



EFFECT OF USING ROUNDHOUSE DIAGRAMS ON PRESERVICE TEACHERS' UNDERSTANDING OF ECOSYSTEM

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Introduction

It is generally accepted that science courses include many abstract concepts and those prevent students' meaningful understanding. One of the main objectives of science education is to enable students to become more aware of science and science-related issues. During three decades, research has focused on identifying students' understanding of and difficulties with many topics in science education. Research has indicated that students have difficulty in understanding many science topics (Griffiths & Grant, 1985; Oluk, 2009; Simpson & Marek, 1988; Webb & Bolt, 1990). Ecosystem including material cycle, energy flow, food chain, food web is found to be one of the difficult topics (Griffiths & Grant, 1985; Oluk, 2009; Simpson & Marek, 1988; Webb & Bolt, 1990). Many research have reported that students hold numerous difficulties and misconceptions with food chain (Adeniyi, 1985; Bahar, Johnstone, & Hansell, 1999; Barman & Mayer, 1994; Eilam, 2002; Gallegos, Jerezano, & Flores, 1994; Griffiths & Grant, 1985; Munson, 1994; Reiner & Eilam, 2001; Tekkaya, Çapa, & Yılmaz, 2000), food web (Griffiths & Grant, 1985; Munson, 1994), energy flow (Adeniyi, 1985; Barman & Mayer, 1994; Lin & Hu, 2003), matter cycling (Adeniyi, 1985; Lin & Hu, 2003). It is important that students should be taught these concepts to promote their responsible behaviors toward environment. Also, effective teaching of the concepts associated with the ecosystem helps to overcome misconceptions that preservice teachers have.

It is well known that many concepts in science education are closely interrelated. One subject influences the teaching of another topic. Lack of integrity among subjects largely hinders the understanding of the next one. Students, who are unable to

Abstract. Roundhouse diagram is a visual tool which helps to reveal what a student think about science topics and reflects information that students organise in their mind. The purpose of this study was to investigate the effect of using roundhouse diagrams on prospective classroom teachers' understanding of ecosystem, food chain, energy flow and material cycles. The roundhouse diagram was used with the experimental group ($n = 44$), while a traditional teaching method was employed with the control group ($n = 43$). Environmental Achievement Test consisting of 25 questions was administered to the 87 preservice teachers as pretest and posttest. The results indicated that the use of roundhouse diagrams significantly improved prospective classroom teachers' understanding of ecosystem, food chain, energy flow and material cycles. In the light of the obtained results, some practical implications are discussed.

Key words: academic achievement, ecosystem, roundhouse diagram, science education.

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correctly connect subjects with one another, have difficulty in understanding basic concepts (Bora, Çakıroğlu, & Tekkaya, 2006). In addition, misconceptions that students hold prevent their meaningful learning of science concepts (Haktanır & Çabuk, 2000; Özkan, Tekkaya, & Geban, 2001; Şahin, Cerrah, Saka, & Şahin, 2004; Yücel & Morgil, 1998). Therefore, it is important to employ teaching approaches that will make students active participants and enhance their understanding of science concepts (Şahin et al., 2004).

In the science education research literature, it is reported that abstract scientific concepts that are hard to understand are better taught to students through visual elements including pictures, schemes, graphs, photographs and diagrams (Özalp, 2006). Science educators have emphasized the importance of developing numerous graphic organizers that would facilitate student learning in order to achieve meaningful learning (Cook, 2008). Among these, Vee diagrams (Gowin, 1985), Concept maps (Novak, 1980), Venn diagrams (Venn, 1880), Fishbone diagrams (Herber, 1978), KWL charts (Carr & Ogle, 1987), and Roundhouse diagrams (Wandersee, 1987) are used to promote students' understanding of science concepts.

Graphic organizers help to explain concepts, theories, events, and important points within a subject. These organizers visually demonstrate the relationships between concepts and ideas. They include both visual and verbal information with tips about recalling and using knowledge. It is an effective method used in learning abstract and difficult subjects, and linking newly-acquired knowledge to previous learning during teaching activities. Besides, it could be employed to assess students' learning. By examining graphic organizers prepared by students, the extent to which they understand dimensions of a subject could be understood. Therefore, it is important to use visual instruments during teaching activities (Dönmez, Yazıcı, & Sabancı, 2007).

The impact of the use of visual instructional materials (pictures, schemes, graphs, photographs, diagrams) in science education has been investigated by several researchers. It has been reported that these materials enhance students' creative and critical thinking skills, help make complex concepts easier to understand, and improve the quality of education in a concrete and visual way (Mayer, Bove, Bryman, & Tapanco, 1996; Özdemir, 2010; Piburn, Reynolds, McAuliffe, Leedy, Birk, & Johnson, 2005; Wu, Krajcik, & Soloway, 2001; Yalçın, Yiğit, Sülün, Bal, Baştuğ, & Aktaş, 2003). The use of roundhouse diagrams allow to visualize the content and thus increases their interest in, and willingness to learn science courses (Ermiş, 2008). Then, it becomes possible to understand abstract and difficult concepts, interrelate between concepts, and organize ideas (Bora et al., 2006). One of the graphic organizers used in science education is the Roundhouse diagram, which is the subject of this study.

Roundhouse Diagram

Roundhouse diagram was first developed by Wandersee in 1994 to help students learn and construct new information in a meaningful way. The diagram was developed based on Paivio's "Dual-Coding Theory (1986)", which emphasizes the importance of the use of verbal and visual knowledge on learning and remembering (as cited in Ermiş, 2008). The Roundhouse diagram, which is designed as a two-dimensional circular figure, consists of a central circle and seven sections that surround it. The number of sections can be increased or decreased when needed. The diagram is filled starting from the first section, located in the 12 o'clock position, and moving clockwise. Information given in the sections is not only related to the main concept in the center but are also related to one another. The information is written in sections as textual units with different expressions. These texts consist of words of the student that express the main concept in a more understandable manner (Ward & Wandersee, 2002a, 2002b). An empty example of the Roundhouse diagram that Wandersee developed is given in Figure 1 (Ward & Wandersee, 2001).



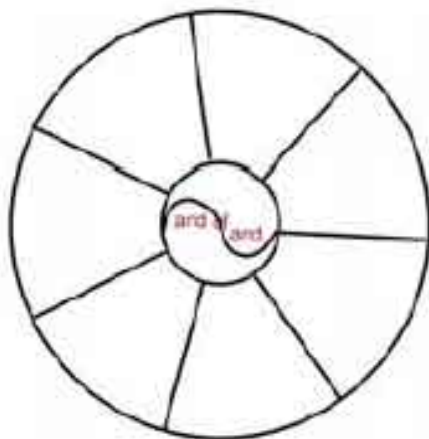


Figure 1: A Blank Roundhouse diagram (Ward & Wandersee, 2001).

Students try to strengthen their understanding of concepts by drawing a symbolic figure related to each text located in the sections. Teachers, on the other hand, examine the diagrams created by students and are thus able to detect their misconceptions and can attempt to address them. Teachers, in this process, provide students with encouragement by helping them to develop their creativity (Ward & Wandersee, 2001). The central circle in the diagram is divided by an S curve and includes the main concept related to the subject. Students try to express this main concept through their own words using "of", "from", "and" etc. and write it down inside this circle. These sub-headings of concepts, which are produced by students, are written on the upper and lower parts of the S curve using "and" (Gönen & Kocakaya, 2012).

According to the findings of studies conducted to investigate the effectiveness of the Roundhouse diagram in the research literature, these diagrams have been found to facilitate learning, enhance students' achievement in science courses, and to detect their misconceptions. In the light of these findings, it is reported that it would be beneficial to use the Roundhouse diagram as an instrument of learning, teaching and assessing (Alemdar, 2004; Bora et al., 2006; Ermiş, 2008; Hackney & Ward, 2002; Ward, 1999; Ward & Lee, 2006; Ward & Wandersee 2001). Moreover, McCartney and Figg (2011) have stated that the Roundhouse diagram can be used as an instrument to help students learn difficult subjects in curricula by partitioning them.

Although many advantages about the Roundhouse diagram have been indicated in the literature, there is some difficulties with it. For example, Gönen and Kocakaya (2012) have reported that if the Roundhouse diagram is not introduced well, then students may fail to build it. This situation may have difficulty in understanding the topic. Also, students may not draw an icon that directly relates to each chunk of information. In addition, some of the students may not separate seven chunk the concept given them.

The review of the research literature on the Roundhouse diagram indicates that studies have been conducted in elementary education (Akyürek & Afacan, 2012; Alemdar, 2004; Ermiş, 2008; Ward, 1999; Ward & Lee, 2006), secondary education (Bora et al., 2006) and with post-graduate students (Trowbridge & Wandersee, 1998). However, no study has been found that has examined the impact of the use of the diagram with students at the undergraduate level.

There are various methods and materials employed in science education. However, those that raise awareness about environmental issues and problems are of more importance. In recent years, methods that are designed according to the constructivist approach in which ways to access information are taught, prior learnings are revealed and mental construction is ensured. The Roundhouse diagram is one example in which the constructivist approach is used (Özalp, 2006).



Purpose

The main purpose of this study was to investigate if the use of the Roundhouse diagram has an impact upon the conceptual understanding of prospective classroom teachers in the subjects of food web and chain, energy flow and material cycles in ecosystem. To achieve this aim, answers were sought to the following research questions.

1. Is the use of the Roundhouse diagram helpful in facilitating conceptual understanding of food web and chain, energy flow and material cycles in the ecosystem?
2. What are the opinions of prospective classroom teachers in the experimental group about applications related to the Roundhouse diagram?

In this study, the following subjects were selected: food web and chain, energy flow and material cycles in the ecosystem", because it has been found in numerous studies that these concepts are among the most abstract and hard-to-learn subjects in an science education course (Griffiths & Grant, 1985; Oluk, 2009; Simpson & Marek, 1988; Webb & Bolt, 1990).

Methodology of Research

Research Model

In this research, the mixed methods design was employed in which both qualitative and quantitative methods are combined (Creswell, 2003). In the quantitative part, an experimental model was utilized to explore the effectiveness of the diagram. In this model, an experimental and a control group were employed in this study. In order to assess the effectiveness of the diagram, achievement test was administered as pretest and posttest. In the qualitative part, on the other hand, the Questionnaire for Opinions about Roundhouse Diagram (QORD) was administered to elicit prospective classroom teachers' opinions in the experimental group.

Study Group

The study group of the research consisted of 87 prospective classroom teachers who enrolled in environmental education course in 2011-2012 academic year at Nigde University, Nigde, Turkey. Since no significant difference was found between the two sections in the comparison of their pretest scores (Table 1), prospective classroom teachers were assigned randomly to the experimental and control groups (Çepni, 2001) and the instruction was conducted with both groups by the same instructor.

One of the groups was determined as the experimental group ($n = 44$), in which instruction was conducted using the Roundhouse diagram, whereas in the other group designated as the control group the traditional teaching method was used ($n = 43$). In the traditional teaching method, instructor-centered direct lecturing was implemented. The study continued for seven weeks in both groups.

Table 1. Results of independent groups t-test for Environmental Achievement Test (EAT) pretest scores of prospective classroom teachers in experimental and control groups.

	N	Mean	SD	df	t	p
Pre-test (control)	43	11.37	3.10	85	0.334	0.739
Pre-test(experimental)	44	11.59	2.99			

Table 1 shows that the EAT pretest mean scores of prospective classroom teachers in the experimental and control groups are very close to each other. Independent groups t-test analysis was performed in order to test whether this difference was statistically significant; no significant difference was observed between the groups with respect to the calculated t value ($t_{(85)} = 0.334$; $p > 0.05$). Therefore, the groups may be considered to be statistically homogeneous.



Data Collection Instrument

In the research, the EAT, developed by the researcher, and the QORD, developed by Ermiş (2008), were employed.

Environmental Achievement Test. The achievement test used in this study was developed by the researcher. It included the basic concepts about the subjects of food web and chain, energy flow and material cycles in ecosystem, which were taught for seven weeks to the experimental and control groups.

The reliability of the test was determined using 188 preservice teachers who had taken the course earlier. The test was firstly developed as a pre-application form with 38 questions, and then 25 questions were selected after validity and reliability studies were conducted. While selecting questions, those with item difficulty indices of above 0.8 and below 0.2 (Kan, 2008; Kline, 1986), and those with item discrimination indices of below 0.3 were excluded (Crocker & Algina, 1986; Tekin, 1996). The internal consistency reliability coefficient of the 25-item test (Kr-20) was found to be 0.84, the mean discrimination level of the questions was 0.58, and the mean difficulty level of the questions was 0.51. Expert opinion was obtained for the content validity of the test. The test was administered to the prospective classroom teachers as pretest and posttest.

Questionnaire for Opinions about Roundhouse Diagram. In the research, the QORD was employed in order to determine the opinions of prospective classroom teachers about the use of the diagrams. This questionnaire was developed by Ward and Wandersee (2002a), was translated and adapted into Turkish by Bora et al. (2006). Then, Ermiş (2008) revised it and developed a 19-item questionnaire. This revised version was used in this study. Three of the items were open-ended and 16 were multiple-choice (Yes - No - Sometimes - Usually). The questionnaire was used in order to determine whether or not it helps prospective classroom teachers' understanding of science concepts of the Roundhouse Diagram and to reveal their positive/negative opinions about the diagram.

Procedure

The research was carried out in the 2011–2012 Academic Year. The EAT was administered to both groups before the start of experimental practices (pretest), and again at the end of experimental practices (posttest). While the Roundhouse diagram was employed with the experimental group, traditional teaching method was used in the control group.

Prospective classroom teachers in the experimental group were taught the course according to the Roundhouse diagram. Before starting experimental activities, prospective classroom teachers in this group were informed by the researcher through a presentation about the structure of the diagram. After the presentation, the prospective classroom teachers were asked to study and summarize each subject and think about important (key) concepts in it one week before each course. Then, prospective classroom teachers constructed the Roundhouse diagram at the end of the lectures. Examples of these diagrams prepared by prospective classroom teachers are presented in the Appendix. The QORD was administered at the end of the experimental study with the aim of determining the prospective classroom teachers' opinions about the diagram.

Prospective teachers in the control group were taught according to the traditional lecture method. The teacher wrote relevant information on the board and asked questions. While waiting for prospective classroom teachers to write down what was being lectured, the instructor gave them assignments. During classes, the teacher was always active whereas students were always passive.

Analysis of Data

Following the administration of the assessment instruments, statistical analyses were performed on the pretest and posttest responses of the prospective classroom teachers. SPSS software (version



15.0) was used in the analysis of data. By comparing the pretest scores of the groups, the equivalence of groups was evaluated. Independent samples t-test was used in order to compare scores from the pretest and the posttest. Results were assessed at the significance level of 0.05. Data obtained from the 16 items of the student opinions questionnaire were summarised into a table as a percentage distribution. Data obtained from the open-ended questions were categorized under common themes and then interpreted.

Results of Research

In order to test whether the distribution was normal or not, the Kolmogorov-Smirnov normality test was performed; the results that are pertaining to this analyze are presented in Table 2. Table 2 shows that all test scores in both groups are distributed normally ($p > 0.05$). This means that parametric tests can be applied on the data.

Table 2. Normality test for the distribution of test scores.

	Control group					Experimental group				
	N	Mean	SD	Z	p	N	Mean	SD	Z	p
Pre-test	43	11.37	3.10	0.928	0.355	44	11.59	2.99	0.846	0.471
Post-test	43	13.84	2.57	0.915	0.373	44	18.80	2.09	1.28	0.075

The first research question was; "Is the use of the Roundhouse diagram helpful in facilitating conceptual understanding of food web and chain, energy flow and material cycles in the ecosystem?". Results related to this sub-problem are given in Table 3.

Table 3. Results of independent groups t-test for EAT posttest scores of prospective classroom teachers in the experimental and control groups.

	N	Mean	SD	df	t	p
Post-Test (control)	43	13.84	2.57	85	9.86	0.000
Post-Test (experimental)	44	18.80	2.09			

Table 3 shows that the two mean scores are quite different from each other. Independent groups t-test analysis was performed in order to test whether this difference was statistically significant or not; the difference was found to be statistically significant ($t(85)=9.86; p < 0.05$). It is seen that this difference is in favor of the experimental group.

The second research question was; "What are the opinions of prospective classroom teachers in the experimental group about the applications related to the Roundhouse diagram?". Table 4 presents the findings related to this research question. Besides, the responses that prospective classroom teachers gave to open-ended questions were categorized, analyzed and interpreted under common themes.

Table 4. Percentages (%) of responses of prospective classroom teachers to QORD (n = 44).

Statements	Yes (%)	No (%)	Sometimes (%)	Most of the time (%)
I enjoyed working through the Roundhouse diagram.	72.7	11.4	9.1	6.8
I answered the questions about the topic on the Roundhouse worksheet well.	61.4	6.8	13.6	18.6



Statements	Yes (%)	No (%)	Sometimes (%)	Most of the time (%)
I found some like textbook, notes, clipart books and did use these well.	75.0	4.5	2.3	18.2
I collected all the necessary information about the topic.	38.6	2.3	15.9	43.2
I planned the Roundhouse diagram well and organized it well.	68.2	4.5	18.2	9.1
I was able to explain with all the information about the topic.	59.1	4.5	27.3	9.1
I was able to present the information about the topic in an interesting and effective manner.	45.5	6.8	22.7	25.0
I used my time well while working with the Roundhouse diagram.	59.1	4.5	15.9	20.5
I was able to work the Roundhouse diagram.	72.7	6.8	15.9	4.5
I can work well the Roundhouse diagram with my friends.	77.3	4.5	6.8	11.4
I did write the information in my own words.	29.5	18.2	40.9	11.4
I was able to link the pictures with the concepts well.	65.9	4.5	11.4	18.2
I was creative while working on the Roundhouse diagram.	36.3	13.7	40.9	9.1
I realized that the Roundhouse diagram was a helpful learning tool.	77.3	6.8	13.6	2.3
I prefer using the Roundhouse diagram rather than taking notes.	47.7	2.3	20.5	29.5
I think the Roundhouse diagram will help improve my understanding of science concepts.	72.7	6.8	9.1	11.4

Table 4 shows that 72.7% of prospective classroom teachers enjoy working with the Roundhouse diagram, 59.1% reported that they successfully summarized the information using other words, 59.1% used their time well while working with the diagram, 72.7% were able to construct the diagram by themselves, 77.3% constructed the diagram better while discussing with their peers, 65.9% were able to link figures to concepts successfully, 77.3% thought that the diagram was an auxiliary instrument that helped learning, 47.7% prefer using the diagram over taking notes in the class, and 72.7% believe that the diagram helps understand and develop scientific concepts. In addition, 40.9% of prospective classroom teachers reported that they are not fully able to write information using their own words and to form the diagram in a more creative way. 15.9% of them stated that they are not self-confident in forming the diagram alone.

Some of the common responses that prospective classroom teachers gave to one of the open-ended questions (Please list the most important things that you have learned while forming the diagram.) are presented below:

"I learned better by concretizing most abstract concepts". (S16)

"I learned how to make complex subjects more understandable by simplifying them using my own words".

"It helped me succeed in the course." (S5)

"It helped me better learn the subject and become a more successful student in my courses". (S2)

"I learned how to connect them (ideas) to one another, and write them understandably in an order (manner) – from simple to complex or from particular to general". (S10)

"I did something in a course and enjoyed it so much for the first time". "I enjoyed learning by entertaining, and thus I became more interested in the course". (S12)

The above statements suggest that thanks to the Roundhouse diagram, prospective classroom



teachers learned how to concretize abstract and complex concepts, and render them more understandable by simplifying them using their own words. This, in return, helped them better understand the concepts and become more successful students. Moreover, the diagram renders Science courses more enjoyable, positively contributes to meaningful learning, and improves students' interest in the courses. Besides, according to most of prospective classroom teachers, summarizing important basic concepts while forming the diagram helps them better understand the topics.

Some of the similar responses that prospective classroom teachers gave to another open-ended question (Did you encounter any problem while forming the diagram? If yes, please list them.) are presented below:

"Initially, I struggled a lot. I had difficulty in finding or drawing pictures suitable to what I wrote. But as the time went by, these problems have disappeared". (S7)

"I had difficulty in breaking the subject into pieces. I did not know what to talk about as the subject was too long". (S15)

"I sometimes struggled to fully put my thoughts into the diagram. It was difficult to cut each subject into seven pieces. The seven sections were sometimes too many and sometimes not enough". (S1)

"I generally had difficulties in turning the information that I had found related to subjects into visuals. I thought a lot about how to visualize the information". (S18)

"I struggled. I am not that creative. Yes, it helps us better learn subjects but some students may encounter problems while forming the diagram as not everybody is creative". (S3)

"Yes. I had some difficulties in finding relevant information from sources". (S20)

"No, not at all, because I enjoyed what I was doing". (S9)

These results indicate that some prospective classroom teachers had difficulties in finding information regarding topics, summarizing and partitioning topics, and drawing symbolic figures related to the topics while forming the diagram.

Some of the similar responses that prospective classroom teachers gave to another open-ended question (Please write down your positive or negative opinions about the diagram.) are presented below:

"Since the diagram expresses information both visually and verbally, it contributes to understanding, expressing creative thinking and improving interest in the course". (S24)

"I think the diagram has rendered teaching more enjoyable. It helped me enjoy learning. I will always like to do such things. It facilitated learning as we cut topics into separate parts". (S25)

"The diagram encourages the student to research. Their creativity improves, they become able to connect topics; therefore, it is an application where the person who forms the diagram is totally active". (S17)

"The Roundhouse diagram helps us better understand the topics. I think it provides a learning that is more permanent and is not based on memorization. I plan to use it in my professional teaching life". (S40)

"I think it helps us better understand the course. But it would be better if it did not have seven boxes, because sometimes we cannot explain some parts of topics". (S38)

"I think it should be applied in courses when possible. It would be enjoyable and fun for us and we would be able to convey what we need to convey to others very easily". (S28)

The above expressions indicate that the Roundhouse diagram renders students more interested in the course, improved their creative thinking skills and helped them better understand the topics; and it is also an activity that provides a more permanent learning and is not based on memorization compared to the traditional teaching method. Moreover, it ensures learning by entertaining and thus renders it more enjoyable and encourages students to investigate. Some prospective classroom teachers reported that the number of empty boxes in the diagram can sometimes be too many. On the other hand, some other prospective classroom teachers stated that they had not encountered any negativity related to the diagram and supported the continuation of the use of the diagram. Furthermore, they stated that they would use the diagram in their future professional lives. It is observed that the opinions of the participants regarding the Roundhouse diagram are positive in general.



Discussion

In this research, the effect of using Roundhouse diagram on prospective classroom teachers' understanding of food web and chain, energy flow and material cycles in the ecosystem was investigated. Results revealed that the experimental group participants were more successful than the control group participants. Results indicate that the use of the diagram is more effective than the traditional teaching method in terms of prospective classroom teachers' understanding and helped to facilitate students' learning topics that are associated with ecosystem. Roundhouse diagramming method was developed based on constructivist learning theory which suggests that students should be active in classroom (Bora et al., 2006; Orak, Ermiş, Yeşilyurt, & Keser, 2010; Ward & Wandersee, 2002a). Because the Roundhouse diagram encourages students' to be active during courses, using the diagram led to increase students' achievement. As a result of this, prospective classroom teachers in experimental group had a significant higher achievement than those in control group. This findings are consistent with the results of previous studies (Hackney & Ward, 2000; Bora et al., 2006). Results from previous research show that the Roundhouse diagram improved students' achievements in science topics (Bora et al., 2006; Hackney & Ward, 2000; 2002; Orak et al., 2010; Ward, 1999; Ward & Wandersee, 2001, 2002a, 2002b). To this parallel, Trowbridge and Wandersee (1998) suggested that the Roundhouse diagram could be used as an auxiliary instrument to overcome students' learning difficulties with science topics.

In this study, prospective classroom teachers were involved to learning process using by Roundhouse diagram so that they expressed that their interest increased through the diagram. This may be a reason that increase students' achievement (Ward & Wandersee, 2002b). In order to build meaningful understanding in science education, graphic organizers such as Roundhouse Diagram could be used by teachers and science educators.

The findings of this study also indicated that prospective teachers: (1) enjoyed working with the diagram, (2) were able to summarize information using different words, (3) were able to take their time while working with the diagram, (4) believed that they could form the diagram by themselves, (5) would prefer using the diagram over taking notes in classes, (6) were able to construct the diagram with their friends through cooperative learning, (7) were able to link the concepts with each other by using suitable figures, (8) found the diagram makes learning easier and more enjoyable, and (9) understood better scientific concepts.

Namely, these findings obtained from students' statements demonstrated that prospective classroom teachers enjoyed working the Roundhouse diagram. Findings also showed that the diagram used in this study helped to prospective teachers' understanding of ecosystem topics. The reason for this kind of obtained findings may stem from that students created the Roundhouse diagram themselves and such an activity allowed prospective classroom teachers to foster their creativity thinking. By using the Roundhouse diagram, prospective classroom teachers had to organize an activity and draw it on the diagram given them. Thus, they learn subjects as more enjoyable, fun and easier. Likewise, previous research have suggested that the diagram is fun and easier too (Bora et al., 2006; Orak et al., 2010; Ward & Wandersee, 2002b). Furthermore, prospective classroom teachers who enrolled in experimental group indicated that they learned to summarize the information given themselves and to order the connections between concepts (Bora et al., 2006; Ward & Wandersee, 2002a, 2002b). These contribute to students' success in positive manner.

In this study, it was observed that a few participants failed to form the diagram. It is believed that this situation might have stemmed from low skills of drawing or forming figures, over use of the diagram, or the fact that the diagram is a relatively new technical instrument (Orak et al., 2010). Therefore, it is suggested that teamwork and more frequent application of the diagram over a longer period could help to overcome these problems (Orak et al., 2010; Ward & Wandersee, 2002a).

Moreover, it was determined, from the responses of prospective classroom teachers to open-ended questions, that they had difficulties in summarizing topics during the implementation of the Roundhouse diagram. Therefore, in particular before implementing the Roundhouse diagram as a teaching method, examples should be performed on how to summarize information and how to fill out the diagram.



Conclusion

Based on the findings obtained from this experimental study, it could be concluded that the Roundhouse diagram functions as an auxiliary instrument helped students better learn ecosystem topics and increased their understanding. It was found that students enjoyed using the diagram while learning the course. Given the boring nature of the traditional method, a variety of strategies such as the Roundhouse diagram should be employed while teaching especially abstract concepts in order to make courses more enjoyable. For all these reasons, the Roundhouse diagram is seemed as an enjoyable, interesting, beneficial and innovative teaching instrument. Graphic organizers such as the Roundhouse diagram should be used more in science education in order to ensure meaningful learning. The Roundhouse diagram can be used not only to enhance academic achievement but also evaluate students' understanding and reveal misconceptions.

The results suggest that teachers and science educators can use the roundhouse diagram as an effective tool. However, this research was only conducted in science classroom. Therefore, it is not know the Roundhouse diagram's effect in other fields. It would be good to investigate the effect of the Roundhouse diagram in other topics. This study was conducted with a total of 87 prospective classroom teachers. Therefore, the Roundhouse diagram should be applied to large sample in further studies. The Roundhouse diagram not only enhances the learning of science-related material but also enhances language arts and reading skills. This method can be used integrating science and other subject matter. Because of the use of drawing in this technique, the artistic possibilities are endless.

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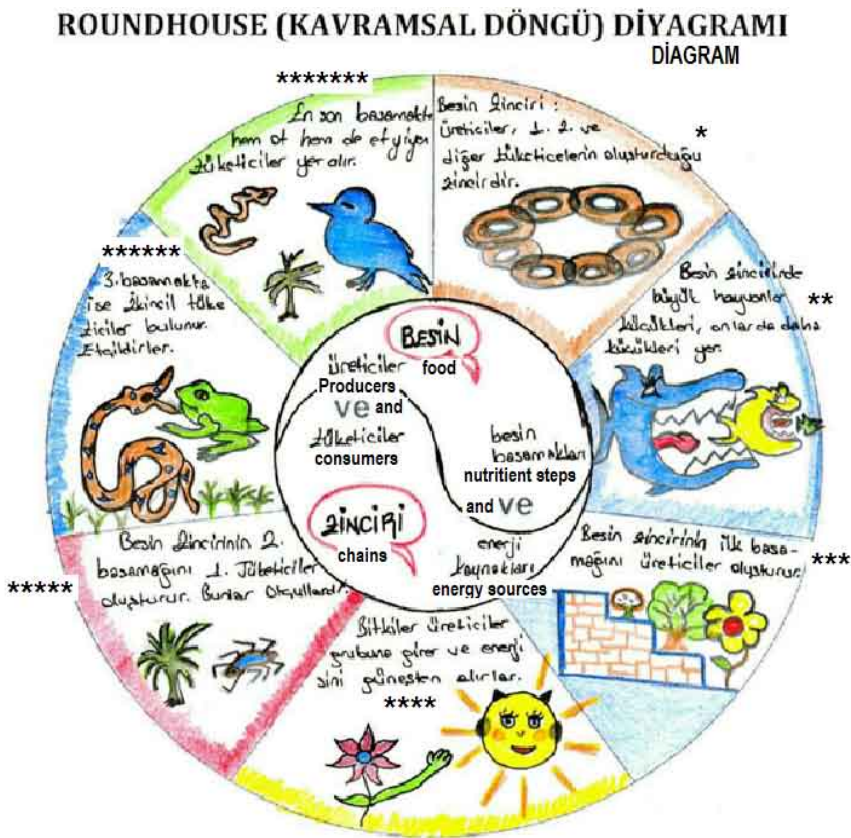
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Appendix

Example 1. Roundhouse diagram.



HEDEF: Üretici ve tüketiciler canlıların besin zincirindeki yerlerini ve önemlerini anlamak ve bilgi sahibi olmak...

Goals: To understand and inform the place of consumers and producers in food chain

*. Food chain is a sequence formed by primary, secondary and other consumers.

** Large animals in a food chain eat small animals.

*** The first step of the food chain forms producers.

**** Plants are in a group of producers and get their energy from the sun.

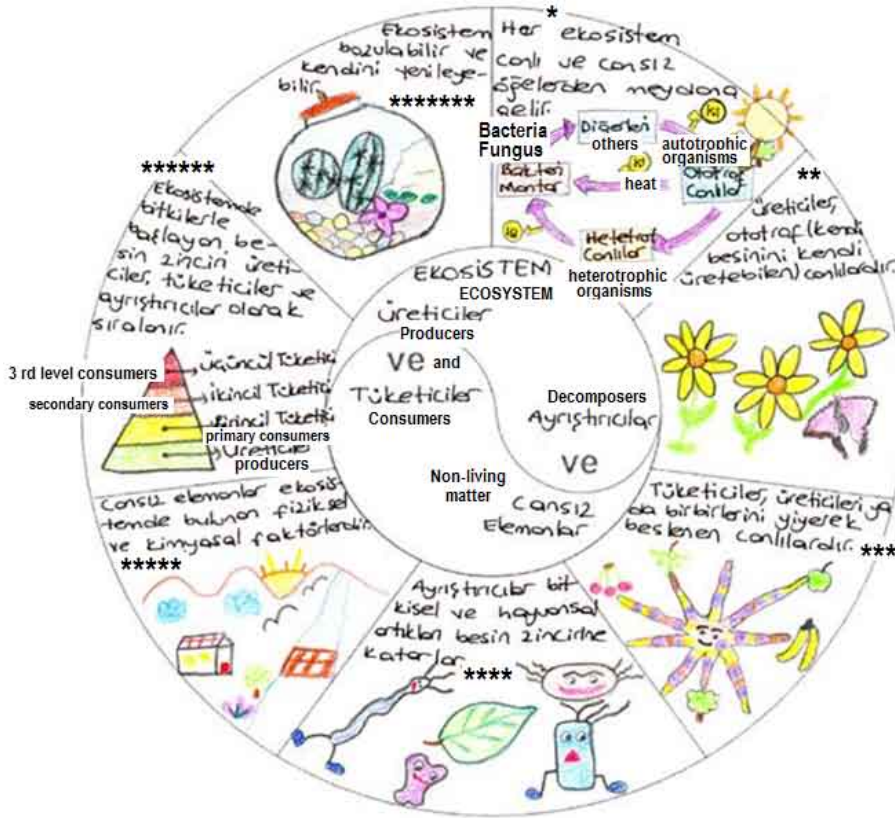
***** The second step of the food chain consists of Consumers. These are herbivores.

***** The third step of the food chain consists of carnivores.

***** In the last step, there are omnivorous.

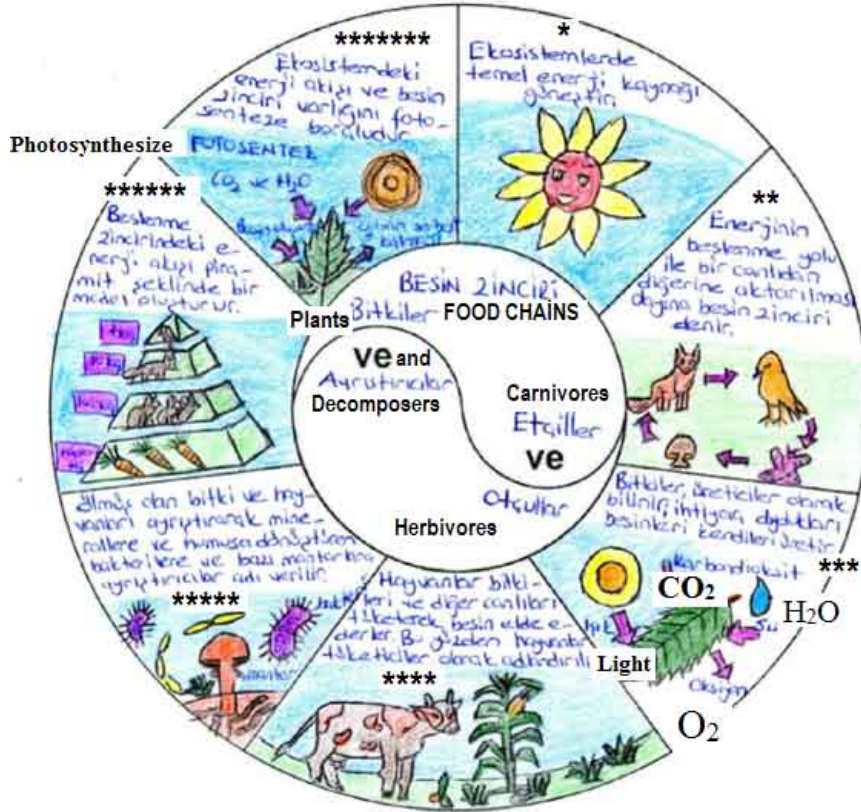
Example 2. Roundhouse diagram.

ROUNDHOUSE (KAVRAMSAL DÖNGÜ) DİYAGRAMI



HEDEF: Ekosistemle ilgili başka fazla bilgi sahibi olmak
 istiyorum. Goals: I want to have information about the ecosystem

- *. Each ecosystem consists of living and non-living elements
- ** . Producers are autotrophic organisms.
- ***. Consumers are ones who eat producers or each other.
- ****. Decomposers strings plant and animal residues to the food chain.
- *****. Non-living organisms are physical and chemical factors in an ecosystem.
- *****. The food chain which begins with plants in an Ecosystem is ranked as producers, consumers, and decomposers.
- *****. An ecosystem could damage and renew itself.

Example 3. Roundhouse diagram.**ROUNDHOUSE (KAVRAMSAL DÖNGÜ) DİYAGRAMI
DIAGRAM**

HEDEF: Ekosistemin bir parçası olan besin zinciri hakkında daha fazla bilgi sahibi olmak istiyordum.

Goals: I want to have more information about food chain which is a part of the ecosystem

- *. The main energy source in the ecosystem is the sun
- ** The transfer of energy from one living thing with feeding path is called the food chain.
- ***. Plants are known as producers, they produce the nutrients they need.
- ****. Animals obtain food by eating plants and other living things. Therefore, consumers are referred to as animals.
- *****. Some fungi and bacteria that break down dead plants and animals are called decomposers
- *****. The flow of energy in the food chain consists of a model-like pyramid.
- *****. Energy flow and food chain in ecosystems are actualized by photosynthesis

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