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**Abstract:** *In this study, it is aimed to identify science and technology pre-service teachers' ideas about the digestive system by using the drawing method. The study was conducted with 95 third and fourth grade pre-service teachers studying at science and technology teacher education department. In the study, a drawing test and The Draw -A-Digestive System Test Rubric (DADST-R), which is developed by the researchers for the analysis of drawings, were used. The scores that science and technology pre-service teachers get from DADST-R are examined in terms of sub-dimensions and the dimension they are best at is found to be digestive system organs while the dimension they are having the most trouble with is establishing connections among digestive system organs. Based on these results, some suggestions were given with regards to the role of the digestive system in the education system.*

**Key words:** *digestive system, drawing method, rubric, science and technology pre-service teacher.*

**Fatma Sasmaz Oren**  
Celal Bayar University, Turkey  
**Ummuhan Ormanci**  
Uludag University, Turkey

## EXPLORING PRE-SERVICE TEACHERS' IDEAS ABOUT THE DIGESTIVE SYSTEM BY USING THE DRAWING METHOD

**Fatma Sasmaz Oren,  
Ummuhan Ormanci**

### Introduction

In revealing individuals' ideas about any event, situation, fact or concept, different methods such as interviews, open ended questions, concept maps and drawings can be used. Drawings which are among these methods are extremely beneficial in revealing the students' level of understanding by putting a little restriction on the answer of the problem (Ayas 2007). As it can be understood, drawings create the opportunity for the students to express their answers more freely compared to other methods. As stated by Prokop & Fančovičova (2006), drawings are also simple tools that ensure making easy comparisons at an international level. Drawings can be used in making concepts meaningful during ordinary activities and collecting a great number of data (Bartoszeck, Machado & Amann-Gainotti, 2008). As seen, the drawing method both provides students with the opportunity to demonstrate their knowledge without restricting them and gives them the opportunity to make cross-cultural studies in different countries.

Drawings have been used in education for many years in order to determine the ideas of people. Firstly, Goodenough (1926) developed the Draw-a-Man Test to survey the intellectual status of young children (Cited: Moseley, Desjean-Perrotta & Utley, 2010). Then, as cited by Picker & Berry (2000) from Mead and Metraux (1957), pupils' images of scientists began in the mid-1950s, when Margaret Mead and Rhoda Metraux initiated a major pilot study in which they investigated images of the scientist held by thousands of American high school pupils. When further research on the issue is examined, it is seen that Shepardson, Wee, Priddy & Harbor (2007) used drawings in their study on students' conceptualizations or mental models of the environment and Alerby (2000) used them in his study on determining an understanding of thinking on the subject of the environment. Moreover, it can be said that drawings are used in determining the students' level of understanding and knowledge, finding out their misconceptions and determining their ideas/images with regards to the concept/issue (Weber & Mitchell 1996; Ayas & Özmen 2002; Kendrick & McKay 2004; Kara 2007; Kaya, Dogan & Öcal 2008; İlkörücü-Göçmençelebi & Tapan 2010; Moseley et al. 2010). When related literature is examined, it is seen that Kara, Erduran-Avcı



& Çekbaşı (2008) made use of open ended questions and drawings in pre-service teachers' understanding of the concept of light. As well as this, Trundle, Atwood, Christopher & Sackes (2010) used interviews and drawings in their study regarding determining the understanding of participants about the phases of the Moon. Dove, Everett & Preece (1999) examined the connections students form between a river basin and the water cycle through drawings in their study. Tunnicliffe & Reiss (1999) used drawings in order to understand the skeleton structure of animals while Prokop, Prokop, Tunnicliffe & Diran (2007) used them in identifying ideas about the inner structure of animals. In this respect, it can be said that drawings are appropriate tools to use in determining students' images, mental models, conceptualizations, misunderstanding, knowledge and ideas.

When literature regarding the digestive system, is examined, it is seen that there is research on determining students' level of knowledge, success and misconceptions. In the studies on the subject when looking at Turkey, it is seen that misconceptions that participants have with regards to the digestive system were found by Güngör (2009) and Güngör & Özgür (2009) through drawings and open ended questions. Also, Çakıcı (2005) aimed to find out the level of primary school students' understanding of digestion through survey forms and follow-up interviews. In a study, Cerrah-Özsevgeç (2007) identified what students know about their internal body parts. The studies on the subject when looking at other countries, Carvalho, Silva & Clement (2007) examined the subject of the digestive system included in primary school textbooks in Portuguese. In a study, Rowlands (2004) identified how students perceive digestion of nutrition through writing-drawings and semi-structured interviews. When research in literature is examined, it is seen that the drawing method in science education is particularly used in studies on what is inside the human body. In their studies, Bartoszeck et al. (2008), Patrick & Tunnicliffe (2010), Prokop & Fancovicová (2006), Reiss & Tunnicliffe (2001), Reiss et al. (2002) asked the participants to draw the inner structure/ systems/ organs of the human body. Teixeira (2000) used the interview method in students' determining the concepts with regards to the structure and functions of the digestive system and asked the participants to draw what organs they use when they eat food and how they process them as well as what happens to the food. As it is seen, although there are several studies regarding the use of drawings on the issue of the human body, only a few of these use drawings on the issue of the digestive system, which is among the systems in our body. In the present study conducted with this purpose, it is aimed to determine science and technology pre-service teachers' ideas about the digestive system, who will teach the subject of the digestive system in their future teaching careers. Moreover, it is aimed that a scoring key is developed for the drawing test and analysis examples are presented. In this respect, the research question of the study can be expressed as follows:

- What ideas do science and technology pre-service teachers have of the digestive system?

## Methodology of Research

### *Research Design*

Within the scope of the current study, a survey was conducted for the purpose of determining science and technology pre-service teachers' ideas about the digestive system. For the Cristensen (2004) the survey technique is a data gathering method which is composed of asking a sample question representing a group opinion about the subject matter condition. The survey studies can be descriptive or analytic. "Descriptive surveys simply describe data on variables of interest, while analytic surveys operate with hypothesized predictor or explanatory variables that are tested for their influence on dependent variables" (Cohen, Manion & Morrison 2007, p. 207). In this context, descriptive survey was used in this study.

### *Participants*

This study was performed with the students of the Faculty of Education in Celal Bayar University, which is a medium sized university in the Aegean region in Turkey. A total of 95 pre-service teachers, 48 of which are studying in the third grade and 47 of which are in the fourth grade in Science and Technology Education participated in the study. A total of 47 of the participants are in day-time education while 48 are in night-time education. A total of 60 percent of the pre-service teachers are female while 40 percent are male. The average age of the sample population was 21.2 years. Prior to this study, this sample population had learned on the digestive system in 'Human Anatomy and Physiology' in their teacher education program. In this lesson, students learn human anatomy, system of body and their structure, place, task etc. This is a mandatory course taken in the fifth semester of the science and



technology education. Thus, third grade pre-service teachers took the course including the digestive system one semester before while fourth grade (last one) pre-service teachers took the same course three semesters before. Participants were recruited on a voluntary basis.

#### Data Collection

The Draw-A-Digestive System Test (DADST), which was developed by the researchers, was used as the data collection tool. The first part of this instrument, which is composed of two different parts, includes some demographic information, such as grade level of the pre-service teachers, program type and gender, while the second part consists of the section where participants are required to draw the digestive system. In the test, there weren't multiple choice questions, open-ended questions, etc. The test included one question about digestive system and the question said that "draw the digestive system in the box". And in the study the pre-application is done and analyzed test's intelligibility. In the main application, all of the pre-service teachers in this study were given the DADST within one week time period in mid-January in 2011. The test is filled out in approximately 15 – 20 minutes in the study.

#### Data Analysis

Different methods of analysis are used for the first and the second part of the test in the analysis of data. While descriptive analysis was used in the first part, in the second part the rubric developed in the analysis of pre-service teachers' drawings was used. A content analysis was done of the 95 drawings using the Draw-A-Digestive System Test-Rubric (DADST-R) to determine the pre-service teachers' ideas about the digestive system. Several resources on the issue of the digestive system have been investigated during the development process of the DADST-R. However, Demirsoy (1992) and Smith's (1995) studies on the digestive system in particular have been used.

The DADST-R rubric is composed of five sub-dimensions in total as digestive system organs, the place of the organs, structure-organs conducive to digestion, connection among organs and the shape of organs. While the score values of each of these parts are different, the highest score was given to the digestive system organs indicator and the lowest score was given to the shape of the organs indicator. The scores that participants took from each part were defined at four different levels as 'insufficient, limited, sufficient and perfect' performance. The highest score that can be taken from DADST-R is 100 and the lowest score is 25. The rubric shown in Table 1 was used by the scorers to independently score the population (n=95).

**Table 1. The Draw-A-Digestive System Test-Rubrics (DADST-R).**

Subscales	Level of Performance			
	Insufficient Performance (1p)	Limited Performance (2p)	Sufficient Performance (3p)	Perfect Performance (4p)
Digestive System Organs (8 p)	Named and 0-2 organs drawn	Named and 3-4 organs drawn	Named and 5-6 organs drawn	Named and 7 organs drawn
Placing of Organs (6 p)	7 or more missing	Indicated in the correct places with 4-6 missing	Indicated at correct places with 1-3 missing	All indicated in the correct places
Structure Organs Conducive to Digestion (4 p)	None is present or there are unrelated structure organs	2 of the structure organs are missing	One of the structure organs is missing	All structure organs are indicated
Connections among Organs (4 p)	Deficiency in 7 or more connections	Deficiency in 4-6 connections	Deficiency in 1-3 connections	All connections are shown clearly
Shape of Organs (3 p)	Deficiency in drawing of 7 or more organs' shape	Deficiency in drawing of 4-6 organs' shape	Deficiency in drawing of 1-3 organs' shape	All organs are drawn and indicated correctly

In DADST-R, it was found to be sufficient to write down 7 organs as the digestive system organs; mouth, pharynx, esophagus, stomach, small intestine, large intestine and anus. Hence for, a perfect performance indicator, the other performance levels of the rubric were determined accordingly based on these organs. The liver, pancreas and salivary glands were based on the sub-dimension of structure-organs conducive to digestion, and



the contents of the other performance levels of the rubric were formed accordingly. Seven organs forming the digestive system and three conducive structure-organs, in other words, ten structure-organs in total were based on the formation process of the sub-dimensions of the location of the organs and the connections among organs, and also the location of the organs in the system as well as to what extent they can perform the connections with each other were investigated. The sub-dimension of the shape of organs is not a scoring in terms of how well the students draw the structure-organs, but a performance dimension regarding to what extent they can represent the comparisons of organ shape and size.

*Reliability and content validity relating to DADST-R:* Drawings of the pre-service teachers were assessed by two different raters based on DADST-R, and inter-rater reliability was calculated. After comparing the grades given by the evaluators, the situations in which there were disagreements were discussed until reaching consensus and final grades were formed. In this study, Kapa statistic was performed to determine consistency among raters (see Table 2). Also Pearson's product-moment correlation was performed to determine index of concordance among raters. Kapa analyses were calculated separately for each criterion, then total grades were transformed into five different levels (grades of 20 and below are level 1, grades between 21-40 are level 2, grades between 41-60 are level 3, grades between 61-80 are level 4, and grades of 81 and above are level 5), thus they became categorical, and Kapa were calculated on grades as well. For the total grades, the results of the inter-rater analysis are Kapa=0.72 with  $p < 0.01$ . Using the formula ( $\text{Estimate} \pm 1.96 \text{ SE}$ ) and the results in the table, an approximate 95% confidence interval on Kapa is (0.85, 0.58). If Kapa analysis results are viewed in each sub-criterion, it can be said that there is perfect agreement between raters in digestive system organs, the location of the organs and structure-organs conducive to digestion; and there is substantial agreement between raters in the connection between organs, the shape of organs and total grades. When correlation results are viewed however, it is seen that relationship level differentiates according to the criteria with 0.69 being the lowest and 0.97 being the highest, and in total there is agreement between raters at a level of 0.91.

**Table 2. Kappa statistic and Pearson's correlations between two scorers on the subscales and overall rubric.**

Subscales	Scorer 1 with Scorer 2 Kappa Statistic	95% Confidence Interval on Kappa	Scorer 1 with Scorer 2 Correlation
Digestive System Organs	0.89	0.97-0.79	0.91
Placing of Organs	0.90	0.98-0.82	0.92
Structure Organs Conducive to Digestion	0.97	1.01-0.93	0.97
Connections among Organs	0.79	0.91-0.67	0.77
Shape of Organs	0.61	0.75-0.46	0.69
Overall	0.72	0.85-0.58	0.91

Additionally, a repeated measures t-test revealed that there was no significant difference ( $p < 0.01$ ) between raters on any of the sub-dimensions (digestive system organs:  $t_{(94)} = 1.65$ ,  $p = 0.10$ ; placing of organs:  $t_{(94)} = -0.44$ ,  $p = 0.66$ ; structure-organs conducive to digestion:  $t_{(94)} = 1.35$ ,  $p = 0.18$ ; connection among organs:  $t_{(94)} = 0.83$ ,  $p = 0.41$ ; and the shape of organs:  $t_{(94)} = 1.82$ ,  $p = 0.07$ ). On the rubric as a whole, there was no significant difference between the raters ( $t_{(94)} = 1.86$ ,  $p = 0.06$ ). Furthermore, according to the t-test results, which have been done for the whole rubric over the results of the whole grades that have been transformed into five different levels as mentioned above, there is no significant difference between raters ( $t_{(94)} = 1.07$ ,  $p = 0.29$ ).

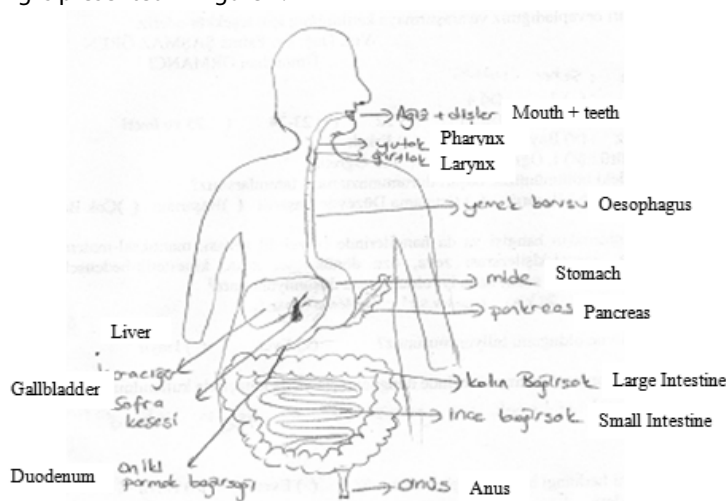
## Results of Research

The results of the study are composed of two main headings, 'findings related to the analysis of the drawings about the digestive system of pre-service teachers' and 'findings related to the ideas about the digestive system of pre-service teachers'.



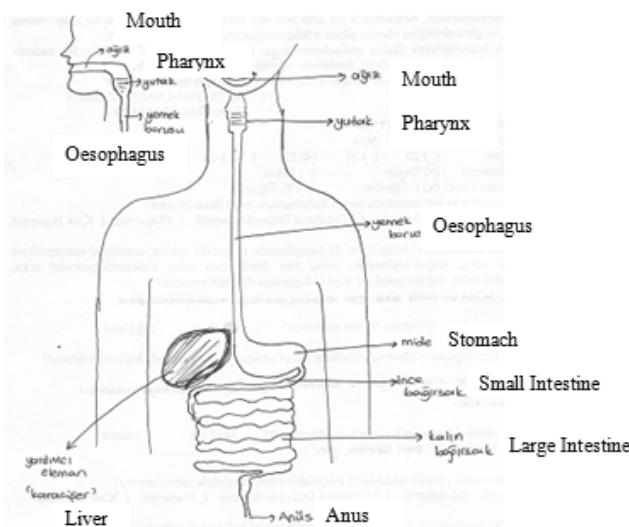
*Findings Related to the Analysis of the Drawings about the Digestive System of Pre-service Teachers*

In this section, analyses examples of the pre-service teachers' drawings devoted to the digestive system are featured. In this line, which has been formed with the purpose of setting a precedent for the use of DADST-R, 4 analyses examples related to five different parts of the rubric have been presented. As a result of the analyses done, it is understood that most of the participants know the digestive system in general, however, have drawbacks on the topic of structure-organs conducive to digestion and in the representation of the connection between organs. A sample for this finding is presented in Figure 1.



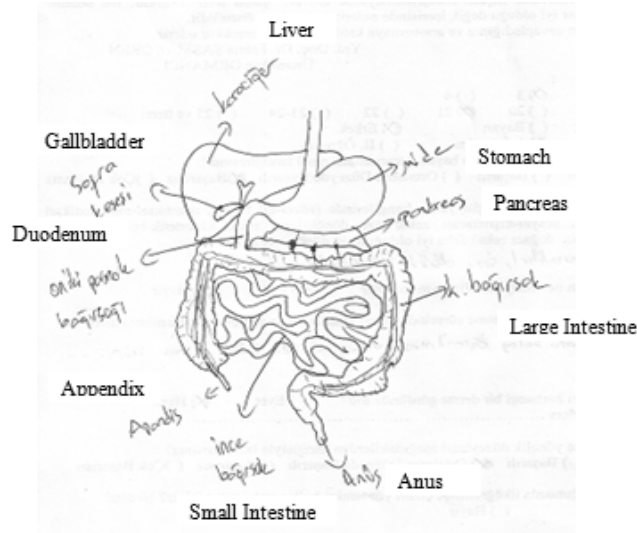
**Figure 1:** An example of a digestive system drawing 1 (pre-service teacher Seher).

When Figure 1 is examined, it is seen that pre-service teacher Seher has an idea about what the organs constituting the digestive system are; however, she drew both the larynx and pharynx as the organs forming the digestive system. As well as this, it is understood that there are some deficiencies about structure-organs conducive to digestion and even though she demonstrated the liver and pancreas in her drawing, she didn't draw the salivary glands. Moreover, when the connection among organs is examined on the participant's drawing, it is seen that there are insufficiency particularly in the connections of conducive organs (for example, no connection is drawn for the liver) and it is determined that this participant is at a 'sufficient performance' level in terms of this sub-dimension in the rubric assessment of the drawing.



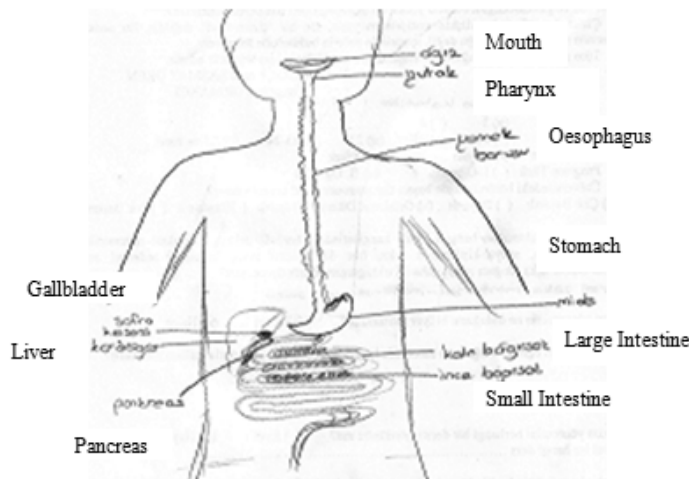
**Figure 2:** An example of a digestive system drawing 3 (pre-service teacher Kübra).

When Figure 2 is analyzed, it is seen that the shapes, locations and connections of the mouth, pharynx and esophagus, which are among the digestive organs, are appropriate. However, when the drawings of the stomach, small intestine and large intestine are viewed, it is understood that their shapes are incorrect and the connections between them could not be formed. Further, it is seen that only the liver is drawn from the organs conducive to digestion and its connection between organs could not be established. In this sense, the participant is evaluated as 'limited performance' in the sub-dimensions of building-organs conducive to digestion, connection between organs and organ location and shape. According to the DADST-R based analysis result, it is understood that most of the participants that took part in the study have problems in the representation of connections between organs, as happened in this drawing.



**Figure 3: An example of a digestive system drawing 5 (pre-service teacher Arda).**

When Figure 3 is examined, it can be seen that candidate teacher Arda has not indicated the mouth, pharynx or esophagus among the digestive system organs. Because of this, he remained at the level of 'limited performance' in the sub-dimension of DADST-R's digestive system organs. However, when the organs included in the drawing are analyzed, it is understood that the shapes of these organs are adequate, their placing is correct and connections are formed nicely. As a result of the analysis done, it is also identified that the pre-service teacher showed 'sufficient performance' in the rubric in these sub-dimensions.



**Figure 4: An example of a digestive system drawing 7 (pre-service teacher Tuğba).**



When Figure 4 is analyzed, it is seen that although most of the organs that constitute the digestive system have been drawn, the anus, which is the last organ of the digestive system, has not been drawn. When the drawings of the pre-service teachers that took part in the study are analyzed, a similar situation has been encountered in most of them and participants have failed to show the anus in their drawings. In this case, the participants in question were graded with the level of 'sufficient performance' instead of 'perfect performance', in terms of the sub-dimension of the digestive system organs, in the rubric. Moreover, in the drawing that pre-service teacher Tuğba made, it is understood that the small intestine and large intestine shapes are shown as mixed. In this study, this problem has been seen in a large part of the pre-service teachers. In their drawings, participants usually indicated the small intestine as a complex structure in the large intestine, or the small intestine and large intestine as structures within each other. In this respect, it can be said that science and technology pre-service teachers have incorrect ideas about the shape and connection of the small and large intestine. These participants have been graded at the level of 'limited performance' in the sub-dimensions of organ shapes and connection between organs, which are part of DADST-R.

#### *Findings Related to the Ideas about the Digestive System of Pre-service Teachers*

According to the final points of pre-service teachers, after the adoption provided between graders, descriptive statistics regarding the results obtained from DADST-R and from its each sub-dimension are given in Table 3.

**Table 3. Frequency and percentage values regarding the grades candidate teachers obtained from the sub-dimensions of the rubric.**

Subscales Points on Rubric	Digestive System Organs		Digestive System Organs		Digestive System Organs		Digestive System Organs		Digestive System Organs	
	n	%	n	%	n	%	n	%	n	%
1	0	0.0	8	8.4	24	25.3	52	54.7	33	34.7
2	7	7.4	53	55.8	29	30.5	42	44.2	50	52.6
3	47	49.5	34	35.8	39	41.1	1	1.1	12	12.6
4	41	43.1	0	0.0	3	3.1	0	0.0	0	0.0
Total	95	100.0	95	100.0	95	100.0	95	100.0	95	100.0

\* From the grades of the rubric, grade 1 refers to "inadequate performance", grade 2 refers to "limited performance", grade 3 refers to "sufficient performance" and grade 4 refers to "perfect performance" (see Table 1).

When the grades that pre-service teachers obtained from DADST-R are analyzed according to their sub-dimensions, it is seen that the area in which they score best is digestive system organs. In respect to this dimension, it can be stated that half of the participants got 3 points, that is, they are at the level of 'sufficient performance' and again 43.1% of them are in the highest point zone. It can be said that the part that science and technology pre-service teachers have most problems with is on the topic of making relations between digestive system organs, and out of 95 pre-service teachers, 52 of them have inadequate ideas related to making connections between organs. As to the location of digestive system organs, it is seen that none of the participants could draw them completely, more than half (55.8%) on the other hand, drew at a limited level. A large part of the primary school pre-service teachers took place in 2 and 3 grade zones in the sub-dimensions of structure-organs conducive to digestion (71.6) and shapes of organs (65.2). As a result, it is seen that there are only three pre-service teachers at the level of 'perfect performance' in all sub-dimensions, except for the first sub-dimension.

When the total grades that the pre-service teachers obtained from the rubric are viewed, it is understood that one person scored in the 21-40 interval and nearly half (49.5%) scored in the 41-60 interval. In addition, it is seen that 46 of them are in the 61-80 interval and 1 of them is in the 81 and above interval. In conclusion, it can be stated that participants know the digestive system topic, but have problems with some aspects of it, especially connections between organs.

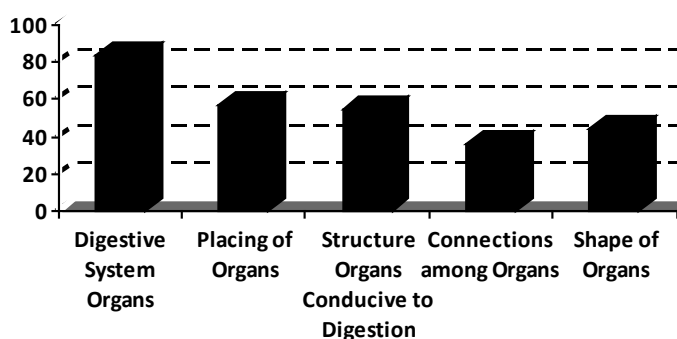
Arithmetic average, which is related to the points the participants obtained from the sub-dimensions of the rubric, and success percentages calculated based on these are shown in Table 4.



**Table 4. Arithmetic averages and success percentages regarding the grades that pre-service teachers obtained from the sub-dimensions of the rubric.**

Subscales	Arithmetic Average	Max. Grade Receivable	Success percentage %
Digestive System Organs	26.88	32	84.00
Placing of Organs	13.64	24	56.83
Structure Organs Conducive to Digestion	8.88	16	55.50
Connections among Organs	5.85	16	36.56
Shape of Organs	5.34	12	44.50
Overall	60.58	100	60.58

As seen in Table 4, pre-service teachers were successful at a rate of 84.0% in the rubric sub-dimension of digestive system organs, at a rate of 56.83% in the sub-dimension of organ location, at a rate of 55.5% in the sub-dimension of structure-organs conducive to digestion, at 36.56% in the sub-dimension of connection between organs, at 44.5% in the sub-dimension of organ shapes, and at a rate of 60.58% in total. In this respect, while pre-service teachers have the most ideas about the digestive system organs in their drawings, the part that they have the least idea about is the connection between organs. This situation is seen in Figure 5.

**Figure 5: Success percentages of teachers regarding the sub-dimensions of the rubric.**

## Discussion

When the grades that pre-service teachers obtained from the rubric regarding digestive system drawings in the study are analyzed, it has been identified that they have sufficient or limited performances in general. In this sense, it can be said that the ideas of the participants related to the topic of the digestive system are at a moderate level. Similarly, in his study with primary school students ( $n=102$ ) about digestion, Çakıcı (2005) concluded that the knowledge and perception of students regarding digestion is less than the expectations of teachers and the curriculum. When the grades of the participants they received from DADST-R in the study are examined, it is seen that the area in which they are best is digestive system organs. It can be said that the stomach, one of the digestive system organs, is included in almost all the drawings. Similarly, in his study continuing with secondary school students and teachers, Güngör (2009) also states that the stomach is often mentioned in digestion and that due to cultural factors, the stomach is the most important digestive organ, which is formed in the minds of the students. In the study we did, it can be said that in terms of the sub-dimension of digestive system organs, science and technology pre-service teachers have drawbacks only on the topic of the anus, which is the last organ of the digestive system. In this regard, it is thought that pre-service teachers relate the anus with the excretory system and because of this they did not include it in their drawings. Similarly, in the study they did, Güngör and Özgür (2009) mention that primary school students ( $n=48$ ) have incorrect ideas about the relationship between the digestive and excretory system organs, and they did not refer to the anus generally in the drawings they did.





It can be stated that science and technology pre-service teachers have sufficient performance about structure-organs conducive to digestion. However, when their drawings about the topic are analyzed, it is seen that the least repeated structure-organ conducive to digestion is the salivary gland. Moreover, it can be expressed that participants are sufficient in the sub-dimension of digestive system organ location, which is part of the rubric; however, they have drawbacks, especially about the placement of organs conducive to digestion. When the grades of the participants obtained from DADST-R are analyzed, it can be said that they have limited performance in the sub-dimension of organ shapes and that almost none of the participants could draw completely. It is seen that there are drawbacks, especially in the shapes of the small intestine, large intestine, salivary glands, pancreas and the liver. Similarly, in the study of Cerrah-Özsevgeç (2007), it is stated that secondary school students (n=112) usually know the names of the organs, but have problems with their functions, locations and shapes. At the same time, in their study Cerrah, Özsevgeç and Ayas (2005) applied a proficiency survey regarding the systems in our body chapter to biology pre-service teachers, and they stated that 22% of pre-service teachers do not have sufficient knowledge about the location of the organs in the systems in the body. However, in the writing part it is seen that results opposite to this situation also occurred. In the study they did, Bartoszeck et al. (2008) state that most of the participants (143 pre adolescents and adolescents students) can place organs and organ systems in the human body in appropriate positions.

In the research done, it can be said that the part that science and technology pre-service teachers have most problems with is making relations between digestive system organs. Similarly, in their study Patrick and Tunnicliffe (2010) asked 71 science teachers to draw the structures in the human body. At the end they stated that the participants cannot form connections between organ systems and organs; and although they recognize the organs, they cannot show their interaction. Moreover, in their study Cerrah et al. (2005) expressed that 40% of the pre-service teachers do not have sufficient knowledge about the connection of organ and structures with each other in the systems. In their study, Dempster and Stears (2013) aimed that a group of seven-year-old South African children understand of their internal anatomy and founded that despite children were able to draw individual organs, they were unable to show relationships between them.

## Conclusions

The digestive system topic is one to one related to daily life like many other biology topics, and is one of the important topics, which can be effective in directing the behaviour of an individual (such as healthy dieting) and in knowing him/herself. In this respect, it can be expressed that bringing up the ideas of pre-service teachers, who will be the teachers of the future, about digestive system and organs that compose it is important. When the ideas of the pre-service teachers about the topic are viewed on the other hand, it is understood that they know the digestive system and structure-organs that compose it, however, they have some problems about the shapes of them and how they are connected to each other. In this respect, workshops about the digestive system topic and how this topic can be learnt more effectively can be arranged for pre-service teachers in universities and for science and technology teachers, who explain the topic in classes, in in-service training. It may be recommended that these workshops include applications besides giving pedagogical knowledge; present technology based examples, such as animation and simulation, and includes a learning process based on inquiry.

In the research it is seen that the drawings of the pre-service teachers provide a large amount of information about their ideas intended for the digestive system. However, in some studies (Prokop and Fančovičova 2006), together with the drawings it is recommended to do interviews by asking students questions especially intended for explaining the drawings they did. Therefore, it is thought that asking for written explanations supporting their drawings, intended for determining their ideas about the digestive system or obtaining their ideas would provide in depth knowledge and it is being recommended for the future research. Moreover, obtaining the ideas of students at different age levels about the digestive system may be recommended. In this respect, obtaining the ideas of both the students at different educational levels and teachers that teach this topic in class with the help of the drawing method and interviews and/or open ended questions, which will deepen the findings of this method, may be proposed.

This study was carried out with the pre-service teachers in a mid-sized university in the Aegean Region in Turkey. Therefore, larger-scale studies done in a greater number of universities are needed. It could also be suggested that the role of variables such as age and gender could also be examined.



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**Fatma Samaz Oren**

PhD., Associate Professor, Celal Bayar University, Faculty of Education,  
Department of Science Education, Turkey.  
E-mail: fsasmaz@gmail.com

**Ümmühan Ormanci**

PhD Student, Uludağ University, Faculty of Education, Department of Science  
Education, Turkey.  
E-mail: ummuhan45@gmail.com

