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Determining the misconceptions of primary school students related to sound transmission through drawing

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Abstract

The aim of this study is to determine the misconceptions of second grade primary school students related to sound transmission through drawing. In the study, the misconceptions determined through drawing were supported by multiple choice questions. Sampling consists of 286 (143 girls, 143 boys) primary school students educated in Samsun in 2007/2008 educational year. In the data collection device, there are three open-ended and two multiple choice questions prepared in accordance with science and technology programme by scanning the literature. Students are requested to answer the open-ended questions using their drawings. The data obtained from multiple choice test were analysed through computing. Drawings were analyzed and categorized into model types corresponding to five and three levels of understanding. As a result of analysis of drawings and multiple choice questions, it was found that students had several misconceptions related to sound transmission. These are some of the misconceptions obtained as a result of the study that students did not notice that sound is heard by reflection and the particles in the medium transfer energy by vibrating while the sound is being transmitted and they thought that matter moves into the direction of the sound transmitted.
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Keywords: Drawings, sound, sound transmission, sound wave, misconception.

1. Introduction

One of the most important factors obstructing the students' meaningful and permanent learning is misconceptions. Misconceptions are understandings that are incorrect, as they are based on faulty thinking (Schmidt, 1997; Fayer, 2010).Students come to classes with misconceptions (Brown & Clement, 1987) and misconceptions are strongly and persistently held by students (Benson, Wittrock & Baur, 1993; Fellows, 1994; Schmidt, 1997).This situation constitutes an obstacle for them to learn correct academic concepts. If the students are desired to discontinue the misconceptions that they have and to tend to academic concepts, first of all, these misconceptions have to be identified (Eisen & Stavy, 1992).

When we searched the literature in our country and in other countries, it was found that students hold some faulty thoughts concerning concepts before coming to class and after the class. Various terms which express these faulty thoughts have been used. These can be clarified as misconceptions (Skelly & Hall 1993), alternative conceptions (Gilbert & Swift, 1985; Boo, 1998), alternative frameworks (Taber, 1998), naive beliefs (Caramazza, McCloskey & Green, 1998), naive conceptions (Smith & Anderson, 1986), erroneous ideas (Fisher, 1983),

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perconceptions (Hashweh, 1988), multiple private versions of science (McClelland, 1984), errors (Fisher & Lipson, 1986), spontaneous reasoning (Viennot, 1979), conceptual framework (Driver & Ericson, 1983), misunderstandings (Taber, 1994), children science (Gilbert, Osborne & Fensham, 1982).

Several methods have been used to determine the misconceptions. These may include interview and tests consisting of open-ended questions (Brown & Clemet, 1987; Mazensa & Lautrey, 2001), multiple choice test (Asoko, Leach & Scott, 1991), concept maps (Markham & Jones, 1994), word association test (Sutton, 1980), prediction-observation-explanation (POE) (Liew & Treagust, 1995), drawing (Eshach & Schwartz, 2006), two-tear diagnostic test (Schmidt, 1995; Mann & Treagust, 1998; Trumper, 2001; Hrepic, 2002; Wu & Tsai, 2007).

Drawings have been considered as a simple research enabling comparisons about students' misconception and understanding level (Reiss et al, 2002). Students may perceive drawing more enjoyable than writing answers. Students' drawings reflect their thoughts, feelings and minds (Thomas & Silk, 1990).

Drawing is a clear technique that does not have any limitations except for the minor ones concerning how the students will answer and therefore, it may introduce unexpected results. Drawings are the way of showing the students' ideas to the students and teachers and reflect the real content and behaviours (Atasoy, 2002).

Studies regarding sound are aimed to find out the misconceptions (Linder, 1992;1993; Merino, 1998; Baety, 2000; Witmann, 2002; 2003) and advance knowledge of the students (Linder & Ericson, 1989; Muarines, 1992; Hrepic, 2002). Apart from these, there are also other studies trying to find out the difference between traditional method and student - centered method (Barman, Barman & Miller, 1996). In previous studies, usually interview and survey methods were conducted (Linder & Ericson , 1989; Boyes & Stanisstreet, 1991; Maurines, 1993; Mazensa & Lautrey 2003; Wittmann, 2003; Menchen, 2005; Eshach & Schwartz, 2006; Chang et al., 2007). Also, open-ended (Hrepic, 2002) and multiple choice questions are frequently used methods (Asoko et al., 1991). Drawing method has not been frequently used in determing the misconceptions (Eshach & Schwartz, 2006).

It has been observed that there are a lot of concepts concerning sound in primary school curriculum. These concepts include especially characteristics of sound vibration and wave, its transmission, velocity, loudness, intensity and isolation It has been attracted the researchers' concern what misconceptions concerning sound transmission the primary school students have. When we searched the literature, we found that there were only a few studies related to sound in Turkey. This study was conducted to assess the effect of drawing method in combination with multiple choice questions on determining Turkish students' misconception about sound transmission.

2. Method

Sampling consists of 286 (143 girls, 143 boys) primary school students educated in Samsun in 2007/2008 education year. Data collection device was prepared by the researchers through scanning the literature and consisted of three open-ended and two multiple choice questions prepared in accordance with science and technology programme. (Wittmann, 2003; Hrepic, 2004; M.E.B., 2006). In the study, students are requested to answer the open-ended questions using their drawings. Enhanced data collection device was controlled by the field experts, field educators and experienced teachers. The data obtained from the open-ended questions were analysed through computing and the data obtained from the drawings were analysed by organizing into categories. The first drawing question was examined under five categories, the second and third ones under three categories (Simpson & Marek, 1998; Dove, Everett & Preece, 1999; Reis & Tunnicliffe, 2001). These categories are shown in Table -1 and 2. In the study, misconceptions determined by drawing were supported by the results obtained from multiple-choice questions.

Table – 1. The categories used in the analysis of the first drawing question

Level	Explain
Level 1: No Drawing:	Students replied, "I don't know," or no response was given to the statement.
Level 2: Non-representational Drawings:	These drawings were including identifiable elements of sound transmission. Also the answers, which include diagrams or formulations instead of the drawings, were evaluated in this category.
Level 3: Drawings with Misconceptions:	These types of drawings showed some degree of understandings on sound transmission concepts but also demonstrated some misconception; however, these drawings were misconceptions not understandings held by scientists or stated in science texts.
Level 4: Partial Drawings:	The drawings in this category were demonstrating partial understanding of the concepts. Includes the drawings of sound transmission like wave, medium wave+vibration, wave+energy, vibration
Level 5: Comprehensive representation Drawings:	Drawings in this category were the most competent and realistic drawings of the sound transmission

Table -2. The categories used in the analysis of the second and third questions.

Level	Explain
Level 1: No Drawing:	Students replied, "I don't know," or no response was given to the statement.
Level 2: Drawings with Misconceptions:	These types of drawings showed some degree of understandings on sound transmission concepts but also demonstrated some misconception; however, these drawings were misconceptions not understandings held by scientists or stated in science texts.
Level 3: Comprehensive representation Drawings:	Drawings in this category were the most competent and realistic drawings of the sound transmission

Students were requested to answer the first three questions using their drawings. The analyses of these questions according to the categories are shown in Table -1, 2 and 3. Also, two multiple choice questions were asked to the students and the analyses of these questions is shown in Table – 4.

Distribution frequency according to degrees of the answers of the students to the first drawing question is shown in Table -1.

Table -1. Distribution frequency according to degrees of the answers of the students between 11 – 14 years of age to the question; 'Person A is speaking in the picture. Explain using your drawings how person B hears the sound of person A '(N: 286 persons)

Answers without degrees		N (Person)
Level 1 No Drawing:		63
Level 2 Non-representational Drawings		43
Level 3 Drawings with Misconceptions		54
Level 4 Partial Drawings:	Medium	5
	Wave	102
	Vibration + Wave	2
	Wave + Energy	3
	Vibration	12
Level 5 Comprehensive representation Drawings		2

Distribution frequency according to degrees of the answers of students to the second drawing question is shown in Table -2

Table – 2. Distribution frequency according to degrees of the answers of children between 11 – 14 years of age to the question; ' Where will the dust particle be when the speaker is turned off while producing sound for a while ? Draw the place of the particles on table ' N: 286 (Persons)

Answers without degrees		N(Person)
Level 1 : No Drawing:		97
Level 2 Drawings with Misconceptions:	Approache to the girl	164
	Approache to speaker	15

Level 3 Comprehensive representation Drawings	Make vibration movement	10

Distribution frequency according to degrees of the answers of students to the third drawing question is shown in Table -3

Table– 3. Distribution frequency according to degrees of the answers of children between 11 – 14 years of age to the question; 'How does the candle move while the speaker is producing sound for a while? Draw the place of the particles on table. N: 286 (Persons)

Answers without degrees		N(Person)
Level 1 No Drawing:		63
Level 2 Drawings with Misconceptions	Approaches to the girl	156
	Flame of candle goes out	29
Level Comprehensive representation Drawings	Make vibration movement	40

The frequency of the answers of the students (primary school) between 11 – 14 years of age to the multiple choice questions related to sound transmission is shown in Table – 4.

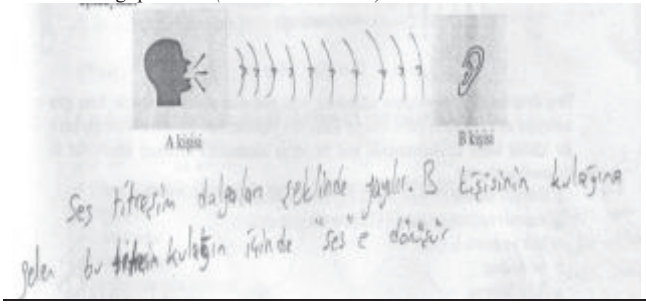
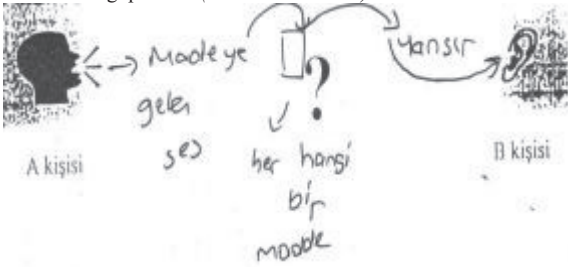
Table – 4. The frequency of the answers of the students (primary school) between 11 – 14 years of age to the multiple choice questions related to sound transmission. (N: 286 persons)

Questions	A	B	C	D
Question 1 Which feature of sound is it that as a result of which we hear the sounds produced by various sound sources?	Refraction 28	**Transmission** **63**	Reflection 187	Absorption 8
Question 2 How do the air particles move while the sound is passing through the air?	Stand still 41	Move to the same direction as the sound goes (away from the source) 136	**Air particles make vibration movement** **51**	Can move into any direction 58

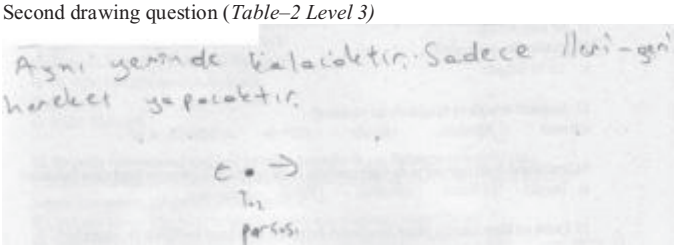
- **correct answer**

The correct and wrong answer samples of students are shown in Table - 5

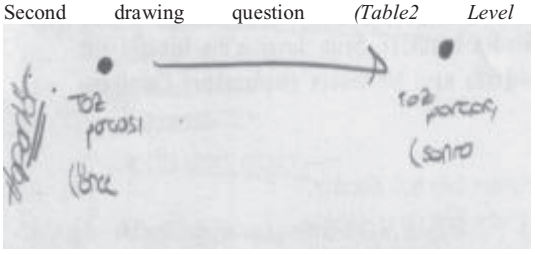
Table-5 The correct and wrong answer samples of students

Correct answer samples to the drawings	Wrong answer samples to the drawings
First drawing question *(Table -1 Level – 5)*	First drawing question *(Table -1 Level – 3)*
	

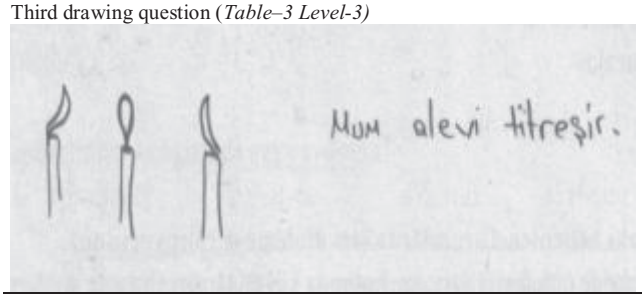
Second drawing question (*Table–2 Level 3)*



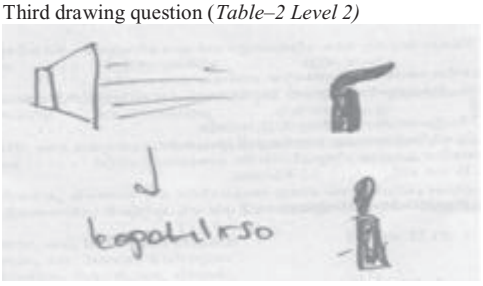
Second drawing question *(Table2 Level 2*



Third drawing question (*Table–3 Level-3)*



Third drawing question (*Table–2 Level 2)*



Results and Discussion

The data obtained from the analysis of quantitative and qualitative questions reveal that students have misconceptions related to sound transmission. Students' first drawing analysis concerning sound transmission and their answers to the first multiple choice question support each other. Students' thinking in their drawings that sound is heard by reflection is supported by the answer of 65 % of the students to the first multiple choice question in that they said that sound was transmitted by vibration. Similarly, in their answers to the first and second drawing questions, about 160 students' thinking that sound causes the particles in the medium to move while it is transmitted is consistent with the answers of about 140 students to the second multiple choice question in that they think that the particles move in the same direction as sound proceeds (away from the source). It is among the misconceptions obtained as a result of the study that students think that sound is heard through vibration and matter moves in the same direction as sound is transmitted. Besides, students said that they were not aware of the fact that the particles in the medium transferred energy by making vibration movement while sound was transmitted. It is one of the obtained data that the frequency of those who explained the candle flame correctly in the same but variformed question concerning the candle flame and dust particle was higher. The reason of this is thought that the candle flame constitutes a more concrete situation.

It was similar to the results obtained from the studies of Watt & Russel (1990), Asoko et. al., (1991), Linder (1992), Driver, Squires, Rushworth & Robinson-Wood (1994), Barman et al. (1996), Menchen (2005) and Chang et. al., (2007) that students had insufficient information that sound was transmitted through vibration, i.e., through energy transfer from one molecule to the other one along the medium.

Students' having difficulty in defining the movements of candle flame and particles is similar to the results of the study done by Wittmann (2003). Moreover, it is consistent with the results of the study done by Linder & Ericson (1989), Wittmann (2003), Hrepic (2004) and Esach & Schwatz (2006) that students think that sound wave will cause the matters in front of it to move during its movement. The higher rate in the answers to the question regarding candle flame compared to the same question concerning particles is consistent with Wittmann' results (2003).

It is consistent with the sdudy done by Chang et al (2007), Menchen (2002), Hrepic (2004) that studensts do not think that sound is transmitted through vibration and will cause the matter in front of it to move as well. Their using only wave concept in sound tranmission shows the same results as the studies done by Watt and Russel (1990) tabloid Driver et. al (1994), Hrepic (2004).The most important misconception that students have is that they

think that reflection is needed to hear the sound. Researchers think that students' explaining hearing the sound by reflection results from their mistaking it for seeing.

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