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Analysing the Feedback that Secondary School Science Teachers Provide for Student Errors that Show Up in Their Lessons[1]

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ABSTRACT

The aim of this study is to reveal the feedback that secondary school science teachers provide for the student errors that show up during their lessons. Six different science teachers were observed throughout 90 sessions of science lessons for sixth and seventh grade in six different units as unstructured with this aim. The case study method was used within the study. Based on the data obtained from the study, feedback that the teachers provide for the students' errors was collected under 10 separate titles, and these titles are: 1. Saying just 'wrong', 2. Giving another student the right to speak, 3. Asking the question again, 4. Giving the answer directly, 5. Explaining the answer directly, 6. Investigating the reason for the mistake, 7. Correcting the incomplete or erroneous part of the answer, 8. Giving clues to student leading, 9. Repeating the answer of the student, 10. Ignoring the student answer. It was concluded from the study that science teachers most often make use of the third type feedback and least often use the last type. It is recommended that feedback provided for the mistakes should be systematically structured by conducting studies similar to this study in places which have different sociocultural structures and different class levels.

Keywords: Science lessons, science teachers, student errors, feedback types

INTRODUCTION

The studies on science education highlight the fact that constructivist learning theory provides a useful and functional framework for achieving the aims of science education and brought new practices into teaching (Ministry of National Education [MoNE], 2005). Constructivist learning theory suggests that students make sense of a new situation and acquire new information through using their existing knowledge (Çepni, Akdeniz and Keser, 2000). According to constructivist learning theory, knowledge is actively constructed by an individual (Matthews, 2002). In this process, teachers guide and help students to construct the knowledge. The constructivist learning theory can be successful in condition that teachers play their roles actively and productively (Kan, 2007). In their study, titled "The role of science teachers in [the] constructivist approach", Akpınar and Ergin (2005) indicated that

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science teachers should first determine the prior knowledge of students relevant to the subject through written tasks, by asking questions in the classroom, through interviews, group discussions or by paying attention to the vocabulary that students use when talking about that subject before the teachers give start to lesson, because the new information to be given would not mean anything without eliminating any misconceptions, incomplete or disorganized knowledge of the students may already have. One of the fundamental aims of science education is to make sure that students understand scientific concepts and use them correctly (Yağbasan and Gülçiçek, 2003). In order to achieve this aim, the misconceptions and incomplete knowledge of students should be replaced with scientifically correct knowledge. In this regard, science teachers should take student errors into account and try to minimize them. An "error" is described as an observable performance which differs from an expected "correct" performance (cited by Fisher and Lipson, 1986 from Fredette and Clement, 1980). In the same vein, misconception is described as a concept that students develop as an alternative to scientific concepts (Tekkaya, Çapa and Yılmaz, 2000) or any scientifically inaccurate idea that takes the mental place of a concept, or understanding, perceiving or using a concept in a way that conflicts with its scientific meaning (Treagust, 1988; Tezcan and Şimşek, 2008). The errors can be defined as the result of misconceptions (Li, 2006; Zembat, 2010). In other words, a misconception is a type of perception that systematically produces errors (cited by Zembat, 2010 from Smith, diSessa and Roschelle, 1993).

In the education environment, students are generally the practitioners of a task (or relevant errors) while the teacher is the assesor who observes whether the task is done correctly or whether there are errors or not. It can be said that it is an indirect aim of teaching to help students notice their own errors and correct them (Fisher and Lipson, 1986). In their study, entitled "The nature of error in the process of science and its implications for the teaching of science", Mermelstein and Young (1995) attributed an important role to errors in science and in the learning process and emphasized that errors were tools for exploration among scientists and students.

In studies carried out on student errors, researchers argued that errors are opportunities in the learning process rather than negative indicators requiring specification and correction (Englehardt, 1982; Confrey, 1990; O'Connell, 1999) and they are too important to be ignored in the learning process (Borasi, 1994, 1996; Santagata and Stigler, 2000; Santagata, 2004, 2005; Heinze, 2005; Bozan and Küçüközer, 2007; Ding, Li, Piccolo and Kulm, 2007; Ding, 2007; Heinze and Reis, 2007; Schleppenbach, Flevares, Sims and Perry, 2007; Baştürk, 2009; Doğan Fırat, 2011; Türkdoğan, 2011). On the other hand, students can understand a concept better through their errors (Fisher and Lipson, 1986). Though errors are regarded as a natural part of the learning process, student errors are not considered positively by adults (Heinze, 2005). Errors are associated with negative feelings for many teachers and students (Heinze and Reiss, 2007). It is known that teachers get angry at students who make simple errors while making a definition or using a term in subjects that they consider to be easy (Heinze, 2005).

The science curriculum, which was put into practice in 2013–2014 education year, includes "an assessment and evaluation understanding aimed to provide continuous feedback in order to monitor and guide students during the process; determine their learning difficulties and support meaningful and permanent learning is adopted" (MoNE, 2013). The biggest difference of the new science curriculum as compared to the previous ones is the principles adopted in relevant to formative assessment even though they are not explicitly stated in this curriculum (Bulunuz and Bulunuz, 2013). Formative assessment requires determining and interpreting the current situation of students and using the obtained results to increase their performance in the learning process (Harlen, Gipps, Broadfoot and Nuttall, 1992). In this process, students are provided feedback about their deficiencies and errors. Thus, they get an opportunity to recover their deficiencies and correct their mistakes (Baki, 2008). In the literature, there are studies on how teachers provide feedback on student errors (Santagata and Stigler, 2000; Santagata, 2002, 2004, 2005; Boz, 2004; Erdoğan, 2005; Baştürk, 2009; Türkdoğan, Baki and Çepni, 2009; Doğan Fırat, 2011; Türkdoğan, 2011; Türkdoğan and Baki, 2012; Türkdoğan and Baki, 2013; Çubuk, 2013). Though there are a lot of studies on the reactions that teachers give to student errors, there is still a significant need for more research in this area (Ball, Lubienski and Mewborn, 2001). The MoNE (2013) adopts a measurement and evaluation approach to provide continuous feedback to support meaningful and permanent learning. However, there is no research has been found in the literature on how science teachers give feedback on student errors in their lessons. This study is the first study to be performed in this area.

In Turkey, behaviourism (the behavioural learning approach) was practised for many years. In behaviourist approach, errors are perceived negatively and so they should be eliminated because they manifest as a result of confusion (Gagatsis and Kyriakides, 2000). It is also known that teachers avoid any discussion of the errors that students make (Santagata, 2004). The constructivist learning theory introduces a completely different perspective on the role that errors play in the learning process. The constructivist learning theory suggests that student errors are necessary and indispensable parts of the learning process (Santagata, 2002). Thus, teachers can handle errors as the marks of the diagrams that should be recreated in construction processes of students and develop suitable strategies in order to facilitate this process (Palinscar and Brown, 1984). When the international and national literature examined, it is seen that there is not any study on the feedback provided by science teachers for student errors. For this reason, it is necessary to perform a study on the feedback that science teachers provide for student errors appeared in their lessons. Thus, the present study aims to determine the types of feedback provided by secondary school science teachers for the student errors in their classrooms.

METHODS

In the present study, the qualitative research method of the case study was applied, intended to analyse the feedback that science teachers provide for student errors that appear in their lessons. The purpose of the case study is to collect comprehensive, systematic and detailed information about each case that is thought to be interesting (Patton, 2002). The situation to be investigated in case studies may involve individuals (teachers, students, administrators, etc.) activities, programmes, groups, policies, actions or behaviours (Mc Millan and Schumacher, 2001). In the study, an embedded multiple case study design was preferred, according to the categorization made by Yin (2003), for the feedback provided by different science teachers on the student errors that appeared in their lessons in different units compraising physics, biology and chemistry—the three main science courses—are taught. Each case handled in the embedded multiple case study and included in the present study can be studied by being divided into various subunits (Yıldırım and Şimşek, 2006).

The Study Group

In qualitative research, purposive sampling is employed in order to make possible to understand and investigate a phenomenon in detail in comparably small samples (Patton, 1990; Creswell, 2007). The purposive sampling method used in qualitative research is useful on many situations in exploring and explaining phenomena and cases (Yıldırım and Şimşek, 2006). One of the purposive sampling methods is maximum variation sampling. In this method, the aim is to find out whether there are common or shared phenomena in cases that indicate variation, rather than creating a variation to make a generalization and to demonstrate different dimensions of the programme according to this variation (Yıldırım and Şimşek, 2006). The qualitative research is generally carried out in detail with small samples chosen for the purpose (Patton, 2002). In this study, because the sample group consisted of six science teachers and only the feedback with respect to student errors was examined, purposeful sampling was preferred. All teachers in the studied group work in schools located in the city centre. In Table 1 below, information is given about the teachers who took part in the study group.

Table 1. *Characteristics of the teachers included in the study group*

Teacher	Gender	Age Range	Faculty	Major	Years of Professional Experience	Educational Background
T1	Male	40–45	Faculty of Education	Chemistry Education	20	Bachelor's Degree
T2	Male	35–40	Faculty of Science	Physics	16	Master's Degree
T3	Male	30–35	Faculty of Education	Science Education	11	Bachelor's Degree
T4	Male	35–40	Faculty of Education	Science Education	10	Bachelor's Degree
T5	Male	30–35	Faculty of Education	Science Education	10	Bachelor's Degree
T6	Male	30–35	Faculty of Education	Science Education	5	Bachelor's Degree

Data Collection

In qualitative research, data are collected in four different ways, including observation, interview, document analysis and audio-visual materials (Creswell, 2003). In the present study, the data were collected through unstructured observations carried out by the researcher during the instruction of science lesson. In the study, the unstructured observation technique was employed because it was aimed to analyse the feedback provided for the errors of students appeared in science lessons. While the observations were carried out, the researcher was in the classroom as an observer only and did not get into any dialogue with the students or the teacher. Thus, the observation was carried out adopting the non-participant observation approach.

Data Collection Process

The data for this study were obtained by observing six different teachers in six different schools during the 2013–2014 academic year. In the observations carried out during the data collection process, no differentiation was made among units or subjects; observations were carried out about the subject that the teacher was teaching that particular day in a classroom or laboratory. Since the observations were unstructured, the researcher tried to write down all the teacher-student dialogues that occurred during the lesson. A total of 90 lesson hours were observed by the teachers in the scope of the study. (This study is based on a doctoral dissertation, in which 80 lesson hours were observed in the pilot study. However, the 90 hours of data collected in the original study were used here). In addition to the notes taken by the researcher, all the data within the scope of the study were recorded with a voice recorder. Thus, data could be collected and transferred to the computer environment without missing anything.

Data Analysis

Within the scope of the study, six science teachers were observed while they were teaching six different units. The data obtained as a result of these observations were transcribed by the researcher. As feedback provided by teachers for student errors is analysed in the study, the feedback for the errors was extracted from the data that were put on paper; codes, categories and themes were created and given names. For the purpose of presenting the findings, students were coded as S1, S2, S3 and teacher as T. After the codes and categories were determined, two different faculty members in the science education department and three different science teachers were contacted and asked to repeat the categorization on this subject. The categorizations made by the faculty members and teachers were mainly the same as those made by the researcher, and the differences were discussed and a compromise was reached on the whole. Feedback types which is "Type 1, Type 2 ..." is the theme, "Saying that it is just wrong", "Repeating the question" one of the coding. The researcher categorized 40 random dialogues and presented them to faculty members and science teachers. Of these, 36 dialogues have been classified with consensus on the classification.

Content analysis requires the analysis of the collected data in detail to make possible to identify themes and dimensions that were not obvious beforehand (Yıldırım and Şimşek, 2006). For the reliability calculation, the formula suggested by Miles and Huberman (1994) was used (Reliability = [Number of Agreements / (Agreements + Disagreements)] x 100). In this process, 36 out of 40 codes created by the researcher through content analysis were accepted by two faculty members and two science teachers who are experts on qualitative research. With regards to the suitability of the codes in the study, researchers reached an agreement by (36/40).100= 90 %. The reliability was calculated based on the codes and found to be 80%, which proved the study to be reliable (Miles and Huberman, 1994; Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz and Demirel, 2014).

FINDINGS

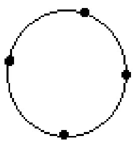
Based on the data obtained during the study, the types of feedback that science teachers provided for the student errors are gathered under 10 different titles. The feedback types obtained in the study are given in Table 2.

Table 2. *Feedback Types*

Feedback Types	Feedback	Explanation
TYPE 1	Saying that it is just 'wrong'	
TYPE 2	Giving chance to speak to another student	
TYPE 3	Repeating the question	
TYPE 4	Giving the correct answer	

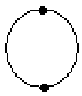
TYPE 5	Explaining the answer	-The answer is explained by the teacher, -The answer is read from the coursebook, -The answer is read from the workbook,
TYPE 6	Asking the reason for the error	-Asking questions about the error
TYPE 7	Correcting/completing the wrong/missing part of the answer	
TYPE 8	Giving a clue to the student (guiding)	
TYPE 9	Repeating the exact answer of the student	
TYPE 10	Ignoring the answer of the student	

Example of Feedback Type 1
Dialogue 1:
01…T**:** Let's show the electron configuration of $_{20}$X atom
01…S1:

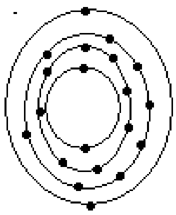


02…T: This part is wrong. First orbital can hold only two electrons.

03…S1:



04…T: It's right. First orbital holds two electrons and the second one holds eight electrons.



In the dialogue given above, the teacher directly said that the student's answer was wrong in line two and gave feedback Type 1.

Example of Feedback Type 2
Dialogue 2:
01…T: What path does a ray of light sent from an environment with a [low] density to a very dense one follow?
02…S1: It goes far from the normal.
03…T: Merve?
04…S2: It comes closer to the normal.

In the dialogue given above, the teacher gave another student the chance to speak in response to the wrong answer given by the first student in line two and used feedback Type 2.

Example of Feedback Type 3
Dialogue 3:
01…T: Let's think of a food chain consisting of green plants, grasshoppers, frogs, snakes and hawks. What does it mean if the number of grasshoppers increases in this food chain?
02…S1: Frogs eat a lot of green plants.
03…T: What does an increase in the number of grasshoppers mean?
04…S2: It means that snakes will eat more frogs and there will be left no frog[s] in the chain.
In the dialogue given above, the teacher repeated the question for the student in line three and used feedback Type 3.

Example of Feedback Type 4
Dialogue 4:
01…T: Imagine that you are on a bridge and watching the fish in the water. Do you think you would see the fish closer or further than the real?
02…S1: Further.
03…S2: Further.
04…T: You would see them closer.
In the dialogue given above, the students responded as seen in line two and three to the question asked by the teacher in line one, and the teacher directly gave the right answer, using feedback Type 4.

Example of Feedback Type 5
Dialogue 5:
01…T: When we talk about "Black Sea fish", what concept do you think of?
02…S1: Population.
03…T: Black Sea fish [do] not constitute a population. There are several types of fish in [the] Black Sea, [aren't] there? There are many types of fish in the sea. So, what should we say instead? We should say "Black Sea anchovy" so that it can constitute a population.
In the dialogue given above, a student gave a wrong answer to the teacher's question in line one and the teacher explained the answer in line three, using feedback Type 5.

Example of Feedback Type 6
Dialogue 6:
01…T: Is squeezed orange juice 100% pure?
02…S1: It is.
03…T: Why?
04…S1: Because there are no additives in it.
05…S2: It is pure because it contains no additive[s].
06…S3: It is not pure because they add hormones in it.
07…S4: I think it is a mixture.
08…S5: We don't add anything in it.
09…S6: It is not pure because there are other things in it. So, it's a mixture.
10…T: Yes, there are different things in it such as vitamins, minerals and water. Check out what we have even in drinking water.

In the dialogue given above, the teacher asked a student the reason for the (wrong) answer in line three and thus used feedback Type 6.

Example of Feedback Type 7
Dialogue 7:
01…T: Did we say what happens when the light encounters with a substance that we talk about in our previous lesson? Do you remember what happens?
02…S1: It reflects.
03…T: It may reflect. But that's not that it definitely does. What else?
04…S2: It may absorb.
05…T: It may absorb and?
06…S3: The light may pass through the substance.
07…T: In a transparent environment, it may pass through.
In the dialogue above, the incomplete answer given by a student in line two was corrected by the teacher. Thus, the teacher used feedback Type 7.

Example of Feedback Type 8
Dialogue 8:
01…T: [Why] is the sky blue?
02…S1: Because the light reflection and scattering make it look blue.
03…T: You are almost there.
04…S2: The blue colour of the sky is about clouds.
05…S3: It is because of the sun. The sun reflects the blue light.
06…S4: The light from the sun hits substances in the sky and reflects blue light.
07…S5: The white light in the sky appears blue due to the blue light in the ocean.
08…T: It has become very confusing. The atmosphere does not actually have a colour. It is about light scattering. The air molecules in the sky scatter the blue colour and its shades more than other colours—that's why the sky looks blue.
In the dialogue given above, the teacher gave a clue to the students in line three, using feedback Type 8.

Example of Feedback Type 9
Dialogue 9:
01…T: Have we compressed the air in the syringe? Yes. Well, why is it compressed?
02…S1: Force causes pressure.
03…S2: Because of pressure.
04…T: Because of pressure.
05…S3: That's because the void is filled.
06…T: Because the void is filled.
07…S4: That's because no air is left.
08…T: Because no air is left.
09…S5: That's because it's compressed from both sides.
10…T: Because it's compressed from both sides. Now, let's try to leave out the air and compress the liquid. I try to compress the liquid, but I can't. So, what does it show about liquids?
In the dialogue given above, the teacher repeated the students' answers exactly in lines four, six and eight, using feedback Type 9.

Example of Feedback Type 10
Dialogue 10:

[Prompt]: In the "Granular Structure of the Substance" unit, you learned that molecules are very tiny granules and cannot be seen with the naked eye. So, is it possible that the movement you have seen is caused by one molecule only?
A: (students answer the question given in the paragraph above).
01…S1: You said when we were learning molecules that…
02…S2: This movement cannot have been caused by one molecule because solids are packed fairly close and the particles can move only when they come together.
03…T: Yes, let's go on.
In the dialogue given above, the teacher ignored the student's answer in line three, using feedback Type 10.

All types of feedback used by the teachers during the study are given on Table 3.

Table 3: *The distribution of feedback used by the teachers within the scope of the study*

	TYPES OF FEEDBACK USED									
TEACHERS	TYPE 1	TYPE 2	TYPE 3	TYPE 4	TYPE 5	TYPE 6	TYPE 7	TYPE 8	TYPE 9	TYPE 10
T1	1	-	5	1	2	-	5	-	-	-
T2	7	-	16	16	9	11	9	7	1	1
T3	-	1	14	2	6	4	-	3	5	-
T4	2	1	10	2	3	11	2	2	2	-
T5	-	1	6	4	9	5	2	2	7	1
T6	1	2	8	2	14	2	3	3	-	-
TOTAL	11	5	59	27	43	33	21	17	15	2

When Table 3 is examined, it is seen that science teachers used feedback Type 3 the most within the scope of the study, while feedback Type 10 was used the least.

DISCUSSION, CONCLUSION AND IMPLICATIONS

As a result of the study, it was seen that the feedback used the most by the teachers was feedback Type 3 (Repeating the question) while feedback Type 10 (Ignoring the answer of the student) was used the least. It was also seen that there were differences in the feedback types that teachers used. For example, while the Ö2 teacher uses the third and fourth types of feedback most often, the Ö6 teacher has used the fifth type of feedback the most. In other words, the type and frequency of feedback that each teacher used was different.

The feedback of primary school mathematics teachers provided for student errors was investigated in the study carried out by Türkdoğan (2011). As a result of the study, the feedback given by mathematics teachers was gathered under six titles which are 1. Ignoring the error or accepting it as a correct answer, 2. Giving the answer, 3. Telling them their error, 4. Creating a contradiction, 5. Simplifying and 6. Association. The feedback category three in this categorization created by Türkdoğan (2011) is similar to feedback Type 1 in the present study. Also, feedback Type 10 in the present study is similar to feedback category one in the study carried out by Türkdoğan. Even though "Giving the answer" among the feedback types created by Türkdoğan (2011) can be found in the categories used in the present study, the feedback types such as "Creating a contradiction", "Simplifying" and “Association” are not encountered in this study. It is considered that such feedback types that are not encountered in this study were created especially for mathematics lessons. On the other hand, the most of the feedback was not about concepts in mathematics lessons, while the most of the feedback provided by science teachers consisted of answers to student errors relevant to scientific concepts.

In the study carried out by Çubuk (2013) on the feedback provided by mathematics teachers for student errors, the feedback types were gathered under the three categories of “direct”, “indirect” and “unresponsive” feedback. “Telling the error directly” would be placed under “direct” feedback, similar to feedback Type 1 mentioned in the present study, while “Giving the answer” would be considered “indirect” feedback in the study by Çubuk (2013), similar to feedback Type 4 in the present study. “Giving clues” under the “Giving the answer” category is similar to feedback Type 8 in the present study. In the study carried out by Çubuk (2013), “Asking the student to explain his/her answer” is a division of the “Questioning” subheading of the main “indirect feedback” category, and is similar to feedback Type 6 in the present study. Lastly, “Repeating the same operation” under the “Implying that the answer is wrong” subheading under the main “indirect feedback” category is similar to feedback Type 3 in the present study.

As for the feedback “Telling the students what to do” under the main “Correction” category in the study carried out by Çubuk (2013), this type was not encountered in the present study. It is possible that this feedback type was developed particularly for mathematics lessons. Similarly, the feedback “Creating a contradiction” and “Drawing students” attention to the structure of the questions in the study by Çubuk (2013) are not encountered in the present study, probably because of the above-mentioned reason.

In the study carried out by Köğce (2012) in which the feedback types used by mathematics teachers in their lessons were examined, two of the teachers in the study group indicated that they could give feedback for student errors by teaching the relevant points repeatedly, whereas the other teacher said that he/she would give feedback that would help the students control their errors. These feedback types employed by mathematics teachers are similar to the feedback Types 4 and 6 in the present study.

In the study carried out by Odabaşı-Çimer, Bütüner and Yiğit (2010) with the aim of determining the feedback types used by elementary school teachers in mathematics lessons, it was indicated that most of the verbal feedback used by the teachers in the study group was evaluative, while very little of it was descriptive. It was also pointed out that the descriptive feedback used by teachers was not useful in terms of showing students where they made an error or how they could reach the correct answer but just included telling them the correct answer. It can be said that this feedback type is similar to feedback Type 4 mentioned in the present study.

In the study carried out on the feedback types given to pre-service mathematics teachers within the scope of mathematics lessons on the characteristics of feedback based on usefulness, sensitivity, privacy, keeping in mind dimensions and on the feedback types that pre-service mathematics teachers preferred, Çabakçor, Akşan, Öztürk and Odabaşı-Çimer (2011) pointed out that pre-service teachers were provided feedback in the form of notes, praise, clues, corrective feedback or confirmation feedback when they were also given questions to prove or given the answers for the parts they could not complete. Among this feedback, ‘Confirmation’ and ‘Giving the answers for the parts they couldn’t complete’ are similar to feedback Types 1 and 7 mentioned in the present study.

In the study carried out by Santagata (2002), the feedback given by teachers for student errors was examined and categorized as follows: 1. Correction, 2. Giving a clue to the same student, 3. Repeating the question, 4. Asking the reason, 5. Giving a clue to another student, 6. Repeating the question indirectly, 7. Choosing the correct answer, 8.

Asking the answer to the class, 9. Another student gives the answer before the teacher and 10. Others. The similarities and the differences between the feedback types named in the study carried out by Santagata (2002) and the ones used in the present study can be summarized as follows: ‘Correction’ is similar to feedback Type 7 in the present study, ‘Giving a clue to the same student’ is similar to feedback Type 8, ‘Repeating the question’ is similar to feedback Type 3, ‘Asking the reason’ is similar to feedback Type 6 and ‘Choosing the correct answer’ is similar to feedback Type 4 used within the scope of the present study. There are differences among the other feedback types. Accordingly, it is seen that the feedback given by teachers for student errors is mostly similar. However, there might be some differences in the feedback types both because the content of the lessons was different and the societies where the studies were carried out had some specific differences. The feedback categories eight, nine and 10 from those created in the study by Santagata (2002) are not encountered in the present study, while the feedback categories three and six are gathered under one type in the present study.

In the study carried out by Schleppenbach et al. (2007), the feedback provided by Chinese and American teachers for student errors was investigated and the answers that teachers gave just after student errors were gathered under one group (Group 1) while the questions the teachers asked after student errors were gathered under another group (Group 2). Thus, one group of feedbacks consisted of general feedbacks given by teachers while another consisted of questions only. The feedback listed under Group 1 and 2 are as follows:

Group 1:

i.) Telling the students that their answers are wrong
ii.) Giving the correct answer
iii.) Ignoring the error
iv.) Explaining or guiding
v.) Students correct their errors immediately

Group 2:

i.) Repeating the question
ii.) Explaining the question
iii.) Asking the student to add something to the answer
iv.) Asking for precision
v.) Paraphrasing the question
vi.) Asking the student to explain

There are great similarities between feedback Type 1 used within the scope of the present study and the first statement in Group 1 created by Schleppenbach et al. (2007), as well as between feedback Type 4 and the second statement; between feedback Type 10 and the third statement; between feedback Type 8 and the fourth statement in Group 1 mentioned above. In addition, feedback Type 3 and ‘Repeating the same question’, ‘Explaining the question’ and ‘Paraphrasing the question’ under Group 2 in the aforementioned study can be considered the same type of feedback. However, the other statements under Group 2 are not encountered in the present study.

According to the results of the present study, it can be said that there exist different types of feedback even though there are similarities among the feedback types provided by teachers in different subjects and in different countries. However, the fact that all the aforementioned studies focused on mathematics lessons, while there have been no such studies in science, is the biggest difference of the present study. The other studies were carried out on one subject only in mathematics lessons, while the present study encompassed different units in physics, chemistry and biology under the umbrella of science, and the feedback was provided accordingly. Thus, it may account for the differences among the feedback types.

In the science curriculum (2003), teachers assume a facilitating and guiding role in the learning and teaching process while students assume the role of an individual who researches the source of knowledge, asks questions, explains and discusses. On the other hand, the role of a teacher is to facilitate learning by guiding students in the learning process. To facilitate their learning, a teacher should both encourage students to think about, discuss and analyse alternative ideas suggested and guide students at every occasion so that they can construct scientifically correct knowledge by their own (MoNE, 2006). According to the data obtained in the present study, the three types of feedback that teachers used the most frequently are 'Repeating the question', 'Giving the answer directly', 'Asking the reason for the error'. Thus, it is considered that teachers do not give students enough opportunity think about, discuss and analyse alternative ideas. In the constructivist approach, students take responsibility for their own learning and develop their thinking skills (Koç and Demirel, 2004). So, it is thought that students are not given a chance to construct new knowledge themselves, with these types of feedback. The frequent use of the feedback type defined as 'Giving the answer directly' prevents the effectiveness and productivity of the 'exploration' stage in the 5E learning cycle model based on the constructivist approach. Accordingly, it cannot be said that science teachers exactly guided student learning. In the study carried out by Atila (2012), it was found that the teachers taking part in the study did not precisely explain how they could guide learning and thus did not have the desired constructivist approach. In this regard, it is possible to say that the results of the present study are parallel to the results of the study carried out by Atila (2012). It was also indicated in the study carried out by Atila (2012) that 'Creating cognitive contradiction'—one of the important components of constructivist approach—was hardly ever done during the lessons by the science teachers. Thus, it can be said that the feedback provided by the science teachers within the scope of the present study was not used to create a cognitive contradiction, either. On the other hand, in constructivist learning environments it is suggested that teachers ask and find out how the learner builds these structures and forms the basis for knowledge before making any statement about the accuracy or wrongness of the knowledge structures (Yurdakul, 2008). For this reason, it can be said that teachers should focus on how a student reaches wrong conclusions when they encounter student errors. They should create contradictions in the knowledge structures that learners construct (Yurdakul, 2008). From this perspective, it is seen that the teachers in the present study did not sufficiently use the feedback methods that would cause a cognitive contradiction. In the study carried out by Türkdoğan (2011), it was demonstrated that mathematics teachers did not make sufficient use of feedback that would create cognitive contradictions, which is in parallel to the results of the present study. It was also indicated in the study carried out by Çubuk (2013) with secondary school mathematics teachers that feedback aimed at creating a cognitive contradiction was employed very infrequently, which is compatible with the results of the present study.

The results obtained within the scope of the study can be summarized as follows:

1. The types of feedback and the frequency of use differ from teacher to teacher.

2. Some of the feedback methods generally provided in mathematics lessons, such as 'Causing the students to fall into contradiction' or 'Simplifying' have not been encountered in science lessons.

The implications suggested based on the results of the study are as follows:

1. In the present study, it is seen that teachers mostly used feedback Type 3, categorized as 'Repeating the question' for student errors. This means that they took the easy way out, because it is not right to deprive students of an 'exploration' environment or

to not give them the chance to ask questions in the learning process where the 5E learning cycle model is adopted generally. Consequently, teachers should include 'Showing them alternative situations', 'Asking them to reconsider' and 'Creating a hypothesis and retesting it' in their feedback.

2. The feedback types provided by teachers for student errors are affected considerably by the sociocultural structure. In our country, there are regions and areas with different cultural and demographic structures. This situation affects students', parents' and even teachers' perspectives on errors and thus on the feedback provided. In new educational approaches, parents, students and even teachers should be taught that an 'error' is something acceptable and is not seen as a result of teaching but as something that occurs during the learning process.

3. The present study was carried out with science teachers teaching in secondary schools in the Erzurum Province. It is suggested that the study should be implemented 'n different times and in diffent schools with different teachers that can be selected across different regions and areas, because different sociocultural structures affect the feedback types provided for student errors. Also, similar studies should be carried out in science; thus, the errors and feedback types in the field of science can gain a more systematic structure.

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