THE EFFECT OF 7E LEARNING CYCLE MODEL ON THE IMPROVEMENT OF FIFTH GRADE STUDENTS' CRITICAL THINKING SKILLS

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ABSTRACT

THE EFFECT OF 7E LEARNING CYCLE MODEL ON THE IMPROVEMENT OF FIFTH GRADE STUDENTS' CRITICAL THINKING SKILLS

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The main purpose of the present study was to investigate the effect of 7E learning cycle model as an inquiry-based learning on the improvement of 5^{th} grade students' critical thinking skills.

This study was conducted during 2005-2006 spring semester in a private primary school in Sakarya. A total of 46 fifth grade students from two different classes of the same science teacher was involved in the study. Two classes were randomly assigned as experimental group and control group. While students in the control group were instructed with traditional method, inquiry-based learning was carried out in the experimental group. Since phenomena that show cause and effect relationships are good inquiry subjects, water cycle in the science and technology curriculum was taken as the unit in the present study. The Cornell Conditional Reasoning Test, from the Cornell Critical Thinking Skills Tests Series was administered as pre-test and post-test to students both in the experimental and control groups. The effects of gender and family income of the students on the dependent variable were also checked. Statistical Analysis of Covariance was used to test the hypotheses of this study.

The results indicated that the experimental group achieved significantly better than the control group in both the critical thinking skill test, F (1, 41)=35.03, p=0.000, partial $\eta^2 = 0.46$. In other words, inquiry-based learning improved students' critical thinking skills. On the other hand, no significant effect of gender and family income on improvement of students' critical thinking skills was found.

Keywords: Inquiry-Based Learning, 7E Learning Cycle Model, Traditional Method, Critical Thinking Skills

ÖZ

7E ÖĞRENME EVRESİ MODELİNİN BEŞİNCİ SINIF ÖĞRENCİLERİNİN ELEŞTİREL DÜŞÜNME YETENEĞİ GELİŞİMİNE ETKİSİ

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Bu çalışmanın amacı 7E öğrenme evresi modelinin ilköğretim beşinci sınıf öğrencilerinin eleştirel düşünme yeteneği gelişimine etkisini incelemektir.

Çalışma 2005-2006 eğitim öğretim yılı bahar döneminde Sakarya ilinde özel bir ilköğretim okulunda gerçekleşmiştir. Çalışmaya aynı Fen ve Teknoloji dersi öğretmenine ait iki ayrı sınıfta okuyan toplam 46 beşinci sınıf öğrencisi katılmıştır. Sınıflar deney ve control grubu olmak üzere rastgele seçilmiştir. Kontrol grubundaki öğrenciler geleneksel yöntem ile ders işlerken, deney grubunda sorgulamaya dayalı öğrenme yaklaşımını temel alan 7E öğrenme evresi modeli kullanılmıştır. Sebep-sonuç ilişkileri gösteren olaylar iyi birer sorgulama konusu olduğu düşünülürse, Fen ve Teknoloji ders programı içinde yer alan su döngüsü bu çalışma için uygun bulunmuştur. Cornell Eleştirel Düşünme Becerisi Testleri Serisine ait Cornell Koşullu Sorgulama Testi her iki gruba da öntest ve sontest olarak uygulanmıştır. Çalışmada, ayrıca cinsiyet ve aile gelir düzeyi değişkenlerinin öğrencilerin eleştirel düşünme becerisi gelişimi üzerine etkilerine bakılmıştır. Çalışmanın hipotezleri covaryans istatistiksel analizleri kullanılarak test edilmiştir.

Sonuçlar deney grubunun eleştirel düşünme becerisi testinde kontrol grubuna göre daha başarılı olduğunu göstermiştir, F (1, 41)=35.03, p=0.000, partial $\eta^2 = 0.46$. Diğer bir deyişle, sorgulamaya dayalı 7E öğrenme evresi modeli öğrencilerin eleştirel düşünme becerileri gelişimini olumlu etkilemiştir. Öte yandan, cinsiyet ve aile gelir düzeyi değişkenleri açısından öğrencilerin gelişimlerinde anlamlı bir etki bulunamamıştır.

Anahtar Kelimeler: Sorgulamaya Dayalı Öğrenme, 7E Öğrenme Evresi Modeli, Geleneksel Öğretim Yöntemi, Eleştirel Düşünme Becerisi

To My Father

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To all whose name is here, this thesis is dedicated.

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LIST OF SYMBOLS

EG	: Experimental Group
CG	: Control Group
CCT-X	: Cornell Conditional-Reasoning Test, Form X
SAT	: Science Achievement Test
TM	: Traditional Method
7E LC	: 7E Learning Cycle Model
N	: Sample Size
Mean	: Mean of Sample
Std.Dev.	: Standard Deviation of the Sample
t-value	: T statistics
p or Sig.	: Significant Level
F:	: F statistics
η^2:	: Effect Size Measure
Wilk's Λ	: Multivariate Analysis of Variance
ANCOVA	: Analysis of Covariance
ANOVA	: Analysis of Variance

CHAPTER 1

INTRODUCTION

Studies in the field of education reveal that there seems to be a growing recognition of the need to refocus teaching methods on development of students' critical thinking skills (Ahern-Rindell, 1999; Kronberg & Griffin, 2000; McKendree, Small & Stenning, 2002; Niedringhaus, 2001; Yager & Lutz, 1994). The research in critical thinking has increased after studies which demonstrated that a significant number of students show difficulties when faced with complex reasoning tasks. Critical thinking involves grasping the deeper meaning of problems, keeping an open mind about different approaches and perspectives, and thinking reflectively rather than accepting statements and carrying out procedures without significant understanding and evaluation (Santrock, 1997). Thus, critical thinking is an important aspect of both everyday and scientific reasoning so the critical thinking skills should be sharpened. Cited by Kalman (2002), Facione (1990) stated that effective and meaningful education requires that curricular, pedagogical and assessment strategies at all levels of education must be coordinated so as to foster in students cognitive skills and habits of inquiry associated with critical thinking. Educating students to be critical thinkers is vital for the students themselves and for society in general. To think critically, students need to take an active role in learning. This means that students need to participate in a variety of active thinking processes instead of passively listening to teachers. Inquiry is an approach to learning, which requires direct involvement of the students with subject content in the learning process. This implies active student participation. In inquiry activities students are directed to accumulate data, and then explain their data by questioning to seek the truth or information concerning the subject. Thus, in inquiry activities students need to ask higher order questions and search for answers to these questions. All these activities force students to become a "critical thinker" in his own right, and not merely a mirror of what he thinks the teacher thinks (Bibens, 2001). In classrooms where inquiry-based learning method is used, students are engaged in scientifically oriented questions; they give priority to evidence, which allows them to develop and evaluate explanations that address scientifically oriented questions. Then, students formulate explanations from evidence to address these questions. They evaluate their explanations in the light of alternative explanations, particularly those reflecting scientific understanding. Finally, students communicate and justify their proposed explanations (National Research Council 2000, p.25).

The idea of inquiry in the class requires teachers to be flexible with lesson plans and daily routines. Unit planning based on inquiry involves students asking and seeking answers to their own questions about something. Inquiry can be viewed as understanding which will last until the learner has time to ask new questions to create more difficult questions. Thus, teachers cannot expect to use inquiry-based teaching methods if they are slaves to fixed routines and schedules. The role of the teacher must be a facilitator who monitors and guides the students' inquiry. Through such inquiry learning approaches, students are put into situations that demand critical thinking and encourage the internalizing of major concepts (Bevevino, Dengel and Adams, 1999).

Inquiry must be a curriculum focus in the early grades that endeavors to create situations that evoke spontaneous elaboration and thinking on the part of the child (Wadden, 2003). Different ideas should be encouraged and every child should be involved in an inquiry-based curriculum. Only then can students be inspired and open-minded thinking, and discussions can free students to take the risks that will encourage critical thinking. Because, inquiry begins with a meaningful problem or issue, the process engages students as that come to value the driving questions that motivate their inquiry process.

One of the inquiry-based learning instructional strategies for helping students to learn concepts while fostering cognitive development is the learning cycle (Karplus, 1977). The learning cycle model is a teaching procedure consistent with the inquiry nature of science and with the way children naturally learn (Cavallo & Laubach, 2001). The learning cycle represents a general philosophy of teaching and learning with strong constructivist underpinnings. Central to this methodology is the idea that a hands-on exploration or activity is to be done prior to the formalization of concepts. Many versions of the learning cycle appear in science curricula with phases ranging in number from three to five to seven. Regardless of the quantity of phases, every learning cycle has at its core the same purpose (Settlage, 1999). Learning cycle used in this study has seven phases; that is the 7E learning cycle model. The 7E learning cycle model requires instruction to include the following discrete elements: elicit, engage, explore, explain, elaborate, evaluate, and extend (Eisenkraft, 2003). Each learning cycle begins with the active engagement of students in inquiring the concepts. In *engage phase*, the teacher may use a relevant scenario or a simple experiment activity just to capture students' attention, raise questions in their minds and assess their prior knowledge about the subject matter. After the initial engagement, eliciting of prior knowledge about the subject matter takes place. This *elicit phase* lets the teacher assess any misconceptions the students have. During the *explore phase*, children are encouraged to play with the materials, discover how things work, talk among themselves and with the teacher/leader. Generally, students work in groups. The explore phase is student-centered with the teacher acting as facilitator by providing materials, giving directions, asking questions and encouraging students' discovery. Then, students are introduced to models, laws, and theories during the *explain phase* of the learning cycle (Eisenkraft, 2003). The facilitator teacher guides the discussion as he/she works with the children to organize data, look for patterns, make comparisons, and identify problems. After all students have constructed and expressed understanding of the concept, the teacher or students may introduce related scientific terminology. Then, children are asked to look for many solutions and ideas, not just one "correct" answer. They might repeat the activity or they might wonder about some component or application of the activity, thus beginning the cycle again as they explore a new idea. This *elaborate phase* of the learning cycle provides an opportunity for students to apply their knowledge to new domains, which may include asking new questions and making new hypothesis (Eisenkraft, 2003). These applications help extend and expand students' understandings and apply the concept to everyday life experiences. The *extend phase* gives students opportunity to see the relationship between what they've just learned how it applies to their own life. To make sure the students have understood the subject matter, the students and the teacher employ the *evaluate phase*. These phases engage students in an inquiry-based learning environment where students can confront new ideas, deepen their understanding, and learn to think logically and critically about the world around them. Using the learning cycle model, the teacher can create a series of activities that are personally meaningful for students and give students opportunities to practice critical thinking skills (Bevevino et al., 1999). Thus, critical thinking skill development is one of the outcomes of the inquiry-based learning. In present study, the science and technology concept, "the water cycle" will be taught to students by using 7E learning cycle model to investigate the development of critical thinking skills of 5^{th} grade students.

The main purpose of current experimental study is, therefore, to investigate the effect of inquiry-based learning on the improvement of primary school students' critical thinking skills. More specifically, this study will examine the effect of inquiry activities in a 7E Learning Cycle unit in 5^{th} grade science and technology classes on the improvement of students' critical thinking skills .

1.1 Definitions of Important Terms

Critical thinking- the process of purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation and inference.

Critical thinking skills- combination of skills including induction, credibility, observation, deduction, and assumption identification. Cornell Critical Thinking Test, Level X, will be used to measure these skills.

Inquiry- the action of seeking, especially for truth, knowledge or information about something; search, research, investigation, examination; the action of asking or questioning.

Inquiry-based learning method – is a dynamic model to learning in which students directly involve in the learning process by searching, investigating, asking questions and in which they develop their thinking.

Learning cycle – an instructional model or approach based on inquiry-based learning.

Traditional method – is an instructional method in which students are passively receiving all information from the teacher and the textbook.

Prior critical thinking skills – critical thinking skills of students measured via instrument prior to treatment.

Science Achievement – students' achievement in a Science Achievement Test developed by the teacher and the researcher.

1.2 Significance of the Study

The idea that critical thinking is a valuable teaching and learning tool has been validated at least since the time of Socrates. Although research has demonstrated the value of critical thinking, there is not sufficient literature on how the critical thinking skills can be developed and sharpened in students. Studies on critical thinking have revealed that critical thinking is essential as a tool of inquiry (Zohar, Weinberger & Tamir, 1994; Kronberg & Griffin, 2000). Nevertheless, no study examining the effect of inquiry-based learning on the improvement of students' critical thinking skills has been found so far. Actually, the concept of critical thinking is new in the field of science education in Turkey. High stakes assessment, time and increasing demands for teaching content knowledge hinder the promotion of critical thinking and understanding skills of students. Thus, present study has an intention to take researchers', teachers' and other experts' attention to the importance of development of critical thinking skills in students for efficient science education in Turkey. Moreover, since inquiry-based learning is still a topic many teachers associate with specific science activities, further discussion is needed in order to explore methods of inquiry-based teaching that touch all areas of curriculum. The 7E learning cycle model of inquiry-based learning has not been used for many of the primary school science concepts up to now. The first E refers to "elicit" in 7E learning cycle. Since studies on student misconceptions has become a central issue in science education for the past two decades, instructional strategies trying to foster effective learning first deal with students' prior knowledge. In science education literature, there is a need to add new models that aim both cognitive development in students and eliciting and eliminating students' misconceptions. Therefore, this study has aimed to emphasize the interrelation of the critical thinking and inquiry by examining the effectiveness of inquiry-based learning on the improvement of primary school students' critical thinking skills.

CHAPTER 2

REVIEW OF RELATED LITERATURE

This chapter is devoted to the presentation of the previous studies that have produced theoretical and empirical background for this study.

2.1 Inquiry-based Learning

When educators see or hear the word "inquiry", many think of a particular way of teaching and learning science. However, the definition of inquiry in education is not just simple. National Science Education Standards attempt to define inquiry with a broad descriptive statement: "Inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations and predictions; and communicating the results. Inquiry requires the identification of assumptions, use of critical and logical thinking, and consideration of alternative hypothesis." (National Research Council, 2000, p.14)

On the basis of this definition, examining the role of inquiry in science education has received a great deal of attention in educational research for many years. Studies suggested teachers to replace traditional teacher-centered instructional strategies with inquiry-based approaches that engage student curiosity and interest in science. In his meta-analysis study, Lott (1983) reported the effect of inquiry teaching and advance organizers upon student outcomes in science education. In terms of inquiry teaching, he found that the approaches in which subjects made judgments or organized elements into new patterns were inductive-oriented with a higher level of inquiry than those which required subjects to simply retrieve information. The effect sizes were largest for inquiry teaching in knowledge and process skill outcomes.

Keefer (1999) presented the criteria for designing an inquiry-based learning activity by reviewing the literature to answer the question “How does a teacher incorporate inquiry-based learning as a teaching methodology?” (a) students must have a problem to solve, (b) students must have a background information, (c) students must come to see that their way of approaching the problem will not work, (d) students must come to a recognition, on their own, that the approach offered by the instructor has promise in the solution of the problem, (e) adequate time must be provided for students to be able to work out the details of a new approach on their own or with their partners, (f) students must practice from examples and the discrimination of nonexamples that relate to the problem, (g) students should experience success. In order to validate these criteria, Keefer studied with 116 students in three separate lecture classes and six different laboratory classes. One lecture class and two laboratory classes were taught using conventional instruction and a conventional laboratory activity from a published manual. The other lecture class received the same conventional lecture as the prior group and the laboratory component of the author’s inquiry-based module. The third one received the author’s entire inquiry-based module, both lecture and laboratory components on the topic of projectile motion. The results of his study showed that the inquiry-based learning group scored over 50 percent more correct answers on the final standardized questions compared to the other group.

Drayton and Falk (2002) stated key features of the inquiry-based classroom in the school environment. They defined the inquiry-based classroom as where the student is the one who is doing the most important part of the intellectual work, rather than the teacher. Their study revealed that the effective inquiry-based classrooms include more peer-work, problem solving, investigation, discussion and argumentation about science. Drayton and Falk (2002) summarized inquiry-based learning as it places a high emphasis on conceptual learning, enables the learner to think critically, motives the learner to continue learning, to ask questions.

Inquiry-based learning or inquiry and hands-on learning may be considered as the same in science education. Barnes and Foley (1999) differentiated inquiry and hands-on science instruction in teaching sections of elementary and secondary science methods course of undergraduates and post baccalaureate students by using three approaches to hands-on learning. They summarized as follows:

1- Hands-on instruction does not always have a critical thinking component; true inquiry demands the incorporation of processes that underlie critical thinking, such as observing, inferring, comparing, communicating, hypothesizing, collecting and analyzing data, and planning investigations.
2- Hands-on instruction may not use the students' ideas for shaping explorations; inquiry builds on student's own prior knowledge.
3- Hands-on instruction does not guarantee inquiry.
4- Hands-on activities provide students with opportunities for exploration and manipulating equipment so further questions may be generated. In situations in which questions are generated, students are more likely to be active inquirers.
5- Memory of concepts embedded in hands-on activities may be strengthened in true inquiry contexts.

Drayton and Falk (2002) also mentioned the importance of examining the ways that hands-on activities serve student sense-making and learning in order to understand the state of inquiry in the classroom. Moreover, previously Uno (1990) defined inquiry as a pedagogical method that combines hands-on activities with student-centered discussion and discovery of concepts and presented some ways for teachers to encourage inquiry and good discussions in the class:

1- Have students use as many hands-on activities as possible to help them discover biological concepts for themselves. Provide students with an introduction to a concept and enough background information so they can work out in the rest of the idea.
2- Incorporate elements of a scientific method as often as possible. Allow students to make observations, form hypotheses, test hypotheses through experiments or demonstrations that illustrate experimental results, and analyze and discuss data.
3- Start asking questions on the first day of class, encourage discussion from the start, and let students know that they are expected to be active participants.
4- Before class, formulate questions in order to control the direction of the discussion.
5- Ask only one question at a time. Use open-ended questions.
6- Do not answer your own questions. Wait for answers from students. If there is no response, rephrase questions until there is one.
7- Accept all responses made by students, focusing on those that advance class discussion.
8- Summarize the main points each class, and encourage students to apply their knowledge to new situations.
9- Try to involve everyone.
10- Do not use inquiry-based learning all of the time; use a variety of teaching methods (Uno, 1990).

In their quasi-experimental design, Chang and Mao (1999) compared traditional instruction and inquiry-group instruction with respect to ninth-grade Taiwan students' achievement and attitudes toward earth science. The inquiry-group instruction in their study focused on discussions and interpretations of data in a cooperative-learning setting, where students work together and share ideas. Their inquiry-based learning environment had three main characteristics: 1- Students organized their own research teams and worked with the same team to learn concepts being taught through inquiry and group discussion. 2- Students worked on group projects that emphasized gathering and interpreting data generated from hands-on, inquiry-oriented activities. 3- Teams prepared final reports and presented project results as group to their classmates. Their findings with 319 students in the experimental group and 293 students in the control group revealed that students in the experimental group had significantly higher achievement scores than did students in the control group; and that there were statistically significant differences in the favor of the inquiry-group instruction on student attitudes toward the earth science. Chang and Mao concluded that the findings of their study showed that the inquiry-group instruction was superior in promoting students' achievement abd attitudes toward earth science because the inquiry-based approach enabled students to plan their own investigations, gather and interpret data, analyze results, and share findings with their friends.

Asking questions is one of the skills that students need to learn in an inquiry-based learning environment (Edwards, 1997)., In a recent study, Hofstein, Navon, Kipnis, and Mamlok-Naaman (2005) investigated the ability of students to ask questions related to their observations and findings in an inquiry-type experiment and the ability of students to ask questions after critically reading a scientific article. They studied with six 12^{th} grade chemistry classes, consisting 55 students in the inquiry group and 56 students in the traditional laboratory type group. The researchers developed a practical test and a questionnaire based on a scientific article and their quantitative analyses revealed that students in the inquiry group asked many more high-level-type questions than the students in the control group. For example, students in the inquiry-based laboratory environment asked "what would happen if…." type of questions addition to "why did this happen?" low-order type of questions. The results of this study confirmed the most essential characteristic of the inquiry-based learning, where students are continuously asking questions and formulating inquiry questions.

Besides the quantitative studies that tried to investigate the effectiveness of inquiry-based learning on several student outcomes, qualitative studies were also conducted to provide a better understanding for inquiry science teaching. Keys and Kennedy (1999) developed a case study to describe how one teacher interpreted inquiry science teaching in her fourth grade classroom. This study explored the daily interactions of the teacher with her class as she strove to incorporate as inquiry orientation. This teacher identified two major challenges in implementing inquiry science teaching. First, it was taking more time. This finding was consistent with the findings of Lawson et al. (1990) who also indicated that the inquiry approach takes more time to get to the main facts or concepts than any traditional approach. Second challenge of inquiry science teaching was turning students' questions back over to them. The main part that was very difficult for a teacher was not telling them how and to keep asking when they asked a question.

2.2 Learning Cycle Model

For many years research in science education has tried to meet the need of teachers for student-centered instructional strategies based on constructivist theory. An instructional methodology that is founded on constructivist learning theory should be aware of the following key points: (1) a student's prior knowledge is a key factor affecting future learning because what a student already knows interacts with a new conception; (2) students construct meaning through interactions with others, with materials, and by observation and exploration of interesting and challenging activities; (3) students need to build their understanding around core concepts and big ideas (Brooks and Brooks, 1999). The learning cycle is an inquiry-based instructional approach or model with its roots on constructivist perspective. Karplus (1977) declared that the learning cycle is an effective inquiry-based instructional strategy for helping students to learn concepts and conceptual systems while fostering cognitive development. The learning cycle incorporates the Piaget's Theory of Cognitive Development into a succinct methodology of learning: experiencing the phenomena or concept (Exploration Phase), applying terminology to the concept (Concept Introduction), and the application of the concepts into additional conceptual frameworks (Application). Odom and Kelly (2001) stated that the main idea is that learning cycle provides opportunities for students to explore their belief systems, which may result in argumentation, prediction, and hypothesis testing, resulting in self-regulation and knowledge construction.

Lawson, Rissing and Faeth (1990) used the learning cycle approach to teach photosynthesis. They indicated that a substantial portion of students who enroll in a nonmajors, one semester introductory biology course taught at Arizona State University, have poorly developed scientific reasoning skills. They claimed that students learn facts but do not experience science as a process of describing and attempting to explain nature. Considering the scientific reasoning as one of the fundamental abilities of inquiry, they renewed the course on the basis of learning cycle approach to help students acquire an explicit awareness of and an ability to use the reasoning patterns involved in learning about one's world through creative and logical process of generating and testing alternative hypothesis. Lawson et al. (1990) concluded that the learning cycle approach provided the opportunity to emphasize the nature of scientific inquiry, engage students' minds, and teach a substantial number of important biological concepts as well. The findings of this study seem to be just the belief of the researchers. There was no evidence supporting the gain in deeper understanding of biological concepts and the development of scientific reasoning skills in students. This study offered the application of learning cycle approach on photosynthesis well, but the student outcomes were not measured either quantitatively or qualitatively. Also, the generalization on the effectiveness of the learning cycle in many biological concepts was unsupported in this study.

The relationship between the reasoning ability and the biology achievement in inquiry classes was also studied by Johnson and Lawson (1998). They claimed that inquiry instruction deals more with how science is done, i.e., with scientific processes; therefore perhaps the best predictor in inquiry classes is reasoning ability. To test this hypothesis, they studied with 366 students enrolled in a one-semester nonmajors biology course at a large suburban southwestern community college. One hundred eighty-one students experienced expository instruction, while 185 students experienced inquiry instruction, as learning cycle. Students were pretested to determine reasoning ability. After a semester of eight, either expository or learning cycle, instructions, students took a comprehensive final biology examination and a post reasoning ability test. The results showed that reasoning ability did predict achievement in introductory level college biology taught by inquiry. Students not only developed their achievements in biology, they also developed their reasoning ability skills with the help of the learning cycle approach. This result offers support for Piaget's Cognitive Developmental Theory with its emphasis on knowledge construction as Karplus (1977) and then Odom and Kelly (2001) stated.

Odom and Kelly (2001) conducted a study to explore the effectiveness of the learning cycle and concept mapping in promoting understanding of diffusion and osmosis in high school biology. They proposed that the learning cycle and the concept mapping provide a unique approach to learning that can help students construct knowledge. The topics they selected to study, diffusion and osmosis, involve many complex process that require multiple learning cycles. From this point of view, one of the negative viewpoints of the learning cycle approach was mentioned in this study: With the learning cycle there is no formal mechanism to make connections between numerous concepts and activities. Thus, Odom and Kelly (2001) studied with 108 secondary, in grades 10 and 11, students enrolled in four different sections of college preparatory biology course. They randomly assigned students into four different treatment groups: concept mapping (CM) (n=26); learning cycle (LC) (n=28); expository (EX) (n=27); and the concept mapping/learning cycle (CM/LC) (n=27). Each group took eight lessons on the defined instruction strategy. The conceptual understanding of students was measured with the Diffusion and Osmosis Diagnostic Test. This study was set out to investigate the effectiveness of concept mapping, the learning cycle, expository and the concept mapping/learning cycle instructional strategies on enhancing achievement in diffusion and osmosis content. The results indicated that both the CM/LC and CM strategies enhanced learning of diffusion and osmosis concepts more effectively than expository teaching. However, the two treatments (CM/LC and CM) were not significantly different from the LC treatment ($p>.05$). Although this study showed that concept mapping and the learning cycle provide an exceptional combination of strategies, because each method brings a unique epistemology to learning, additional research is needed to determine the role of the learning cycle at teaching diffusion and osmosis concepts. The effect of the learning cycle was not clearly identified in this study.

In his study, Lauer (2003) used games and simulations to help students learn terms of ecology in first and second year college science major. These games followed the three-phase of learning cycle model to promote the understanding and comprehension of particular terms and to break up the monotony and drudgery of a long lecture. For example, to teach population ecology Lauer (2003) used a maze puzzle during the exploration phase and then the teacher briefly explained the population ecology in term application phase and finally students were forced to find other examples to population ecology. He suggested that any game with competitive interaction could be used in this activity.

More recently, Balcı, Çakiroğlu and Tekkaya (2006) investigated the effect of 5E learning cycle instruction on 8^{th} grade students' understanding of photosynthesis and respiration in plants. In their study, they also used conceptual change text based instruction as another learning tool. Their findings revealed that students in the 5E learning cycle treatment group demonstrated better performance on photosynthesis and respiration in plants concept test over the students in the traditional instruction control group.

On the other hand, Hampton and Odom (1995) investigated the teachers' understanding and misunderstanding of the learning cycle by developing a diagnostic test. They developed a two-tier diagnostic test and administered this test to 28 undergraduate students who received instruction on the learning cycle before. The results of the learning cycle test indicated that the students did not acquire a statisfactory understanding of the learning cycle. They identified twenty-eight misconceptions through analysis of the items on the learning cycle test. They found that the most common misconceptions were centered around the role of the teacher during the exploration phase of the learning cycle. They implied that the learning cycle test and the findings from the application of this test could be used to improve instruction on learning cycle in elementary science methods course for preservice teachers.

2.3 Critical Thinking

Critical thinking is thinking that has a purpose and has cognitive skills like interpretation, analysis, evaluation, inference, explanation and self-regulation. Critical thinking is recently defined by the Curriculum Development Center of Ministry of Education as the capability to consider the issues with suspicion-based interrogating approach. It includes the sub-capabilities such as finding cause-effect relations, catching the similarities and differences of details, sequencing by using various criteria, determination of the acceptance and validity, analyzing, evaluation, explanation of and inference from given data

(MEB Müfredat Geliştirme Süreci, Program Temel Yaklaşımı, 2006). Critical thinking is reflective thinking focused on deciding what to believe or do (Ennis, 1993). This definition includes the creative aspects of critical thinking such as conceiving of alternatives, formulating hypotheses and definitions, and developing plans for experiments. Ennis (1993) also identified the abilities and dispositions a person needs in reasonably and reflectively going about deciding what to believe or do:

> Judge the credibility of sources.
> Identify conclusions, reasons, and assumptions.
> Judge the quality of an argument, including the acceptability of its reasons, assumptions, and evidence.
> Develop and defend a position on an issue.
> Ask appropriate clarifying questions.
> Plan experiments and judge experimental designs.
> Define terms in a way appropriate for the context.
> Be open-minded.
> Try to be well informed.
> Draw conclusions when warranted, but with caution.

This list can serve as a set of goals for an entire critical thinking curriculum or as a partial set of goals for some subject-matter or other instructional sequence. Lawson (1993) stated that critical thinking skills develop as a consequence of provoked encounters with situations in which students struggle to answer and reflect on those answers and on the methods of obtaining those answers. Bailin, Case, Coombs and Daniels (1999) argued that in order to become a critical thinker one must understand what constitutes quality reasoning. This includes background knowledge relevant to the context in question, knowledge of the principles and standards of argumentation and inquiry both in general and in specialized areas. Recently, Bailin (2002) highlighted the contextual nature of critical thinking: Critical thinking always takes place in response to a particular task, question, problematic situation or challenge, including solving problems, evaluating theories, conducting inquiries, interpreting works, and engaging in creative task, and such challenges always arise in a particular context. More recently, Lawson (2005) implied that instructional strategies based on inquiry-based approach provide students with several opportunities to encounter puzzling observations and force them to explain these using their reasoning by repeatedly asking higher-order questions. Therefore, since critical thinking is contextual, applying this conception in science education involves focusing on the tasks, problems and issues in the science curriculum, which require or prompt critical thinking.

2.4 Critical Thinking Skills and Instructional Strategies

According to Uno (1990) students develop critical thinking skills by using several steps of scientific methodology like, observing, asking good questions, hypothesizing, predicting, designing an investigation to solve a problem, drawing conclusions, inferring and generalizing, evaluating, relating cause and effect, explaining and applying knowledge to new situations. Thus, any instructional strategy that aims to improve students' critical thinking skills should create an environment where students can perform these activities.

Having critical thinking skills does not mean that students learn and list critical thinking components, but rather their cognitive abilities are improved through several instructional practices. Bailin et al. (1999) proposed for teachers three components of teaching critical thinking to students:

1- engaging students in dealing with tasks that call for reasoned judgment or assessment,
2- helping students develop intellectual resources for dealing with these tasks, and

3- providing an environment in which critical thinking is valued and students are encouraged and supported in their attempts to think critically and engage in critical discussion.

Studies aimed to develop critical thinking skills of students in science include several different activities or instructional strategies. Kronberg and Griffin (2000) suggested the use of analysis problems as a means to develop students' critical thinking skills in biology. The use of such problems correlates well with developing Bloom's higher-level cognitive domains. These questions require students to move beyond comprehension to the levels of application, analysis and synthesis, thus promote critical thinking. This study just defined the analysis problems constitutionally and by exemplification.

Zohar, Weinberger and Tamir (1994) investigated the effect of a Biology Critical Thinking (BCT) project on the development of critical thinking skills in various biological topics. They selected seven skills as the goals of the BCT project:

Recognizing logical fallacies.

Distinguishing between findings of an experiment and conclusions made on the basis of findings.

Identifying explicit and tacit assumptions.

Avoiding tautologies.

Isolating variables.

Testing hypothesis.

Identifying relevant information for answering a question or solving a problem.

Six hundred seventy-eight seventh grade students (aged 12-13; 340 boys and 338 girls) participated in their study. The experimental students (n=367) studied in 11 classes in four schools, whereas the control students (n=311) studied in 10 classes in four different schools. Both groups from the same textbook studied the same unit "Water Balance in Living Organisms" for about

24 periods. The control group studied the same topic in a conventional manner while experimental group completed the BCT activities. The General Critical Thinking Test was used as pre- and posttest to assess the students' critical thinking skills. Comparison of gain of the experimental (*M*=36.7) and control groups (*M*=5.4) in these tests showed that students who participated in the BCT project improved their critical thinking skills compared to their initial level and compared to their counterparts in the control ($p<.001$). This result indicated that even the students in the control group improved their critical thinking skills to some extent. The researchers explained this finding by referring the textbooks they used. The textbook follows an inquiry approach; therefore students in the control group had opportunities to practice several skills that are similar to those of the BCT project, to some extent.

Ahern-Rindell (1999) conducted a study that applied inquiry-based and cooperative group learning strategies to promote critical thinking in molecular genetics. The problem-based activities were used for the inquiry-based learning. She claimed that the students described the problem-based laboratory exercises as challenging but refreshing. They gained critical thinking skills and skills of problems solving. The writer implied that the success of inquiry-based learning lies in students' learning critical thinking skills by using them to do science. Since there was no information about the population, sample and the assessment and statistical analysis of that study, the author's findings and implications stayed unsupported and could not be generalized. Instead, this study just gave idea about the application of inquiry-based and cooperative learning strategies in molecular genetics. Nevertheless, studies of Zohar et al. (1994) and Ahern-Rindell (1999) are consistent in terms of their assertions that inquiry approach promotes critical thinking in students.

Tsui (1999) tried to identify courses and instruction that affect enhancement of critical thinking and to draw inferences about how effective instruction is related to effective courses. She found that the amount of time students devote to studying and doing homework positively affects growth in critical thinking.

She also indicated that growth in critical thinking is positively related to giving class presentations, which is an "active learning" experience that usually requires students to utilize a range of skills and negatively related to taking a multiple-choice examination, which is more passive, often involving only the ability to recall. Her study also revealed that science courses were significantly related to students' growth in critical thinking.

The underlying idea in all of these studies is that development of critical thinking skills is an crucial and vital topic in science education. Designing curriculum and instructional activities to promote students' critical thinking skills is not a new concept in science education literature. Inquiry-based learning strategy is one of them used to develop critical thinking skills. However, none of the studies in the reviewed literature directly looked for the effect of 7E learning cycle approach of inquiry-based learning strategy on the improvement of primary school students' critical thinking skills. Studies in the inquiry-based learning strategies generally concentrated on the scientific reasoning ability of students. All of the studies revealed that students have higher reasoning abilities in inquiry classrooms versus non-inquiry classrooms. Thus, inquiry-based learning procedures that involve students in data gathering, formulating hypotheses and definitions, asking appropriate questions and evaluating findings, also promote reasoning abilities. Actually, the researches on critical thinking propose these activities to foster critical thinking skills of students. Therefore, in this study, the effect of 7E learning cycle model on the improvement of primary school students' critical thinking skills is investigated.

All of these studies showed that the learning cycle has a positive effect in acquisition of scientific knowledge construction and in development of reasoning skills of students. The analysis of related studies also indicated that there are some gaps in application of inquiry-based learning strategies and in assessment of student outcomes after application. In present study, the learning cycle approach will be used as an instructional strategy.

2.5 Keyword List

The following keywords were search within the ERIC, SSCI, and EBSCO Publishing Service databases and through the Internet for the purpose of the study.

Inquiry
Inquiry-based learning
Inquiry teaching
Inquiry learning
Inquiry learning activities
Inquiry teaching strategies
Inquiry learning and science education
Inquiry and science
Learning cycle
5E Learning cycle
7E Learning cycle
Learning cycle and science education
Critical thinking
Critical thinking skills
Critical thinking skills and inquiry
Critical thinking skills and inquiry learning
Cognitive development and critical thinking
Water cycle

CHAPTER 3

PROBLEMS AND HYPOTHESES

This chapter presents the main problem and the sub-problems of the current study and the hypotheses tested in Chapter 5.

3.1 Main Problem

The main problem of this study is: What is the effect of 7E Learning Cycle Model on the improvement of 5^{th} grade students' critical thinking skills as compared to the traditional method in the Science and Technology classes in a Private primary school of Sakarya?

3.2 Sub-Problems

1. Is there a significant difference between the effect of 7E Learning Cycle model and that of traditional method on the improvement of 5^{th} grade students' critical thinking skills?

2. Is there a significant population mean difference between boys and girls with respect to improvement of critical thinking skills?

3. Is there a significant population mean difference between low-, middle-, and high family income of students with respect to improvement of critical thinking skills?

3.3 Hypotheses

3.3.1 Research Hypothesis

Students experiencing 7E Learning Cycle model will improve their critical thinking skills as compared to students experiencing traditional method in the Science and Technology classes when gender, family income and prior critical thinking skills of students are controlled.

3.3.2 Null Hypotheses

The sub-problems were statistically tested by the following hypothesis:

$H_0 1$: There is no statistically significant difference between the population means of students experiencing 7E Learning Cycle Model (7E LC) and the students experiencing traditional method (TM) in Science and Technology classes with respect to improvement of critical thinking skills, when gender, family income and prior critical thinking skills of students are controlled.

$H_0 2$: There is no statistically significant mean difference between the boys and girls with respect to improvement of critical thinking skills.

H_03: There is no statistically significant mean difference between low-, middle, and high family income of students with respect to improvement of critical thinking skills.

CHAPTER 4

DESIGN OF THE STUDY

This chapter presents the sample of the study, definition of variables, instruments used, detailed description of the treatment, expression of methods to analyze data, and assumptions and limitations.

4.1. Population and Sample

The target population of this study consists of all primary school students attending in the Governmental primary and Private primary schools in Turkey. The accessible population is the primary school students attending in the Governmental primary and Private primary schools in Sakarya. There are 120 Governmental primary and 6 Private primary schools in Adapazarı with approximately 53685 students (Sakarya Milli Eğitim Müdürlüğü, 2005). The population being sampled in this study consisted of, 5^{th} grade, approximately 5600 students according to the results of 2004-2005 censuses.

The sample was selected conveniently from this accessible population. The reason for convenient sampling procedure for schools is to make communication with the teachers easily and frequently and to make observations for treatment in schools simultaneously. Forty-six 5^{th} grade students were the sample of this study. Two intact classes were assigned to experimental and control groups. These classes were randomly assigned to the experimental and control groups.

The students were typical fifth graders, with a mean age of 10 years. The family income of the students in both groups was different, coming from low- to high-class families.

4.2 Instruments

In the current study, data were collected through two instruments: The Cornell Critical Thinking Test Series, The Cornell Conditional-Reasoning Test, Form X, and Science Achievement Test.

4.2.1 The Cornell Critical Thinking Test Series, The Cornell Conditional-Reasoning Test, Form X

In this study, a published critical thinking test was used. The Cornell Conditional-Reasoning Test, Form X (CCT-X) from the Cornell Critical Thinking Test Series by Ennis and Millman (1985), was used to assess 4^{th} – 14^{th} grade students' critical thinking skills. This instrument is selected because it measures critical thinking in an objective manner and its content matches to the aspects of inquiry-based learning. This test is a general-content based test; it uses content from a variety of areas with which test takers are presumed to be already familiar. It yields only a total score that is derived from items measuring skills involved in deduction, evaluation, observation, judgment of credibility of statements made by others, identification of assumptions and discerning meaning. CCT-X is a 72-item multiple-choice test intended to be taken in a 50-minute period. Each item has three choices and one keyed answer. Reliability estimates for the instrument with various populations ranged from .87 to .91. The following is a sample item from the CCT-X.

"Suppose you know that
Jane is standing near Betsy.

Then would this be true?
Betsy is standing near Jane.
YES
NO
MAYBE"

The correct answer is C, "MAYBE". Even is Jane is standing near Betsy, Betsy may be sitting. Betsy might be standing near Jane, but she might be sitting near Jane, or something else. You were not told enough to be certain about it, so "maybe" is the answer.

The CCT-X was translated and adapted into Turkish by the researcher and a group of panel from the departments of Foreign Languages, Educational Sciences and Secondary School Science and Mathematics Education (see Appendix A). School teachers also checked the test to provide face and content validity. After, the item analysis was done and the reliability coefficient computed by Cronbach alpha estimates of internal consistency of this test was found to be 0.75.

4.2.2 Science Achievement Test

The other instrument used in the study was Science Achievement Test (see Appendix B), developed by researcher and the science teacher. The Science Achievement Test included 20 multiple-choice items about the concepts in the 5th grade Science and Technology curriculum. The same items were administered to both control and experimental groups before the treatments to elicit students' science achievement and the data obtained by Science Achievement Test was used as covariate in the analyses.

Inquiry-based learning activities with 7E learning cycle model were developed just for the water cycle concept in this study. The science teacher tried to use inquiry model for other concepts, diversity of living things, matter, heat, light and sound, force and electricity in 5th grade curriculum throughout the semester. Therefore, researcher and the science teacher decided to include items related to all concepts in 5th grade curriculum to the Science Achievement Test.

4.3 Procedures

A quasi-experimental design was used in this study because the random assignment of subject to treatment groups was not possible. However, for the group formation random assignment of treatments to intact groups was employed. Treatment consisted of either traditional method or inquiry-based learning method in a four-week period of science and technology course. Both traditional and inquiry classes used the same textbook. The CCT-X was administered as pre- and post-test in both experimental and control groups in order to investigate the effect of 7E learning cycle model on the improvement of students' critical thinking skills. Research design of the study is presented in Table 1. In this table, EG represents the Experimental Group using 7E learning cycle model while CG represents the Control Group receiving traditional method. CCT-X donates the Cornell Conditional-Reasoning Test, Form X and SAT donates Science Achievement Test. 7E LC and TM represent the 7E Learning Cycle Model and Traditional Method, respectively.

Table 4.1 Research Design of the Study

Groups	Pre-tests	Treatment	Post-tests
EG	CCT-X, SAT	7E LC	CCT-X
CG	CCT-X, SAT	TM	CCT-X

In control group, the traditional method was implemented. Traditional method in present study means that the teacher informs students what they are going to learn. New terms and topics are introduced within the lecture setting. The activities serve primarily to verify that what the students are told is true and provide them with opportunities to practice and reinforce ideas previously introduced. However, the new curriculum developed for the 1^{st} – 5^{th} grade primary school education has started to put into practice in 2005-2006 academic year. This new curriculum is based on "learning how to learn" perspective. It pretends that learning occurs when students actively involve activities which are planned as student-centered instead of teacher-centered lessons. In addition, lesson plans developed according to the new curriculum try to stimulate students' natural curiosity and interest in inquiry. Thus, although it was based on traditional method, lesson activities done in the control group also tried to force students find answers themselves or with peers.

In experimental group, an inquiry-based learning strategy called the 7E learning cycle model was used. The teacher participated in the study was trained about the inquiry-based learning strategies and the activities of learning cycle model, prior to beginning the study. The science teacher joined a workshop about inquiry before the treatment. In this workshop, following questions were answered and discussed by a group of teachers: "What is inquiry?" All teachers wrote a brief definition of what inquiry means to them. From the definitions, they realized that one sort of inquiry involves gathering information. Then, they described a recent exercise in which they had asked students to gather information. They tried to answer questions: "How successful was it? How did you assess the students?" An object that was unfamiliar to teachers was brought and asked them to construct a hypothesis about what the object was on their table and how it was used. A second sort of inquiry involves building a hypothesis and a third sort of inquiry involves testing a hypothesis. Then, they tried to collect, investigate, and interpret evidences about the object to test their hypothesis. At the end, as a result of the inquiry all teachers wrote a report, weighing up all the evidences and coming to a conclusion.

The following question was asked to science teacher to find answers and clues for an effective inquiry-based learning environment: What will be the process of reforming a unit to make it more inquiry-based? First of all, the teacher and the researcher described the teacher's role in an inquiry lesson. In an inquiry lesson, teacher tries to encourage students to identify issues, state hypotheses, and then clarify, probe and resolve conflicting ideas and problems. He/She helps students identify materials and sources of information that may help them to answer questions. The teacher helps students gather evidence upon which to make a decision. Finally, he/she creates a classroom environment where students are comfortable stating and supporting their ideas and questioning the ideas of others.

The Water Cycle lesson plan was reformed according to 7E Learning Cycle model proposed by Eisenkraft (2003). For each phase of the learning cycle, different inquiry activities were developed by the researcher and the science teacher (see Appendix C). The role of the teacher in this learning cycle model was as a facilitator and consultant rather than the traditional model of teacher as the knower who dispenses knowledge. As a facilitator, the teacher provided the appropriate environment for the students to learn rather than the teacher telling them what to learn and how. This was more time-demanding for the teacher but ultimately more beneficial to the students. Teacher should have known that to facilitate students' critical thinking and achievement, it was clear that the teacher must look beyond a passive lecture model to one that is more active. Inquiry-based learning is most effective if teacher can determine what students already know about the subject. Thus, in the first phase of the learning cycle, *Elicit*, teacher tried to identify students' prior knowledge and misconceptions about water and water cycle. At this phase, students tried to answer following questions: What could happen when we heat and cold water? Where does the Earth's supply of water come from? How much of the Earth's surface is covered by water? Students used their prior knowledge about the states of water while answering these questions. Answers coming from students revealed some misunderstandings about water and its cycle in nature. During *Engage* phase of the 7E learning cycle, teacher tried to get attention of students into the subject matter, water cycle. He read the article "The story of a water drop" from a children science journal. In this article, students came to know the whole story of the water cycle and the importance of water cycle for living things. At this point, their desire to learn was established by stimulating their natural curiosity. Students are asked about the events occurred until the water run out from our taps. Students started to discuss about the ways water came considering the states of water. At this phase, students were transferred to the computer laboratories to search Internet for the water cycle. Students search results were evaluated with the teacher and the animations about the water cycle in the site http://www.epa.gov/safewater/kids/flash/flash_watercycle.html were watched with the whole class. Since the animations were vocalized in English, an English teacher and the researcher helped science teacher to translate the events into Turkish. During the *Explore* phase of the 7E learning cycle, students are divided into four groups. Each group represented a station for the phases of the water cycle. Students explored the three phases of the water cycle, evaporation, condensation and precipitation. Since in the elicit phase of the learning cycle, teacher identified the misconception that most of the students believe only water from oceans and lakes evaporates and not from plants, animals and other sources, teacher and the researcher decided to add the transpiration activity to the water cycle. Thus, the four stations, evaporation, condensation, precipitation and transpiration were formed by six students. In the evaporation station, students explored that when water boils, its state changes to water vapor. In the activity, the water vapor hit to the cold plate and then condensation was occurred and it precipitated as drops. Actually, at this station students could observe all the phases of water cycle, so the whole water cycle. However, they were focused on just evaporation and they understood the whole cycle when they visited all four stations (see photograph on Figure 4.1).

Figure 4.1 Students taking notes about the evaporation phase.

At the same station, students also explored two wet cleaning cloths; one of them was in the plastic bag and the other was in the open air. They observed that the wet cleaning clot dried in the open air due to evaporation of water drops on it. The cleaning cloth in the plastic bag could not dry because water could not evaporate to air in a closed bag. At the station 2, clear bottles filled with ice and water allowed students to directly explore the phenomenon of condensation. At this station, the science teacher asked students about the formation of clouds. One of the students thought correctly that “at altitude it is cold and the water vapor in the air cools and forms clouds”. Students also gave the example of condensation on the outside of a cold drinking glass on a hot day (see photograph on Figure 4.2).

Figure 4.2 Students exploring condensation at one station

At the station 3, precipitation, students observed the water as it left the spray bottle on to the relief map. Students explored the precipitation by considering the rain and snow. A plant in a large plastic bag allowed students at the fourth station to directly explore transpiration (see photograph on Figure 4.3) After nearly five minutes each group moved to their next station to explore the phenomena at each station. While changing the stations, students shared their experiences at their own stations with other students. During the explore phase of the 7E learning cycle, teacher was just a facilitator. He assisted students in making connections between classroom instruction and students' own knowledge and experiences by encouraging students to create new solutions, by challenging their assumptions, and by asking probing questions.

Figure 4.3 Plant that students observed for the transpiration

At the *Explain* phase of the 7E learning cycle, students discussed their observations with peers and the teacher. While students were talking about their observations, teacher wrote the key terms on the board. He tried to introduce the whole water cycle by making connections between students' simple observations and examples from the nature. For example, students used a gas burner in their experiment to observe the evaporation. He forced students to find answer for the question "how does evaporation work for the water in oceans, rivers and other large bodies of water?". He explained the sun's energy that changes the liquid water into a gas called water vapor, which becomes part of the air. In order to explain the connection between the events, teacher asked the question about condensation immediately after the explanation of evaporation: "Then, what happens this water vapor in the air?" Students at the station 3 remembered the formation of clouds and easily answered this question. Teacher added the information related to precipitation that the clouds were actually made up of tiny water droplets. Then, he asked "what happens to these tiny water droplets?" Students answered altogether that "it rains or snows". He also gave a whole explanation that the tiny water droplets in clouds combine and become larger and fall back to Earth in the form of precipitation, which is rain or snow and sometimes sleet. And finally, when the water in the form of rain or snow reaches the ground, the water cycle starts all over again with evaporation. At this point, teacher asked students whether evaporation only occur from oceans and lakes or not. In order to explain that water can evaporate from plants, animals, puddles and the ground in addition to oceans and lakes, the plant in the plastic bag was again shown to whole class. Students observed the moisture on the surface of plastic bag and explored the water that was released from plants' leaves to the air. Thus, they realized that plants were also the part of water cycle. During the *Elaborate* phase of the 7E learning cycle, students found the opportunity to apply their knowledge about water cycle to new domains, water pollution and the importance of water cycle for living things. The activity students performed in the elaborate phase was about care and concern for the environment and living things by showing students how to take simple precautions to keep pollutants out of the water cycle. Students were first asked to read the warnings on some cleaning supplies that people use everyday. Nearly all of the cleaning supplies' some ingredients are harmful to people. At this phase, students were divided to form three groups and each group was asked to produce a kind of cleaning supply. By using harmless ingredients, students produced three kinds of cleaning supplies and they used their products to clean the laboratory desks, windows and laboratory materials. At this phase, teacher tried to encourage students to think critically on the consequences of harmful cleaning supplies when they enter the water cycle. Since students recognized that when they used their own products, they mixed with water and went to the drainage. The teacher made a conclusion that people should learn how to protect Earth's limited fresh water supply, preventing water cycle from chemicals used in homes and factories. For the *Evaluation* phase of the 7E learning cycle, students did not take a test or an oral exam. Teacher wanted them to check their own report sheets in terms of the definition of phases of water cycle by themselves. To evaluate their understanding of the water cycle, he gave some events occurred during the whole cycle and asked students to find out the correct ordering for water cycle. Some of the students repeated the correct ordering of the water cycle. Teacher used a water cycle poster to evaluate students' learning and to ask more questions about the subject. Each student studied the water cycle figure for few minutes and first teacher wanted them to develop questions about the water cycle. From the fact that students' questions show their cognitive skills, teacher and the researcher carefully listened their questions. The following questions were recorded:

Student 1: What are the stages of the water cycle? Write their names.
Student 2: What happens to the rain after it falls down to ground?
Student 3: Why does it rain?
Student 4: Are all cleaning supplies harmful to people?
Student 5: Give examples to condensation.
Student 6: What happens if the water cycle does not occur?
Student 7: What makes a cloud?
Student 8: Is transpiration same as sweating?

The other questions developed by the students were generally the same, asking the definition of each stage of the water cycle. These questions provided teacher an opportunity to assess students' comprehension of key points in the water cycle concept. At the last *Extend* phase of the 7E learning cycle, the goal of the teacher was to transfer of students' learning to new concepts. To achieve this goal, the water cycle experiment in their textbooks was done (see photograph on Figure 4.4). In this experiment, students were asked to focus on the energy source that caused the evaporation without considering the stages of water cycle. The purpose of this experiment was to transfer of students' knowledge about water cycle in nature to the new concept of heat and temperature, which was another unit in the 5th grade science and technology curriculum. Students in the control group just did this experiment to learn water cycle instead of dealing with the each stage of the water cycle separately. The 7E learning cycle activity in the experimental group finished with the Extend phase. Students were ready to pass a new concept relating it to their knowledge about the water cycle and its importance for nature.

Figure 4.4 Students discovering the energy source for water cycle at the Extend phase

This study was conducted in the 2005-2006 spring semester. During the study, several meetings with teacher were conducted in order to facilitate the proper use of 7E learning cycle activities. The teacher was also trained so as not to use any strategy of inquiry-based learning in control groups. Thus, implementation was not a threat to internal validity of this study.

One-week before the treatment the CCT-X was administered to both control and experimental groups as a pre-test. This study continued approximately five weeks. Throughout five weeks, both the control and experimental groups were observed to verify the independent variable, treatment in this study. The observers will be the researcher herself and senior students from the Faculty of Education in Sakarya University. The data for the verification of the treatment was gathered through direct, systematic observation via an observation checklist developed by the researcher (see Appendix D). The checklist was prepared to differentiate between methods so all characteristics of both the inquiry-based learning and traditional methods were included in this checklist. This verified the validity of the checklist. The same checklist was used both for the control and experimental groups. Inter-observer agreement was checked for the reliability of observational data. After a four-week treatment the CCT-X was again administered to both groups as a post-test.

Prior to study, the teacher was informed about the observations and the purpose of these observations. Any deception was needed from an ethical point of view. The same checklists were given to teacher also. Thus, by this way, teacher had the opportunity to report his behavior during the study and this supported the verification process of our treatment.

To determine whether the changes in the critical thinking skills of students are directly related to treatment or not, the researcher considered the several threats to internal validity of this study. The possible threats to internal validity can be listed as subjects' characteristics, mortality, location, data collector bias, testing, maturation and attitude of subjects. One of the subject characteristics, gender, may affect the results of this study. Gender may be considered as confounding variable and it was not equal for control and experimental groups. In order to remedy this problem, gender variable is included in the covariate set of statistical analysis of this study. Thus, this confounding variable was controlled and statistically equalized for both groups. To control mortality threat, missing data analysis might be performed but there were no missing data. Location of control and experimental groups in different classroom may affect the outcome of this study. To control this location threat, detailed information was collected about the locations of the groups and the same Science Laboratory was used for both groups. In addition, observers attended during the data collection process to provide verification. The use of a pre-test may cause differential effects but there was a sufficient time, six weeks, for desensitization of the effect of pre-test. However, during this long period maturation may be a threat for this study. Including students' ages in covariate set may eliminate this threat. For this experimental study, probably the most important threat was the attitudinal threat. Students in the experimental groups may improve due to a novel lecturing style or students in the control group may do poorly due to perceived unfairness. Thus, to eliminate these effects teachers were informed that they try to make experiment less novel and part of the regular routine.

4.4 Analysis of Data

In this study, the data were collected in two steps. The same test was used twice, first as pre-test and then as post-test. The gender of the participants was obtained via demographic questions at the beginning of the main test. The family income of students was gathered from the school official documents. The family income of the students was assessed by their salary per month. Thus, parents who have income between 300-750 YTL (New Turkish Liras) were donated as "low income". Parents who have income between 751-1500 YTL were donated as "middle income", and finally parents who have income more than 1500 YTL were categorized as "high income". From an ethical perspective to ensure the confidentiality of research data, the names of the participant were removed from the data by assigning a number to each participant. The teacher conducted the tests as a regular process of lessons. The observers attended during the testing also to control the application and time of testing.

The collected data were analyzed by both descriptive and inferential statistics. For the descriptive statistics, the mean, standard deviation, skewness and kurtosis values were calculated for the pre- and post-test scores of CCT-X. The descriptive statistics were useful for the indication of any missing data. Prior to inferential statistics, missing data analysis was performed. Any missing data in the dependent variable of a participant, post-test score of CCT-X, all data about this participant would be dropped. However, there were no missing data both in independent and dependent variables of this study.

For the inferential statistics, One-Way Analysis of Covariance was used to test the effect of treatment on dependent variable. This was the appropriate statistical test since the dependent variable was continuous and the continuous independent variables, pre-test scores of CCT-X and SAT, were used as covariates. In addition, there were categorical independent variables, gender and family income, in this study. The variables, gender, family income and pre-test scores were not equal for control and experimental groups, and so these variables should have been controlled in order to measure the effect of treatment. Thus, they included in the covariate set to equalize them for both groups and the variables having significant correlation with the dependent variable were retained. The F value obtained from ANCOVA test was checked at .05 alpha level for statistical significance. The gender and family income variables were tested by one-way ANOVA on dependent variable.

El-Nemr (1979) conducted a meta-analysis about the outcomes of teaching biology by inquiry as cited in Glass (1982). It was indicated that the average effect sizes for the critical thinking outcome of the inquiry-based biology teaching was 0.18, which was above the medium effect size value defined by Cohen and Cohen (1983). Therefore, for this study, it was appropriate to set effect size to medium effect size value as 0.15. Alpha was set to .05 as the probability of rejecting null hypothesis and beta was set to .01 which is the probability of failing to reject false null hypothesis. Thus, the power was set to .99.

4.5 Assumptions and Limitations

4.5.1 Assumptions

1. The teacher was not biased during the treatments.

2. Tests were administered under standard conditions.

3. All students' responses to the test items were sincere.

4. There was no interaction between the students in the experimental and control groups.

4.5.2 Limitations

1. The subjects of this study were limited to 46 fifth grade students in a private school of Sakarya. Their characteristics and prior experiences may not reflect other fifth grade students in state or other kind of schools in Sakarya or in Turkey. Thus, the results of this study may not be reliable if generalized to all fifth grade students in Turkey.

2. Students in the experimental group worked in groups. This might have led to the violation of the independency of observations assumptions of ANCOVA.

3. This study was limited to the unit of "water cycle" in science and technology curriculum.

CHAPTER 5

RESULTS AND CONCLUSIONS

5.1 Statistical Analysis of Hypotheses

In this section, the results obtained from the treatment are presented according to hypotheses stated in Chapter 3. The statistical analyses were carried out by using SPSS 10.0 for Windows (Statistical Package for Social Sciences for Windows).

All of the subjects were administered to the Critical Thinking Test-Form X (CCT-X) as both pre- and post-tests. Students were administered to Science Achievement Test just as pre-test before the treatment. The pre-test results in both experimental and control groups were used to evaluate students' prior critical thinking skills and their science achievement before 7E learning cycle treatment. These results were also used to ensure that there was homogeneity between the experimental and control groups in terms of prior critical thinking skills and science achievement. Table 5.1.1 reveals the results of Independent-Samples T Test analyses conducted for comparison of the groups concerning those variables prior to treatment.

Table 5.1.1 The Comparison of the Experimental and Control Groups with respect to Measures before Treatment

Variable	Group	N	Mean	S.D	*t*	*p*
CCT-X	EG	23	31.0	3.58	1.129	.265
	CG	23	29.5	5.38		
SAT	EG	23	74.35	13.2	1.145	.258
	CG	23	70.44	9.76		

An independent-samples *t* test was conducted to evaluate the hypothesis that there was no significant difference between the students in the experimental and control groups in terms of critical thinking skills and science achievement before treatment. The tests for both CCT-X scores, t (44)=1.129, p=0.265 and SAT scores, t (44)=1.145, p=0.258 were not significant. Thus, there were no statistically significant differences between the two groups in terms of critical thinking skills and science knowledge prior to treatment.

Hypothesis $H_0$1:

A one-way analysis of covariance (ANCOVA) was conducted to test the hypothesis stating there is no significant different between the post-test mean scores of students experiencing 7E learning cycle model and the students experiencing traditional method in Science and Technology classes with respect to improvement of critical thinking skills, when students' gender, family income and prior critical thinking skills and science knowledge are held constant.

Before conducting an ANCOVA, the assumptions underlying should first be tested. Assumption 1: The dependent variable is normally distributed in the population for any specific value of the covariates and for any one level of a factor. This assumption is taken under control with a sample size of 23 cases per group. This may be large enough to yield accurate *p* values. Assumption 2:

The variances of the dependent variable for the conditional distributions described in Assumption 1 are equal. With equal sample sizes, the variances of the dependent variable are assumed equal. Assumption 3: The scores on the dependent variable are independent of each other. This is a quasi-experimental design and random assignment of treatments to groups was employed and the scores are independent of each other. Assumption 4: Homogeneity-of slopes assumption. The test evaluates the interaction between the covariates and the factor in the prediction of the dependent variable. If the interactions are significant, the results from an ANCOVA are not meaningful, and ANCOVA should not be conducted. However, our results for interaction of each covariate were not significant; for pre-CCT-X scores F (1, 38)=1.25, p=0.272, partial η^2 = 0.032; for gender covariate F (1, 38)=3.39, p=0.073, partial η^2 = 0.082; for family income covariate F (1, 38)=1.44, p=0.238, partial η^2 = 0.036 and for SAT covariate F (1, 38)=2.15, p=0.151, partial η^2 = 0.056. Thus, ANCOVA can be proceeded assuming homogeneity of slopes.

Table 5.1.2 Results for the test of homogeneity of slopes

Source	F	Sig.	Eta Squared
PreCCT-X	1.25	.272	.032
Gender	3.39	.073	.082
SES	1.44	.238	.036
SAT	2.15	.151	.056

The ANCOVA results for the hypothesis indicate that this hypothesis should be rejected, F (1, 41)=35.03, p=0.000, partial η^2 = 0.46 suggests a strong relationship between the treatment and the post-test scores of CCT-X, controlling for pre-test scores. As a result, it can be said that there was a significant difference between the post-test mean scores of students received inquiry-based learning and those received traditional method with respect to improvement of critical thinking skills, in the favor of 7E learning cycle model group.

The covariates, pre-test scores, science achievement test score, gender and family income, were included in the analysis to control for differences on dependent variable and were not focus of this study. The test of the covariate evaluated the relationship between the covariate and the dependent variable, controlling for the groups. In this study, the relationship between pre-test scores and the post-test scores of CCT-X was significant, F (1, 41)=43.89, p=0.000, partial η^2 = 0.52, accounting for about 52% of variance of the post-test scores for the treatment group. However, relationship between gender and post-test scores F (1, 41)=5.99, p=0.019, partial η^2 = 0.13 and family income and post-test scores F (1, 41)=0.221, p=0.640, partial η^2 = 0.005, SAT and post-test scores F (1, 41)=16.18, p=0.116, partial η^2 = .061 were not significant.

Table 5.1.3 ANCOVA results with respect to Post-test scores of Critical Thinking Skills

Source	F	Sig.	Eta Squared
Treatment	35.03	.000	.46
Pre-test CCT-X	43.89	.000	.52
Gender	5.99	.190	.13
Family income	.221	.640	.005
SAT	16.18	.116	.061

Hypothesis $H_0 2$:

In order to test the hypothesis there is no statistically significant mean difference between the boys and girls with respect to improvement of critical thinking skills One-Way Anova statistical analysis was conducted. The results were presented in Table 5.1.4.

Table 5.1.4 ANOVA results with respect to Post-test scores of Critical Thinking Skills among Boys and Girls

Source	N	Mean	S.D.	*F*	*p*
Girls	22	38.95	4.18	.762	.387
Boys	24	39.95	3.61		

The results indicated that the ANOVA was not significant. There was no significant mean difference between girls and boys with respect to post-test scores of Critical Thinking Skills.

Hypothesis $H_0$3:

One-way ANOVA was also conducted to test the hypothesis; there is no statistically significant mean difference between low-, middle, and high family income of students with respect to improvement of critical thinking skills. The results were presented in Table 5.1.5.

Table 5.1.5 ANOVA results with respect to Post-test scores of Critical Thinking Skills among Levels of Family Income

Source (Family income)	N	Mean	S.D.	*F*	*p*
Low	6	39.0	2.75	.208	.813
Middle	26	39.8	3.90		
High	14	39.07	4.41		

The results showed that there was no statistical significant mean difference between students coming from different levels of family income in terms of their improvement of critical thinking skills.

Descriptive statistics for the dependent variables across the experimental and control groups, gender and socio-economic status were also displayed in Table 5.1.6.

Table 5.1.6 Descriptive Statistics with respect to CCT-X

	Mean						Std. Dev.					
	Boys			Girls			Boys			Girls		
Income	low	mid	high$_{s}$	low	mid	high	low	mid	high	low	mid	high
EG	40.50	41.20	43.00	-	42.50	42.00	1.73	4.26	1.82	-	3.5	3.09
CG	37.00	38.83	37.25	35.00	36.57	35.50	-	2.92	4.99	-	2.37	2.88

Table 5.1.6 showed that the experimental group had the highest mean score on dependent measure. Concerning the gender and family income, the mean scores did not differ across gender and the levels of family income on dependent measure.

5.2 Conclusions

The following conclusions can be deduced from the results of this study:

1. 7E learning cycle model caused significantly better improvement on students' critical thinking skills than traditional method did

2. Gender had no effect on students' critical thinking skills.

3. Family income had no effect on students' critical thinking skills and science achievement.

CHAPTER 6

DISCUSSION, IMPLICATIONS AND RECOMMENDATIONS

6.1 Discussion

The main purpose of the present study was to investigate the effect of 7E learning cycle model of inquiry-based learning on the improvement of 5^{th} grade students' critical thinking skills.

In this study, 7E learning cycle model was used for teaching the water cycle concept in 5^{th} grade science and technology lesson. Students in the experimental group received inquiry-based learning following the unit plan developed using 7E learning cycle; while students in the control group received traditional instruction following their teacher's lecturing and their textbooks. Before the treatment, the Cornell Conditional Reasoning Test, CCT-X, and the Science Achievement Test, SAT, were administered to students both in the experimental and control groups. Analyses revealed that there were no differences between students in two groups in terms of critical thinking skills and science achievement. Homogeneity between the two groups is of great importance on investigation the effectiveness of the treatment. Critical thinking skills test was given to both groups as post-tests after the treatment to investigate and compare the effect of inquiry-based learning on improvement of students' critical thinking skills.

Statistical analyses results showed that inquiry-based learning was superior in improving students' critical thinking skills (EG_{mean}= 41.91; CG_{mean}= 37.04) and science achievement (EG_{mean}= 83.69; CG_{mean}= 73.69). Results, showing the positive effect of inquiry-based learning on improvement of students' critical thinking skills support the idea that with the help of a n inquiry-based instructional strategy, students may learn how to think better, and then criticize and reason into subject matter. Coming from the fact that is good thinking is the result of good teaching, which includes much student practice, the 7E learning cycle model in which students feel free to express their ideas, consider alternative opinions and join discussions and cooperative work with peers, is one of the good teaching strategy fostering students' critical thinking skills. Students in the control group also showed an improvement their critical thinking skills after the treatment although this increase was not as high as the students in the experimental group. ($CG_{gain\ score\ mean}$=7.56; $EG_{gain\ score\ mean}$=10.91). This result supports the new curriculum approach for the primary schools in Turkey. The lesson activities for the control group were developed according to the objectives of the new curriculum for primary education. The new curriculum asserts that it is not always possible to identify the characteristics that students should have in the future beforehand. However, it is possible to make them gain skills which can be used in order to adapt to the contexts they may face in the future. For this reason, the new programs provide contexts in which students are motivated to improve their creativity, leadership, problem solving, critical thinking, scientific thinking, and questioning skills (MEB Müfredat Geliştirme Süreci, Program Temel Yaklaşımı, 2006). Team work and good communication skills are among the characteristics required from individuals as the world conditions are developed. Teaching and learning strategies should help in gaining these skills and the developing behaviors. The inquiry-based learning engages students in investigations to seek answers, solutions or explanations and to satisfy their curiosities. Having critical thinking skills guides the students for transformation and not being affected by the challenges that may appear during the transformation, adaptation to transformation, getting risk management skills, and getting risks when necessary. The argument in this study is consistent with the idea of Lawson

(2000) that a key aspect of learning cycle lessons is that they attempt to engage students in meaningful inquiries with the aim of improving their thinking skills and with the aim of helping students construct meaningful concepts.

Consequently, as Lauer (2005) indicated thinking at a higher level can be taught using course content material; but placing less emphasis on teaching factual knowledge and more on thinking skills should be a high priority for science teachers. The science teacher cooperated in this present study became aware of promoting students to think and criticize give them lifelong skills, rather than short-term gains in memorized concepts or information. Having critical thinking skills is essential in today's increasingly complex society and world. Using multiple teaching strategies forcing thinking skills in children at early ages help students to acquire many other skills as they progress to higher grades. Cavallo (2005) also experienced learning cycle instructional model with primary school third grade students while teaching the life cycle of plants. In her study, students had the opportunity to get abilities necessary to do scientific inquiry. As in students in the experimental group of this study, students observed, took notes, gathered data, discussed with peers, constructed hypotheses and found answers to their questions. Her conclusion was consisted with the argue in this study that students could construct a strong foundation for learning more complex topics as they progress to higher grades by engaing in learning cycles.

Each phase of the 7E learning cycle model, students were encouraged to think critically. The first E of the 7E learning cycle, the *Elicit,* students taught about their prior experiences on the subject matter. It is important for the teacher to discover what students already know about the subject so that their misconceptions can be elicited and then corrected. For example, teacher's preliminary questions about the water and its cycle manifested students' misconceptions about these concepts. For example, when the teacher asked "what could happen when we heat and cold water?" most of the students said "it boils and freezes". So they believe that water cycle involves boiling, freezing and melting of water. Students' experience with the concepts boiling and freezing in early grades might be the reason of this misconception. These findings were consisted with the findings of Marquez et. al., (2006) that students were familiar with many concepts about water such as water sources, rivers, rain, states of water but this knowledge did not enough for students to explain water cycle in nature. However, during the *Explain* phase of 7E learning cycle students have learnt that water cycle involves liquid water being evaporated, water vapor condensing to form rain or snow in the clouds which falls to the earth by precipitation. Since water cycle diagrams in textbooks tend to have the evaporation arrow coming from a large body of water like ocean or lakes, students could not think that water can also evaporate from plants, animals, and the ground. The question "where does the Earth's supply of water come from?" revealed this alternative conception of students. Another misconception most of the students had was groundwater is a dirty water source. However, groundwater is Earth's most important fresh water supply. Students understood this reality easily when teacher gave the example of wells that people drill to tap underground water. As a conclusion, the 7E learning cycle model used in this study helped teacher to identify the prior knowledge of students about the subject matter and provided opportunities for students to think critically on their ideas. As mentioned, one of the major advantages of the learning cycle instructional model is to provide students with opportunites to focus on the process of thinking while discussing with peers. During the *Exploration* phase, students use thinking skills to understand the critical aspects of the concept by constructing it for themselves. In their study, Beisenherz, Dantonio and Richardson (2001) also discussed the importance of engaging students in thinking experience. They argued that without using the thinking skills of comparing, students are unable to construct an explanation that is consistent with all their observation.

The new primary school curriculum in Turkey asserts that child's desire to learn can be established by only stimulating his desire to investigate and his natural curiosity (MEB Müfredat Geliştirme Süreci, Program Temel Yaklaşımı, 2006). Thus, the new instructional strategies, lesson activities and materials have been planned as student centered. In the control group, teacher also did some student-centered activities and used visual materials according to national curriculum. However, the main difference between the learning cycle lesson and traditional lesson was that in traditional lesson students were informed about the outcome of the experiment before doing it. Thus, students in the control group could not discover the phenomena like in 7E learning cycle group. Comments of the science teacher on the learning cycle model demonstrated the superiority of this model. He expressed as:

"…at first, I found the learning cycle hard to put into practice. We (teachers) always give the terminology first and then we do the experiment by ourselves and finally demonstrate the findings to students. However, in learning cycle unit, students were not given the terminology before they explored the concepts by themselves. So, they really enjoyed doing the experiments and were not bored by the terminology. After inquiring the phenomena, the terms became more meaningful to them. I also enjoyed while they were working and discussing in groups. I also observed that students wanted to work longer and raised interesting questions and forced me and their friends to think like scientists…"

The interpretations of the science teacher participated in this study was consistent with the findings of several studies on preservice and inservice teachers' beliefs and experiences with learning cycle and other inquiry-based learning approaches (Crawford, 1999; Damnjanovic, 1999; Keys & Kennedy, 1999; Lindgren & Bleicher, 1999).

According to the results of this study, gender and family income had no effect on improvement of students' critical thinking skills. This was an expected result because development and improvement of thinking skills in any subject matter should be independent of gender and family income of the students. Moreover, the majority of the students in both groups were coming from middle level of family income and the students from low and high level of family income have the same opportunities with them. Any speciality occurred in terms of materials, class environment among boys and girls and also among different levels of family income. This finding supports the opportunity of equality in education.

As a conclusion, this study showed that 7E learning cycle model of inquiry-based learning helped fifth grade students to improve their critical thinking skills by arousing their curiosity.

6.2 Implications

The findings of this study showed that instructions which combine inquiry-based learning activities and group work can lead to improvement of students' critical thinking skills. Assigning students to work on an independent project or work on a group project provide enhancement critical thinking skills (Tsui, 1999) by encouraging students to seek for answers, to construct their own knowledge instead of simply to memorize the given information. The use of teaching strategies like learning cycle, focusing on not only fostering students' achievement but also their thinking skills should begin at early grade levels in primary school education. According to the Piaget's theory of intellectual development, thinking skills develop between the ages 0-16 years (Lawson, 1993). Thus, at all levels of education, teaching thinking skills must be at the center of the teaching-learning process. The instruction should be designed in a way that students are persuaded that the making inferences, criticizing others' perspectives and drawing conclusions are more useful than simply recalling the written knowledge in textbooks. Because the use of textbook in general has many limitations as a teaching strategy, students should be provided with more resources such as videos, Internet sources, and articles from related journals in the library. This may take more time than the textbook based lecture method, but the rewards both to the students and the teachers are worth the efforts.

In 7E learning cycle model, students feel free to investigate materials before any new terms are introduced or applied in new contexts. Teacher provides students with a chance to explore on their own and he becomes the facilitator by providing appropriate materials for students to explore. For this reason, inquiry-based learning is most effective if the teachers are well prepared for the lessons. Teachers should begin lessons with clearly stated goals, purposes for inquiry, higher order questions, resources and materials to be able to apply learning cycle model and to foster students' academic achievement and critical thinking skills. However, for students to become good critical thinkers, teachers must be good thinkers themselves. Consequently, teachers should undergo continuous and long-term professional training aimed at enhancing both their higher order thinking abilities and their pedagogical content knowledge. By this ways, teachers may easily apply inquiry-based learning and also other student-centered instructional strategies in their classes.

Moreover, inquiry-based lessons that encourage students to think are complicated and time consuming to plan and require a complex set of decisions. For example, the learning cycle model is not one to be used for every concept and every day. This model should be used when the teacher wants students to construct their own knowledge and to extend this knowledge to other areas. Creating student-centered activities for every concept may be realistically beyond some teachers' capabilities. In addition, some teachers may have problems with managing an inquiry-based learning environment because students work in groups and they continuously discuss. Teachers should be aware of that students must talk and teachers must listen students as they express their understandings and beliefs. Student talk should not be considered as noise or misbehavior.

The findings of this study represented an approach to connect research, practice, and both preservice and inservice teacher education because it tries to help fill the gap in understanding how the intended curriculum of the reforms links to classroom practice of teachers. One on one relationship between science education researchers and teachers should be efficiently made and teachers should be informed about the new findings of the researches in science education. Each finding or product should be presented to clarify their intentions for teachers.

6.3 Recommendations

On the basis of this study, the following recommendations can be given:

1. The effect of 7E learning cycle model can be searched for different grade levels.

2. The 7E learning cycle model can be implemented for whole semester with several units not only in science lessons but also in other subject areas.

3. Development and enhancement of critical thinking skills can be studied at earlier graders than fifth graders.

4. This study can be replicated in different school types with a larger sample size to increase generalizability.
5. The effect of 7E learning cycle model on improvement of students' critical thinking skills can be investigated in other science concepts other than water cycle.

6. Further studies can be conducted to assess the effectiveness of other instructional models based on inquiry-based learning on improvement of students' critical thinking skills.

7. More research is needed to present student-centered instructional strategies that provide teachers with the skills to implement these strategies in classroom environment.

8. Lesson plans developed according to 7E learning cycle model can be multiplied in other subject areas.

9. If not, science teacher educators should include 7E learning cycle model in curriculum of undergraduate methods course.

10. A research can be done to explore what inservice teachers understand from inquiry-based learning and how they put their beliefs into practice.

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APPENDIX A

CORNELL ELEŞTİREL DÜŞÜNME BECERİSİ TESTLERİ

CORNELL KOŞULLU SORGULAMA TESTİ, FORM X

Lütfen aşağıdaki boşlukları doldurunuz.

Sadece soyadınızı yazınız ______________________________

Sadece birinci ve ikinci adlarınızı yazınız _________________

Bitirdiğiniz yaşı yazınız ________________________________

Doğum tarihiniz: gün _____ ay_____ yıl ____________

Sınıfınız ____

Okulunuz ____

Sınıf öğretmeniniz _____________________________________

Tarih: gün _______ ay _________ yıl __________________

Genel Açıklamalar:

Bu test, belli bir düşünme türünde ne kadar iyi olduğunuzu incelemektedir. Bunu "eleştirel düşünme/sorgulama" olarak adlandırıyoruz. Bu tür düşünmenin bazı örneklerini uyguladığınızı göreceksiniz. Örnek sorular size neyin beklendiğini gösterecektir.

Yanıtı bildiğinizi düşünüyorsanız, ancak emin değilseniz, o yanıtı işaretleyin. Ancak yanıtla ilgili bir fikriniz yoksa, soruyu geçin.

Testte önce 4 örnek soru, sonra da 72 soru yer almaktadır. Örnekleri yaptıktan sonra testi zorlanmadan yapabileceksiniz.

Soruların yanıtlanması

Her bir soruyu yanıtlarken soruda sizden istenen konuyu yanıtlayın. Bunu yapmak için zihninizin boş olduğunu düşünebilirsiniz çünkü size söylenenlerden bazıları kesinlikle yanlıştır. Öyle olsa bile bunların sadece bu soru için doğru olduğunu düşünebilirsiniz.

Üzerinde düşünmeniz için bir ya da daha fazla sayıda tümce size verilmektedir. Daha sonra size, sadece verilenleri kullanarak hakkında karar vermeniz gereken bir başka tümce verilmektedir.

Üç olası yanıt bulunmaktadır. Bunlar aşağıda örneklenmektedir:

A. EVET Doğru olmalı.

B. HAYIR Doğru olamaz.

C. BELKİ Doğru olabilir ya da doğru olamaz. Yanıtın "EVET" ya da "HAYIR" olduğu konusunda emin olmanız için yeterince bilgi verilmedi.

Doğru yanıtları ilgili seçeneği daire içine alarak bu metin üzerinde işaretleyin.

Unutmayın: Yanıta ilişkin fikriniz yoksa, soruyu geçin ve bir sonraki soruyu okuyun.

Örnek sorular:

Birinci soruyu okuyunuz ve nasıl işaretlendiğini anlayınız.

---

1. Ayşe'nin Ali'nin yanında olduğunu bildiğinizi varsayın. O halde Ali'nin Ayşe'nin yanında olduğu doğru mudur?
   A. EVET
   B. HAYIR
   C. BELKİ

Doğru yanıt, A, "EVET" dir. Ayşe, Ali'nin yanında ise Ali de Ayşe'nin yanında olmalıdır. Bu, doğru olmalıdır, o halde "EVET" seçeneğini daire içine alın.

Aşağıda bir örnek daha verilmektedir. Bu kez siz yanıtı daire içine alın.

2. Serçenin atmacanın üstünde olduğunu bildiğinizi farz edin. O halde, Atmacanın serçenin üzerinde olduğu doğru mudur?

    A. EVET

    B. HAYIR

    C. BELKİ

4

B, "HAYIR" seçeneğini daire içine almanız gerekir. Serçe atmacanın üzerinde ise atmaca serçenin üzerinde değildir. Bu doğru olamaz.

Bir sonraki örnek sorunun yanıtını daire içine alın. Dikkatli olun:

3. Elif'in Zeynep'in yanında ayakta durduğunu bildiğinizi varsayalım.

    Zeynep de Elif'in yanında ayakta duruyor olabilir mi?

    A. EVET

    B. HAYIR

    C. BELKİ

Doğru yanıt, C, "BELKİ"dir. Elif Zeynep'in yanında ayakta duruyor olsa bile Zeynep oturuyor olabilir. Zeynep Elif'in yanında duruyor olabilir ancak Elif'in yanında oturuyor da olabilir. Bu soruyu yanıtlamak için yeterince emin olmanızı sağlayacak şekilde size bilgi verilmemiştir, bu nedele yanıt "BELKİ"dir.

Şimdiye kadar sunulan örnek sorularda size sadece tek bir şey söylenmiştir. Aşağıdaki örnekte ise iki şey söylenmektedir. Bu örnek sorunun yanıtını daire içine alınız.

4. Aşağıdakileri bildiğinizi düşünün:

Meyve çekirdeği, tilkinin ağzının içindedir.

Kiraz, tilkinin ağzının içindedir

O halde aşağıdaki doğru mudur?

Meyve çekirdeği kirazın içindedir.

A. EVET

B. HAYIR

C. BELKİ

Doğru yanıt, C, “BELKİ”dir. Size, meyve çekirdeği ve kirazın tilkinin ağzında olduğu söylenmiştir. Çekirdeğin kirazın içinde olup olmadığını bilmek mümkün değildir.

Örneklerimiz bitti; aynı şekilde diğer soruları da siz yanıtlamaya çalışın. İYİ ŞANSLAR!

1. Aşağıdakileri bildiğinizi düşünün.

Masanın üzerindeki şapka maviyse, şapka Hakan'ındır.

Masanın üzerindeki şapka mavidir.

O halde aşağıdaki doğru mudur?

Masanın üzerindeki şapka Hakan'ındır.

A) EVET

B) HAYIR

C) BELKİ

---

2. Aşağıdakileri bildiğinizi varsayalım:

Park yerindeki araba Mehmet Bey'inse araba mavidir.

Park yerindeki araba mavi değildir.

O halde aşağıdaki doğru mudur?

Park yerindeki araba Mehmet Bey'indir.

A) EVET

B) HAYIR

C) BELKİ

---

3. Aşağıdakileri bildiğinizi varsayalım:

Ali beyaz bir evde yaşıyorsa soyadı Yılmaz'dır.

Ali beyaz bir evde yaşamamaktadır.

O halde aşağıdaki doğru mudur?

Ali'nin soyadı Yılmaz değildir.

A) EVET

B) HAYIR

C) BELKİ

---

4. Aşağıdakileri bildiğinizi varsayalım:

Emre sadece annesinden izin alabilirse futbol takımına girer.

Emre futbol takımındadır.

O halde aşağıdaki doğru mudur?

Emre annesinden izin almıştır.

A) EVET

B) HAYIR

C) BELKİ

---

5. Aşağıdakileri bildiğinizi varsayalım:

Özlem beyaz bir evde yaşıyorsa soyadı Korkmaz'dır.

Özlem'in soyadı Korkmaz'dır.

O halde, aşağıdaki doğru mudur?

Özlem beyaz bir evde yaşamaktadır.

A) EVET

B) HAYIR

C) BELKİ

---

6. Aşağıdakileri bildiğinizi varsayalım

Sadece mutfakta yiyecek varsa Adem mutfaktadır.

Mutfakta yiyecek yoktur.

O halde, aşağıdaki doğru mudur?

Adem mutfaktadır.

A) EVET

B) HAYIR

C) BELKİ

---

7. Aşağıdakileri bildiğinizi varsayalım:

Park yerindeki araba Ahmet Bey’e aitse araba siyahtır.

Park yerindeki araba Ahmet Bey’e ait değildir.

O halde, aşağıdaki doğru mudur?

Araba siyah değildir.

A) EVET

B) HAYIR

C) BELKİ

---

8. Aşağıdakileri bildiğinizi varsayalım:

Oğuz ’un bisikleti bozuktur.

Oğuz’un bisikleti bozuksa okula yürüyerek gitmek zorundadır.

O halde aşağıdaki doğru mudur?

Oğuz bugün okula yürüyerek gitmek zorundadır.

A) EVET

B) HAYIR

C) BELKİ

---

9. Aşağıdakileri bildiğinizi varsayalım:

Sadece Y varsa X vardır.

Y yoktur.

O halde aşağıdaki doğru mudur?

X vardır.

A) EVET

B) HAYIR

C) BELKİ

---

10. Aşağıdakileri bildiğinizi varsayalım:

Can dün öğleden sonra evde değildi.

Can dün öğleden sonra futbol maçında değildiyse evdeymiştir.

O halde aşağıdaki doğru mudur?

Can dün öğleden sonra futbol maçında değildi.

A) EVET

B) HAYIR

C) BELKİ

---

11. Aşağıdakileri bildiğinizi varsayalım:

Onur sadece kille yaptığı çalışmaları bitirince boyaları kullanabilir.

Onur boyaları kullanabilir.

O halde aşağıdaki doğru mudur?

Onur kille yaptığı çalışmayı bitirmiştir.

A) EVET

B) HAYIR

C) BELKİ

---

12. Aşağıdakiler bildiğinizi varsayalım:

Fatih dün gece filme gitti.

Fatih filme gitmezse bir sonraki gün kendini kötü hisseder.

O halde aşağıdaki doğru mudur?

Fatih bugün kendini kötü hissetmemektedir.

A) EVET

B) HAYIR

C) BELKİ

---

13. Aşağıdakileri bildiğimizi varsayalım:

X varsa Y de vardır.

X vardır.

O halde aşağıdaki doğru mudur?

Y vardır.

A) EVET

B) HAYIR

C) BELKİ

---

14. Aşağıdakileri bildiğinizi varsayalım:

Merve sadece oyunları severse okuldaki oyunlara katılır.

Merve okuldaki oyuna katılacaktır.

O halde aşağıdaki doğru mudur?

Merve oyunları sevmemektedir.

A) EVET

B) HAYIR

C) BELKİ

---

15. Aşağıdakileri bildiğinizi varsayalım:

Veli sadece eldiveni varsa top oynamaktadır.

Veli'nin eldiveni yoktur.

O halde aşağıdaki doğru mudur?

Veli top oynamaktadır.

A) EVET

B) HAYIR

C) BELKİ

---

16. Aşağıdakileri bildiğinizi varsayalım:

X varsa Y de vardır.

Y yoktur.

O halde aşağıdaki doğru mudur?

X vardır.

A) EVET

B) HAYIR

C) BELKİ

---

17. Aşağıdakileri bildiğinizi varsayalım

Balinalar kuşsa uçabilirler.

Balinalar kuş değildirler.

O halde aşağıdaki doğru mudur?

Balinalar uçamaz.

A) EVET

B) HAYIR

C) BELKİ

---

18. Aşağıdakileri bildiğinizi varsayalım:

Mahmut bir çiftlikte yaşıyorsa bir köpeği vardır.

Mahmut'un bir köpeği vardır.

O halde aşağıdaki doğru mudur?

Mahmut bir çiftlikte yaşamaktadır.

A) EVET

B) HAYIR

C) BELKİ

---

19. Aşağıdakileri bildiğinizi varsayalım:

Veysel'e top oynamak isteyip istemediği sorulmamıştır.

Sadece Veysel'e top oynamak isteyip istemediği sorulmuşsa, evde değildir.

O halde aşağıdaki doğru mudur?

Veysel evde değildir.

A) EVET

B) HAYIR

C) BELKİ

---

20. Aşağıdakileri bildiğinizi varsayalım:

İpek yeşil bir evde yaşıyorsa soyadı Öztürk'tür.

İpek yeşil bir evde yaşamamaktadır.

O halde aşağıdaki doğru mudur?

İpek'in soyadı Öztürk değildir.

A) EVET

B) HAYIR

C) BELKİ

---

21. Aşağıdakileri bildiğinizi varsayalım:

Askıdaki palto kahverengiyse bu, Ahmet'in paltosudur.

Askıdaki palto kahverengi değildir.

O halde aşağıdaki doğru mudur?

Askıdaki palto Ahmet'in değildir.

A) EVET

B) HAYIR

C) BELKİ

---

22. Aşağıdakileri bildiğinizi varsayalım:

Sadece pembe kediler varsa siyah kediler vardır.

Siyah kediler vardır.

O halde aşağıdaki doğru mudur?

Pembe kediler vardır.

A) EVET

B) HAYIR

C) BELKİ

---

23. Aşağıdakileri bildiğinizi varsayalım:

Garajdaki bisiklet Samet'inse bisiklet kırmızıdır.

Garajdaki bisiklet kırmızı değildir.

O halde aşağıdaki doğru mudur?

Garajdaki bisiklet Samet'in değildir.

A) EVET

B) HAYIR

C) BELKİ

---

24. Aşağıdakileri bildiğinizi varsayalım:

X varsa Y de vardır.

Y vardır.

O halde aşağıdaki doğru mudur?

X vardır.

A) EVET

B) HAYIR

C) BELKİ

---

25. Aşağıdakileri bildiğinizi varsayalım:

Farelerin beş bacağı varsa fareler atlardan daha hızlı koşar.

Farelerin beş bacağı vardır.

O halde aşağıdaki doğru mudur?

Fareler atlardan daha hızlı koşar.

A) EVET

B) HAYIR

C) BELKİ

---

26. Aşağıdakileri bildiğinizi varsayalım:

Hülya attan düşmüşse çok kötü yaralanmıştır.

Hülya çok kötü yaralanmıştır.

O halde aşağıdaki doğru mudur?

Hülya attan düşmüştür.

A) EVET

B) HAYIR

C) BELKİ

---

27. Aşağıdakileri bildiğinizi varsayalım:

Kısa kalem, Süleyman'ın en sevdiği kalem değildir.

Sadece sarı renkli değilse, kısa kalem Süleyman'ın en sevdiği kalem değildir.

O halde aşağıdaki doğru mudur?

Kısa kalem sarı renklidir.

A) EVET

B) HAYIR

C) BELKİ

---

28. Aşağıdakileri bildiğinizi varsayalım:

X varsa Y de vardır.

X yoktur.

O halde aşağıdaki doğru mudur?

Y yoktur.

A) EVET

B) HAYIR

C) BELKİ

---

29. Aşağıdakileri bildiğinizi varsayalım:

Arda beyaz bir evde yaşıyorsa soyadı Özkan'dır.

Arda'nın soyadı Özkan'dır.

O halde aşağıdaki doğru mudur?

Arda beyaz bir evde yaşamaktadır.

A) EVET

B) HAYIR

C) BELKİ

---

30. Aşağıdakileri bildiğinizi varsayalım:

Kuşlar sadece piyano çalabiliyorsa uçabilirler.

Kuşlar piyano çalamaz.

O halde aşağıdaki doğru mudur?

Kuşlar uçabilir.

A) EVET

B) HAYIR

C) BELKİ

---

31. Aşağıdakileri bildiğinizi varsayalım.

Araba çalışacaktır.

Isı donma noktasının altında değilse, araba çalışacaktır.

O halde aşağıdaki doğru mudur?

Isı donma noktasının altında değildir.

A) EVET

B) HAYIR

C) BELKİ

---

32. Aşağıdakileri bildiğinizi varsayalım:

Sadece Y varsa X vardır.

X vardır.

O halde aşağıdaki doğru mudur?

Y vardır.

A) EVET

B) HAYIR

C) BELKİ

---

33. Aşağıdakileri bildiğinizi varsayalım:

Köpeklerin dört tane bacağı varsa üç tane gözü vardır.

Köpeklerin üç tane gözü yoktur.

O halde aşağıdaki doğru mudur?

Köpeklerin dört tane bacağı vardır.

A) EVET

B) HAYIR

C) BELKİ

---

34. Aşağıdakileri bildiğinizi varsayalım:

Arda parka giderse arkadaşı Doruk'u görür.

Bugün Arda parka gitmektedir.

O halde aşağıdaki doğru mudur?

Bugün Arda arkadaşı Doruk'u görecektir.

A) EVET

B) HAYIR

C) BELKİ

---

35. Aşağıdakileri bildiğinizi varsayalım:

Eğer atlar yeşilse, iki kuyrukları vardır.

Atların iki kuyruğu vardır.

O halde aşağıdaki doğru mudur?

Atlar yeşildir.

A) EVET

B) HAYIR

C) BELKİ

---

36. Aşağıdakileri bildiğinizi varsayalım:

Kırmızı kalemler masanın üzerindeyse Deniz'indir.

Kırmızı kalemler masanın üzerinde değildir.

O halde aşağıdaki doğru mudur?

Kırmızı kalemler Deniz'in değildir.

A) EVET

B) HAYIR

C) BELKİ

---

37. Aşağıdakileri bildiğinizi varsayalım:

Hasan okula bisikletle gidiyorsa uzun yoldan gitmektedir.

Bugün Hasan okula bisikletle gitti.

Eğer Hasan uzun yoldan giderse, okula geç kalır.

O halde aşağıdaki doğru mudur?

Hasan bugün okula geç kalmadı.

A) EVET

B) HAYIR

C) BELKİ

---

38. Aşağıdakileri bildiğinizi varsayalım:

Eğer sandalye yeşilse, masa siyahtır.

O halde aşağıdaki doğru mudur?

Eğer masa siyahsa, sandalye yeşildir.

A) EVET

B) HAYIR

C) BELKİ

---

39. Aşağıdakileri bildiğinizi varsayalım:

İkinci kutuda mavi kalem varsa, birinci kutuda yeşil kalem vardır.

Birinci kutuda yeşil kalem varsa, üçüncü kutuda kırmızı kalem vardır.

O halde aşağıdaki doğru mudur?

İkinci kutuda mavi kalem varsa üçüncü kutuda kırmızı kalem vardır.

A) EVET

B) HAYIR

C) BELKİ

---

40. Aşağıdakini bildiğinizi varsayalım:

Eğer Hatice Hanım çiçek yarışmasına katılmışsa, gülleriyle katılmıştır.

O halde aşağıdaki doğru mudur?

Hatice Hanım gülleriyle katılmamışsa, çiçek yarışmasına katılmamıştır.

A) EVET

B) HAYIR

C) BELKİ

---

41. Aşağıdakileri bildiğinizi varsayalım:

Hakan sadece ve sadece Ankara'ya giderse Ahmet'i görecektir.

Bu yıl Hakan Ahmet'i görmeyecektir.

O halde aşağıdaki doğru mudur?

Hakan bu yıl Ankara'ya gidecektir.

A) EVET

B) HAYIR

C) BELKİ

---

42. Aşağıdakileri bildiğinizi varsayalım:

Eğer Gürkan Sinem'i görürse, İstanbul'a gider.

Bu kış Gürkan Sinem'i gördü.

O halde aşağıdaki doğru mudur?

Bu kış Gürkan İstanbul'a gitmiştir.

A) EVET

B) HAYIR

C) BELKİ

---

43. Aşağıdakileri bildiğinizi varsayalım:

A varsa B de vardır.

B varsa C de vardır

O halde aşağıdaki doğru mudur?

A varsa C de vardır.

A) EVET

B) HAYIR

C) BELKİ

---

44. Aşağıdakini bildiğinizi varsayalım:

Kuşlar uçabiliyorsa altı bacağı vardır.

O halde aşağıdaki doğru mudur?

Kuşların altı bacağı yoksa uçamazlar.

A) EVET

B) HAYIR

C) BELKİ

---

45. Aşağıdakileri bildiğinizi varsayalım:

Otobüs şehre giderse yeni caminin yanından geçer.

Otobüs şehre gitmektedir.

Otobüs yeni caminin yanından geçerse yeni köprüden de geçer.

O halde aşağıdaki doğru mudur?

Otobüs yeni köprüden geçmemektedir.

A) EVET

B) HAYIR

C) BELKİ

---

46. Aşağıdakileri bildiğinizi varsayalım:

Okul takımı maçı kaybederse Enka Lisesi liginde birinci olacak.

Burçin iyi atış yapamazsa takım maçı kaybedecek.

O halde aşağıdaki doğru mudur?

Burçin iyi atış yapamazsa Enka Lisesi liginde birinci olacak.

A) EVET

B) HAYIR

C) BELKİ

---

47. Aşağıdakileri bildiğinizi varsayalım:

Ayşe alışverişe çıkarsa İzmit'e gider.

Geçen Cumartesi Ayşe alışverişe çıkmıştır.

Ayşe halasını sadece İzmit'e giderse ziyaret eder.

O halde aşağıdaki doğru mudur?

Geçen cumartesi Ayşe halasını ziyaret etti.

A) EVET

B) HAYIR

C) BELKİ

---

48. Aşağıdakileri bildiğinizi varsayalım:

Tekin sadece Faruk'un montunu ödünç alabilirse kayağa gidecek.

Tekin kayağa gitmiyor.

O halde aşağıdaki doğru mudur?

Tekin Faruk'un montunu ödünç alabilmiştir.

A) EVET

B) HAYIR

C) BELKİ

---

49. Aşağıdakileri bildiğinizi varsayalım:

Eğer Sinan otobüsü kaçırırsa okula yürüyerek gider.

Eğer Sinan okula yürüyerek giderse köprüden geçer.

O halde aşağıdaki doğru mudur?

Sinan otobüsü kaçırırsa köprüden geçer.

A) EVET

B) HAYIR

C) BELKİ

---

50. Aşağıdakini bildiğinizi varsayalım:

Eğer Arda yeni bir mayo almamışsa, bugün basketbol oynamıştır.

O halde aşağıdaki doğru mudur?

Eğer Arda bugün basketbol oynamamışsa, yeni bir mayo almıştır.

A) EVET

B) HAYIR

C) BELKİ

---

51. Aşağıdakini bildiğinizi varsayalım:

Bülent'in beslenme çantasında bir elma varsa Sezen'in çantasında kraker vardır.

O halde aşağıdaki doğru mudur?

Sezen'in beslenme çantasında kraker varsa Bülent'in çantasında bir elma vardır.

A) EVET

B) HAYIR

C) BELKİ

---

52. Aşağıdakileri bildiğinizi varsayalım:

Berna sinemaya gidiyor.

Sadece ve sadece Ayşe sinemaya giderse, Berna sinemaya gitmez.

O halde aşağıdaki doğru mudur?

Ayşe sinemaya gidiyor.

A) EVET

B) HAYIR

C) BELKİ

---

53. Aşağıdakini bildiğinizi varsayalım:

X varsa Y de vardır.

O halde aşağıdaki doğru mudur?

Y varsa X de vardır.

A) EVET

B) HAYIR

C) BELKİ

---

54. Aşağıdakileri bildiğinizi varsayın:

Filler sadece ve sadece büyükse, pembe renktedir.

Filler pembe değildir.

O halde aşağıdaki doğru mudur?

Filler büyüktür.

A) EVET

B) HAYIR

C) BELKİ

---

55. Aşağıdakini bildiğinizi varsayalım:

X varsa Y de vardır.

O halde aşağıdaki doğru mudur?

Y yoksa X de yoktur.

A) EVET

B) HAYIR

C) BELKİ

---

56. Aşağıdakileri bildiğinizi varsayalım:

Akın'ın kırmızı tebeşiri varsa kartona resim yapmaktadır.

Akın'ın kırmızı tebeşiri vardır.

Akın kartona resim yapıyorsa kütüphanededir.

O halde aşağıdaki doğru mudur?

Akın kütüphanededir.

A) EVET

B) HAYIR

C) BELKİ

---

57. Aşağıdakileri bildiğinizi varsayalım:

Bu bisiklet sadece ve sadece kırmızı ise, Can'ın bisikletidir.

Bu bisiklet Can'ındır.

O halde aşağıdaki doğru mudur?

Bu bisiklet kırmızı değildir.

A) EVET

B) HAYIR

C) BELKİ

---

58. Aşağıdakini bildiğinizi varsayalım:

Köpek ön bacakları üzerinde dikiliyorsa, yavru bir köpektir.

O halde aşağıdaki doğru mudur?

Köpek yavruysa ön bacakları üzerinde dikilmektedir.

A) EVET

B) HAYIR

C) BELKİ

---

59. Aşağıdakileri bildiğinizi varsayalım:

X varsa Y de vardır.

X vardır.

Sadece Y varsa Z vardır.

O halde aşağıdaki doğru mudur?

Z vardır.

A) EVET

B) HAYIR

C) BELKİ

---

60. Aşağıdakileri bildiğinizi varsayalım:

Suna, Hatice Öğretmenin sınıfında ise oyun bahçesindedir.

Suna oyun bahçesindeyse, ip atlamaktadır.

O halde aşağıdaki doğru mudur?

Eğer Suna Hatice Öğretmenin sınıfında ise, ip atlamaktadır.

A) EVET

B) HAYIR

C) BELKİ

---

61. Aşağıdakileri bildiğinizi varsayalım:

X varsa Y de vardır.

X vardır.

Y varsa Z de vardır.

O halde aşağıdaki doğru mudur?

Z yoktur.

A) EVET

B) HAYIR

C) BELKİ

---

62. Aşağıdakileri bildiğinizi varsayalım:

Eğer Özlem dün sinemaya gitmediyse, arkadaşı Ali ile görüşmüştür.

Özlem sadece arkadaşı Ali ile görüşmüşse dün parka gitmiştir.

Özlem dün sinemaya gitmemiştir.

O halde aşağıdaki doğru mudur?

Özlem dün parka gitmiştir.

A) EVET

B) HAYIR

C) BELKİ

---

63. Aşağıdakileri bildiğinizi varsayalım:

Eğer Nesrin yeni bir elbise aldıysa, Çark Caddesindeki dükkana gitmiştir.

O halde aşağıdaki doğru mudur?

Eğer Nesrin Çark Caddesindeki dükkana gitmediyse yeni bir elbise almamıştır.

A) EVET

B) HAYIR

C) BELKİ

---

64. Aşağıdakini bildiğinizi varsayın:

Eğer Esma okulda değilse grip olmuştur.

O halde aşağıdaki doğru mudur?

Eğer Esma grip olmuşsa okula gitmemiştir.

A) EVET

B) HAYIR

C) BELKİ

---

65. Aşağıdakileri bildiğinizi varsayın:

Eğer Raziye evde çalışıyorsa kütüphane kapalıdır.

Raziye evde çalışmaktadır.

Orhan sadece kütüphane kapalıysa sınıftaki sözlüğü kullanmaktadır.

O halde aşağıdaki doğru mudur?

Orhan sınıftaki sözlüğü kullanmaktadır.

A) EVET

B) HAYIR

C) BELKİ

---

66. Aşağıdakileri bildiğinizi varsayın:

Eğer birinci kutuda mavi kalemler yoksa, ikinci kutuda yeşil kalemler vardır.

Eğer ikinci kutuda yeşil kalemler varsa, üçüncü kutuda kırmızı kalemler vardır.

Birinci kutuda mavi kalemler yoktur.

O halde aşağıdaki doğru mudur?

Üçüncü kutuda kırmızı kalemler yoktur.

A) EVET

B) HAYIR

C) BELKİ

---

67. Aşağıdakileri bildiğinizi varsayın:

Eğer bir hayvan kaplumbağaysa, o hayvan uçabilir.

Eğer bir hayvan uçabiliyorsa, tüyleri vardır.

O halde aşağıdaki doğru mudur?

Eğer bir hayvan kaplumbağaysa tüyleri vardır.

A) EVET

B) HAYIR

C) BELKİ

---

68. Aşağıdakini bildiğinizi varsayın:

Eğer birinci kutuda sarı bilye varsa ikinci kutuda mavi bilye vardır.

O halde aşağıdaki doğru mudur?

Eğer ikinci kutuda mavi bilye yoksa, birinci kutuda sarı bilye yoktur.

A) EVET

B) HAYIR

C) BELKİ

---

69. Aşağıdakileri bildiğinizi varsayın:

Eğer insanların yüzgeçleri varsa suda yaşarlar.

İnsanların yüzgeçleri vardır.

İnsanlar sadece suda yaşıyorlarsa yüzebilirler.

O halde aşağıdaki doğru mudur?

İnsanlar yüzebilir.

A) EVET

B) HAYIR

C) BELKİ

---

70. Aşağıdakileri bildiğinizi varsayın:

Eğer bu hayvan köpekse uçabilir.

Bu hayvan köpektir.

Eğer bu hayvan uçabiliyorsa tüyleri vardır.

O halde aşağıdaki doğru mudur?

Bu hayvanın tüyleri yoktur.

A) EVET

B) HAYIR

C) BELKİ

---

71. Aşağıdakini bildiğinizi varsayın:

Eğer Celil voleybol takımındaysa, voleybolu iyi oynamaktadır.

O halde aşağıdaki doğru mudur?

Eğer Celil voleybolu iyi oynuyorsa, voleybol takımındadır.

A) EVET

B) HAYIR

C) BELKİ

---

72. Aşağıdakileri bildiğinizi varsayın:

Sadece ve sadece X varsa Y vardır.

Y yoktur.

O halde aşağıdaki doğru mudur?

X vardır.

A) EVET

B) HAYIR

C) BELKİ

I would like to thank Robert H. Ennis for permitting me to use the Cornell Conditional-Reasoning Test, Form X.

APPENDIX B

Adı ve Soyadı: **…./ …. /2006**
Sınıf: **No:**

5. SINIFLAR

FEN ve TEKNOLOJİ DERSİ BAŞARI TESTİ

1. Ağzı tıpayla tıkalı ve içinden bir cam boru geçen beherglasın içindeki suyu ısıttığımızda, suyun hangi özelliği <u>değişmez?</u>

A. yoğunluğu B. sıcaklığı C. hacmi D. kütlesi

2. Yapılan bir deneyde içi su dolu cam balon üzerine geçirilen plastic balon bir sure dik durduktan sonra düşmektedir, bunun nedeni ne olabilir?

A. Balon içindeki hava ısı alıp genleştiğinden
B. Balon içindeki hava ısı verip büzüldüğünden
C. Cam balon içindeki su buharlaştığından
D. Cam ve plastik balon içindeki havanın kütlesi azaldığından

3. Maddelerin özellikleri ile ilgili aşağıdaki hangi sonuç <u>çıkarılamaz</u>?

A. Naftalin ve kükürt tozu ısı kaybettiğinde dondu.
B. Her maddenin farklı erime ve donma noktası vardır.
C. Bütün maddeler ısı aldıklarında erirler.
D. Maddelerin erime ve donma noktaları eşittir.

4. Yağın ve suyun kaynama noktalarını düşündüğümüzde hangi sonucu çıkarabiliriz?

A. Yağın ve suyun kaynama noktaları eşittir.
B. Kaynama devam ettikçe sıcaklık artar.
C. Suya tuz katılması suyun kaynama noktasını değiştirmez.
D. Kaynama noktası maddelerin ayırt edici özelliklerindendir.

5. Saydamlıkla ilgili aşağıdakilerden hangisi <u>yanlıştır?</u>

A. Işığı az geçiren maddelere yarı saydam madde denir.
B. Maddelerin kalınlığı arttıkça saydamlığı artar.
C. Işığı geçiren maddelere saydam madde denir.
D. Işığı geçirmeyen maddelere opak madde denir.

6. Su buharı gibi gaz maddelerin, sıvı hale dönmesine ne denir?

A. buharlaşma B. kaynama C. yoğunlaşma D. donma

7. Aşağıdakilerden hangisinin yapılması sürtünme kuvvetini <u>azaltmaz</u>?

A. kışın araçlara kar lastiği takılması
B. ahşap zeminin cilalanması
C. bazı araçların hareketli parçalarının yağlanması
D. yüzük takarken parmağın ıslatılması

8. Su içinde cisimlerin hareketini zorlaştıran etkiye ne ad verilir?

A. yer çekimi B. su direnci C. kaldırma kuvveti D. hava direnci

9. Aşağıdaki kuvvetlerden hangisi fiziksel temas gerektirir?

A. yer çekimi kuvveti B. elektriksel kuvvet
C. mıknatısın çekme kuvveti D. sürtünme kuvveti

10. Yeterli sayıda bağlantı kablosu, duy ve anahtar kullanarak aşağıdaki verilen ampul ve pillerle dört ayrı devre oluşturulsa hangi devredeki ampuller <u>daha sönük</u> yanar?

A. 1 pil, 2 ampul B. 2 pil, 1 ampul
C. 2 pil, 2 ampul D. 1 pil, 1 ampul

11. Kurulu bir devrede hangisi yapıldığında ampulün verdiği ışığın parlaklığı <u>artar</u>?

A. Ampul ve pil sayısını aynı oranda artırmak
B. Pil sayısını sabit tutup ampul sayısını artırmak
C. Pil sayısını azaltıp ampul sayısını artırmak
D. Pil sayısını artırıp ampul sayısını sabit tutmak

12. Yunus ve balinaların su altında çeşitli sesler çıkararak haberleşebilmeleri hangisinin kanıtıdır?

A. Sesin katılarda yayıldığının
B. Sesin sıvılarda yayıldığının
C. Sesin gazlarda yayıldığının
D. Sesin boşlukta yayıldığının

13. Ses ile ilgili verilen bilgilerden hangisi doğru <u>değildir</u>?

A. Yayılması için maddesel ortam gerekir.
B. Faklı cisimlerle üretilen sesler birbirinin aynıdır.
C. Ses kaynakları aynı iken ortam değişse, sesler farklı olur.
D. Her yönde yayılır.

14. Gölgenin oluşumu ile ilgili bilgilerden hangisi doğru <u>değildir</u>?

A. Işık kaynağının ve cismin yeri değiştirildiğinde gölgenin büyüklüğü ve şekli değişebilir.
B. Gölgenin büyüklüğü ve şekli cismin büyüklüğü ve şekline göre değişir.
C. Işın çizgileri gerçek çizgilerdir.
D. İki veya daha fazla ışık kaynağının bulunduğu ortamda birden fazla gölge oluşabilir.

15. Bir öğrenci, ışığın davranışını incelemek için bir deney yapıyor. Öğrenci, hortumla baktığında mumun ışığını görüyor. Aynı hortumu biraz bükerek baktığında, mumun ışığını göremiyor. Öğrenci bu deneyden hangi sonucu çıkarır?

A. mumun söndüğü
B. ışığın doğrusal yayıldığı
C. hortumun ışık geçirmediği
D. hortumun çok ince olduğu

I. cam   II. yağlı kağıt   III. su   IV. buzlu cam

16. Yukarıdakilerden hangisi ya da hangileri <u>yarı saydam</u> maddelerdir?

A. yalnız I   B. Yalnız II   C. II ve IV   D. I ve III

17. Aşağıdakilerden hangisini yaptığımızda, bir elektrik devresini tamamlamış <u>olmayız</u>?

A. Televizyonun düğmesine basarak çalıştırdığımızda
B. Bulaşık makinesini çalıştırdığımızda
C. Pille çalışan oyuncak arabayı çalıştırdığımızda
D. Bir kablonun iki ucunu birbirine dokundurduğumuzda

18. Aşağıdakilerin hangisi basit bir elektrik devresinin çalışmama nedenlerinden birisi <u>olamaz</u>?

A. Piller ters bağlanmıştır.   B. Anahtar kapalıdır.
C. Ampul gevşektir.   D. Bağlantı kablosu kopuktur.

I. bulutlardaki su buharının yağış olarak yeryüzüne dönmesi
II. yeryüzündeki suyun buharlaşması
III. bulutların soğuk havaya rastlaması
IV. gökyüzünde su buharının bulutları oluşturması

19. Suyun dolaşımının oluşması için doğru sıralama aşağıdakilerden hangisidir?

A. I - III - II - IV B. II - I - IV - III
C. II - IV - III - I D. I - IV - III - II

20. Aşağıdaki canlılardan hangisi kendi besinini <u>yapamaz</u>?

A. eğrelti otu B. buğday C. mantar D. su yosunu

APPENDIX C

DERS PLANI

BİR 7E ÖĞRENME EVRESİ ÜNİTESİ

Konu başlığı: Su Döngüsü

Ders: Fen ve Teknoloji Dersi

Düzey: 5. sınıf

Amaç: Bu ders öğrencilerin yağış, buharlaşma, yoğunlaşma ve terlemeyi su döngüsünın evreleri olarak incelemelerini ve su döngüsünün doğadaki önemini kavramalarını amaçlamaktadır.

Öğrenme Hedefleri:

Bu ders sonunda öğrenciler:

I. Su döngüsü evreleriyle ilgili yaptıkları gözlemleri kaydederek su döngüsünün özelliklerini tanımlayabilecekler.
II. Su döngüsü evrelerinin bir bütün olarak nasıl işlediğini tartışabilecekler.
III. Su döngüsündeki akışın yönünü resimleyebilecekler.
IV. Su döngüsünün doğadaki önemini kavrayabilecekler.

Materyaller:

- 2 veya 3 tane saydam plastik şişe (buz veya su ile kaplı)
- 2 tane beher
- Yayvan (geniş tabanlı) tabak
- Isıtıcı (ispirto ocağı)
- 2 tane temizlik bezi

- Naylon poşet
- buz
- istasyon 1, istasyon 2, istasyon 3 ve istasyon 4 yazan kartlar
- bitki (geniş bir plastik poşet içinde)
- kabartma harita
- su dolu püskürtmeli (sprey) şişe
- su döngüsü posteri
- öğrenci rapor kağıtları

Anahtar Noktalar:

Bu derste, buz ve su ile kaplı saydam şişeler öğrencilerin yoğunlaşma kavramını doğrudan araştırmalarına olanak sunmaktadır.(Derse başlamadan önce kısa bir süre birkaç su şişesinin buz ve su ile doldurulması gerekmektedir)

Plastik bir poşet içindeki bitki öğrencilerin terleme evresini doğrudan araştırmalarına olanak sunmaktadır. (Bitkinin dersten bir gece önce poşete yerleştirilmesi tavsiye edilmektedir)

Öğretmen dersten birkaç dakika önce sınıfa gelip bu ders için hazırladığı dört ayrı istasyonu kurmak isteyebilir. 1 nolu istasyon-buharlaşma- için ısıtıcı olarak elektrikli ocak veya ispirto ocağı kullanılabilir. Isıtıcı koyu renkli bir duvar ya da başka bir koyu arka plan önüne yerleştirilirse kaynayan sudan çıkan buharlar daha rahat görülebilir.

Anahtar Kelimeler:

Buharlaşma: suyun sıvı halden gaz haline geçmesi
Yoğunlaşma: suyun gaz halden sıvı hale geçmesi
Yağış: yüzeye düşen yağmur/su miktarı
Terleme: bitkiler aracılığıyla taşınan su. Su gaza dönüştüğü yerde bir bitkinin köklerinden yapraklarına doğru hareket eder ve sonra atmosfere salınır.

Su Döngüsü: suyun yeryüzünden atmosfere çıkması daha sonra tekrar yeryüzüne dönmesidir.

UYGULAMA (7E Modeli)

E1: Önbilgileri ortaya çıkartma (Elicit)

Öğrencilerden suyun doğadaki halleri ile ilgili önbilgilerini kullanarak aşağıdaki soruları tartışmaları ve yanıtlamaları istenir?

1- Acaba dünyanın ne kadarı su?
2- Bu suyun kaynağı nereler olabilir?
3- Suyu ısıttığımızda ve soğuttuğumuzda ne olur?
4- Yağmur neden yağar?

E2: İlgiyi çekme (Engage)

Öğrencilerin konuya ilgilerini çekmek amacı ile "Bir Su Damlasının Öyküsü" yazısı okunur. Musluğumuzdan akan su acaba biz kullanana kadar nerelerden geçmektedir? Sorusu ile öğrencilerin konuya ilgileri çekilir ve dersin amacı öğrencilere aktarılır.

E3: Araştırma-keşif yapma (Explore)

Konu öğrencilere tanıtılır. Araştırma-keşif aktivitesi ve öğrencilerin ne yapacakları anlatılır. Sınıf dört gruba bölünerek, dört ayrı istasyon oluşturulur. Her grubun farklı istasyonlara hareket edeceği ve her istasyonda anlatıldığı gibi keşifte bulunacağı ve gözlemlerini rapor kağıtlarınıza kaydedecekleri söylenir. Öğretmen istasyonları isimlendirir ve öğrencilerden her istasyonda kullanılacak olan olası malzemeleri ön bilgilerini kullanarak seçmeye çalışmalarını ister. İstasyonlar için doğru malzemeler öğretmenin rehberliğinden öğrenciler tarafından seçildikten sonra, öğretmen her bir istasyonda yapılacak etkinlik adımlarını öğrencilere anlatır. Ayrıca, Öğrencilere 1 nolu İstasyondan başlamak zorunda olmadıkları da hatırlatılır. Her istasyonda 5 dakika çalıştıktan sonra gruplara sıradaki istasyonlarına geçmeleri söylenir. Tüm öğrenciler tüm istasyonlara uğrayıncaya dek etkinlik devam eder.

İstasyon 1: Buharlaşma

1- Deney masanızın uygun bir yerinde ispirto ocağını yakınız.
2- Beherlerden birine yarısına kadar su doldurunuz ve ocağın üzerine koyunuz.
3- Su kaynamaya başlayınca, diğer beheri alta koyunuz ve yayvan tabağı kaynayan su buharının önüne tutunuz.
4- Tabağa çarparak soğuyan su buharına ne oldu? Dikkatlice gözlemleyin ve gözlemlerinizi rapor kağıtlarınıza yazınız.
5- İki temizlik bezini suyla ıslatın ve iyice sıkın.
6- Bezlerden birini masanızın bir kenarına serin.
7- Diğer bezi plastik bir torbaya koyup, torbanın ağzını sıkıca bağlayın.
8- Önce hangi bez kuruyacak? Tartışın ve yorumlarınızı rapor kağıtlarınıza yazın.
9- Dersin sonunda bezleri kontrol edin; hangisinin daha kuru olduğunu not edin.

Bu istasyonda dikkatli olmanız çok önemlidir. Ne olup bittiğini daha iyi bir şekilde gözlemleyebilmek için kaynayan suyun üzerinde olduğu ısıtıcıdan mümkün olan en uzak mesafede durun lütfen. Isıtıcının olduğu yere kesinlikle dayanmayın, hatta gözlemlerinizi kaydederken bile dayanmayın.

İstasyon 2: Yoğunlaşma

1- Buz ve su şişelerini gözlemleyin.
2- Şişeler kuru mu yoksa ıslak mı duruyorlar?

3- Şişeler odadan daha mı soğuk yoksa ılık mı duruyorlar? Bu gözlemlerinizi kağıtlarınıza kaydedin.
4- 1.istasyondaki arkadaşlarınızla benzer bir gözlemleri olup olmadığını tartışın.

İstasyon 2: Yağış

1- Sprey şişesini kabartma haritanın üzerinde tutun ve iki kez püskürtün.
2- Suyu şişeden çıkarken dikkatlice gözlemleyin. Su hangi yolla hareket ediyor? Bu gözlemlerinizi kağıtlarınıza kaydedin.
3- 1.istasyondaki arkadaşlarınızla benzer bir gözlemleri olup olmadığını tartışın.

İstasyon 3: Terleme

1- Plastik poşet içindeki bitkiyi gözlemleyin.
2- Plastik poşetin yüzeyindeki suyu görüyor ya da hissediyor musunuz? Bu gözlemlerinizi kağıtlarınıza kaydedin.

E4 : Kavram Aktarımı (Explain)

Öğrencilerin çalışma kağıtlarında aldığı notlar tartışılır. Öğrencilerden gözlemlerini paylaşmaları istenir. Önemli kelimeler belirlenir. Terimler tahtaya yazılır. Her bir terimin açıklanmasında öğrencilerin yaptığı gözlem notlarını göz önünde bulundurarak cevapları onların bulmasına yardımcı olunur. Su döngüsü posterinden yararlanılır.

Yoğunlaşmanın Tanımı: Yoğunlaşma, suyun gaz halden sıvı hale dönüşümüdür. Yoğunlaşmayı nerede gözlemledikleri sorulur. Soğuk bir camın ya da metalin dış yüzeyi, bulut ve soğuk bir cama üflediğimizde yüzeyinde oluşan su damlaları örnekleri verilerek tanım desteklenir.

Yağışın Tanımı: Yağış, bulutlardan dünya yüzeyine düşen yoğunlaşmış nemdir. Öğrencilerden kendi hayatlarından örnekler vermeleri istenir.

Terlemenin Tanımı: Terleme, bitkiler tarafından açığa çıkarılan nemdir. Su, bitkilerin köklerinde, suya dönüşeceği yapraklarına yolculuk eder, oradan da atmosfere geri döner. Öğrencilerden terlemeye örnekler vermeleri istenir. Bahçede çimlerin üzerinde oluşan çiğ damlaları gözlenir.

Buharlaşmanın Tanımı: Buharlaşma, suyun sıvı halden gaz hale dönüşümüdür. Öğrencilere buharlaşmayı nerede gözlemledikleri sorulur. Yağmurdan sonra kaldırım kenarlarında oluşan su birikintilerinin kaybolması, ıslak çamaşırların bir süre sonra kuruması örnekleri verilerek tanım desteklenir.

Su Döngüsünün Tanımı: Su döngüsü, suyun dünyanın yüzeyinden atmosfere ve sonra tekrar dünya yüzeyine durmaksızın dönmesidir. Yoğunlaşma, yağış, terleme ve buharlaşmanın su döngüsünün birer aşaması olduğu açıklanır.
Öğrencilerden aşağıdaki su döngüsü resmini grup halinde çalışmaları ve aşamalarını doğru yerlere yazmaları istenir.

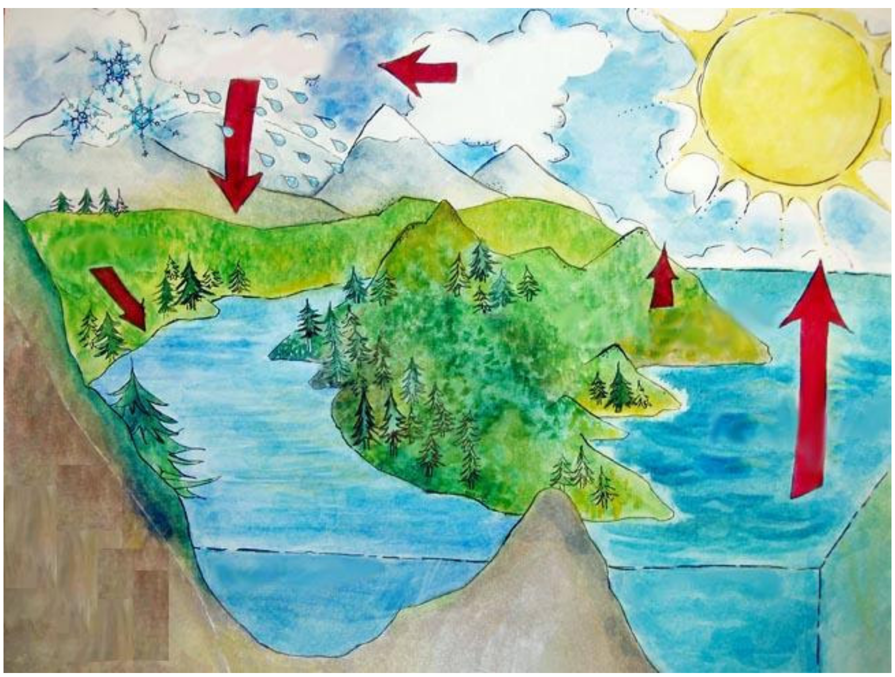

Figure C.1 A drawing of water cycle

E5: Kavram Uygulaması (Elaborate)

Bu etkinlik öğrencilerin, birkaç kolay adımda evlerinde ve okullarında kirletici unsurları su döngüsünden nasıl uzak tutabileceklerini anlatarak çevreye, hayvanlara ve insan sağlığına dikkatlerini çekmeyi hedeflemektedir. Öğrenciler temizlikte kullanılmak üzere kendilerine ait zehirsiz ve ayrışabilen (ya da "çevre dostu") temizlik ürünleri yapabileceklerdir.

Okululun park alanındaki bir su birikintisinde güneşlenen bir su damlası düşünün. Buharlaşana ve havadaki suyun, bulutların bir parçası oluncaya kadar güneş tarafından ısıtılacaktır. Uygun hava şartları oluştuğunda yoğunlaşacak ve yağış olarak yeryüzüne geri dönecektir. Peki, yere ulaşınca nereye gider? Insanlar, hayvanlar veya bitkilerce mi kullanılır? Belki de bitkiler ve hayvanlarca kullanılır, belki de insanlarca bir yangını söndürmek için kullanılır, ya da araba yıkamak için veya bahçedeki sebzeleri sulamak için. İnsanlar arabalarını yıkadıklarında veya evlerini temizlediklerinde kullandıkları temizlik malzemeleri de su döngüsüne eklenir. Bazı temizlik ürünlerinin üzerinde insanlar için tehlikeli olduğunu belirten uyarıları da farketmişsinizdir. Bu temizleyiciler su döngüsüne girdiklerinde balıklar, diğer hayvanlar ve bitkiler için hatta insanlar için zararlı olabilmektedirler. Su temizlendikten sonra bile az miktardaki zararlı madde bu döngüye karışabilmektedir.

Öğrenciler aşağıdaki gündelik kullanılan malzemelerle çevre dostu temizleyiciler yapabileceklerdir.

Ürün	Karışımdaki maddeler	Formül ve uygulama
Çok amaçlı temizleyici	**Karbonat Sirke Su**	**2 paket karbonatı, ½ litre su ile karıştır. Yağları temizlemek için 1 fincan sirke ekle. Karışımı sprey kutusuna koy.**
Çizmeyen cam-pencere temizleyicisi	**Sirke Su**	**1 fincan sirkeyi ¼ litre ılık su ile karıştır. Karışımı sprey kutusuna koy. İyi sonuç almak için gazete kağıdı ile temizlik yap.**

Fırın temizleyicisi	**Karbonat** **Su** **Tuz**	**1 fincan karbonatı, bir miktar tuz ve su ile macun olana dek karıştır.** **Fırın yüzeyine uygula ve bir süre bekle.** **Ovalayarak temizle.**

E6: Değerlendirme (Evaluate)

Öğrencilerin kavramları öğrenmelerinin değerlendirilmesi aşaması aşağıdaki soru ile başlayabilir.

Su döngüsünün oluşması için doğru sıralama nasıldır?

I. bulutlardaki su buharının yağış olarak yeryüzüne dönmesi

II. yeryüzündeki suyun buharlaşması

III. bulutların soğuk havaya rastlaması

IV. gökyüzünde su buharının bulutları oluşturması

Sıralama birkaç öğrenciye yaptırıldıktan sonra her öğrenci, parmağını aşağıdaki resim üzerinde hareket ettirirken doğadaki su döngüsünü sözlü olarak ifade eder. Öğretmen, gerekli yerlerde düzeltme yaparak veya soru sorarak, bir yandan öğrencinin ardışık süreçleri birbirine bağlama becerisini geliştirirken bir yandan da o öğrencide eksik görünen zihin yapılanmalarını tespit eder ve uygun fırsatlar yaratarak düzeltir. Ayrıca, öğrencilerin tümünden aşağıdaki soruları cevaplandırmaları istenir:

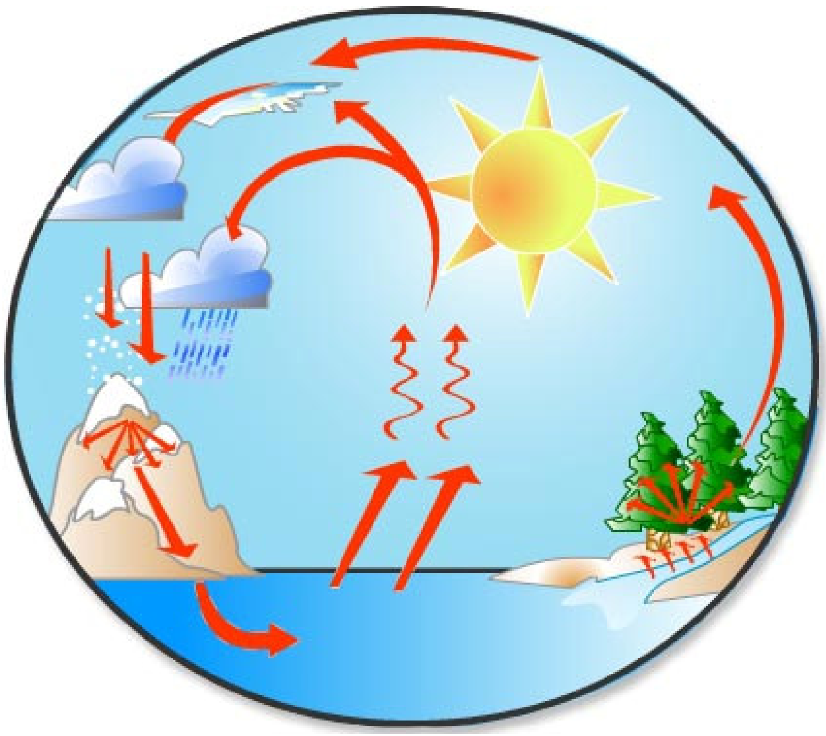

Figure C.2 An illustration of water cycle
(obtained from http://earthguide.ucsd.edu/)

Değerlendirme ve Tartışma Soruları

1. Dünyanın ihtiyacını karşılayan su nereden geliyor?

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2. Resimdeki hangi olay suyun yoğunlaşması sonucunda oluşmuştur?

----

3. Yağmurdan sonra su nereye gider?

----

4. Yer altı suları sizce temiz midir? Neden?

----

5. Resimde yönleri belirtilen okları su döngüsünün aşamalarını düşünerek adlandırınız.

E7: Kavramların İlişkilendirilmesi-Genişletilmesi (Extend)

Düz ağızlı bir cam kâse içine bir miktar kaynar su konarak ortasına boş küçük bir fincan yerleştirilir. Büyük kâsenin ağzı saydam plastik (streç) film ile kapatılır. Fincanın tam üstüne gelecek şekilde film üzerine buz yerleştirilir. Kâse, mum veya ispirto lambası alevinden biraz yükseğe (15-20 cm) yerleştirilir. Öğrenciler buzla soğutulan plastik film yüzeyinde su damlalarının oluşup damlamasını gözlemlerler. Damlayan suyun nereden geldiği tartışılır. Isıtma kesilince yoğunlaşmanın yavaşladığı ve durduğu gösterilir. Su döngüsünün devam etmesi için ısıtma aracının gerekliliği vurgulanır. Isıtma aracının bir enerji kaynağı olduğu hatırlatılır. Isıtma ve soğuma sağlandıkça kâsedeki su döngüsünün de süreceği vurgulanır. Doğadaki su döngüsünün hangi enerji kaynağıyla yürüdüğü tartışılır.

Bu aşamada öğrencilerin bir sonraki derste işleyecekleri ısı-sıcaklık kavramları ile ilgili olarak, doğada su döngüsü ve güneş temaları etrafında ısının bir enerji türü olduğunu ve başka enerjilere dönüşebileceğini düşünmeleri, ısı-sıcaklık kavram ikilisini su döngüsü ile ilişkilendirmeleri; ısının madde üzerindeki etkilerini gözden geçirirken bu ilişkiyi içselleştirmeleri; genleşme-büzülme ve hâl değişimi olgularının gündelik hayattaki önemini düşünmeleri beklenmektedir.

APPENDİX D

DERS GÖZLEM FORMU

	Evet	*Hayır*	*Yorum Yok*
Sorular			
Ders, öğrencilerin dikkatini çekecek, merak uyandıran sorularla başlar.			
Öğrenciler, soru sormaları için motive edilir.			
Öğretmen, sorulması gereken soruları sorar.			
Öğrencilerden gelen sorular dersin sonuna bırakılır. Öğrenci cevaplanmaz.			
Öğrenciler birbirlerine sorular sorarak doğru cevapları grup çalışması ile bulmaya çalışırlar.			
Cevap bulunamamalı, keşfedilmeli veya online kaynaklarda araştırma sonucu bulunmalıdır.			
Öğrenciyi Meşgul Tutma			
Öğretmen yönlendiricidir.			
Öğrenciler pasif bir şekilde boşluk doldurur veya sorulara cevap verir durumda değil, konuyu anladıklarını gösteren özgün ürünler ortaya koyarlar.			
Öğrenciler ders materyallerini kullanarak, gözlem, değerlendirme yaparak ve bilgileri kayıt altına alarak aktiviteleri gerçekleştirirler.			
Öğrenci derste verilenden çok hangi kavramlardan sınavda sorumlu olduğunu düşünür.			
Öğrenci ders boyunca pasif bir şekilde öğretmeni dinler.			
Derste daha çok aktif olan öğretmendir.			
Detayları görürler, olay sırasına ve değişime dikkat ederler, farklılıkları ve benzerlikleri keşfederler.			
İnteraktif İşbirliği			
Öğrencilerden iletişim kurmaları istenir, ikili ve çoklu gruplar halinde çalışmaları ve fikirlerini tartışmaları istenir.			

Öğrenciler deney grupları oluşturarak çalışırlar.			
Öğrenciler bireysel çalışma için motive edilirler.			
Öğrenciler bir yarış halinde değillerdir.			
Performans Değerlendirmesi			
Öğrenciler, bilgilerini paylaşmak üzere genellikle bir son ürün ortaya koyarlar. Bunlar, sunum, poster, şarkı, rapor veya pano olabilir.			
Öğrencilerin deneyler sonucunda elde ettikleri bulguları tartışarak yorum yapmaları beklenir.			
Öğrencilerin konuyu anlayıp anlamadıkları sözlü ve yazılı sınavlarla değerlendirilir.			
Ürünler, onların daha üst düzey düşünme yeteneklerini kapsar.			
Kaynakların Çeşitliliği			
Öğrenci kaynak olarak sadece ders kitabını kullanır.			
Öğrenci öğretmeninin söylediklerini defterine birebir not alır.			
Öğrenciler çeşitli kaynaklar kullanırlar. Kitaplar, İnternet siteleri, videolar, posterler, dergiler…			
Diğer gözlemler: Gözleyen: ……………………………..			

APPENDİX E

İZİN BELGESİ

Sayın Özlem MECİT,

Tez çalışmanızda Adapazarı Özel Enka İlköğretim Okulu öğrenci ve öğretmenleri ile çalışmanızda ve teziniz içerisinde öğrenci ve öğretmen fotoğrafları kullanmanızda sakınca bulunmamaktadır.

Okul Aile Birliği adına
Dr. Gürhan ERKAN

CURRICULUM VITAE

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EDUCATIONAL BACKGROUND

Degree	Institution	Year of Graduation
MS	METU, Faculty of Education	2001
BS	METU, Faculty of Education	1999
High School	Tevfik Sırrı Gür Lisesi, Mersin	1994

WORK EXPERIENCE

Year	Place	Enrollment
January 2006-Present	ENKA Schools, Adapazarı	Primary School Principal
June 2003- January 2006	ENKA Schools, Adapazarı	Primary School Vice Principal

June 1999-June 2003	METU, Faculty of Education, Secondary Science and Mathematics Education Department	Research Assistant

PUBLICATIONS

Thesis

"Remediation of Seventh Grade Students' Misconceptions Related to Ecological Concepts Through Conceptual Change Approach", A Thesis Submitted to the Graduate School of Natural and Applied Sciences of the Middle East Technical Univeristy, The Degree of Master of Science in the Department of Secondary Science and Mathematics Education, June, 2001.

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Poster Presentation

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