Students’ Misconceptions About The Subjects in The Unit “The Systems in Our Body”

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Received October 09, 2008; revised December 16, 2008; accepted January 04, 2009

Abstract

This research was carried out with 62 students in three 6th grade classes at a primary school in Izmir. Two of the three classes were chosen as the experimental groups. The first experimental group was taught with technologically-supported mind-mapping technique. The second experimental group was taught with technologically-supported concept-mapping and the control group was taught with the activities based on the Science and Technology Curriculum. After the experimental implementation, students were given a conceptual comprehension test to find out their misconceptions regarding the unit “Systems in Our Body”. The qualitative analysis of the students’ answers was made and their misconceptions about the subjects were determined.

Keywords: Systems in our body, misconceptions

1. Introduction

Subjects of Science and Technology courses consist of various concepts and the relations among them. Misconceptions, which are defined as explaining a concept in a different form than the scientists could accept, are to be avoided by means of meaningful learning. For a sound planning of learning activities, it is significant to identify the students’ misconceptions on a specific subject.

For an effective Science education, it is necessary to know the students’ misconceptions on Science subjects. For conceptual change to occur, the misconceptions, which students come up with and also contradict to the scientific explanation of the subject should be identified well and the teaching should be planned accordingly (Efe, Hevedanlı & Yetişir, 2005).

Although there are many researches in science literature on how to identify misconceptions, it can be seen that most of them are descriptive, not experimental. Besides, there is no such study in which misconceptions are
identified at the 6th grades in primary school on the unit “Systems in Our Body” in Science and Technology Curriculum.

Koray & Bal (2002) prepared an open-ended concept test to identify the 5th and 6th grade students’ misconceptions on “Light and The Speed of Light” subject. The study points out those students have misconceptions about some basic concepts on the light subject and those misconceptions are usually caused by students’ own daily experiences.

Tekkaya (2002) found out some misconceptions in Biology subjects such as: “The purpose of respiration is to provide oxygen and to remove carbon dioxide.”, “Respiration is a gaseous exchange process during which oxygen is taken in and carbon dioxide is given off.”, “Respiration is synonymous with breathing.”, “Heart is responsible for storing, cleaning, filtering or manufacturing blood.”

Özdemir (2005) did a descriptive research on 8th grade primary school students to identify their misconceptions on Genetics and Biotechnology subjects. At the end of the research, Özdemir found out that students have misconceptions on Genetics and Biotechnology subjects.

Tatar & Koray (2005) gave a concept test to 8th grade primary school students in order to find out their misconceptions on some basic concepts in the unit “Genetics” and then they identified students’ misconceptions.

Aykanat, Doğru & Kalender (2005) did a research on the effects of computer-supported concept mapping technique it upon primary school students’ success in learning the structure and function of the cell. The results of the research points out that computer-supported concept mapping technique is more effective than the traditional method in teaching subject “The Cell”.

Amma (2005) found out that computer-supported mind mapping technique is more effective than the traditional method in teaching the unit “The Bacteria” at the second grade university students.

1.1 Concept maps

In science teaching, concept maps can be used in organizing the knowledge, discussing the meanings of concepts, identifying the misconceptions and remediating them, developing advanced level thinking skills and evaluating the things learnt (Atasoy, 2002; Ölmez & Geban, 2001). Concept maps are defined as the schematic drawings which are used for showing the meaningful relations among the concepts in a proposition form (Novak & Gowin, 1984). Concept maps can help students integrate the new knowledge with the prior knowledge and organize their complicated thoughts (Zhao, 2003).

1.2 Mind maps

Mind maps consist of a central thought that connects to the related concepts. The mind map contains a central thought and 5 or 10 related concepts at the second or third level (Zhao, 2003). Mind maps are the most free and meaningful tools among the conceptual tools (Kommers, 2002). In a mind map, the learner reflects all s/he knows onto the paper, so it is possible to see all the concepts and relations among them as a whole. Because mind maps are the visual expression of the schemas which students have constructed in their minds, mind maps are of great importance in identifying the students’ misconceptions.

The mind and concept maps should be taken into account as mental models. Mind and concept maps can also be used for visualizing a complicated phenomenon (narrated by Bahlm, Aydin & Evrekli, 2006 from Honkela et al., 2000).

1.3 The purpose of the research

The purpose of the study is identifying the 6th grade students’ misconceptions on the unit “Systems in Our Body”, “The Skeletal System”, “The Circulatory System”, and “The Respiratory System”.

2. Method

This research was done with 62 students in three different 6th grade classes at a primary school in Izmir in the spring term of 2006-2007 academic year. Two of the three classes were chosen as the experimental groups and one as the control group according to the results of the “Concept Test on Systems in Our Body” which was given to students as a pre-test. The first experimental group was taught with technologically-supported mind mapping
technique on the basis of the constructivist approach. The second experimental group was taught with technologically-supported concept mapping technique on the basis of the constructivist approach and the control group was taught with the activities based on the Science and Technology Curriculum for the 6th grades. Before the experimental implementations, lesson plans that are based on the 7E model of the constructivist approach were prepared and the plans were designed according to the objectives and acquisitions of the course. The lesson plans and activities are the same in both experimental groups. The first experimental group prepared mind maps whereas the second experimental group prepared concept maps on subjects related to the unit “Systems in Our Body”. After a 4-week (16 lessons) experimental implementation, students were given a conceptual comprehension test which has 13 open-ended questions to identify their misconceptions on the subjects related to the unit “Systems in Our Body”.

In order to check out the construction of concepts on the unit “Systems in Our Body” and identify the existence of misconceptions, the qualitative analysis of the students’ answers to the open-ended test on the unit “Systems in Our Body” was separately made by three Science and Technology teachers. The analysis of the answers proved that some students had misconceptions. The three teachers enlisted the misconceptions on the students’ answers and prepared a common list of misconceptions. The answers that are thought to have misconceptions were examined by five academics, a research assistant, a Ph.D. student, and 5 graduate students.

This study also includes students’ misconceptions regarding questions in the 13-question open-ended test and the frequencies and percentage tables related to their misconceptions. Besides, students’ misconceptions on the units “The Skeletal System”, “The Circulatory System” and “The Respiratory System” were enlisted. The subjects on which the students have the most misconceptions were discussed and the significance of identifying the misconceptions was explained.

3. Findings

The problem of the study was formulated as “What are the misconceptions of students in each group on subjects of the unit ‘Systems in Our Body’”. The misconceptions that are found out all students’ answers to the open-ended questions at the experimental and control groups and the frequencies and percentages related to them are given in this section of the study.

The third question in the conceptual comprehension test is; “We cannot twist our waists as much as we can twist our arms. We cannot move our necks as much as we can move our fingers. What is the reason for this?”. The misconceptions, related frequencies and percentages that students have on this subject are shown in table 1.

Table 1. The misconceptions identified in the answers of experimental and control group students to the 3rd question in the open-ended test on the unit “Systems in Our Body” and related frequencies and percentages

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Misconceptions</th>
<th>Experiment 1 (n=20)</th>
<th>Experiment 2 (n=22)</th>
<th>Control (n=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>There are fixed joints in our necks.</td>
<td>1 5</td>
<td>0 0</td>
<td>2 10</td>
</tr>
<tr>
<td></td>
<td>There are fixed joints in our waists.</td>
<td>0 0</td>
<td>0 0</td>
<td>2 10</td>
</tr>
<tr>
<td></td>
<td>We can twist our arms and fingers because they are thin. We cannot twist our waists and necks because they are thick.</td>
<td>0 0</td>
<td>1 4,5</td>
<td>0 0</td>
</tr>
</tbody>
</table>

When the misconceptions in table 1 are analyzed; it can be seen that: % 5 of the students in the first experimental group (n=20) and % 10 of the students in the control group (n=20) have the misconception of “There are fixed joints in our necks”. % 10 of the students in the control group (n=20) have the misconception of “There are fixed joints in our waists” and % 4,5 of the students in the second experimental group (n=22) have the misconception of “We can twist our arms and fingers because they are thin. We cannot twist our waists and necks because they are thick.”

There is a schema that depicts the chambers and vessels by numbers in the human heart in the 5th question of the conceptual comprehension test given to students. Students are asked “In which parts of the heart there is the blood that is the oxygen-rich blood?” The misconception, related frequencies and percentages that students have on this subject are shown in table 2.

Table 2. The misconception identified in the answers of experimental and control group students to the 5th question in the open-ended test on the unit “Systems in Our Body” and related frequencies and percentages

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Misconceptions</th>
<th>Experiment 1 (n=20)</th>
<th>Experiment 2 (n=22)</th>
<th>Control (n=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>There are fixed chambers and vessels by numbers in the human heart.</td>
<td>1 5</td>
<td>0 0</td>
<td>2 10</td>
</tr>
<tr>
<td></td>
<td>We cannot twist our arms and fingers because they are thin. We cannot twist our waists and necks because they are thick.</td>
<td>0 0</td>
<td>1 4,5</td>
<td>0 0</td>
</tr>
</tbody>
</table>
Experiment 1 (n=20)  Experiment 2 (n=22)  Control (n=20)

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Misconceptions</th>
<th>f</th>
<th>%</th>
<th>f</th>
<th>%</th>
<th>f</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>On the right side of the heart there is the oxygen-rich blood.</td>
<td>5</td>
<td>25</td>
<td>8</td>
<td>36.4</td>
<td>10</td>
<td>50</td>
</tr>
</tbody>
</table>

When the misconception in table 2 is analyzed; it can be seen that:
% 25 of the students in the first experimental group (n=20) and % 36.4 of the students in the second experimental group (n=22) and % 50 of the students in the control group (n=20) have this misconception.

The 7th question in the conceptual comprehension test asks students to “Explain and give examples to the concepts of active immunization and passive immunization”. The misconceptions, related frequencies and percentages that students have on this subject are shown in table 3.

Table 3. The misconceptions identified in the answers of experimental and control group students to the 7th question in the open-ended test on the unit “Systems in Our Body” and related frequencies and percentages

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Misconceptions</th>
<th>f</th>
<th>%</th>
<th>f</th>
<th>%</th>
<th>f</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Passive immunization is gained with the help of vaccine.</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>4.5</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Having caught chicken pox is an example to the passive immunization and having caught influenza is an example to the active immunization.</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Passive immunization is; having a disease once and never having it again.</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>4.5</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

When the misconceptions in table 3 are analyzed; it can be seen that:
% 5 of the students in the first experimental group (n=20) and % 4.5 of the students in the second experimental group (n=22) and % 10 of the students in the control group (n=20) have the misconception “Passive immunization is gained with the help of vaccine”. % 5 of the students in the first experimental group (n=20) have the misconception “Having caught chicken pox is an example to the passive immunization and having caught influenza is an example to the active immunization”. % 4.5 of the students in the second experimental group (n=22) have the misconception “Passive immunization is; having a disease once and never having it again”.

The 8th question in the conceptual comprehension test is; “Which system in our body do the tonsils belong to and why swollen tonsils are important?”. The misconceptions, related frequencies and percentages that students have on this subject are shown in table 4.

Table 4. The misconceptions identified in the answers of experimental and control group students to the 8th question in the open-ended test on the unit “Systems in Our Body” and related frequencies and percentages

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Misconceptions</th>
<th>f</th>
<th>%</th>
<th>f</th>
<th>%</th>
<th>f</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Tonsils are a part of the respiratory system.</td>
<td>5</td>
<td>25</td>
<td>3</td>
<td>13.6</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Tonsils are in the throat.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Tonsils are a part of the digestive system.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

When the misconceptions in table 4 are analyzed; it can be seen that:
% 25 of the students in the first experimental group (n=20) and % 13.6 of the students in the second experimental group (n=22) and % 5 of the students in the control group (n=20) have the misconception “Tonsils are a part of the respiratory system”. % 5 of the students in the control group (n=20) have the misconception “Tonsils are in the throat”. % 5 of the students in the control group (n=20) have the misconception “Tonsils are a part of the digestive system”.

The 10th question in the conceptual comprehension test is; “Write down the names and explain the functions of the numbered structures and organs of The Respiratory System on the figure”. The misconceptions, related frequencies and percentages that students have on this subject are shown in table 5.
Table 5. The misconception identified in the answers of experimental and control group students to the 10th question in the open-ended test on the unit “Systems in Our Body” and related frequencies and percentages

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Misconception</th>
<th>Experiment 1 (n=20)</th>
<th>Experiment 2 (n=22)</th>
<th>Control (n=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Alveolus is for expelling the oxygen-poor blood.</td>
<td>f=1 % 5</td>
<td>f=0 %</td>
<td>f=0</td>
</tr>
</tbody>
</table>

When the misconception in table 5 is analyzed; it can be seen that:
Whereas % 5 of the students in the first experimental group (n=20) has this misconception, there is no misconception observed in the second experimental (n=22) and control group (n=20) regarding this question.

The 11th question in the conceptual comprehension test is:
“Explain how the gas exchange occurs between alveoli and capillaries by taking the figure into consideration”. The misconceptions, related frequencies and percentages that students have on this subject are shown in table 6.

Table 6. The misconceptions identified in the answers of experimental and control group students to the 11th question in the open-ended test on the unit “Systems in Our Body” and related frequencies and percentages

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Misconceptions</th>
<th>Experiment 1 (n=20)</th>
<th>Experiment 2 (n=22)</th>
<th>Control (n=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>The oxygen-poor blood passes from the capillaries to alveoli.</td>
<td>2 10</td>
<td>4 18,2</td>
<td>0 0</td>
</tr>
<tr>
<td></td>
<td>The oxygen-rich blood passes from alveoli to the capillaries.</td>
<td>1 5</td>
<td>0 0</td>
<td>0 0</td>
</tr>
<tr>
<td></td>
<td>Capillaries give oxygen to the alveoli.</td>
<td>1 5</td>
<td>0 0</td>
<td>0 0</td>
</tr>
<tr>
<td></td>
<td>Carbon dioxide in the alveoli passes to the capillaries.</td>
<td>0 0</td>
<td>0 0</td>
<td>1 5</td>
</tr>
</tbody>
</table>

When the misconceptions in table 6 are analyzed; it can be seen that:
% 10 of the students in the first experimental group (n=20) and % 18,2 of the students in the second experimental group (n=22) have the misconception “The oxygen-poor blood passes from the capillaries to alveoli.”. % 5 of the students in the first experimental group (n=20) have two misconceptions as “The oxygen-rich blood passes from alveoli to the capillaries.” and “Capillaries give oxygen to the alveoli.” and % 5 of the students in the control group (n=20) have the misconception “Carbon dioxide in the alveoli passes to the capillaries”.

The 12th question in the conceptual comprehension test asks students “What should be done to maintain the good health of The Respiratory System?”. The misconception, related frequencies and percentages that students have on this subject are shown in table 7.

Table 7. The misconception identified in the answers of experimental and control group students to the 12th question in the open-ended test on the unit “Systems in Our Body” and related frequencies and percentages

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Misconception</th>
<th>Experiment 1 (n=20)</th>
<th>Experiment 2 (n=22)</th>
<th>Control (n=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>We should take the oxygen through the mouth and release it through the nose.</td>
<td>0 0</td>
<td>0 0</td>
<td>1 5</td>
</tr>
</tbody>
</table>

When the misconception in table 7 is analyzed; it can be seen that:
% 5 of the students in the control group (n=20) have this misconception. However there is no misconception observed in the first (n=20) and second (n=22) experimental groups on this question.

4. Conclusion

In order to find out whether there is a meaningful difference among the students in experimental groups and control group about the way they construct concepts, a 13-question open-ended test on the unit “Systems in Our Body” was given to students as a post-test. When the open-ended post-test average grades of the experimental groups and control group were compared, there was a meaningful difference observed in favour of the first experimental group.
It was found out that the rate of correct answers to the 1., 3., 4., 6., 7., 9., 11., 12. and 13th open-ended questions are higher at the first experimental group, with whom the lessons were studied with technologically-supported mind mapping technique, than the other groups’ students. It was also observed that the rate of correct answers to the 2., 5., 8. and 10th open-ended questions are higher at the second experimental group, with whom the lessons were studied with technologically-supported concept mapping technique, than the other groups’ students.

In order to identify the misconceptions of students on the unit “Systems in Our Body”, the qualitative analysis of the students’ answers to the open-ended test on the unit “Systems in Our Body” was made. Below are the students’ misconceptions that have been observed in the analysis:

“There are fixed joints in our necks.,” “There are fixed joints in our waists.,” “We can twist our arms and fingers because they are thin. We cannot twist our waists and necks because they are thick.”, “On the right side of the heart there is the oxygen-rich blood.,” “Passive immunization is gained with the help of vaccine.,” “Having caught chicken pox is an example to the passive immunization and having caught influenza is an example to the active immunization.,” “Passive immunization is; having a disease once and never having it again.,” “Tonsils are in the throat.,” “Tonsils are a part of the digestive system.,” “Alveolus is for expelling the oxygen-poor blood.,” “The oxygen-poor blood passes from the capillaries to alveoli.,” “The oxygen-rich blood passes from alveoli to the capillaries.,” “Capillaries give oxygen to the alveoli,” “Carbon dioxide in the alveoli passes to the capillaries.”, “We should take the oxygen through the mouth and release it through the nose.”.

It has been found out that: Control group students have a higher rate of misconceptions at 3., 5. and 12th questions; all the three group students have the same rate of misconceptions in 7th open-ended question; the first experimental group students have a higher rate of misconceptions in 8. 10 and 11th open-ended questions than the rest two groups; students have no misconceptions observed at 1., 2., 4., 6., 9. and 13th questions.

It is thought that identifying students’ misconceptions and remediating them by making use of conceptual change strategies will enable and enhance the meaningful learning and contribute to students’ academic achievement. Students’ preparing mind or concept maps by hand or in computer environment will be a guiding experience for teachers to reveal students’ pre-learning and to identify how they make correlations among the concepts. Teachers can encourage students to prepare mind and concept maps in Science and Technology course and identify their existing misconceptions.

Acknowledgement

This study has been supported by the TUBITAK Project numbered 106K093.

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