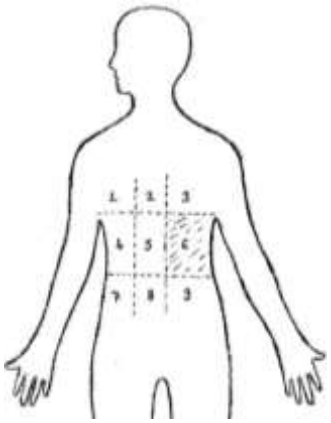

Figure 2. Stomach location

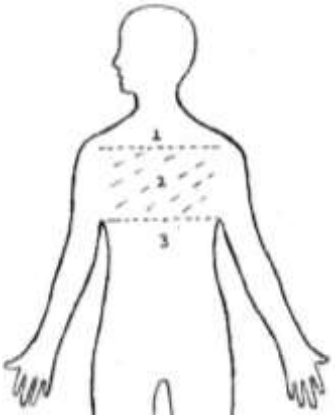

Figure 3. Lungs location

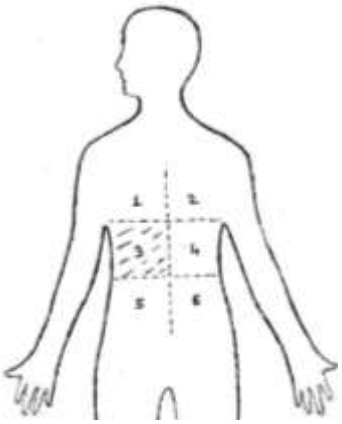

Figure 4. Liver location

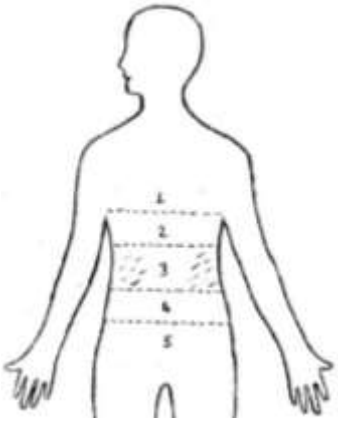

Figure 5. Kidneys location

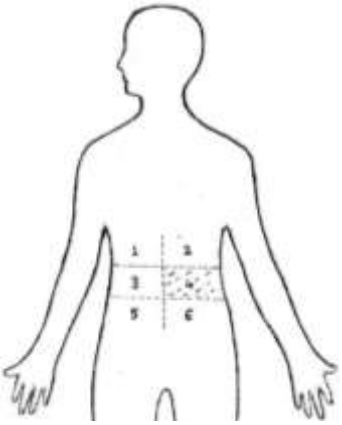

Figure 6. Pancreas location

3. Results

An analysis of the primary student teachers' drawings revealed their conceptions of the human internal organs. Interviews assisted to explain more accurately their drawings. A great majority of the students could show many of the human internal organs but usually without connections between them and also not well-represented.

Table 1. Primary student teachers' drawings of the human internal organs (n=104).

Human body organs	*Drawn*		*Not Drawn*	
	f	*%*	*f*	*%*
Heart	104	100	-	-
Stomach	104	100	-	-
Lungs	104	100	-	-
Liver	92	88.5	12	11.5
Oesophagus	86	82.7	18	17.3
Kidneys	75	72.1	29	27.9
Small intestines	69	66.3	35	33.7
Large intestines	69	66.3	35	33.7
Anus	53	51.0	51	49.0
Pancreas	48	46.2	56	53.8
Gullet	46	44.2	58	55.8
Trachea	41	39.4	63	60.6
Intestines	27	26.0	77	74.0
Spleen	26	25.0	78	75.0
Gall bladder	20	19.2	84	80.8
Urethra	11	10.6	93	89.4
Spinal cord	8	7.7	96	92.3
Others	12	11.5	92	88.5

As seen in Table 1, not surprisingly, all students illustrated the heart, lungs and stomach. Then, the most frequently drawn organs were the liver, oesophagus, kidneys and intestines, respectively. This finding is consistent with the study conducted by Aydın (2016), and Stears and Dempster (2017).

As known, the heart, lungs and stomach are the most frequently referred internal organs for several reasons in the daily life. For example, we always mention the heart for things related to heart beating/blood circulation, the lungs for things related to breathing, and the stomach for things related to eating/hunger in some way. Therefore, they are probably the first organs to be remembered for the students. However, many students drew these organs often without connection to the other organs.

Although 66 percent of the students showed the small and large intestines, a quarter of the students illustrated small and large intestines as simply 'intestine' (Figures, 7 and 8). In the same way, Cerrah Özsevgeç (2007) reported similar findings in her study. Only 12 percent of the 8th grade students showed small and large intestines, and a quarter of them labelled it only as intestines. In this study, during the interviews, when asked why you did not show intestines separately, they often stated in the following way.

"…As you see here, you had drawn intestines as only intestines. Can you explain this? *Yes I am aware of it I knew small and large intestines but I was not sure about the location of them*…"

"…Can you tell me a bit about the intestines? How many intestines do we have?*...I did not know how to show them in the human body. I was confused of shape and location of intestines, then passed it*…"

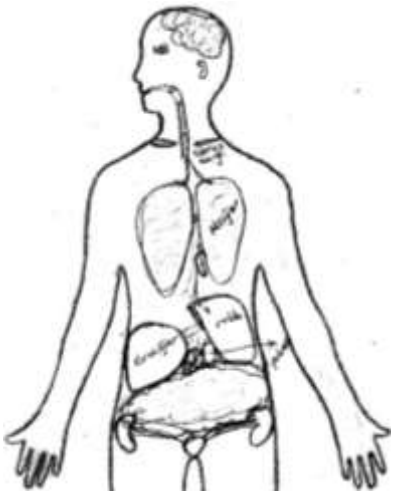

Figure 7. A drawing showing intestines.

(Intestines: Barsaklar)

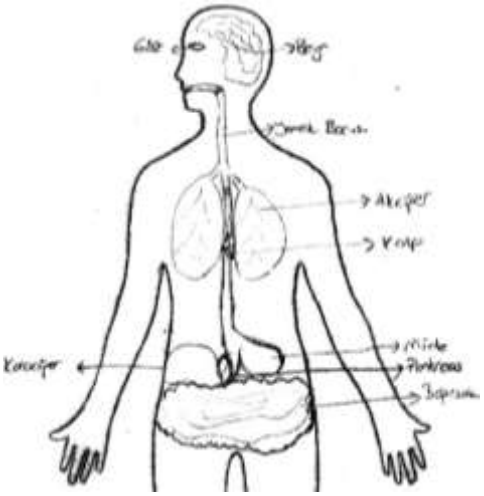

Figure 8. A drawing showing intestines.

(Intestines: Barsaklar)

Interestingly, a great majority of the teacher candidates (75 percent) omitted the spleen in their drawings. Although a quarter of the students drew it, half of them depicted it in different location and size than it was (Figures 9 and 10). There is no doubt that primary student teachers knew the existence of spleen in the body. However, they tended to ignore it in their drawings because of the fact that it is less familiar organ in the daily life, even to adults. Therefore, many students seemed to have more difficulty where it was in the body compared to other familiar organs.

"…*I knew the spleen. It makes pain when running after eating too much. I think it is over the kidneys or around stomach*…"

"…Are you sure about the location of the spleen? *It is in somewhere around the abdomen but I am not sure about its place*…"

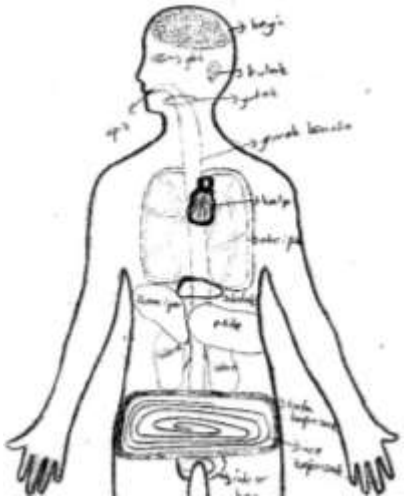

Figure 9. A drawing showing spleen in the middle

(Spleen: Dalak)

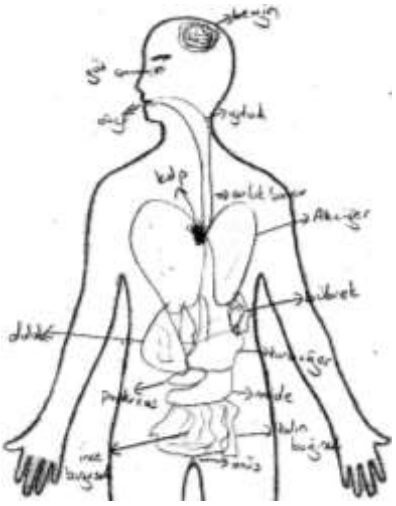

Figure 10. A drawing showing spleen on the right

(Spleen: Dalak)

In this study, a great majority (88 percent) of the students showed the liver in their drawings, but only 46 percent drew the pancreas. Similarly, almost half of the students illustrated anus in their drawings. This was probably due to the view that excretion of the waste foods out of the body occurs in the anus. Hence, they might show the last part of the digestive tract. Less frequently illustrated organs in the students' drawings were trachea, gall bladder, urethra,

spinal cord, respectively. However, a great deal of them was not scientifically acceptable e.g. in terms of location and size.

3.1 Heart

The heart is one of the most vital human internal organs about the size of a closed fist. It is located between the two lungs, behind the breastbone and slightly to the left of the center. In this study, size of the heart was not analysed because of the fact that it was quite hard to categorize students' drawings in terms of bigness. It might be better to use a bigger human outline.

A summary of students' drawings about the heart location is presented in the Table 2 below. The students' drawings were mainly categorised as scientific and non-scientific. Non-scientific responses were recategorised as too high, too low, and on the both side of the heart.

Table 2. Primary student teachers' drawings of the heart location.

The heart location	*f*	*%*
Scientific	***(48)***	***46.2***
Mostly the heart area (cell 5)	48	46.2
Non-scientific	***(56)***	***53.8***
On the both side of the heart	*(24)*	*23.1*
On the right of the heart (cell 4)	2	1.9
On the left of the heart (cell 6)	22	21.2
Too high	*(24)*	*23.1*
Above - on the right (cell 1)	3	2.9
Above the heart (cell 2)	14	13.5
Above - on the left (cell 3)	7	6.7
Too low	*(8)*	*7.7*
Below - on the right (cell 7)	-	-
Below the heart (cell 8)	4	3.8
Below - on the left (cell 9)	4	3.8
Total showing heart	*104*	

Although all students showed the heart in their drawings, less than half could illustrate it mostly in the area encompassed by the heart. About one in five drew the heart on the left of the correct place of it. It was interesting that almost one in four tended to illustrate the heart too high than the correct place of it (cells 1, 2, 3).

It is a fact that 'heart' is a very well-known organ in everyday life compared to the others. However, student teachers still lack of basic knowledge about the location of it. It is worth noting that the heart is not located in the center of human chest. The textbooks and teachers need to emphasize this point.

"…About the place of the heart, are you sure about it?...*Yes I am. It is here. On the left*…How do you know about it?...*I remember from courses, textbooks. I had read that it was on the left*…Is it completely on the left or some parts of it?...*For me, it is completely on the left*…" (Fig.11).

"…What do you think about the place of the heart in your drawing?...*Is it wrong?*...It is not important wrong or correct. Just tell me about your drawing…*I think it is here. It must be here.*…Are you sure about it? How do you know?...*I consider it is there. I put my hand here when my heart beats fast…*" (Fig. 12).

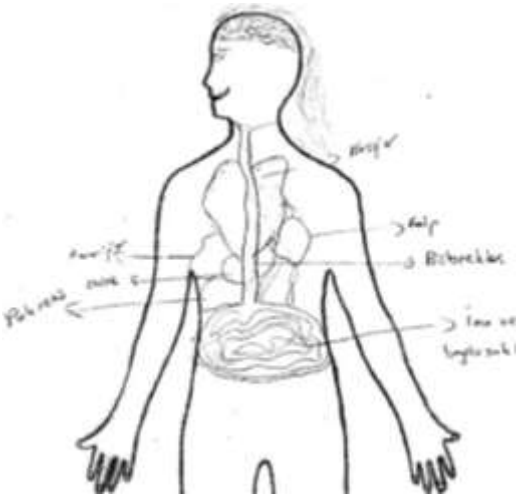

Figure 11. A drawing showing heart on the left

(Heart: Kalp)

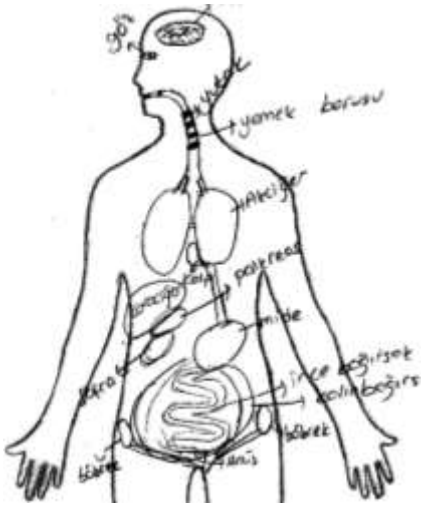

Figure 12. A drawing showing heart too low.

(Heart: Kalp)

3.2 Stomach

The stomach is a bean-shaped digestive organ and located in the upper left part of the abdominal cavity and next to the liver. It holds food a while and secretes enzymes for the breakdown process of food. As seen from Table 3, primary student teachers had a wide variety of diverse ideas about the location of the stomach, and usually placed the stomach in different parts of the body cavity. Only about one in third of students (32 percent) showed the stomach accurately.

Table 3. Primary student teachers' drawings of the stomach location.

The stomach location	*f*	*%*
Scientific	***(34)***	***32.7***
Mostly the stomach area (cell 6)	34	32.7
Non-scientific	***(70)***	***67.3***
Too high	*15*	*14.4*
Over the liver (cell 1)	-	-
Above - on the median line (cell 2)	13	12.5
Above the stomach (cell 3)	2	1.9
Median line	*(51)*	*49.0*
On the right of the stomach (cell 4)	4	3.8
In the middle (cell 5)	47	45.2
Too low	*(4)*	*3.8*
Below the liver (cell 7)	-	-
Below - on the median line (cell 8)	2	1.9
Below the stomach (cell 9)	2	1.9
Total showing stomach	*104*	

As seen in Figure 13, almost half of the students drew the stomach in the middle of upper abdominal cavity, where the area the stomach and liver overlap. In addition, about 15 percent of the students tended to place the stomach too high as in Figure 14. A few students also illustrated the stomach too low. These results show similarities with findings of the study carried out by Cardak (2015) with science student teachers.

"…Can you show me where the stomach is in your body?...*It is here, in the middle…*How do you know?...*The food we eat, goes to there…*"

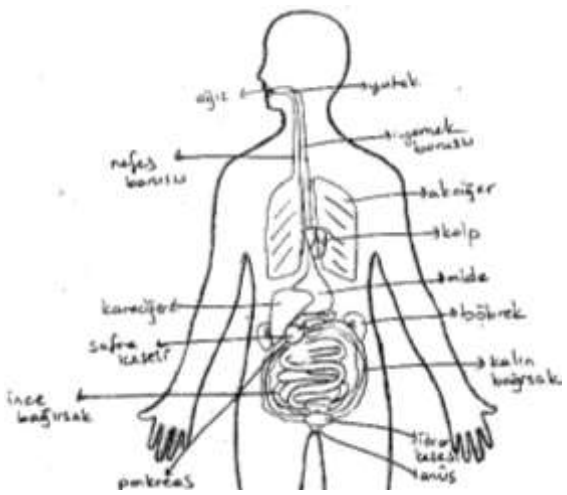

Figure 13. Drawing showing stomach in the middle. (Stomach: Mide)

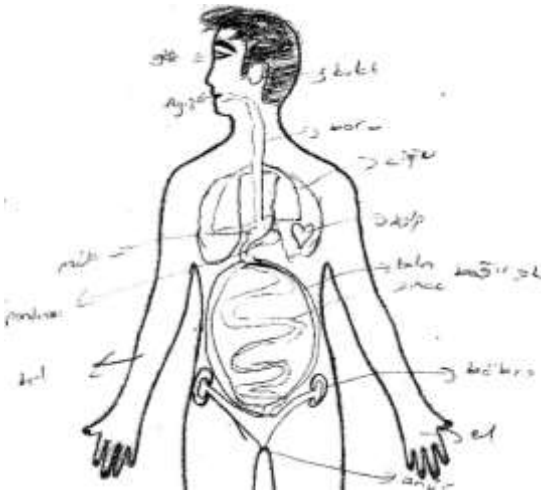

Figure 14. Drawing showing stomach too small. (Stomach: Mide)

Table 4. Primary student teachers' drawings of the stomach size.

The stomach size	*f*	*%*
Scientific	***(38)***	***36.5***
Normal size	*38*	*36.5*
Non-scientific	***(66)***	***63.5***
Too small	44	42.3
Too large	22	21.2
Total showing stomach	*104*	

As seen from Table 4 above, one in three of the students showed the stomach accurately and drew it close to its normal size. While one in five of the students (21 percent) illustrated the stomach larger than normal, the rate of the students depicted the stomach smaller than normal size was around 42 percent, as shown in Figure 14. This finding is not consistent with the results of the study conducted by Cakici (2001) with upper primary level students. Based on the research literature, children are tended to draw familiar organs bigger than normal size but it seems that this changes as the age increased.

3.3 Lungs

Lungs are the major organ of the respiratory system. In the human body, lungs are located in the chest, on either side of the heart. As seen in Table 5 below, a high percentage (80 percent) of student teachers illustrated the lungs as scientifically acceptable. This is not surprising because of the fact that students feel easily the lungs in action when deeply breathing or when they put their hands over their chest. Concerning non-scientific responses, only a few students drew the lungs higher than their correct position but 15 percent of the students showed them lower than normal. These results about the location of lungs were relatively more positive with compared to the findings of previous studies (Prokop & Fancovicova, 2006).

"…How did you decide about the location of lungs? Are you sure about their place in your drawing?...*Yes, our lungs must be here, a little below, in the chest cavity, around the heart*…What about this space at the top, around the shoulders?...*For me, there are muscles over there. Some bones, shoulder bones. I do not think that they might be in higher position…*" (Fig. 15).

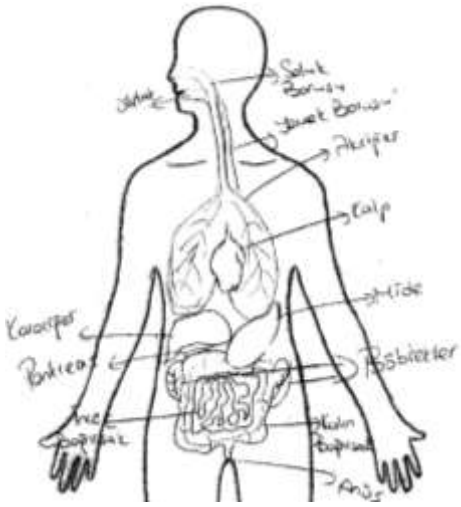

Figure 15. A drawing showing lungs too below.

(Lungs: Akciger)

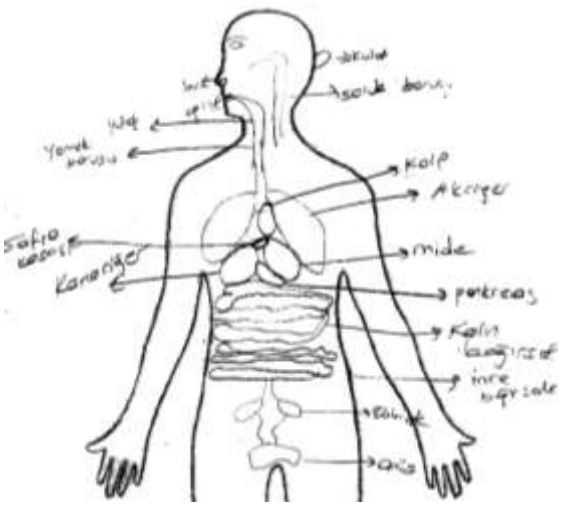

Figure 16. A drawing showing lungs too small.

(Lungs: Akciger)

Table 5. Primary student teachers' drawings of the lungs location.

The lungs location	*f*	*%*
Scientific	***(83)***	***79.8***
Mostly the lungs area (2)	83	79.8
Non-scientific	***(21)***	***20.2***
Too high	*(5)*	*4.8*
Above the lungs (1)	5	4.8
Too low	*(16)*	*15.4*
Below the lungs (3)	16	15.4
Total showing lungs	*104*	

As seen in Table 6, even though all students showed the lungs in their drawings, only a quarter of them illustrated them in their real sizes. Almost 70 percent of them showed the lungs smaller than normal. This finding showed that student teachers were more knowledgeable about the location of the lungs compared to the size of them. Here, we can assert that drawings clearly reveal a high number of students' lack of knowledge about the size of the lungs. In this sense, Kantz (2017) states that drawings have communication benefits that are different from writing, and may become more effective than verbal descriptions for some topics. They help to make learning accessible and accurate for both students and teachers. The following is a student's view about the size of lungs.

"…Let's look at your drawing of the lungs. What do you think about the size of the lungs?...*It was difficult to draw them…*Why?...*Compared to others, the lungs are difficult…*Are you sure about their size in the body cavity?...*Yes, I am. They are here, that big, as I have shown…*" (Fig. 16).

Table 6. Primary student teachers' drawings of the lungs size.

The lungs size	*f*	*%*
Scientific	***(25)***	***24.0***
Normal size	25	24.0
Non-scientific	***(79)***	***76.0***
Too small	73	70.2
Too large	6	5.8
Total showing lungs	*104*	

3.4 Kidneys

The kidneys are one of the most essential organs in the body that filter blood, absorb minerals and produce urine. The kidneys are bean-shaped organs, and located in the upper abdominal area, on the left and right sides of the spine.

Table 7. Primary student teachers' drawings of the kidneys location.

The kidneys location	*f*	*%*
Scientific	***(19)***	***25.3***
Mostly the kidneys area (3)	19	25.3
Non-scientific	***(56)***	***74.7***
Too high	*(14)*	*18.7*
Above the lungs (2)	13	17.3
Very much too high (1)	1	1.3
Too low	*(42)*	*56.0*
Below the kidneys (4)	31	41.3
Very much too low (5)	11	14.7
Total showing kidneys	*75*	*72.1*

Although the kidneys appeared in three quarters of the drawings, only a quarter depicted it correctly. Surprisingly, most of the students' drawings of the kidneys were not acceptable or understandable for this age group. The majority of these students (56 percent) located the kidneys lower than its actual position. It was interesting that there was a high tendency to place the kidneys lower in the body outline compared to its real place (Fig. 17). As was the case in the other organs, the kidneys were frequently drawn in isolation from each other. Cerrah Özsevgeç (2007) found out similar results in her study conducted with 6th and 8th grade students. Only half of the students showed the kidneys in their drawings, and mostly attached the kidneys to the waist area or some located them under the intestines.

"…Can you tell me about the location of the kidneys?...*Kidneys are both sides, and just below intestines*…Are you sure about it or do you guess their place?...*As far as I knew, my drawing shows the kidneys correctly*…Do you remember where you had this knowledge from?...*I think from primary school years. We learnt the function and place of body organs in the middle school years as well*…" (Fig. 18).

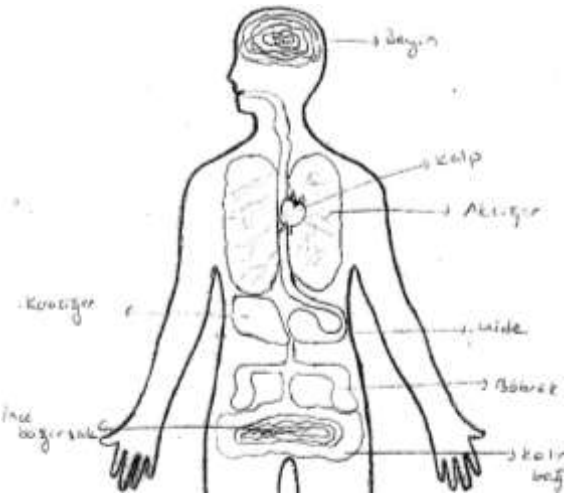

Figure 17. A drawing showing kidneys too low.

(Kidneys: Böbrek)

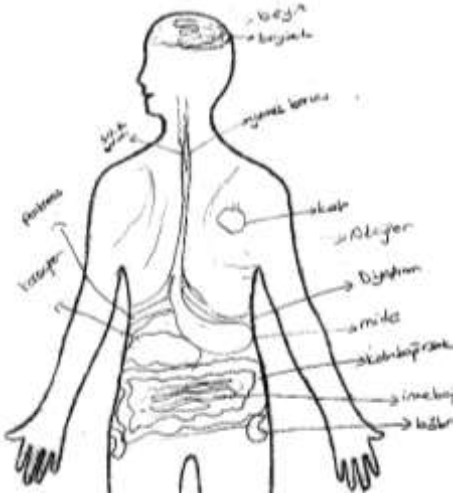

Figure 18. A drawing showing kidneys too low.

(Kidneys: Böbrek)

3.5 Liver

The liver is one of the largest internal organs and located on the right side of the body in the upper right abdomen, beneath the diaphragm. It performs many essential functions e.g. cleaning the blood toxins, aiding digestion and storing nutrients. As seen in Table 8, almost one in three of the students drew correctly the location of the liver, and a similar portion of them depicted it too low. While a small number of them showed the liver on the left, a quarter illustrated it too high.

Table 8. Primary student teachers' drawings of the liver location.

The liver location	*f*	*%*
Scientific	***(31)***	***33.7***
Mostly the liver area (3)	31	33.7
Non-scientific	***(61)***	***66.3***
Too high	*(25)*	*27.2*
Above the liver (1)	20	21.7
Above the stomach (2)	5	5.4
Too low	*(29)*	*31.5*
Below the liver (5)	23	25.0
Below the stomach (6)	6	6.5
On the left	*(7)*	*7.6*
To the left of actual position (4)	7	7.6
Total showing liver	*92*	*88.5*

Table 9. Primary student teachers' drawings of the liver size.

The liver size	*f*	*%*
Scientific	***(36)***	***39.1***
Normal liver size	36	39.1
Non-scientific	***(56)***	***60.9***
Too small	47	51.1
Too large	9	9.8
Total showing liver	*92*	*88.5*

Compared to the stomach size, more students (39 percent) depicted the liver correctly. Although the liver was drawn by 92 students, over the half of them tended to show it smaller than its actual size. Relatively a small number of students (10 percent) depicted the liver larger than normal size.

"…Can you tell me about the location of the liver?...*It is under the stomach, just next to intestines*…Are you sure about it? Can you explain?...*Maybe it might be a little bit around, it can be by the stomach*…There are some empty place in the abdominal cavity in your drawing. What about this space?...*Over there, there might be some fats, some meat, or other organs*…" (Fig. 19).

"…What about the size of the liver?...*I think it is like this. It should not be too big*…How do you know about it?...*I remember from biology courses*…Are you sure about its size?...*Yes I am. As far as I know, it should not bigger than the stomach size…* " (Fig. 20).

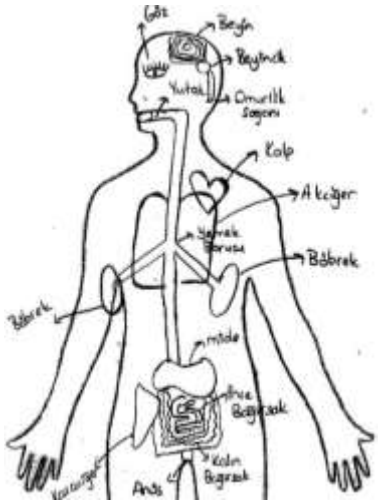

Figure 19. A drawing showing liver too low

(Liver: Karaciger)

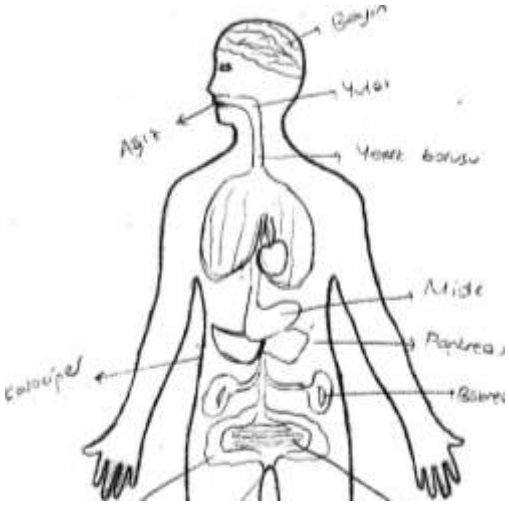

Figure 20. A drawing showing liver too small

(Liver: Karaciger)

3.6 Pancreas

The pancreas is another vital organ in the body. It plays an essential role in digestion process by releasing the digestive juices into the small intestine, and in regulating blood sugar by producing insulin-glucagon hormones. The pancreas, with an average of 15 centimetres long, is located just behind the stomach and is surrounded by the spleen, liver and small intestines in the body.

Table 10. Primary student teachers' drawings of the pancreas location.

The pancreas location	*f*	*%*
Scientific	***(19)***	***39.6***
Mostly the pancreas area (cell 4)	(19)	39.6
Non-scientific	***(29)***	***60.4***
Too high	*(6)*	*12.5*
Over the liver (cell 1)	1	2.1
Above the pancreas (cell 2)	5	10.4
Median line	*(17)*	*35.4*
The liver area (cell 3)	17	35.4
Too low	*(6)*	*12.5*
Below the liver (cell 5)	3	6.3
Below the stomach (cell 6)	3	6.3
Total showing stomach	*48*	

Less than half showed the pancreas in their drawings. As seen from Table 10, only almost 40 percent of them correctly illustrated it. It was remarkable that many students placed the pancreas in the liver area. A small number of the students depicted the pancreas above the correct place of it or below the liver or stomach.

"…What do you think about your drawing of the pancreas?...*Actually, I do not really know exactly where the pancreas is. I think it is very close the liver but not sure*…" (Fig. 21).

"…Can you tell me about the pancreas?...*Actually, I hesitated whether it is an organ or secretion gland but I remember it has an important function for digestion process*…What about its location?...*It is below the liver*…" (Fig. 22).

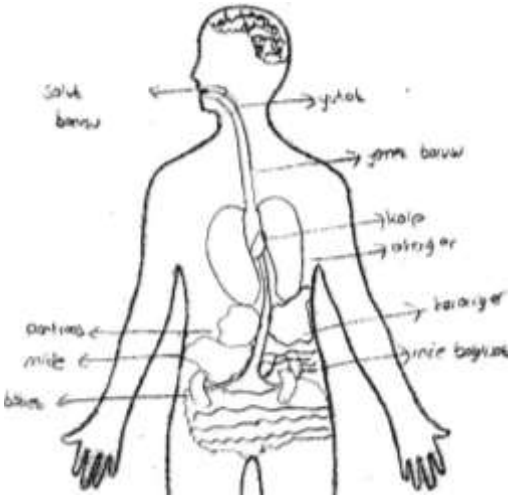

Figure 21. A drawing showing pancreas by liver (Pancreas: Pankreas)

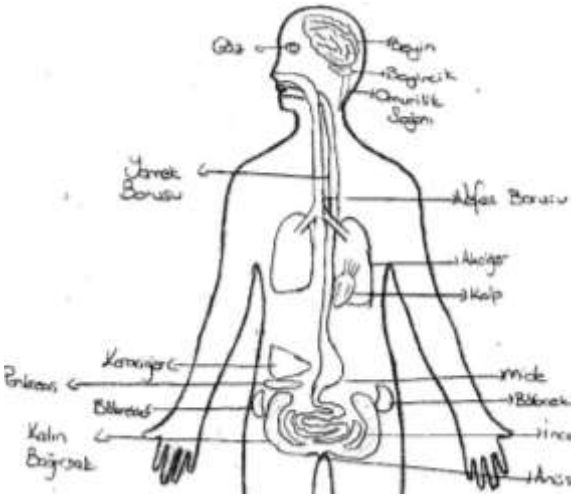

Figure 22. A drawing showing pancreas under liver (Pancreas: Pankreas)

4. Discussion and Conclusion

This study reports primary student teachers' ideas about the location and size of the human internal organs. Students' drawings revealed their understanding of the human internal anatomy. As expected, all students drew the heart, lungs, and stomach. The most commonly drawn other organs were intestines, liver, kidneys, pancreas and spleen respectively. However, many student teachers omitted some crucial organs in their drawings. For example, only 46 percent illustrated the pancreas. This is disappointing because of the fact that the pancreas is a vital organ, and plays an essential role in the digestion of proteins, carbohydrates and fats, and also regulates blood sugar by producing insulin. The case was similar for the spleen, only a quarter showed it in their drawings. Another point to be

considered is related to the sizes of the stomach, lungs and liver. In this study, the student teachers tended to usually draw the stomach, lungs and liver smaller than normal size. This finding is contrary to the findings of studies conducted with younger students in the literature that commonly drew the well-known internal organs larger than normal size (Cakici, 2001).

In general, the students seemed to enjoy during their drawings. As seen in many students' drawings, they drew external features e.g. eyes, ears, lips, nose and hairs, may be due to the fact that they would want to present their drawings more enjoyable and attractively.

It must be noted that 3D anatomy of the human body shows relative overlaps between some organs (notably liver-stomach and intestines-kidneys). For this reason, it might be considered that some students could locate any organ a little bit into different position. In order to overcome this difficulty, during the analysis, if the related organ is roughly in the correct position, it was accepted as scientific. The main intention in this study was not to see whether student teachers list the human internal body organs, rather, to reveal how knowledgeable they are about location and size of them. As seen in the drawings, the knowledge that primary student teachers have of their internal body organs largely have its sources in informal experiences they have had personally or socially outside school, because of the fact that their drawings do not reflect formal information they experienced through the school years (Dempster & Stears, 2014). Misconceptions are still too common in their drawings.

In the drawing approach, participants are required to present their mental models as pictures rather than as verbal or written statements (Boulter & Buckley, 2000; Dempster & Stears, 2014). In this context, drawings can provide teachers very valuable information and clues that can be taken into consideration during teaching-learning process. Many student teachers had a variety of non-scientific ideas about the location and size of the organs. There is no doubt that all students at these ages knew about the human internal organs and it is expected them to provide a relatively well representation of the internal organs. However, in spite of the fact that students have received several biology courses in many levels e.g. middle, secondary and university, a great majority of them had difficulty in providing a good representation of the human internal organs. They were relatively able to draw individual organs, but commonly was no connection in order to show relationships between them. Overall findings show that the previous informal knowledge students hold about what are inside the human body, their location and shape, are still exist in their minds ever since their primary and secondary school years. As Reiss *et al.* (2002) stated, by simply asking students to draw what is inside your body, we may obtain a great deal of valuable information. During teaching process, it might be better to teach initially children individual organs and then organ systems. Children are more familiar with their digestive and skeletons, and then science curriculum may begin the study of human systems with the digestive and skeletal system (Stears & Dempster, 2017).

As Reiss and Tunnicliffe (2001) emphasized, in order to reveal a student's mental model completely, we need to interview with all students about their drawings. We warned the students during their drawing but did not probe them later whether they knew anything else or to label their drawings. Giving the students a human body outline facilitated the placement of the organs. It also made easier the comparison of their drawings with scientifically acceptable ones. However, even though all studies in the literature used A4 sized papers for drawings, using a bigger sized paper e.g. A3, may help to see thin differences in students' drawings.

Based on constructivist approach, children begin to obtain many knowledge and ideas about several scientific phenomena at very early years from their environments e.g. parents, media, peers, friends, books. Vygotsky's theory of cognitive development emphasizes social interaction and conversation. Drawing may be an effective way of obtaining students' informal knowledge and then teachers can use this knowledge for conceptual change (McCaslin & Hickey, 2001). On the constructivist view of learning, Asubel (1968) argued that;

'If I had to reduce all of educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly' (p.7).

Ausubel's theory of meaningful learning postulates that new knowledge is interpreted in terms of the framework of our existing ideas. Rote learning takes place when new information is not connected with other already existing concepts in the cognitive structure of the pupils (Driver & Oldham, 1986). In brief, he strongly emphasized that any teaching-learning strategy should take into account the student' existing ideas prior to instruction. In this context, the teachers have the responsibility to reveal and evaluate what a student's concepts are prior to instruction. As was the case in this study, the drawings can be used as one of the effective research instruments in revealing students' ideas or misconceptions about several scientific phenomena.

In conclusion, before formal education in schools, individuals develop their conceptions of natural phenomena in the early years through personal experience or social life activities (Mintzes, 1984). This is also case for the human body internal organs (Cuthbert, 2000). This knowledge about students' drawings of the human body may have an important educational value for teachers when planning their teaching.

Considering that the vision of Turkish Science Education Program is to graduate each student as scientifically literate individuals from 8th grade, these findings are quite disappointing. Even many teacher candidates are not aware of the position and size of the human body internal organs. The findings of this study suggest that drawings as a teaching method should not be ignored in science teaching-learning process in the class. To build up a more holistic understanding, there is a need to conduct a longitudinal study and to interview all participants.

Acknowledgements

A brief summary of this study was presented in *World Conference on Science and Technology Education-World STE*, 1-5 November 2016, Antalya-Turkey.

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