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Full Length Research Paper

Determining students' reflective thinking levels and examining their reflections on science concepts

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ABSTRACT

The study aims to learn that they want to reflect on their reflective thoughts and reveal how they reflect what they have learned. Reflective thinking, one of the higher-order thinking skills, enables students to learn more easily and permanently. Students with high reflective thinking skills will be more successful both in their academic and social life. A screening model was used in this study. Since we want to describe an existing situation as it is, the screening model has been the most suitable model for our study. The sample of the study consists of the 2nd-grade students of Ağrı İbrahim Çeçen University Classroom Teaching Department. The study was conducted with 59 students selected by a simple random method. A learning diary study was conducted with 10 students out of these 59 students. It is important to develop students' existing potential by determining their reflective thinking levels. This gives us information on how to plan and implement reflective activities in learning environments. The data were collected through the learning diary and reflection papers by analogy. The students were asked to write a learning diary during the first 8 weeks of the science teaching lesson of the primary school teaching department. After the lecture was completed, the students were asked to make an analogy using the science concepts they learned. The analogies were asked to be formed regarding the analogies between the concepts that students learned in the science lesson and their friends. In addition, students were asked to write down the reason why they made analogies between their friends and the science concepts. In this way, the accuracy of their reflections on whether they learned the concepts or not was examined. The data were analyzed using content analysis. The reflection levels of the expressions of the students in the diaries where they describe their learning processes were determined using the method of Moon (2009). In the results obtained through content analysis, it was observed that the reflective thinking levels of the students were at medium level and they did not have high-level reflective thinking skills. In the analogy study in which science concepts were used, 61% of the students did not make conceptual errors while associating the science concepts, while 39% of them had conceptual errors. The basis of misleading about science concepts should be investigated and corrections should be made on this issue. Appropriate techniques and time are needed to develop students' reflective thinking skills. Students should be allowed to reflect on their learning situation. It is known that individuals who can think reflectively are more successful academically. This way of thinking provides convenience to students both in academic success and in social life. Techniques that develop reflective thinking should be given more places in educational settings.

Keywords: Reflective thinking, reflective thinking levels, science teaching.

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INTRODUCTION

One of the main goals of the constructivist approach is to raise individuals with high awareness. It is emphasized that students should take responsibility throughout their learning process and be active in education by making use of their own experiences (Ünver, 2003). Nations have developed very different strategies and used different techniques and methods in terms of education systems throughout history (İnci Kuzu, 2020a). Behaviors

expected from students in the educational environment are taking responsibility for their development, analyzing oneself and realizing the situations in which it is incomplete or successful, finding solutions to problems, frequently questioning and making changes and expressing oneself (Kember et al., 1999). It is important for the student to discover and interpret the information without prejudice in the teaching process where there are too many environmental factors (İnci Kuzu and Uras, 2019). Students' understanding of the connection and relationship between concepts is important for structuring the learned knowledge (Crawford, 1998). The constructivist approach offers the student a rich learning environment. In this environment, students and teachers have different responsibilities (Erlandson, 2005). The rapid development in scientific and technological fields, changes in social and individual needs, new approaches and developments in learning and teaching theories have changed the roles desired from individuals (İnci Kuzu, 2020b). It is the teacher's responsibility to guide students and develop higher-level thinking skills. Higher-level thinking skills used in learning knowledge are creative thinking, critical thinking, analytical thinking, problem solving and reflective thinking skills (Nian, 2020). The teacher should be in search of developing students' reflective thinking skills in the learning process. For students to acquire this skill, methods to develop reflective thinking should be included in their educational processes. Students should be allowed to reflect on their learning situation and should be encouraged to make their assessment (Keskinkılıç-Yumuşak, 2017). The student who starts to think about the subject of learning is made aware of what he has learned and if any, his incomplete learning. What did I learn? What am I lacking? How can I learn better? Where did I go wrong? With such questions, analysis of the learning process starts. At the same time, effective self-analysis should also be supported (Arslan, 2017). Some methods are used for students to do so. These methods are learning diaries, concept maps, self-evaluation, questioning. Learning diaries is a common method used to develop reflective thinking. It is a high-level skill for a student to express themselves by thinking first about a situation and then writing it. Students are asked to examine their learning processes in depth. In this manner, students reach conclusions about their learning by thinking about their learning processes before they start writing. They write about how much they have learned the subject, their views on why they cannot learn if there are concepts that they cannot learn, and their general cognitive and affective situations during the process (Malthouse and Roffey-Barentsen, 2013; Wilson and Jan, 1993). The study focuses on reflective thinking. It was decided that it would be more appropriate to work with higher education students in terms of questioning and reflection. It is important for determining students' reflective thinking potential and revealing their ability to reflect on what they have learned, to plan further lessons and to make learning efficient. Different methods are used in the literature to determine the levels of reflection and the number of studies using the levels determined by Moon (2009) is rare. Studies on learning, on the other hand, are rare for students to reflect on us what they have learned.

Reflective thinking levels

The sentences that students make about their cognitive states may contain reflections at different depths. Therefore, the reflection value of each statement is different. The levels of this difference can be determined by Moon's (2009) reflective thinking levels. These levels are as follows:

1. Descriptive writing: Writing productions involve a small amount of reflection. The order followed in the learning process is described rather than the evaluation of the learning process.
2. Descriptive writing that includes some reflection: These are productions that do not contain much reflection. It usually includes definitions as if they were in the form of questions and answers. Analysis for the learning process is insufficient.
3. Reflective writing: The student has an idea about the process, but this idea does not cover the whole process, it only includes certain stages for interest, attention, etc. reasons For these stages, the student has analyzed the process, makes reflective evaluations, and awareness begins to occur. But this awareness is limited to certain stages.
4. Advanced reflective writing: It is the structure of the diaries that have followed the learning process, produced different solutions to eliminate the problems encountered in the process and made an evaluation for this. There is a deep reflection in production and metacognition strategies are actively used. Prior knowledge and experiences guide new learning.

Reflective thinking levels were determined by considering these levels in the reflective diaries of the students.

There are few studies done to determine the reflective thinking levels of students. Cengiz and Karataş (2014) analyzed students' reflective thinking levels with the help of diaries, taking into account the levels Moon determined, and it was found that they were generally at the level of reflective writing.

METHOD

Sample and method

Descriptive research method is used in accordance with

the purpose of the study. Among the descriptive methods, it was decided that the scanning method was the most appropriate. The scan method is a method used to reveal or describe a certain situation. It is more appropriate to use qualitative methods to learn how students think. The interpretation of the data obtained in this way is more meaningful.

Population and sample size

The sample of the study consists of 59 classroom teacher students studying at Ağrı İbrahim Çeçen University, selected using the simple random method. All of the students participated in the analogy activity. Learning diary activity was held with 10 students.

Data collection

The data of the research conducted with 10 students were obtained by using reflective learning diary writings and reflection writings with an analogy. The study lasted 8 weeks. Each week the study continued; these students were asked to write their cognitive status related to the learning process in the learning diary they wrote at the end of the Science laboratory lesson. After the lecture part of the study was completed, 59 students were asked to make an analogy between their friends and the concepts they learned during the lesson. In addition, students were asked to indicate in which aspect the analogy was made It is important that students state the reason for the analogy between the concepts and their friends in terms of providing information about conceptual errors. Content analysis was used in the data obtained from the learning diaries and reflection texts with an analogy. The expressions of the students in the diaries were examined and cognitive expressions were determined. Later, these expressions were categorized by considering the levels determined by Moon (2009).

Measurement item

In line with the obtained results, the reflection levels of the students were determined separately for 8 weeks and presented as a table. After the content analysis of the data obtained from the analogy writings was completed, two themes were formed as analogies with and without conceptual errors. Expert help was consulted to ensure the consistency of the study. During the analysis of the study, the researcher and the expert took the statements in the learning diaries independently from each other and a consensus was reached on the common statements. This consensus was calculated using the formula: Reliability=(Consensus)/(Consensus+Disagreement)×100 developed by Miles and Huberman (1994). In the calculation made, the harmony between the researcher and the expert was 0.92. The same sequence of operations is used in the analogy writings. The correct use of the concepts related to the lesson that the students used to describe their friends was examined separately by the researcher and the expert, and the agreement between the researcher and the expert was 0.95. This value shows that the findings obtained in our study are reliable in terms of consistency. The data providing consensus formed the findings of the study.

In the articles obtained from the diaries, the expressions of the students about the lesson were discussed. How much reflection each statement contains was determined by looking at the levels of Moon (2009). The same procedure was followed in the diaries written for 8 weeks. Finally, the statements of the students were concretized as a table at which level. In the analogy articles, it was examined whether the academic information overlapped between the analogy and the explanation. If the concept and definition simulated overlap with each other, it is determined as false if it is not correct. The data obtained are presented both in a table and graphically.

Some abbreviations were made for the tables to be understandable. The students participating in the study are expressed as S. Since a learning diary was made with 10 students, a coding such as S1, S2,… S10 was made. The weeks in which the study was conducted are expressed in the form of W. A coding in the form of W1, W2,… W8 was made.

FINDINGS

Table 1 was created by considering the analysis results of the learning diaries written by the students, and week and reflective thinking level.

When Table 1 is considered, it is seen that students reflect mostly at Level 2. The least reflection is made at level 4 which is the highest level of reflection levels. The frequencies of the 1st and 3rd level reflection levels are close to each other. It is understood that the majority of the students cannot reflect on a high level. Some students' reflection levels sample expressions are as follows:

S4 (W1): "Our teacher started the lesson with questions, but I could not answer the questions." (Level 1)

S9 (W2): "I couldn't do my homework this week; there must be some missing grades." (Level 2)

S2 (W7): ‘I could not understand the lesson, this situation made me a little depressed, I think I would have understood if I had been more careful. I knew the

Table 1. Reflective thinking levels distribution.

	W1	W2	W3	W4	W5	W6	W7	W8	f
Level 1	S4, S6, S8, S10	S5, S6, S10	S1, S4, S9	S4, S5	S5, S6, S8	S1, S4	S5	S4, S5	20
Level 2	S1, S5, S9	S1, S2, S3, S4	S5, S6, S8,	S2, S3, S6, S9	S1, S2, S4	S2, S3, S5, S7	S1, S4, S6, S10	S1, S3, S8, S10	29
Level 3	S2, S3,	S7, S8, S9	S2, S3, S10	S1, S7, S8, S10	S3, S7, S9	S6, S8, S10	S2, S8, S9	S2, S6, S9	24
Level 4	S7		S7		S10	S9	S3, S7	S7	7

W: Week, S: Student Codes

functions of some organs, it would be easier for me to learn the functions of organs I do not know." (Level 3.)

S7 (W8): 'While solving problems in the lesson, I thought of the parts I did wrong, I did it wrong because I was not sure of myself although I knew it. While our teacher was explaining the correct answer to the friends who made mistakes, I realized that I already know the answer. I have to be a little courageous because making mistakes is not a crime, I have to encourage myself in this matter."(Level 4)

Students' average level of reflection is given in Figure 1. It is seen that only the S7 coded student is above the 3rd level, while the other students are approximately close to the 2nd level or have passed the 2nd level. As is shown in the figure, the reflective thinking levels of the students are at a medium level.

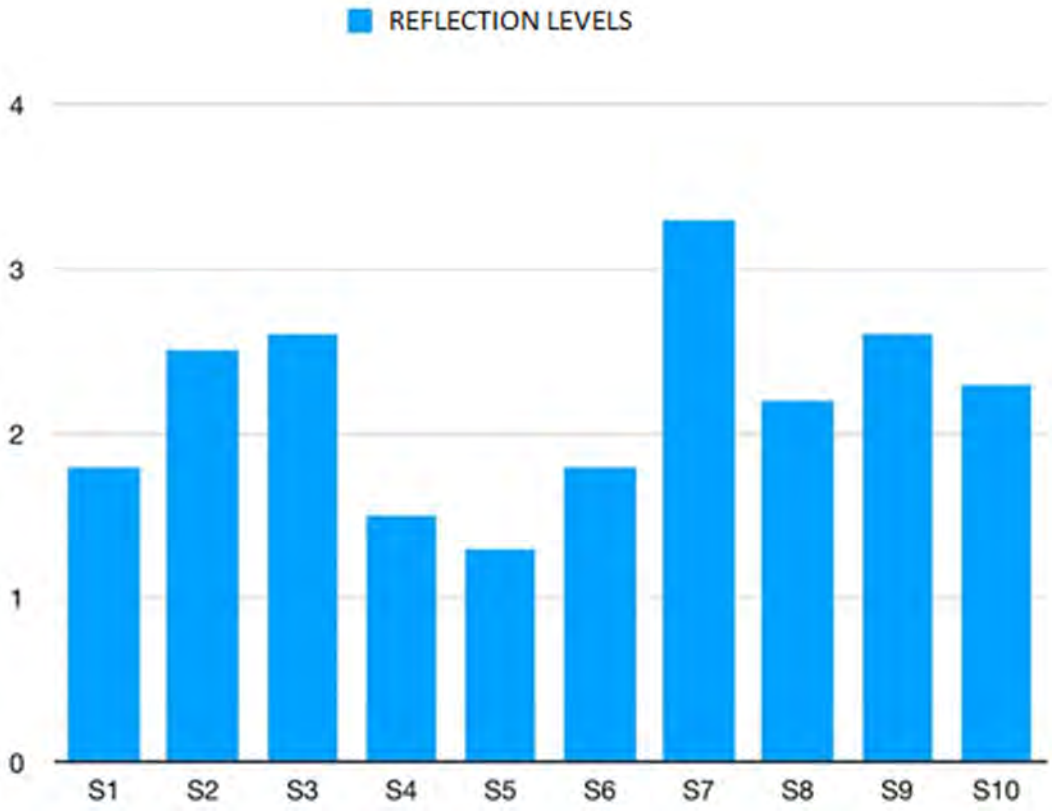

Figure 1. Students' reflective thinking levels.

Unlike other metaphor studies, this metaphor study was that the concepts to be used for metaphor were limited to the concepts learned in the science lesson. Students were asked to describe their classmates with the concepts they learned and write the reason for their definition. During the analysis, it was determined that some students had misconceptions about the concept while explaining the reason for the analogy between the concept they used and their friend. While 36 of 59 analogies were found to be correct, conceptual errors were encountered in 23 of them (Table 2). This informs us about the things they learned incorrectly with concepts (Figure 2). Some students' sample analogies are as follows:

"My friend X is like mitochondria; gives me energy." (Correct)

"My friend X is like chlorophyll; colors up my life." (Correct)

"My friend X is like a brain; manages the class." (Correct)

'My friend X is like a ribosome; scatters everything.' (Wrong)

'My friend X is like a stomach; does not keep its promises.' (Wrong)

'My friend X looks like a case; generates new ideas.' (Wrong)

Table 2. Analogy chart of positive perceptions.

Themes	f	%
Correct analogy	36	52.5
Incorrect analogy	23	47.4

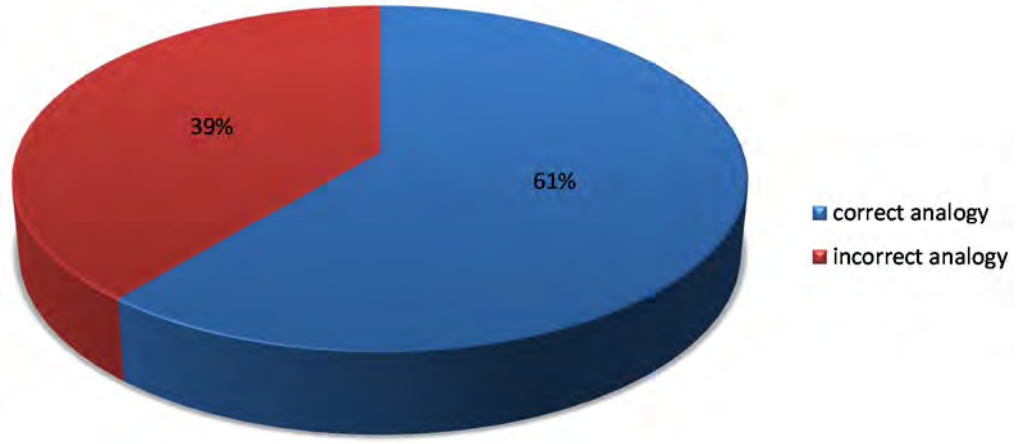

Figure 2. Analogy distribution ratios.

DISCUSSION

In this section, the findings of the practices made to determine the students' thinking levels and the reflection of the concepts they learned with the use of analogies was discussed. The expressions of the students in the diaries they wrote are generally at level 2. Results differed for only 1 student. These results are similar to those of Cengiz and Karataş (2014). Considering the previous studies on these issues, it is seen that there are a limited number of studies on the reflection levels of Moon (2009). It is possible to see different levels of reflection in the literature. Although the methods are different, the same comments can be made because the reflection potential of the students is at a basic level. There is an analogy between the levels of students in Arslan's (2007) study and the levels of students in this study. The most striking feature between the two studies is that very few students reach level 4, which is the highest level of reflective levels. In the study conducted by Nurfaidah et al. (2017), they investigated the reflection levels of teachers through their learning diaries. They tried a different way to detect levels. Although two different methods were used in the studies, the results of the studies are similar. It was understood that teachers were unable to reflect at a high level and their reflection level was medium. Cengiz, Karataş and Aslan (2017) found in their study that pre-service teachers' reflection levels were medium and a high level of reflection was not performed. El-Dib (2007) stated that teachers generally have basic reflection skills. In another study, it was determined that students reflect at a simple level, which

can be regarded as the first step as the reflection level, and that time and development are needed for advanced reflection skills (Davis, 2006). The studies that were conducted before and the study we conducted have the same results (Kallarackar and Thomas, 2020; Jony et al., 2017). While Ussher and Chalmers (2011) stated that students' reflective thinking bases were generally low, Şahin (2009) emphasized that students were at a descriptive level. By looking at the results of all these studies and the findings we have, we can say that the reflective levels of the working groups are at a basic level. The reason for this is that there is a need for activities and practices to improve the reflective thinking skills of the participants. People can increase their reflective thinking levels with the right methods and orientations over time. Practices should be made to develop different thinking methods both in student education and in the field of teachers. Different thinking skills have an important place both for the effectiveness of the teaching environment and for positive social interaction.

In the practice of using an analogy for learning reflections, which is the other dimension of the study, 61% of the students used the concepts related to science subjects correctly, while 39% of them had conceptual errors. It is seen that students are generally successful in creating analogies by using science concepts. Conceptual errors were found in the analogies made by some students. For example, the analogy because she does not know the basic function of mitochondria contains "(My friend X is similar to mitochondria because it calms me") contains a conceptual error. In our study, the issue of whether the concepts are used correctly or not is discussed. Analogies are often used to learn how students think and how they make connections between concepts. In this way, the concepts used correctly and the concepts used incorrectly were brought to light. Many studies have been conducted to reveal students' subjective opinions about the concepts. (Argan et al., 2020; Lynch and Fisher-Ari, 2017; Hoseini et al., 2019; María and Villamil, 2000; Osgerby et al., 2018; Nikitina and Fumitaka, 2008; Saraç, 2018). Reflective thinking also includes critical thinking. It was stated that students' critical thinking skills were improved by using the analogy technique (Surdanya, Azrai, Nuramadhan and Ichsan, 2020). These results are in line with the results of our study. In the study, in which the analogy technique was used to reveal the misconceptions of the students in biology subjects, it was stated that the information taught in the lesson was more effective and permanent (Aydın Gürler, 2020). These studies were aimed to reveal how students think and to have information about how they perceive concepts. In this study, in addition to these purposes, students were asked to make analogies about science concepts and the opportunity to evaluate their learning situation was intended. Thus, the teaching of the incorrect learning of subjects or concepts can be reviewed by making an evaluation. Teaching can be made more effective. Students' reflection on the concepts they learned at the end of the mental process in this way enabled the learned information and concepts to become more permanent. Mentally restructured information has a positive contribution to permanence.

CONCLUSION

Reflective thinking is a skill that can be developed. It is possible to bring this potential to the upper level by revealing the reflective thinking potential of students. Reflective thinking potentials can be developed individually or together with the group. The analogy technique is very effective in understanding how they make a connection between learning situations and concepts. Techniques that focus on the learning process rather than what students learn to have an important place in terms of students' success and thinking strategies in general. It is predicted that individuals' reflective thinking levels will be higher in long-term studies. Reflective thinking skill is expected to develop well with properly used activities.

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