

Teaching Seventh Graders about the Digestive System Using Formative Assessment to Evaluate Comprehension Levels*

Türkan ÇAKMAK^a, Nermin BULUNUZ^b

Abstract

Biology lesson is one of the leading lessons that the students at all educational levels encounter with difficulty in grasping the subject matter and the teachers in teaching it. The reasons for this situation can be identified as the methods and techniques used in the education process being traditional, the fact that some biology course's subject matter concepts are abstract and the teachers have difficulties in concretizing while teaching them and the students having difficulties in grasping these abstract concepts. The purpose of this study was to investigate the effect of the formative assessment method on the conceptual understanding of 7th grade students about the digestive system in the "systems in our body" unit in the science course. Formative assessment probes were given to both the experimental and control groups as pre-test and post-test. Formative assessment strategies were developed and applied in an attempt to replace the existing misconceptions with scientific concepts. Hundred and five seventh grade students participated in the experimental study which included a pre-test/post-test control group design. The findings illustrated that there was a significant difference about the digestive system between the conceptual understanding levels of the experimental group students and the control group students.

Keywords: Formative Assessment Strategies, Conceptual Understanding, Formative Assessment Probes

Introduction

In the relevant literature, the concept of formative assessment is defined as providing feedback and correction at every stage of the teaching-learning process (Bennett, 2011). The main objective of the formative assessment method is not to evaluate students through their grades. It aims, instead, to reshape the course to be taught through the provision of feedback on learning and teaching so that the students can accomplish their conceptual understanding (Black & William, 2009; Metin & Özmen, 2010). According to Keeley, Eberle, and Farrin, (2005), formative assessment is the assessment used for learning and teaching. In this assessment, the students' prior knowledge and alternative concepts enlighten the teacher about how the subject matter course will be taught, and the teacher, eventually, decides what kind of technique to use. Assessment is implemented continuously at the beginning of the course and throughout its teaching (Bulunuz & Bulunuz, 2013).

Formative assessment probes, forming the basis of the formative assessment method, which is also the subject of this study, are also utilized to identify the knowledge and information that the students have that is lacking in scientific content. These questions, which are briefly termed as "formative assessment probes" can be designed as both open-ended and multiple choice question. Therefore, the students not only reveal the misconception with the option they mark, but also illustrate the thought system with the open-ended answers they give. The formative assessment probe, which means "examining", "probing", "investigating" (TDK, 2005) in the English-Turkish dictionary, was effective in revealing the misconceptions when included in science education.

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Corresponding Author:
Türkan ÇAKMAK
Bursa Uludağ University, Turkey.
E-mail: turkancakmak35@windowslive.com

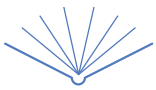
^aTürkan ÇAKMAK
ORCID: <https://orcid.org/0000-0002-0992-5902>
Faculty of Education, Bursa Uludağ University,
Bursa/Turkey.
E-mail: turkancakmak35@windowslive.com

^bNermin BULUNUZ
ORCID: <https://orcid.org/0000-0001-7891-0379>
Faculty of Education, Bursa Uludağ University,
Bursa/Turkey.
E-mail: nbulunuz@uludag.edu.tr

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However, formative assessment strategies have features that are similar to the argumentation method and differ in certain aspects. Argumentation basically requires coordinating theory with evidence and choosing between competing theories through critical evaluation (Köseoğlu & Tümay, 2011). In this respect, formative assessment strategies are similar to the argumentation method.

Argumentation can be expressed as a written or verbal process in which opinions are exchanged about the validity of a claim, using data, reasoning, support and rebuttals to persuade people, to get their claim accepted, and the other claim is criticized, discussed and reconsidered (Berland & Reiser, 2011; Driver, Newton & Osborne, 2000; Toulmin, 2000). Argumentation, which differs from formative evaluation strategies in this respect, includes an effort to prove or disprove the asserted claims. Students are aware of each other's ideas and discuss these ideas. The formative assessment strategy, on the other hand, includes the scoring part as an assessment strategy. Answers are evaluated with rubrics. In this method, other students do not see or discuss the answers given by the students to the open-ended questions. The student only writes answers to open-ended questions using their own cognitive processes. He gets a point based on his answers.

Together with the advancing technology, the new educational technologies have affected biology education as well. The use of gamification, virtual reality, digital games, concept cartoons has become widespread in biology lessons, which are seen as abstract, boring and difficult by students. For example, nowadays simulations are used especially in impractical, expensive or very dangerous laboratory work (Bajzek, Burnette & Brown, 2005). It has made it inevitable for the use of traditional methods and techniques to be reduced. It is simply because proceeding to teach the fast-advancing biology science to students with traditional methods and techniques means becoming distanced from innovation and investigative research (Canoğlu, 2004). As far as majority of the students are concerned, biology, one of the sub-branches of science, can only be learned through memorization (Ursavas, & Kesimal, 2020). Nevertheless, biology is very significant both in terms of being closely related to other branches of science such as chemistry and physics and being closely related to such the issues as global climate changes, sustainable development, and rapid depletion of energy resources in today's world (Börü, Öztürk, & Cavak, 2003).

When the secondary school biology subjects are examined, students who are initially introduced to the digestive systems in the fifth grade study these subjects by a certain model in order for them to be suitable for their cognitive levels (add citation) (Soeharto, Csapó, Sarimanah, Dewi, & Sabri, 2019). Nevertheless, in addition to the advantages of using a model, it also possesses some disadvantages such as misconceptions. The students who fail to acquire sufficient subject matter foundation in the fifth grade encounter these concepts again in the seventh grade and suffer from difficulties in constructing new knowledge with the misconceptions they have acquired (add citation). (Soeharto, and et all, 2019). In many studies done on the digestive system, it is clearly stated that the fact that the digestive system is defined as "a tube with two open ends" (Carvalho, Silva & Clement, 2003). (add citation), the stomach as "a balloon that has no connection with the mouth, without any entrance and exit" (Carvalho, Silva & Clement, 2003). (add citation), and the stomach as the most important organ of the digestive system all lead to some epistemological-based misconceptions (Bahar, 2001; Carvalho, Silva, & Clement, 2003; Yaman, Dervişoğlu & Soran, 2004).

In order to stop the misconceptions to emerge in students, teachers and pre-service teachers themselves should not have any misconceptions and teachers should know about possible misconceptions in their students in advance (Gökkurt Özdemir, Bayraktar & Yılmaz 2017). New strategies an important role to play in identifying and eliminating these misconceptions. Despite all this progression, the traditional methods are valued more considerably in our country than these strategies. When this particular situation is regarded from the point of view of teachers, the prejudiced point of view towards the new methods can be listed as a lack of self-confidence in using the new educational technologies and methods, and resistance to innovations. It is commonly known that when the teacher applies the method effectively in the lessons taught with formative assessment, which is one of the alternative assessment and evaluation approaches, student participation and motivation increase, it has a positive effect on conceptual understanding levels, and students learn the subject matter knowledge and information more permanently. As far as some previous research results are concerned, it was concluded from the observations, experiences, and the applications of formative assessment probes that the formative assessment approach had considerable potential to assist the conceptual learning in science courses (Bulunuz & Bulunuz, 2013).

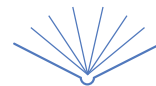
In the literature, it has been revealed that there are learning difficulties in biology, photosynthesis, osmosis-diffusion, cell divisions, ecology, evolution, digestive system, respiratory system, excretory system, nervous system and hormones, circulatory system, enzymes and genetics and there are misconceptions on these issues. There are studies that put (Pelaez, Boyd, Rojas, & Hoover, 2005; Sebitosi, 2007; Selvi & Yakaşan, 2004). Contrary to this situation, when the studies on the concepts in the seventh grade "systems in our body" unit in our country are examined, it is seen that very few studies have been carried out on the detection and elimination of misconceptions in the teaching of digestive systems. (Bahar, 2001; Carvalho, Silva, & Clement, 2003; Yaman, Dervişoğlu, & Soran, 2004). Please add here literature review on about the digestive system !!!

The purpose of the present study is to investigate the effect of formative assessment method on the conceptual understanding levels of 7th grade students about the digestive system in the "systems in our body" unit in the Science course. Therefore, the study has sought answers to the following research questions:

1. Is there a significant difference between the pre-tests of the experimental groups that have used the formative assessment method in teaching the concepts of the digestive system in the seventh grade "systems in our body" unit and the control groups that have not used this method?
2. Is there a significant difference between the post-tests of the experimental groups that have used the formative assessment method in teaching the concepts of the digestive system in the seventh grade "systems in our body" unit and the control groups that have not used this method?

Method

In the present study, the "experimental design with pre-test-post-test control group", one of the quantitative research methods, was used. The designs that aim to identify the cause-effect relationships between variables are called experimental designs (Büyükoztürk, 2001). The experimental studies, conducted to identify the cause-effect relationships,



are those in which data to be observed are generated under the control of the researcher (Karasar, 2000).

Data Analysis

In the present study, a rubric developed by Karataş (2003) was utilized to evaluate the formative assessment probes numerically, and the answers given by the students were evaluated based on this key. The analyses of the open-ended answers of the students were carried out by categorizing the answers of the students as a whole.

Research Design

The formative assessment probes, which were used as a pre-test at the beginning of the semester, were given to all students as a post-test at the end of the semester, and the data collected from the formative assessment probes were analyzed and compared. For the experimental design used in the study, see Table 1.

Table 1. Experimental Design of the Study

Group	Pre-tests	Experimental Process	Post-tests
Experimental Group	Formative probe question 1 and 2	Formative Assessment strategies	Formative assessment probes

Formative Assessment Strategies

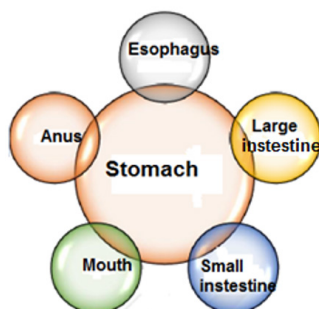
In this study four formative assessment strategies were used. The names of these strategies are: 1) First drawing-final drawing; 2) Where does the digestion of proteins begin? 3) Which ones pass into the blood without being digested? 4) Can you find the different sentence?

These formative assessment strategies were explained in the following section:

1) First Drawing - Final Drawing

In this formative assessment strategy, students are initially asked to show, by drawing, the place of digestive system organs such as mouth, pharynx, esophagus, stomach, small intestine, large intestine and anus, and other structures and organs with which they are associated. It is aimed that the students are expected to achieve the following outcome; "The students are able to indicate the structures and organs that make up the digestive system on a model, plate and/or diagram".

Figure 1. First Drawing, Final Drawing



Before teaching the concept of digestive system, the following information was given to the students and also the researcher wanted the students to draw the digestive system in the box:

"You know, previously we learned the organs of the digestive system. Using the names of the digestive system organs given above, please draw our digestive system in the 1st box given below."

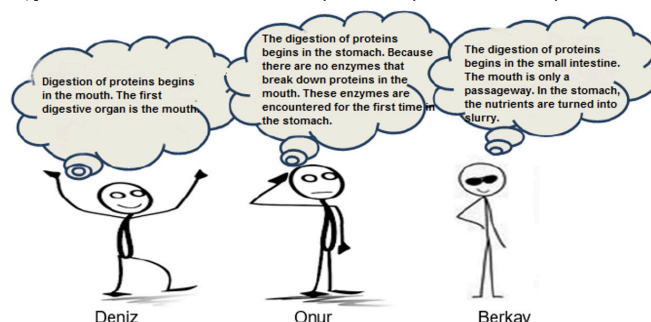
Then, the researcher taught the concept of digestive system by using the formative assessment techniques, shared the following information with her students, and wanted them to redraw their second drawing in the second box given:

"You know, previously we learned the digestive system. Within the framework of your new knowledge and information about this subject, please redraw our digestive system in the 2nd box given below. Please make sure that the names of the organs mentioned above are included in your drawing."

2) Where Does the Digestion of Proteins Begin?

In this formative assessment strategy, it was attempted to teach the students that even though the journey of food in the digestive tract began in the mouth, the places of initiation of digestion were different. At the same time, students were aimed to achieve the outcome that the students could predict that the foods had to undergo some changes in order for them to be beneficial to the body and explain that the passage of digested foods from the intestines to the blood.

Figure 2. "Where Does the Digestion of Proteins Begin?"

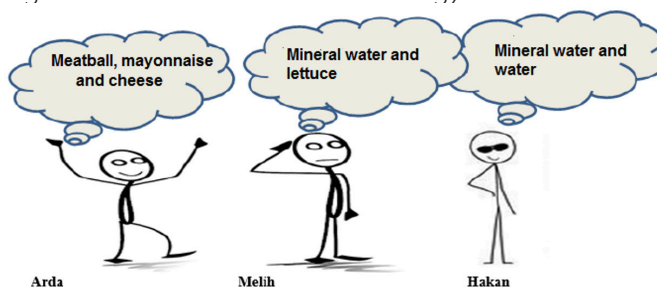


Which stickman opinion do you agree with? Explain your reason.

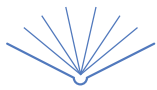
3) Which Ones Pass into the Blood without Being Digested?

In this formative assessment strategy, it was aimed to provide the students with the knowledge that some foods did not need to be digested during the journey of foods in the digestive tract, and some foods were mixed into the blood without being digested. Similarly, the digestion of proteins was important since the concepts learned in the fifth grade such as vitamins and minerals were needed to be remembered.

Figure 3. "Which Ones Pass into the Blood without Being Digested?" Formative Assessment Strategy



Which stickman opinion do you agree with? Explain your reason. 4) Can You Find the Different Sentence?



In this formative assessment strategy, it was aimed to enable the students to be able to distinguish the concept of digestion as physical digestion and chemical digestion and categorize the many examples. It aimed to help the students to learn the skill of analyzing, which is one of the upper skills of the cognitive level, as well as the knowledge that in order for nutrients to pass into the blood, they should undergo physical (mechanical) and chemical digestion.

One sentence given below is different from the others in the sentence groups regarding "chemical digestion". Circle the sentence that is different and explain why you think it is different next to the relevant sentence.

Figure 4. "Can you find the different sentence?"

Which one is different?	Why is it different?
Butter breaks down in the small intestine	
Chewing the biscuit in the mouth	
Softening bread with saliva	
Gall breaks down the fat	
Which one is different?	Why is it different?
pancreatic juice breaks down the proteins	
Enzymes break down foods	
Food mixes in the stomach	
Effect of gastric juice on proteins	
Which one is different?	Why is it different?
The effect of enzymes in the stomach on food	
Passage of nutrients through the large intestine	
Passage of food through the esophagus	
Absorption of water from the large intestine	

The outcomes targeted by the formative assessment strategies applied to the experimental groups, the misconceptions it revealed and the concepts that students needed to learn are given in the table below.

Study Group

This study was implemented at a public secondary school in Beykoz, Istanbul. In this study, data were collected from four 7th grade sections (total of 105 students) from the same school, two of which were experimental and two were control groups. Four 7th grade sections, which are the experimental and control groups, were randomly selected from all the branches in the school. The researcher was the science teacher of 2 classes (Sections 7D and 7E) identified as the experimental group. Another science teacher taught the students (Sections 7B and 7F) included in the control group. During the education period in which the research data were collected, the researcher science teacher was given not four but only two 7th grade branches by the school administration. For this reason, the researcher had to determine these two 7th grade branches given to her as the "experimental group". The other two 7th grade branches, which will be the control group, had to be selected from the 7th grade branches entered by another science teacher working in the same science department. The distribution of the students in the experimental and control groups taking part in the study by sections is shown in the Table 2 below.

Table 2. Distribution of Students in the Experimental and Control Groups by Their Sections

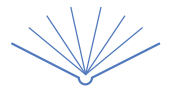
Section	Experimental Group	Control Group
7-B	-	23
7-F	-	28
7-D	28	-
7-E	26	-
Total	54	51
Grand Total	105	

Before the onset of the study, an official petition was submitted to the relevant authorities; materials such as the scale activity to be applied were presented and the necessary legal application permissions were obtained. The permission petition is available in Appendix-1. Based on this, in the science course, primarily the formative assessment probes consisting of 2 stages were applied to 33 students in order to identify the prior knowledge of the 7th grade students about this unit and their first information ever about the digestive and excretory systems or the concepts that had no scientific content (misconceptions), if any, were identified.

The formative assessment probes used in the study were related to the concepts of digestive systems, a subject available in the 7th grade "systems in our body" unit of the Primary School Science Course Curriculum. A pre-test was applied to the experimental and control groups and the students' answers were analyzed to identify the students' conceptual comprehension levels. Afterwards, in line with the experimental design, specific science lessons were planned to replace the misconceptions of the students in the experimental groups with scientific concepts or correct the alternative concepts. For this purpose, the following formative assessment strategies were applied: a) First drawing- last drawing, b) Can you find the different sentence? c) Where does the digestion of proteins begin? d) Which ones pass into the blood without being digested? In addition to these strategies, the students in the experimental groups were also given activities such as the digestive tract experiment, poster work, and game preparation.

For this purpose, new lesson plans were created for the experimental group students and a special education program including formative assessment strategies was implemented in these sections. The strategies applied to the experimental groups were designed and created by the researcher in a way to eliminate the common misconceptions about the digestive systems in students. For example, There are misconceptions that the digestive system is depicted as a pipe with two ends, the digestion of proteins begins in the mouth because digestion begins in the mouth, the systems in our body work in separate sections independently of each other, and all the nutrients taken into the body must be digested (Çuçin, Özgür, & Güngör Cabbar, 2020.) The formative assessment strategies were not applied to the students in the control group; instead they were taught in accordance with the outcomes projected in the 2014 Science program.

During the study (lasting for 6 weeks, 22 course hours in total), the researcher and the science teacher who taught the students in the control group were in constant communication and informed each other about the teaching processes.



Data Collection Tools

Formative assessment probes

The formative assessment probes in the study consisted of two stages. The first part of these questions included the options related to the question, and the second part included the part where scientific explanation of the choice was required. The formative assessment probes and formative assessment strategies utilized were generated by the researcher, inspired by the strategies in the book titled "Science Formative Assessment: 75 Practical Strategies for Linking Assessment, Instruction, and Learning" written by the subject matter expert Page Keeley (2011). The validity and reliability check of the probe questions were implemented by consulting expert opinions in the Fall of 2015. According to Lawshe's 1975 study, at least 5 different experts should be consulted to determine validity. For the determination, the opinions of 2 science teachers working in the same school and 3 science teachers working in different schools were taken. Teachers who expressed their opinions expressed their opinions by dividing them into three categories. They chose one of the categories "Cannot measure the targeted outcome, fully measure the targeted outcome, partially measure the target related outcome", and necessary corrections were made in the survey questions in the light of this information.

In the present study, an evaluation criteria for the two-stage questions was developed by Karataş, Köse and Coştu, (2003) was utilized to evaluate the formative probe questions numerically, and the answers given by the students were evaluated based on this key. The analyses of the open-ended answers of the students were carried out by categorizing the answers of the students as a whole.

1) Which system?

The students who learned the basic structure of the digestive system organs and their simple functions in the fifth grade also learned the important systems in our body such as the circulation and respiratory system in the sixth grade. As far as the principle of spirality in science education is concerned, the students will learn more comprehensively about the digestive system in the seventh grade. Early in the seventh grade, the students regard the systems as systems that have separate functions rather than as a mechanism that works in harmony as a whole. This probe question helps to reveal what information students have about important systems such as the digestive, excretory, respiratory and circulatory systems that they learned previously, eliminate any misconceptions, if any, or integrate the knowledge and information they learned correctly.

Formative Assessment Probes: "Which system?"

This formative assessment probe is given below:

Mr. Mehmet the postman sets out from his home to deliver the daily mail. When he enters a street, just as he is about to deliver the letters into the mailbox, he encounters a stray dog in front of him. Mr. Mehmet's heart begins to beat rapidly, and he starts to have difficulty in swallowing. Mr. Mehmet, whose hands are sweating, starts to tremble out of fear. When the dog starts to bark and chase him, he feels that he should go to the toilet. In this particular case, regarding the systems in Mr. Mehmet's body:

a) The basic issue here is the heart pumping blood. The physical symptoms Mr. Mehmet experiences are connected to his circulatory system.

b) As the heart has pumped blood, all cells have received more oxygen than normal. This is pertinent to the respiratory system.

c) All systems worked in harmony and in balance in all physical reactions such as sweating of the hands and feeling the need to go to the toilet. This situation can be explained by homeostasis.

d) The physical symptoms we experience in emotional states such as fear and excitement are connected with the hormone adrenaline. Adrenaline is also secreted from the adrenal glands. This situation can be explicated by the functions of the excretory system.

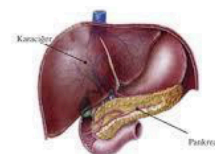
Which opinion do you agree with? Justify your opinion.

2) What is the function of gall?

The students who learned the digestive system for the first time in the fifth grade learned the digestive system organs such as the mouth, pharynx, esophagus, stomach, small intestine, large intestine and anus (The outcome 5.1.2.1. illustrates the places of the structures and organs responsible for digestion on the model, respectively). In the seventh grade, in addition to these organs, the digestive organs and their functions will be learned. The students, who can hardly point out the location of the digestive organs, are supposed to learn the place and function of the liver, pancreas and gall secretion.

This probe question, which also has a visual content, in addition to one of the outcomes of the subject unit, which is "It illustrates the structures and organs that make up the digestive system on a model, plate and/or diagram, and explicates the functions of the liver and pancreas in digestion", also aimed to help the students to remember and learn the concepts such as digestion, digestive system, mouth, pharynx, esophagus, stomach, small intestine, large intestine, anus, liver, and pancreas.

Figure 5. Formative Assessment Probe: "What is the function of gall?"



Hasan, who visits their neighbor Ms. Sevgi with his family, who has had gallbladder surgery, becomes curious. He has not learned about the gallbladder in the digestive organs at school. He asks his family about the role of the gallbladder in digestion. The family members give the following answers.

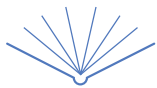
Mother: The gallbladder is a sac attached to the liver. It collects the waste in the liver. It has no role in digestion.

Father: The gallbladder is a sac attached to the pancreas. It stores the waste in the pancreas.

Sister: The gallbladder assists digestion, just like the pancreas and liver. It assists in the digestion of fats with the bile secretion it contains.

Brother: Together with the liver and pancreas, the gallbladder helps to break down the foods that go here.

Whose opinion do you agree with the most? Please explain with your reasons.



Data Analysis

The data obtained from the data collection tools used were analyzed with the SPSS 16.00 statistical analysis program. In this study, although the number of students participating in the research was sufficient (105 students), it was determined that the data were not normally distributed (See Table 4). In order to understand whether the data was normally distributed or not, Kolmogorov-Smirnov Test was used in this research. The pre-test and post-test scores of the 7th grade students participating in the research were investigated with the Kolmogorov-Smirnov Test, and the analysis results showed that the data for all formative probe questions used in the research were not normally distributed ($p < .005$). For this reason, in order to determine whether there is a significant difference between the mean scores of the experimental and control groups, the Mann-Whitney U test, which is one of none parametric tests was used in this study.

Results

In this results section, the answers given by the students in the experimental and control groups to only 2 formative assessment probes (1. What is the function of gall? and 2. Which system?) in the pretest and posttest are compared. The following section presents the findings of the study. Table 3 below illustrates Mann-Whitney U Test values of the answers given by the experimental and control groups to the "first formative assessment probe" in the pre-test.

Table 3. Mann-Whitney U Test Values of the Answers given by the Experimental and Control Groups to the First Formative Assessment Probe in the Pre-Test

Group	N	Mean Rank	Rank Sum	U	p
Experimental	52	38.73	2014.00	623	.000
Control	31	25.66	795.50		

When the Mann-Whitney U Test results of the answers given by the experimental and control group students to the first formative assessment probe in the pre-test were examined, it was observed that there was a significant difference between the scores ($U=623$, $p < .000$).

Table 4 below illustrates the Mann-Whitney U Test values of the answers given by the experimental and control group students to the first formative assessment probe in the post-test.

Table 4. Mann-Whitney U Test Values of the Answers given by the Experimental and Control Groups to the First Formative Probe Question in the Post-Test

Group	N	Mean Rank	Rank Sum	U	p
Experimental	52	66.27	3446.00	534	.000
Control	37	41.91	1550.50		

As far as the relevant Table 6 is concerned, based on the results of the Mann-Whitney U test, which was conducted to reveal whether there was any significant difference between the pre-test and post-test of the formative assessment probe titled as "What is the function of gall?" answered by the students in the experimental and control groups, it was observed that there was a significant difference between the pre-test scores. It was observed that there was a significant difference in post-test scores as well ($U=623$, $p = .000$). Nevertheless, while the pre-test rank average of the experimental groups was 38.73, it increased to 66.27 in the post-test. While the pre-test mean rank of the control groups was 25.66, the post-test mean increased to 41.91. While the increase in the control groups was 16.25, the increase in the experimental groups was 27.54. The results illustrated that the increase in the experimental groups with a high mean rank initially was higher than the control groups.

Table 5 below illustrates the Mann-Whitney U Test values of the answers given by the experimental and control group students to the "second formative assessment probe" in the pre-test.

Table 5. Mann-Whitney U Test Values of the Answers of the Experimental and Control Groups to the Second Formative Assessment Probe in the Pre-Test

Group	N	Mean Rank	Rank Sum	U	p
Experimental	51	36.46	1859.00	288	.520
Control	49	41.93	1929.00		

When the Mann-Whitney U Test results of the answers given by the experimental and control group students to the second formative assessment probe in the pre-test were examined, it was observed that there was no significant difference between the scores ($U=288$, $p > .000$).

Table 6 below illustrates the Mann-Whitney U Test results of the answers given by the experimental and control group students to the second formative assessment probe in the posttest.

Table 6. Mann-Whitney U Test Values of the Answers of the Experimental and Control Groups to the Second Formative Assessment Probe in the Post-Test

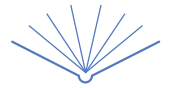
Group	N	Mean Rank	Rank Sum	U	p
Experimental	54	68.62	3705.50	580.200	.520
Control	49	53.69	2631.00		

As far as the relevant table is concerned, based on the results of the Mann-Whitney U test, which was conducted to reveal whether there was any significant difference between the pre-test and post-test of the formative assessment probe titled as "Which system?" answered by the students in the experimental and control groups, it was revealed that there was a significant difference between the pre-test and post-test scores ($U=580$, $p < .000$).

Discussion, Conclusion and Suggestions

In the present study, some formative assessment probes were formed in an attempt to reveal the initial and preliminary knowledge and information of the 7th grade students about the digestive systems. The formative assessment probes not only reveal whether students know which subject or concept, but also help to identify which subject students have learned and how they have learned. As far as the answers given by the students to the probe questions in the pre-test and post-test in the results section, it was clearly revealed that the students had some misconceptions. Students remembered the information they had learned previously in the formative assessment probe called "First Drawing, Last Drawing" and demonstrated this knowledge and information in their drawings. It was clearly observed that the misconceptions about these concepts were not reiterated by the students in the answers they provided in the post-test after the formative assessment strategies were implemented.

The four formative assessment strategies implemented in the experimental groups were decided in an attempt to resolve the students' misconceptions identified in the pre-test. Each strategy was designated to eliminate a certain misconception and was implemented to the experimental groups. Throughout the learning process, the functions of some structures and organs that were difficult and complex to learn such as pancreas, liver and gall bladder were negotiated in detail by the students using the formative assessment strategy question titled "What is the function of gall?". With the formative assessment strategy question



titled "Can you find the sentence that is different?", it was aimed to distinguish the physical and chemical digestion concepts in the unit that were confused the most. The most common physical and chemical digestion examples in daily life were analyzed one by one and their reasons were negotiated. Similarly, the subject of digestion places of foods learned through memorization was taught to the students using the assessment strategy question titled "Where does the digestion of proteins begin?". These strategies helped the students to replace the incorrect information patterns with the correct ones. With the formative assessment strategies called "first drawing and final drawing", the students identified the concepts and misconceptions with no scientific content and they had the opportunity to replace these misunderstandings with the correct ones within the education process.

With the formative assessment strategies implemented in the experimental groups in accordance with the preliminary information identified by the formative assessment probes, it was attempted to increase the conceptual understanding of the students and replace the misconceptions with the correct ones. The pre-test mean rank obtained from the formative assessment probe titled "Which system?" revealed that there was further increase in the experimental groups after the implementation in comparison to the control groups. The formative assessment strategies and other methods implemented in the experimental groups that did not have a significant difference in terms of pre-test scores before the implementation of the study or had lower mean rank were effective in enhancing the students' conceptual understanding levels. In the formative assessment probe titled "What is the function of gall?", the misconceptions such as 'the gallbladder is an organ connected to the pancreas instead of the liver' and 'the fact its name is a sac does not mean that it is related to waste storage and digestion' were revealed and removed from the students.

When the results of the previous studies were examined, it was seen that formative assessment generally had a positive impact over the students' achievement and conceptual understanding; however, in a few studies, it did not have a positive effect on students' learning (İnalıtun & Ateş, 2018). The present study happens to be among the studies that enhances the level of conceptual understanding positively. When the international studies on formative assessment are examined, it explicitly appears that scientists from various countries take a close interest in this subject. Nevertheless, despite this interest, it is plainly evident that formative assessment has not attracted a great deal of attention in Turkey. Therefore, it immediately emerges that there is a genuine need for studies on the subject both in order to make the subject of formative assessment widespread among teachers and researchers in Turkey and make a contribution to the relevant international literature (İnalıtun & Ateş, 2018).

When the other studies in which the formative assessment method has been used in Turkey are examined, it clearly emerges that these studies are pertinent to the concepts in chemistry (Kıryak, Bulunuz, & Zeybek, 2015), in physics (Bulunuz, Bulunuz & Peker, 2014; Bulunuz & Bulunuz (2016) and (2017), and in astronomy (Topçu, 2017). On the other hand, there are a few studies available done by Tekin (2010) and Gülen (2010) in another field, in the teaching of mathematics. When the studies in the relevant literature in the last five years are examined, it has appeared that the studies have generally been on English language teaching and learning.

In these studies, Kurtulmuş (2018) compared the perceptions of Turkish and international adult learners of English as a foreign language about formative assessment; Sarı (2019) investigated the effect of using formative assessment on foreign language learners' writing anxiety; In an action research study, Özkan (2020) investigated the attitudes, intentions and practices of English language instructors in English preparatory schools in Turkey regarding formative assessment; Somuncu (2021) conducted a case study of pre-service English teachers' cognition on formative assessment: and in the evaluation of productive language skills

of English teachers, Arslan (2022) conducted a perspective study on assessment and evaluation, literacy level, and evaluation of productive language skills through formative assessment.

It clearly seems to be the case that both the lack of studies in the field of science and the effectiveness of the formative assessment method in the teaching of biology concepts, which is one of the sub-branches of science, have not been sufficiently studied. However, according to Özay (2008), the difficulty of concretizing the abstract issues in teaching biology subjects and the use of traditional teaching methods and techniques by teachers led to learning difficulties and misconceptions. Therefore, in the present study, unlike in the other studies, the formative assessment method was used in teaching the concepts of "biology", which was one of the sub-branches of science at the national level.

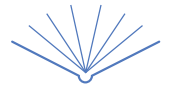
When other studies in the relevant literature are examined, it turned out that Erdogan (2010), Ormancı and Özcan (2012) and Öcal (2014) studied the unit of systems in our body using drama, Güven and Aydoğdu (2009) portfolio and Gök (2014) 7E methods. Analysis of these studies revealed that achievement test, questionnaire and attitude scales were used as data collection tools. They measured the students' pre and post-application knowledge levels with multiple-choice achievement tests. These tests were not qualified to reveal students' misconceptions before the implementation of the study. This study, on the other hand, was implemented with open-ended questions in line with the nature of formative assessment probes and strategies. Consequently, this study is significant since it has revealed the misconceptions and the way students have constructed knowledge in their minds.

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