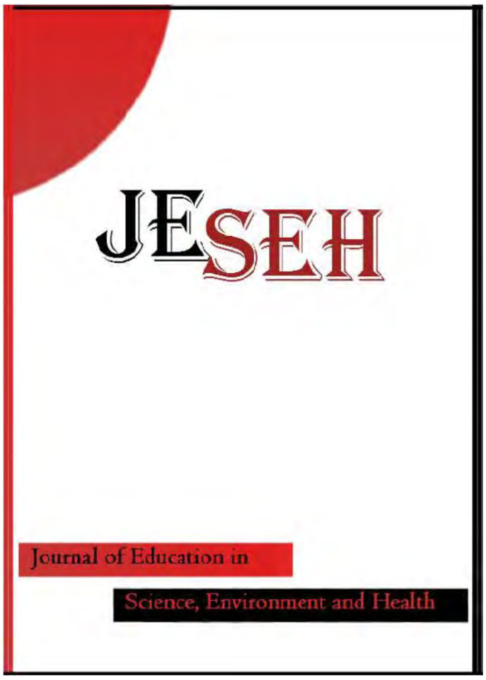

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Abstract

The aim of this study is to investigate the effect of the Common Knowledge Construction Model (CKCM) based instruction on 5th grade students' conceptual understanding of the "biodiversity" topic. The study is conducted with 74 fifth grade female students at middle school in the district of Usküdar, Istanbul. Semi-experimental method is used. In this model, two experimental groups (Experiment 1 and Experiment 2) and a control group are randomly selected among 5th grade students. In the experiment group 1, teaching is carried out with CKCM, in the experiment group 2, CKCM supported out-of-school learning environments, and in the control group, instruction is carried out in accordance with the curriculum of Turkey. Experimental group 1 includes 24 students, 2 involves 25 students, and control group consist of 25 students. The data is collected through Biodiversity Conceptual Understanding Test (BCUT). Analyzing of BCUT data that require two-tier classification, the answers of the first tier of each question are provided by tabulating the percentages of the reasons chosen for these answers (the second tier). Which alternative concepts were chosen mostly and which ones were changed analyzed as percentage. The data collected from the students' responses to the two-tier BCUT are statistically analyzed with the help of SPSS 18.0™. Kruskal Wallis H-Test and Wilcoxon paired pairs test are employed to analyze the data. In addition, Tamhane's T2 test is employed from post hoc tests to determine the direction of the difference of biodiversity post-test scores. While most of the alternative concepts are remediated in experiment 1 and experiment 2 groups, in the control group it revealed that alternative concepts mostly continued. Result of the study show that CKCM is more effective in remediating alternative concepts than curriculum of the ministry of education. On the other hand, CKCM is more than curriculum of the ministry of education in terms of conceptual understanding of biodiversity. Teaching CKCM supported out-of-school learning environments do not differ in BCUT from the academic achievement only with CKCM teaching. When the post-test academic achievement of the groups is taken into consideration, a significant difference is observed between the experimental groups and the control group in favor of the experimental groups.

Introduction

Biological diversity (biodiversity) is one of the most important parts of the ecosystem on the earth. Biodiversity is created by different plants and animals which covers the diversity of all plants and animals on Earth at any given time (Öner, 2011). The beginning of the industrial age with rapid population growth resulted in disruption of the biodiversity on Earth. In 1992 The Biological Diversity Convention in Rio decided that current researches at all levels must focus on protecting and developing biodiversity around the world (Keating, 1993). Therefore, the importance of preparing teaching activities on biodiversity is increasing day by day. The diversity of plant and animal species of a country contributes to economy of the country in different fields such as medicine, industry, forestry and etc. Biodiversity also contributes enrichment of a nation culturally and economically. One of the most important reasons for the decline of biodiversity in a country is to harm living species. Decrease in plant and animal species showed people that biodiversity is very important (Gayford, 2000). If Turkey wants to keep development in every field, society must preserve biological diversity. Turkey needs individuals who have awareness about biodiversity and who know how to protect the natural environment. Hence, Turkey has developed science education programs in biodiversity to educate students at all levels (Ministry of National Education [MoNE], 2018). It is crucial to learn the concepts and the importance of biodiversity at an early age.

If students fail to understand a concept correctly, learning doesn't occur (Schulte, 2001). Incorrectly held scientific concepts by children referred to in the literature as misconceptions or alternative conceptions (Doran, 1972; Driver & Easley,1978; Treagust & Mann, 1998), inadequate understanding of science (Osborne & Freyberg, 1985; Treagust, 1988), general sense concepts, and spontaneous information. The main reason why researchers and teachers are interested in alternative conceptions of students is that these affects subsequent learning and render learning of new concepts difficult (Coştu et al., 2012). Contrary to these models, Marton (1981) developed the variation theory of learning known as phenomenography. Phenomenography supports the knowledge that emerges as a result of the interaction between human beings and the world (Coştu et al., 2012; Ebenezer & Fraser, 2001; Walsh, 2009).

Researchers claim that primary and secondary school students have alternative conceptions about the classification of living things and biodiversity, and they have difficulties in understanding biodiversity (Braund, 1991, 1998; Cardak, 2002; Kellert, 1985; Trowbridge & Mintzes, 1985). However, most of these studies do not elaborate students ' alternative conceptions. Moreover, different studies done in the literature except biodiversity and alternative concepts. The results of some of these studies; Uzun et al. (2010), asked biology teacher candidates about the concept of biodiversity and they stated that biology teacher candidates generally talk about diversity of species and the teacher candidates have limited knowledge about biodiversity. Further, Dervişoğlu (2010) investigated that college students have value orientations towards living species. In his study, it was determined that students have a utilitarian perspective about value, that is, protection of environment for the benefit of people. The study of Yörek (2006) investigated views of secondary school students on how Turkey's biodiversity is determined and how biodiversity is protected in Turkey. He has also researched students' conceptual understanding of biodiversity.

Science is a method of research and thinking that try to explain the world, based on logical thinking and continuous questioning using experimental criteria (Tatar & Bağrıyanık, 2012). One of the main aims of science teaching is to enable students to learn, understand and experience the natural world (MoNE, 2018). Science course is difficult to confine to books and blackboard, it is intertwined with the real life behind the classroom walls (Payne, 1985). To learn science, you need to take advantage of opportunities outside the school environment (Carrier, 2009). Out-of-school learning is a process-based approach that results from the interaction between the student and the environment. In this process, students actively constructed knowledge from first hand. Out-of-school learning aims to gain knowledge in the learning environment as well as to develop social relationships between students (Orion et al., 1997). Out-of-school activities are carried out outside the classroom, class, or school. Generally, classroom, laboratory and out-of-school places are learning environments in which science education is carried out. The learning outcome that the individual will obtain as a result of his life continues beyond the classroom walls. While the classroom and laboratory environment draws a limited learning place for science lessons, it provides students with many learning opportunities in out-of-school places (Sontay et al., 2016).

There are many types of places where out-of-school learning activities can be carried out such as museums, zoos, aquariums, science centers, factories, and botanical gardens. Technical trips are also accepted as out-of-school learning activities. With technical trips, it is possible to teach the subjects that are difficult to learn in the classroom, students gain experience and trips provide enhancement interest in science (Davidson et al., 2010). The importance of using out-of-school learning environments in the educational process emerges especially in science lessons which are all about our surroundings. Because many subjects of science happen in outside of the classroom are related with covering real events and concepts. In this context; any place where human beings interact outside the school to learn science can be used as a resource (Tatar & Bağrıyanık, 2012). As a matter of fact, in the science curriculum updated since 2004 in Turkey, it was stated that science courses should be carried out in student-based learning environments (problem, project, argumentation, collaborative learning etc.) and it was also given more in out-of-school environments. In this way, many points where the classroom environment is insufficient can be completed within the scope of formal education. Therefore, in-school and out-of-school learning environments are designed according to the research-inquiry based learning strategy that forms the basis of the science curriculum which enables students to learn information meaningfully and permanently (MoNE, 2018).

Theoretical Framework of the CKCM

One of the methods used in science teaching in recent years, especially effective in conceptual change and based on phenomenography, is the Common Knowledge Construction Model (CKCM) (Ebenezer & Connor, 1998). The CKCM is based on Marton's variation theory of learning, Bruner's view of language as a part of the symbolic system of culture, Vygotsky's "zone of proximal development" and Doll's post-modern thinking on scientific discourse and curriculum development (Biernacka, 2006). The CKCM argues that students construct world views as a result of their personal interactions with the natural environment and their social interactions (Biernacka, 2006; Ebenezer et al., 2004). Therefore, for students to interpret scientific ideas and rules that contain common knowledge about their views on the world must first be determined and a connection must then be established between scientific ideas and their personal views (Ebenezer & Fraser, 2001). The CKCM argues that schools should provide students with social skills along with basic skills. Therefore, learning environments should be constructed in a place where students can grow up as individuals who think critically and who have responsibility and awareness towards global problems. The teacher should provide opportunities for his/her students in this direction. If the teacher shows empathy, understanding and sensitivity towards his/her students and interacts positively with them, both the students' learning experiences and the ability to deal with the problems they face effectively increases (Noddings, 2005; Wood, 2012).

The CKCM consists of four phases. The first phase is Exploring and Categorizing, it includes activities which are done to pay the students' attention to the subject and to determine their prior knowledge. Preliminary information is uncovered by classifying students' information without categorizing them as true or false. In the second phase, namely Constructing and Negotiating, teacher-students and peer-peer interaction is carried out in order to obtain new information through the students' preliminary concepts under the guidance of teachers. The teacher is not the one who transfers the knowledge in the classroom, but the one who guides the students and contributes to their development. In the third phase, Translating and Extending, students make activities in order to transfer their knowledge into new context by integrating them with different disciplines. They try to solve problems around them and in the world at local or national level. The fourth phase, Reflecting and Assessing, it is the phase in which the students construct and learn the subject by using alternative assessment techniques. The teacher can use different techniques to measure the level of students' learning the subject (Ebenezer et al., 2010).

Earlier Studies of the CKCM

When earlier studies of the CKCM reviewed, it was determined that CKCM provides a significant increase in students' conceptual understanding and ensures the permanence of knowledge (Bakırcı et al., 2018; Bakırcı et al., 2016; Bakırcı & Ensari, 2018; Bakırcı & Yıldırım, 2017; Caymaz & Aydın, 2018b; İyibil, 2011; Özden, 2019), has positive impacts in attitudes towards chemistry lesson (Demircioğlu & Vural, 2016), has positive impacts in students 'critical thinking skills (Bakırcı, 2014; Bakırcı & Çepni, 2016; Bakırcı et al., 2020; Yıldızbaş, 2017), has positive impacts in students' academic achievement (Akgün et al., 2016; Bakırcı, 2014; Bakırcı et al., 2015; Bakırcı & Ensari, 2018; Bayar, 2019; Benli Özdemir, 2014; Caymaz & Aydin, 2020; Caymaz & Aydın, 2018a; Ebenezer et al., 2010; Ertuğrul, 2015; İyibil, 2011; Yıldızbaş, 2017), has positive impacts in improving nature of science (Bakırcı, 2014; Bakırcı & Çiçek, 2017; Caymaz & Aydin, 2020; Çavuş et al., 2020; Yıldırım, 2018; Yıldızbaş, 2017), positive influence on students' science process skills (Bakırcı et al., 2020; Bayar, 2019), has positive impacts in socio-scientific issues (Bakırcı et al., 2016; Yıldırım, 2018).

One of the important aspects of CKCM is that it provides flexibility to the teacher about the choice of method and technique and many learning theories can be synthesized. In addition, it allows students to transfer the new knowledge what they just learned into similar situations in real life (Biernacka, 2006; Ebenezer et al., 2010; Ebenezer & Connor, 1998). CKCM also helps students to become aware of their prior knowledge, creates a constructive discussion environment in the classroom and in this way, it makes lessons become more funny (Akgün et al., 2016). Further, it was emphasized that CKCM is effective in eliminating alternative concepts and that it is significantly successful in changing scientific language with daily language (Kiryak, 2013); CKCM is more effective than traditional teaching (Ebenezer et al., 2010; Wood, 2012). Moreover, it was concluded that CKCM is a suitable model for science teaching, as the lessons carried out with CKCM contribute greatly to the development of students' scientific literacy skills (Biernacka, 2006).

Plant, animal and microorganism that create biodiversity and their variations and the communities they form have a great impact on the preservation of natural balance. Providing the nutrients we eat, the oxygen we breathe, and many other needs, biosphere render our daily waste harmless (Yüce & Önel, 2015). Despite this, the biosphere is not destroyed in any era as it is today (Aydoğdu & Gezer, 2006), and its species are constantly disappearing (Efe, 2010). The gradual extinction of biodiversity means the extinction of genetic diversity (Aydoğdu & Gezer, 2006). The disappearance of biodiversity has reached danger levels and has become a global problem (Yörek, 2006). At this point, solutions obtained from studies showed that awareness towards protection of environment increases day by day (Yörek, 2006). Turkey has to improve awareness about this issue by instructing students because it is very important for future generations. However, deficiencies in the clarity and comprehensibility of the issue of biodiversity are also part of education problems. For this reason, biodiversity has become the focus of educational research in recent years (Dikmenli, 2010). This study is important for the universal and national vital importance of biodiversity and for teaching biodiversity at an early age with correct concepts.

There are many studies on biodiversity in the literature (Barker & Elliott, 2000; Bulut, 2019; Demir, 2020; Fıstıkeken, 2017; Gayford, 2000; Keleş & Özenoğlu, 2017; Kibar, 2019; Kurt, 2018; Lindemann-Matthies, 2002; Uzun et al., 2010; Van Weelie & Wals, 2002; Yörek, 2006). However, there is a paucity of studies on biodiversity conceptual changes in the literature. Since CKCM is an effective model in providing conceptual change (Ebenezer et al., 2010), CKCM was used in this study to provide conceptual changes regarding biodiversity.

The Aim of the Study

The aim of this study is to investigate the effects of CKCM on the determination of alternative concepts of 5th grade students on biodiversity and on the changes of alternative concepts.

The following research questions guided the current study:

1. Is there effect of the teaching based on CKCM to promote conceptual change of 5th grade students' in biodiversity subject?
2. Is there effect of the teaching based on CKCM supported out-of-school learning environments to promote conceptual change of 5th grade students' in biodiversity subject?
3. Is there effect of the science curriculum to promote conceptual change of 5th grade students' in biodiversity subject?
4. Is there any significant difference of the academic achievement of 5th grade students amongst experiment 1, 2 and control groups?

Method

Research Design

In the study, a semi-experimental method was used. In this model, two experimental groups experiment 1 and experiment 2 and a control group were selected randomly among the 5th graders. Experiment 1 is exposed to CKCM, experiment 2 is instructed with CKCM supported with out-of-school learning environments; control group is taught curriculum of the ministry of education in Turkey. All three groups were educated by the responsible the first author. In the instruction of the control group, methods and techniques suitable for the constructivist approach (parallel to Turkey science curriculum) were used. Experimental design is used to reveal cause-effect relationships between variables that can be quantitatively measured in a study. In some studies, it may not be possible to randomly distribute individuals into experiment and control groups. In these cases, the quasi-experimental study is used. In terms of scientific value, this method, which follows the actual experimental method, can be applied in different ways, such as post-test to unequal groups, pre-test and post-test to a single group, and pre-test and post-test to unequal groups (Karasar, 1999). In this method, one or more control and experiment groups are selected. One or more of the groups are randomly selected as experiment and control groups. However, participants are considered to have similar characteristics as possible (Çepni, 2010).

Sample

The study group consisted of 5th grade 74 female students studying in a secondary school in Istanbul, during the spring term of 2018-2019 academic year. There are 24 students in experiment group 1 and 25 students in experiment group 2 and 25 students in control group. As a semi experimental study, random assignment was made while determining all three groups, (namely experiment 1, experiment 2 and control). In the determination of the all study group, easily accessible sampling method was used which makes the research safe and practical (Yıldırım & Simşek, 2008).

Data Collection Tools

Biodiversity Conceptual Understanding Test (BCUT) which is composed of two-tier test items was used as a data collection tool. The conceptual understanding test for biodiversity was developed by Treagust (1988). The content of the test was determined primarily and the boundaries of the subjects and concepts in the test were organized. Then, propositions related to biodiversity were written using question banks, textbooks and different sources related to biodiversity. The relationship between related concepts and the subject contents was determined. Information propositions and concepts related to biodiversity were related. In order to ensure the validity of the scope of the test, four science educators and three experienced science teachers who were experts in their fields examined and gave feedbacks. In this way, the scientific accuracy of the propositions was proved and revised. Missing or incorrect sentences and statements were corrected or removed from the test.

Students' alternative concepts of biodiversity in order to develop two-tier test items were gathered via open-ended questions and semi-structured interviews. Also, it was comprehensively examined related literature about biodiversity to develop BCUT. By taking students' alternative concepts-which are collected according to procedure mentioned above- into consideration, 14 two-tier test questions were developed. The first tier of the test requires the selection of True-False classification, and the second tier requires the selection of the reasons related to the first tier. The pilot study of the developed BCUT was applied to 29 fifth grade students and necessary revisions after the implementation were made. As a result of validity, reliability and item analyzes, only one question was removed from the two-tier test. The validity of the BCUT was provided by a group of four science educators and three experienced science teachers. In the preparation of the BCUT, learning outcome related to biodiversity and student levels were taken into consideration. BCUT was applied to the two experiments and one control group as pre-test and post-test before and after the intervention. BCUT item indexes and reliability coefficient are given in Table 1.

Table 1. BCUT item indexes and reliability coefficient

Item	Difficulty index	Category Difficulty	Item Discrimination	Category Discrimination
1	0,828	Very Easy	0,50	Very Good
2	0,828	Very Easy	0,625	Very Good
3	0,552	Moderate	0,875	Very Good
4	0,621	Easy	0,75	Very Good
5	0,379	Difficult	0,875	Very Good
6	0,621	Easy	0,875	Very Good
7	0,621	Easy	0,875	Very Good
8	0,586	Moderate	0,75	Very Good
9	0,655	Easy	0,5	Very Good
10	0,690	Easy	0,875	Very Good
11	0,759	Easy	0,625	Very Good
12	0,448	Moderate	0,625	Very Good
13	0,448	Moderate	1	Very Good
14	0,103	Very Difficult	0,25	Should be Revised
Total test	0,618	Easy	0,749	Very Good

Reliability; 0,891

According to item indexes (Table 1), item 14 was removed from the test because it is a very difficult item and is a substance that should be revised. BCUT has easy test feature in terms of item difficulty and very good test feature in terms of item discrimination. It is also a very good test in terms of BCUT's reliable coefficient. There are few studies to reveal 5th grade students' alternative concepts related to biodiversity. For this reason, the authors of this paper determined 5th grade student's alternative concepts related to biodiversity. Alternative concepts elicited from students are related to the definition of biodiversity, extinct species, endangered creatures and the effects of biodiversity on nature. The sample questions about the BCUT are given in Figure 1.

Data Analysis

BCUT was analyzed through considering two-tier test items. Students' answers in the two-tier test are provided by tabulating the percentages of each tier. In this way, the percentages of the answers given to the pre-test post-test alternative concepts and the percentages of the pre-test post-test changes of the alternative concepts were measured. Alternative concepts in the second tier that students chose mostly and alternative concepts in the student's mind were the most changed analyzed as a percentage.

In BCUT, the combination of the first tier of student answers and the second tier indicating justification of the first tier were examined (Coştu et al., 2003). As a result of this classification, as indicated in Table 2, a total score is calculated considering the answers given to all tests. A similar study on the analysis of the two- tier tests was utilized Coştu et al., (2007).

Example Question 1.

The only number of plant species living in a region is biodiversity.
I. True II. False

Because;
a. The number of animal species living in a certain region does not affect biodiversity.
b. The richness of all living species in a region express biodiversity.
c. Only the plants determine the richness of the species in a region.
d. ……………………………………………………………………………………….

Example Question 2.

In our country, Caretta carettas are in danger of extinction. Natural habitats are made for these creatures.
For Caretta Carettas, which are in danger of extinction, the construction of natural habitats causes a decrease in biodiversity.
I. True II. False

Because;
a. *Caretta Carettas* have no role in nature, the establishment of natural habitats does not affect biodiversity.
b. The extinction of *Caretta Caretta* species affects biodiversity as it reduces the number of species. Therefore, living spaces are needed.
c. The extinction of *Caretta Carettas* does not affect other creatures. Therefore, there is no need to establish habitats for Caretta Carettas.
d. ……………………………………………………………………………………….

Example Question 3.

Partridge is a bird and feeds on ticks. In an area with partridges, the number of partridges decreased as a result of overfishing of hunters.
Accordingly, the decrease in the number of partridges affected biodiversity.
I. True II. False

Because;
a. Biodiversity has increased, as the number of *partridges* has decreased, leading to an increase in the number of ticks.
b. Biodiversity is not affected because the decrease in the number of *partridges* does not affect other species.
c. Decreasing the number and species of living things in a region reduces the richness of biodiversity.
d.…………………………………………………………………………………………

Figure 1. Sample two-tier test question of BCUT

The categorization of the responses of the two-tier tests is given as follows;

- True Response- True Reason= Sound Understanding (SU)
- True Response - Partially True Reason= Partial Understanding (PU)
- True Response- False Reason= Specific Misconceptions (SM)
- False Response- False Reason= No Understanding
- No Response- No Reason= No Response (NR)

Similar categorization was used in earlier studies (e.g. Coştu and Ayas, 2005). The highest score that the students gain from the BCUT is 39, while the minimum score is 0.

Table 2. Evaluation criteria used to analyze BCUT

Evaluation Criteria Score		
True Response	True Reason	3 Point
True Response	Partially True Reason	2 Point
True Response	False Reason	1 Point
True Response	No Reason	1 Point
False Response	True Reason	2 Point
False Response	Partially True Reason	1 Point
False Response	False Reason	0 Point
False Response	No Reason	0 Point
No Response	True Reason	2 Point
No Response	Partially True Reason	1 Point
No Response	False Reason	0 Point
No Response	No Reason	0 Point

The data obtained from the students' responses to the two-tier BCUT were statistically analyzed with the help of SPSS program. Kruskal Wallis H-Test was utilized for non-parametric tests because the number of students was less than 30 for each group of the study group and the data did not show homogeneous normal distribution. Wilcoxon paired pairs test was used to determine the significant difference between the pre- and post-tests and Tamhane’s T2 test was selected from post hoc tests to determine the direction of the difference of biodiversity post-test scores.

Teaching Intervention

All three groups (namely experiment 1, experiment 2 and control) were taught by the responsible the first author of the paper. He has 10 years of teaching experience and recently he taught relevant research concepts to classes of wide variety students. Thus, he has sufficient experience to teach these concepts properly. In addition, he has also sufficient knowledge and experience about the CKCM and out-of-school learning. The studies in the experiment and control groups were applied at different times in the same week

While lessons were based on science curriculum in the control groups, they were based on the CKCM in experimental groups. In experiment 1 teaching was made only with CKCM, and in experiment 2 teaching was made with CKCM supported out-of-school learning environments. In the teaching of the control group, methods and techniques suitable for the constructivist approach (parallel to Turkey science curriculum) were utilized in period of eight hours. The 5th grade regular teacher taught the control groups with science curriculum involving lectures. The principle of teaching adopted in these classes was that knowledge resides with the teacher and that it is the teacher’s responsibility to transfer that knowledge as facts to students. The teacher explained the knowledge structures in following the prescribed textbook. At the end of each class, the teacher asked direct questions on important concepts. The teacher dictated notes while the students copied. The experiments were carried out on the subjects of the unit and homework assignments were given.

Instructional materials developed based on CKCM were applied in experiment 1 and experiment 2 groups for 8 hours period. Out-of-school learning activities for experiment 2 were carried out outside of class hours. Experiment 2 completed the instruction in out-of-school learning activities such as zoo, recycling activities, water treatment plant. In addition, experiment 2 students gave information about the importance of recycling to environmental trades.

Exploring and Categorizing

The first phase of the CKCM explored the students’ prior knowledge of the biodiversity. In order to attract student’s attention to biodiversity in experiment 1 and experiment 2 groups, the teacher aimed to reveal the students' prior knowledge about biodiversity with the brainstorming technique by hanging photographs of all the living species that the students have never met, all fish species and extinct organisms. The worksheet on extinct and endangered life forms was given to the students and the students' prior knowledge of these life forms was revealed. An event called conservation of Caretta caretta, prepared according to the method of Predict-Explain-Observe-Explain (PEOE), was held to reveal the students ' preliminary knowledge. In a similar study, students' alternative concepts were determined with the PEOE method (Bakırcı, 2014). Before the PEOE method was used, students were shown a video that would predict that the generations of Caretta Caretta are in danger. Then, PEOE worksheet containing the news about the protection of the nests of Caretta Caretta's on the beach in Kas district of Antalya was made. In this way, students were made to guess and observe that the generations of Caretta caretta are in danger. Also, at this stage of the model, Word Association Test (WAT) was used to determine the students' concepts related to biodiversity. Then, two visuals were given to the students to express the importance of biodiversity and the preliminary information about biodiversity was tried to be revealed. At this phase, the students' alternative concepts related to biodiversity were revealed. Alternative concepts have been solved with the help of activities in other stages. As a result of all the studies, the commonalities in the students' thoughts were determined and phenomenographic categories were created.

Constructing and Negotiating

In this phase, teacher-student and peer-peer interaction are implemented. The teacher guides the students and ensures that information is socially structured in the light of scientific discourses (Biernacka, 2006; Duschl & Osborne, 2002). "What is Biodiversity, what are the factors affecting biodiversity, what are the endangered species in our country and in the world, what are the extinct species in our country and in the world? "The subject homework was presented by the students in the classroom. In the experiment 2 where the CKCM supported out-of-school learning environments was conducted the students made their presentations with the help of TV programs and drama activities such as out-of-school learning activities. With the help of out-of-school learning, such as TV presentation and drama production, students learn by structuring their knowledge. In the first phase after the presentations, the observation explanation steps of the worksheet prepared according to the prediction explanation observation explanation method (PEOE), which was filled in the estimation explanation step, were performed at this stage. Before completing the PEOE worksheet, students watched a video about the Caretta caretta and contradictions were found. Those contradictions were resolved by comparing the predictions and observations in the light of this video. Afterwards, students discussed the effectiveness of biodiversity in different ecosystems with group discussions. The activity was held on "human and nature-induced factors that threaten biodiversity". There was an activity about extinct and endangered species in our country and around the world. At this stage, FENVIVOR game was prepared for all groups to learn exactly what was learned and eliminate alternative concepts. This game was created by the researcher in accordance with the lesson outcomes. The letters they wrote to people for the nests of different animals, called sweet creatures ' letters, were read in each group and the nests of animals were drawn by the students. The experiment group 2, the event called "Letters of sweet creatures" was read in each group and students drew animal nests in line with the letters.

Translating and Extending

Students identify and discuss socio-scientific problems related to biodiversity (Ebenezer et al., 2010). In addition, by structuring, students transfer their knowledge to new situations by associating them with different disciplines and concepts. Activities for finding solutions to local or national problems in the environment or around the world are also carried out at this phase (Bakırcı, 2014). At this stage, the activity called "the effects of chemical spraying" was applied to the students in order to draw attention to socioeconomic issues. The aim is to show students that chemical spraying can destroy insects that damage plants, while at the same time damaging bees, flies and spiders that live in that region and negatively affect biodiversity. Then socio-scientific activity related to the effects of an explosion on biodiversity on an offshore platform was applied. With this activity, the students examined the benefits of oil extraction in the seas as well as the negative effects of biodiversity and the effects of living things in danger of extinction. Afterwards, it was ensured that they understood the importance of the issue and offered solutions through group discussions. In order to realize the importance of biodiversity to the experiment 2, they were provided with informal learning through a zoo trip and observed and implemented what they learned in daily life. During the zoo trip, students made observations using the habitats observation form.

Reflecting and Assessing

This is the phase at which students learn the subject by using alternative assessment and evaluation techniques. The teacher can use different techniques to measure the level of students' learning the subject (Biernacka, 2006; Ebenezer et al., 2010). At this phase, students realize that they have experienced meaningful learning according to their behavior at the beginning of the lesson. The word association test applied at the first stage to observe this behavior change was reperformed at this phase. In addition, alternative measurement and evaluation techniques, structured grid and diagnostic branched tree related work sheets were made at this phase. Finally, in this phase, the game of FENVIVOR, which was prepared for the subject of biodiversity and which we used in the third phase, was played. By implementation of the game what information students learned was determined and at what level they learned the alternative concepts. Figure 2 was created to indicate where the intervention in the experiment 1 and experiment 2 groups differed. As can be seen from the Figure 2, for experiment 2 out-of-school learning were added in stage 1, 2 and 3 to support CKCM.

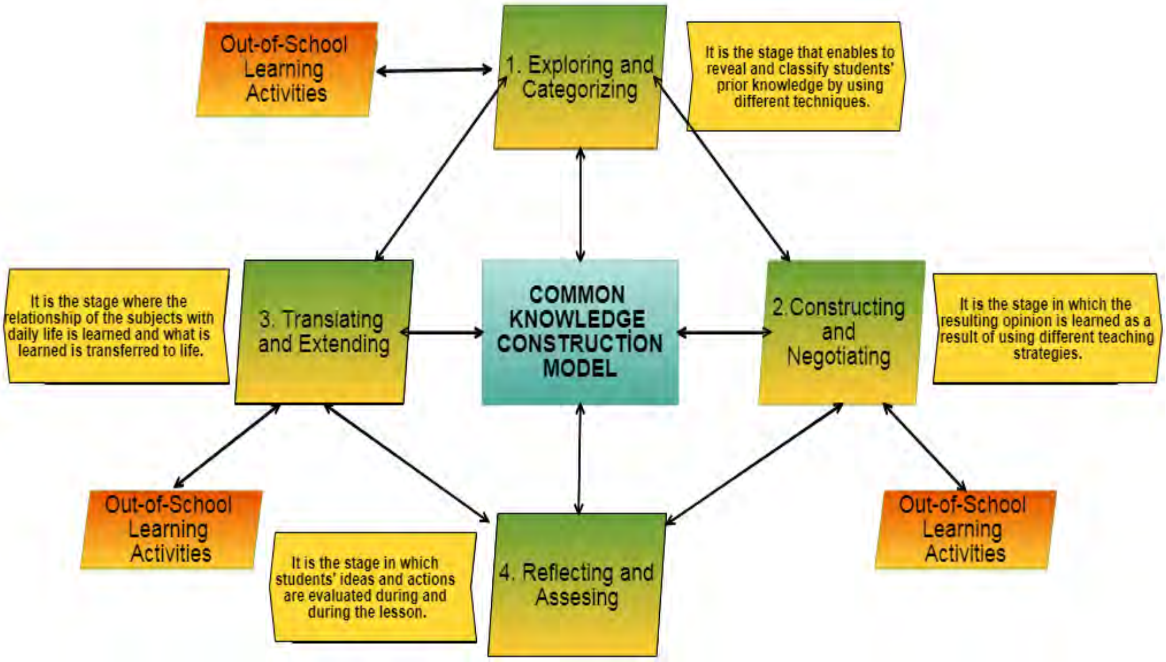

Figure 2. Teaching intervention CKCM and CKCM supported out-of-school learning environments

Findings

As shown in Table 3, when the answers of experiment 1 group to BCUT pre-test questions are analyzed, it is seen that the SU values of all questions are 53%, PU 0%, SM 29%, NU / NR 18%. It is seen that the experiment 1 group students have serious alternative concepts in the questions 1, 2, 3, 4, 5, 6, 7, 9, 12. The answers of experiment group 2 to BCUT pre-test questions are analyzed, it is seen that the SU values of all questions are 73%, PU 0%, SM 19%, NU / NR 8%. It is observed that the experiment 2 group students have serious alternative concepts in the questions 4, 5, 7. The answers of control group to BCUT pre-test questions are analyzed, it is revealed that the SU values of all questions are 53%, PU 0%, SM 30%, NU / NR 17%. It is observed that the control group students have serious alternative concepts in the questions 2, 3, 4, 5, 6, 7, 9, 10, 12. It is observed that the students do not write their own reasons in the justification part of the two-stage test and they choose one of the multiple-choice answers. Partial Understanding percentages are therefore 0%.

As shown in Table 3, when the answers of experiment group 1 to BCUT post-test questions are analyzed, it is seen that the average SU value of all questions is 85%, PU 0%, SM 9%, NU / NR 6%. This value indicates that the alternative concepts of experiment group 1 have been greatly reduced and eliminated. When the answers of the experiment group 2 to the BCUT post-test questions were analyzed, it was seen that the SU values of all questions were 88%, PU 0%, SM 7%, NU / NR 5%. This value shows that the alternative concepts of experiment group 2 are greatly reduced and eliminated. Only in the 10th and 11th questions there was a slight increase in the alternative concepts. It is seen that alternative concepts have decreased in other questions. When the answers of the control group to BCUT post-test questions were analyzed, it was seen that the mean SU values of all questions were 72 percent, PU 0%, SM 16%, NU / NR 12%. It was determined that the alternative concepts of the control group students continued in the questions 3, 5, 6, 12, while there was a slight increase in the alternative concepts only in the 12th question. When Table 3 is analyzed, the group with the least change in alternative concepts is observed as the control group. Table 3 shows the percentages of the BCUT as a pre-test and post-test for the experiments and control groups.

Table 3. Percentage of pre-test and post-test of student responses to items of BCUT

	Response Categorization	Experiment 1		Experiment 2		Control	
		Pre- (%)	Post- (%)	Pre (%)	Post- (%)	Pre- (%)	Post- (%)
Q 1	SU	50	92	84	100	64	100
	PU	0	0	0	0	0	0
	SM	29	0	12	0	16	0
	NU/NR	21	8	4	0	20	0
Q 2	SU	58	75	92	96	60	88
	PU	0	0	0	0	0	0
	SM	30	17	8	4	24	8
	NU/NR	12	8	0	0	16	4
Q 3	SU	29	63	64	92	36	40
	PU	0	0	0	0	0	0
	SM	58	33	36	4	52	24
	NU/NR	13	4	0	4	12	36
Q 4	SU	46	83	40	68	56	72
	PU	0	0	0	0	0	0
	SM	33	13	56	32	24	20
	NU/NR	21	4	4	0	20	8
Q 5	SU	33	83	44	64	40	56
	PU	0	0	0	0	0	0
	SM	33	8	32	16	36	28
	NU/NR	34	9	24	20	24	16
Q 6	SU	54	88	68	96	44	56
	PU	0	0	0	0	0	0
	SM	46	8	28	4	48	36
	NU/NR	0	4	4	0	8	8
Q 7	SU	50	88	48	76	48	68
	PU	0	0	0	0	0	0
	SM	12	0	16	4	24	4
	NU/NR	38	12	36	20	28	28
Q 8	SU	67	100	80	100	64	72
	PU	0	0	0	0	0	0
	SM	21	0	8	0	20	8
	NU/NR	12	0	12	0	26	20
Q 9	SU	46	79	68	76	28	72
	PU	0	0	0	0	0	0
	SM	38	17	28	20	48	24
	NU/NR	16	4	4	4	24	4
Q 10	SU	71	92	100	92	48	88
	PU	0	0	0	0	0	0
	SM	0	4	0	4	24	12
	NU/NR	29	4	0	4	28	0
Q 11	SU	67	88	100	96	64	80
	PU	0	0	0	0	0	0
	SM	17	4	0	0	28	12
	NU/NR	16	8	0	4	8	8
Q 12	SU	46	83	68	96	52	48
	PU	0	0	0	0	0	0
	SM	38	13	24	0	32	24
	NU/NR	16	4	8	4	16	28
Q 13	SU	75	96	92	92	80	96
	PU	0	0	0	0	0	0
	SM	12	0	4	4	16	4
	NU/NR	13	4	4	4	4	0

SU:Sound Understanding, PU: Partial Understanding, SM:Specific Misconception, NU/NR:No Understanding/No Response

Table 4. Percentages of change in students' alternative concepts from pre-test to post-test in BCUT by groups

		Experiment 1			Experiment 2			Control		
Alternative Concepts	Related Questions	Pre (%)	Post (%)	CC (%)	Pre (%)	Post (%)	CC (%)	Pre (%)	Post (%)	CC (%)
1: The sheer number of living things is called biodiversity.	2, 3, 4	22.2	12.5	+9.7	26.7	12	+14.7	21.3	8	+13.3
2: The habitat differences of living things are called biodiversity.	12	4.2	0	+4.2	12	0	+12	8	16	-8
3: Living together is called biodiversity.	3	29.2	2.5	+26.7	16	4	+12	20	24	-4
4: Only the large number of animal species is called biodiversity.	1,4,	16.7	0	+16.7	0	0	0	4	2	+2
5: Only the excess number of plant species is called biodiversity.	1,2	14.6	0	+14.6	8	0	+8	12	0	+12
6: Decreasing the number of living species, increases the habitats of other living things.	6,8	20.8	8.3	+12.5	8	2	+6	26	16	+10
7: The decrease in the number of species does not affect the lives of other species.	6,7,8	11.1	0	+11.1	8	0	+8	10.7	5.3	+5.4
8: The decrease in the number of species affects only the organisms that feed on it.	9,10	12.5	6.25	+6.25	16	4	+12	16	10	+6
9: Extinct creatures are creatures that have no role left in nature over time.	5,12,13	20.8	6.9	+13.9	12	4	+8	16	14.7	+2.7
10: The extinct life forms are those that stop reproduction over time.	5	12.5	0	+12.5	8	8	0	8	4	+4
11: Endangered organisms die over time because of them cannot meet their nutritional needs.	13	4.2	0	+4.2	4	0	+4	4	0	+4
12: Some living things have no role in nature.	7	4.2	0	+4.2	16	4	+12	8	0	+8
13: Some creatures have no use for nature.	9,10,11	5.6	4.2	+1.4	2.7	6.7	-4	17.3	8	+9.3
14: Some species have only harm to other creatures.	11	12.5	0	+12.5	0	0	0	16	8	+8

CC:Conceptual Change

As a result of BCUT pre-test post-test analysis, SU change was calculated as 32%, PU change as 0%, SM change as 20%, NU / NR change as 12% in experiment group 1. In the Experiment 2, the posttest difference in the pre-test difference was calculated as 15%, PU change 0%, SM change 12%, NU / NR change 3. In the control group the post-test pre-test difference was calculated as SU change 19%, PU change 0%, SM change 14%, NU / NR change 5%. In the groups taught with experiment 1 and experiment 2, it is observed that the alternative concepts are reduced in most of the questions. It is observed that students do not write their own reasons in the questions and choose one of the multiple-choice answers. PU percentages are therefore 0%. Furthermore, when the differences between pre-test and posttest were examined, the difference between the total of SM and NU/NR values was 32 % in experiment 1, 15 % in experiment 2, and 19 % in control group. According to this result, the highest variation between pre-test and posttest alternative concepts was observed in experiment 1. The difference in experiment 2 and the control groups came close to each other. However, this closeness seen in the percentages of concept changes in experiment 2 and control groups is due to low percentage of alternative concepts in pre-test results of experiment 2.

As shown in Table 4, when alternative concepts in BCUT were examined before and after intervention, it was observed that the most significant change was in experiment 1 and then in experiment 2 and control groups. The number of alternative concepts showing more than 10% conceptual change is higher in experiment 1. The change below 10% was considered insignificant. No change was observed for some alternative concepts. Some increase in 14. Alternative concepts were observed in experiment 2. In the control group, a slight increase was observed in alternative concepts 2 and 3. Since some alternative concepts were less in the pre-tests in the experiment 2 than the other groups, the percentage rate of conceptual changes was low. When the changes in alternative concepts were examined, a change of more than 10% was observed only in experiment 1 in 4, 7, 9, 10, 14 alternative concepts. When comparing the academic achievement of the BCUT of the experiment and control groups, analysis revealed that BCUT does not fit into the normal distribution. Kruskal Wallis H-Test was used for independent samples to test whether there was a significant difference between the pre-test and post-test averages of experiment 1, experiment 2 and control groups. In addition, Wilcoxon paired pairs test was used to determine the significant difference between the pre and posttests. Tamhane's T2 test was selected from post hoc tests to determine the direction of the difference in BCUT post-test scores.

Table 5. Pre-test and post-test academic achievement points of the groups

TEST	GROUP	N	X	sd
Pre-Test	Experiment 1	24	26.21	9.146
	Experiment 2	25	27.84	4.368
	Control	25	26.88	5.872
Post-Test	Experiment 1	24	35.46	2.904
	Experiment 2	25	36.32	1.701
	Control	25	31.44	6.063

As shown in Table 5, the mean BCUT pre-test scores and standard deviation of the groups are similar. Kruskal Wallis H-Test was used for independent samples in BCUT to determine whether the differences between the students' pre-test and post-test mean were significant. Table 6 shows the Kruskal Wallis H-Test results of BCUT pre-test and post-tests scores.

Table 6. Kruskal Wallis H-Test results of BCUT pre-test and post-test scores

Group	N	p (pretest)	p (posttest)
Experiment 1	24		
Experiment 2	25	.730	.001
Control	25		

According to Table 6, the results of the analysis show that there is no significant difference between the scores of the classes taken from the biodiversity conceptual understanding pre-test. X^2 (sd=2, n=74) = 0.628, p >.05. This shows that the academic achievement levels of the students participating in the study are close to each other. According to Table 6, the Kruskal Wallis H-Test analysis results of BCUT post-test scores show that there is a significant difference between the scores obtained from the post-test of academic achievement. X^2 (sd=2, n=74) = 14.709, p<.05. In order to reveal the source of the differences, Tamhane's T2 Test was selected from multiple comparison (post-hoc) tests (recommended for unevenness of group variances). Tamhane's T2 Test results are shown in Table 7.

According to Table 7, the mean differences of the experiment 1 in which CKCM was applied as a result of multiple comparisons of BCUT post-test results differ significantly from the mean differences of the control group was conducted (p<0.05). Similarly, the mean differences of experiment 2 differ significantly from the mean differences of the control group (p<0.05). There was no significant difference between the mean differences of BCUT post-test results of experiment 1 and experiment 2 groups (p>0.05). Biodiversity post-test scores which were obtained from CKCM supported out-of-school learning environments did not differ significantly regarding academic achievement post-test scores obtained from teaching conducted with CKCM.

Table 7. BCUT posttest Tamhane's T2 test results

(I) Class	(J) Class	Mean Differences (I-J)	p
Experiment 1	Experiment 2	-0.862	0.517
	Control	4.018*	0.016
Experiment 2	Experiment 1	0.862	0.517
	Control	4.880*	0.002
Control	Experiment 1	-4.018*	0.016
	Experiment 2	-4.880*	0.002

Note: * Mean difference is significant at 0.05 levels.

Discussion and Conclusion

The main aim of this study is to investigate the impact of CKCM on the changes of alternative concepts on biodiversity. When examining students' answers to the alternative concepts in Table 3, it showed that the alternative concepts of all groups decreased from pre-test to post-test and alternative concepts were replaced with the correct concepts. It was observed that CKCM supported out-of-school learning did not have more effect in eliminating alternative concepts compared to the use of CKCM alone. Furthermore, it was observed that there were differences between BCUT pre-test and post-test changes in experiment and control groups of 5th grade students. It was also observed that most of the alternative concepts were eliminated in both experimental groups. In the control group, it was shown that alternative concepts mostly continued to use before and after the intervention. In BCUT, Sound Understanding (SU), Specific Misconceptions (SM), No Understanding/No Response (NU/NR) were the highest change in the experiment 1 and the lowest in the experiment 2. The reason for the lowest change in the experiment 2 may be that students have fewer alternative concepts in the pre-test than the other groups. As shown in Table 3, PU values were not formed because the students did not write their own reasons as answers to BCUT questions.

When the answers of experiment 1 students to the questions of 1, 2, 3, 4, 5, 6, 7, 9, 12 were examined in the BCUT pre-test, it was observed that students' alternative concepts were 40 % and above. It was observed that the answers of the experiment 1 students to BCUT post-test greatly decreased their alternative concepts in these questions and did not have alternative concepts of 40% or more. When the answers of the experiment 2 students to the questions of 4, 5, 7 were examined in the BCUT pre-test, it was observed that the given answers had 40% and more alternative concepts. It was observed that alternative concepts decreased by 40% or more in the responses of the students of experiment 2 to the BCUT post-test. When the answers of the control group students to the questions of 2, 3, 4, 5, 6, 7, 9, 10, 12 were examined in the BCUT pre-test, it was observed that the given answers had 40% and more alternative concepts. The control group students' answers to the 3,5, 6 questions of BCUT post-test, showed that alternative concepts resist to change, and that there were no alternative concepts by 40% decreasing the alternative concepts in other questions.

When the difference between BCUT pre-test and post-test conceptual changes is examined, the highest conceptual changes in experiment 1 are 3, 4, 5, 6, 7, 9, 10, and 14, and the most conceptual changes in experiment 2 are 1, 2, 3, 8, and 12, the highest conceptual changes were observed in alternative concepts 1, 5 and 6 in the control group. When alternative concepts are examined, the 2nd alternative concepts in the Table 3 "biodiversity differences of living things" are called as biodiversity and the 8th alternative concepts the decrease in the number of species, affect only the creatures fed with it" have experienced a change of more than 10% in experiment 2. The reason for this change can be explained by taking students to the zoo to learn outside of school. This situation shows that teaching with method of CKCM leads to a significant difference in students' understanding of biodiversity. The literature results regarding the effect of CKCM on alternative concepts are as follows; It shows that CKCM is an effective model for eliminating alternative concepts by showing similarities such as greenhouse effect (Bakırcı & Yıldırım, 2017), urinary system (Ebenezer et al., 2010), energy issue (İyibil, 2011), acids and bases (Vural et al., 2012; Wood, 2012) and water pollution (Kiryak, 2013). Following the teaching of biodiversity that is based on CKCM, it is understood that the existing alternative concepts that the students have learned about the subject have been largely eliminated in a comparison to control group

(Ebenezer et al., 2010). This can be explained by the effectiveness of the activities in the first phase of the CKCM, Exploring and Categorizing. Furthermore, the use of different techniques with CKCM may have played an important role in eliminating alternative concepts. Which techniques on the other hand, in the last phase of the model, Reflection and Assessing, it may be due to the application of different alternative assessment and evaluation techniques (structured grid, word association test, diagnostic branched tree) and process-oriented.

According to the results of statistical analysis, BCUT pre-test results were similar and there was no significant difference between academic achievement pre-test results of both groups. BCUT pre-test results showed that the academic achievement levels of the experiment and control groups are similar. When the analysis of BCUT post-test academic achievement results was examined, it was concluded that the groups differed significantly from each other. When the related literature is analyzed, it is seen that there is a limited number of studies on the effects of CKCM on academic achievement supporting this study. (Atayeter, 2019; Bakırcı, 2014; Bayar, 2019; Caymaz & Aydin, 2018a, 2020; Ebenezer et al., 2010; Ertuğrul, 2015; Uzunkaya, 2019; Yıldızbaş, 2017). Post-test BCUT academic achievement results of the experiment 1 and experiment 2 who participated in the study significantly differed from the control group post-test BCUT. According to the results of Tamhane's T2 Test which is one of the post-hoc techniques to determine significant differences among groups, it is concluded that there is a significant difference between experiment 1 and control groups in favor of experiment 1 and experiment 2 and control groups in favor of experiment 2. It was concluded that there was no significant difference in BCUT post-test between experiments 1 and experiment 2 groups. This showed that teaching with CKCM is more effective in terms of academic achievement of biodiversity. According to the study Bakırcı, Artun, Kutlu, et al. (2018) CKCM is effective on students' academic achievement in the human and environmental unit where it is involved in biodiversity.

The use of CKCM supported out-of-school learning did not differ in terms of the academic achievement of biodiversity only from the group taught with CKCM. That is, the inclusion of out-of-school learning in the CKCM did not make a difference in academic achievement of biodiversity from the group taught with CKCM. This may be because experiment 1 and experiment 2 groups provide effective teaching with CKCM. When studies on the effects of CKCM on academic achievement are examined, it was seen that CKCM has a positive effect on academic achievement (Atayeter, 2019; Bakırcı, 2014; Bakırcı et al., 2018; Bakırcı et al., 2015; Bakırcı & Ensari, 2018; Bayar, 2019; Caymaz & Aydin, 2018a, 2020; Ertuğrul, 2015; İyibil, 2011; Sütlüoğlu Dursun, 2019; Wood, 2012; Yıldızbaş, 2017). In addition, the fact that the academic achievement levels of the experiment 1 and experiment 2 groups were close to each other before the education may have resulted in no significant difference between the experiment groups. Moreover, it can be said that the application of worksheets and FENVIVOR game prepared according to CKCM in both experiment 1 and experiment 2 groups for a period of time does not make a significant difference in terms of academic achievement. When the related literature is examined, a study involving out-of-school learning has not been found in CKCM. For this reason, this was the first study to investigate the effect of CKCM supported out-of-school learning environments.

The present study claimed that CKCM will be effective in achieving conceptual understanding and improving conceptual change in other subjects of science courses given the level of progress of conceptual understanding of fifth grade students in biodiversity (Coştu et al., 2012; İyibil, 2011; Kiryak, 2013). It was concluded that the studies about CKCM are related to science and chemistry courses (Bakırcı & Çepni, 2016). In this study, the CKCM-based instruction was observed whether it has a positive effect on students' academic achievements and conceptual change on biodiversity. As relevant studies increase, common inferences can be formed concerning the common impact of the model. Besides, future studies can examine the effects of the CKCM-based instruction can be investigated at different grade levels, such as pre-school and primary school. Moreover, in order to understand comprehensively the effects of using CKCM and out-of-school learning together, different researches can be conducted at different class levels

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Scientific Ethics Declaration

The authors declare that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the authors.

References

Akgün, A., Duruk, Ü., & Güngörmez, H. G. (2016). Sixth grade students' views on the common knowledge construction model. *Journal of Amasya University Faculty of Education, 5*(1), 184-203.

Atayeter, M. (2019).*The effect of common knowledge construction model on 4th grade secondary school students' attitudes towards academic success and science within the unit of "structure and properties of matter" in science course* (Master's thesis). Muğla Sıtkı Koçman University, Institute of Educational Sciences, Muğla, Turkey

Aydoğdu, M., & Gezer, K. (2006). *Environmental science*. Anı Publishing, Ankara.

Bakırcı, H. (2014).*The study on evaluation of designing, implementing, and investigating the effects of teaching material based on common knowledge construction model: Light and voice unit sample* (Doctoral thesis). Karadeniz Technical University, Institute of Educational Sciences, Trabzon, Turkey.

Bakırcı, H., Artun, H., Kırıcı, M. G., & Kutlu, E. (2018).The effect of the learning environment designed according to the common knowledge constructuring model on the academic achievement of fifth grade students: "Example of human and environmental unit". *International Symposium on Social Studies and Behavioral Sciences, 21-23 October 2018, Antalya.*

Bakırcı, H., Artun, H., Kutlu, E., & Kırıcı, M. G. (2018). The effect of the common knowledge constructuring model used in teaching the human and environmental unit on the conceptual understanding and permanence of fifth grade students. *International Symposium on Social Studies and Behavioral Sciences, 21-23 October 2018, Antalya.*

Bakırcı, H., Artun, H., & Şenel, S. (2016). The effect of science teaching based on the common knowledge constructuring model on the conceptual comprehension of seventh grade students in secondary school (let's get to know the celestial bodies). *Yüzüncü Yıl University Journal of the Faculty of Education, 13*(1), 514-543.

Bakırcı, H., & Çepni, S. (2016). The effect of the common knowledge constructuring model on the critical thinking skills of the sixth grade students of secondary school: Example of light and sound unit. *Journal of Inönü University Faculty of Education, 17*(3), 185-202.

Bakırcı, H., Çepni, S., & Yıldız, M. (2015). The effect of the common knowledge construction model on sixth grade students' academic achievement: light and sound unit. *Dicle University Journal of Ziya Gökalp Faculty of Education, 26,* 182-204.

Bakırcı, H., & Çiçek, S. (2017). The effect of the learning environment designed according to the common knowledge constructuring model on the nature of science of 5th grade students. *Journal of Social and Humanities Sciences Research, 4(15)*, 1960-1974.

Bakırcı, H., & Ensari, Ö. (2018). The Effect of common knowledge construction model on high school students' academic achievement and conceptual understanding on heat and temperature. *Education and Science, 43*(196), 171-188.

Bakırcı, H., Kahraman, F., & Artun, H. (2020). The effect of the common knowledge construction model on fifth grade students' scientific process skills and critical thinking skills on biodiversity. *Journal of Science, Mathematics, Entrepreneurship and Technology Education, 3*(1), 51-64.

Bakırcı, H., & Yıldırım, İ. (2017). The effect of common knowledge construction model on conceptual understanding of students and greenhouse effect. *Kirsehir University Journal of the Faculty of Education, 18*(1), 45-63.

Barker, S., & Elliott, P. (2000). Planning a skills-based resource for biodiversity education. *Journal of Biological Education, 34*(3), 123-127.

Bayar, M. F. (2019). The effect of common knowledge Cconstruction model on science process skills and academic achievement of secondary school students on solar system and eclipse. *Online Journal of Science Education, 4*(1), 4-19.

Benli Özdemir, E. (2014). *The study on impact of common knowledge construction model on the cognitive and affective learning of primary education students in science education* (Doctoral dissertation). Gazi University, Institute of Educational Sciences,Ankara, Turkey.

Biernacka, B. (2006). *Developing scientific literacy of grade five students: A teacher-researcher collaborative effort.* (Doctoral dissertation), University of Manitoba, Canada.

Braund, M. (1991). Children's ideas in classifying animals. *Journal of Biological Education, 25*(2), 103-110.

Braund, M. (1998). Trends in children's concepts of vertebrate and invertebrate. *Journal of Biological Education, 32*(2), 112-118.

Bulut, M. (2019). *The views of science, biology, geography and social studies teachers on biodiversity and the levels of processing in biodiversity courses in the region where they work* (Master's thesis). Sakarya University, Institute of Educational Sciences, Sakarya, Turkey.

Cardak, O. (2002). *Identification of misconceptions in high school first year students' diversity and classification of living things and elimination with concept maps* (Doctoral dissertation). Selcuk University, Institute of Educational Sciences, Konya, Turkey.
Carrier, S. J. (2009). The effects of outdoor science lessons with elementary school students on preservice teachers’ self-efficacy. *Journal of Elementary Science Education, 21*(2), 35-48.
Caymaz, B., & Aydın, A. (2018a). Investigation of the effect of common knowledge constructuring model on 7th grade students' science achievement. *V. International Eurasian Educational Research Congress, 2-5 May, 2018, Akdeniz University, Antalya.*
Caymaz, B., & Aydın, A. (2018b). Examining the effect of the common knowledge constructuring model on students' conceptual understanding. *V. International Eurasian Educational Research Congress, 2-5 May, 2018, Akdeniz University, Antalya.*
Caymaz, B., & Aydin, A. (2020). The effect of common knowledge construction model-based instruction on 7th grade students’ academic achievement and their views about the nature of science in the electrical energy unit at schools of different socio-economic levels. *International Journal of Science and Mathematics Education*, 1-33. https://doi.org/10.1007/s10763-020-10054-0
Chi, M. T., & Roscoe, R. D. (2002). The processes and challenges of conceptual change *Reconsidering conceptual change: Issues in theory and practice* (pp. 3-27): Springer
Coştu, B., & Ayas, A. (2005). Evaporation in different liquids: Secondary students’ conceptions. *Research in Science & Technological Education, 23*(1), 75-97.
Coştu, B., Ayas, A., & Niaz, M. (2012). Investigating the effectiveness of a POE-based teaching activity on students’ understanding of condensation. *Instructional Science, 40*(1), 47-67.
Coştu, B., Ayas, A., Niaz, M., Ünal, S., & Calik, M. (2007). Facilitating conceptual change in students’ understanding of boiling concept. *Journal of Science Education and Technology, 16*(6), 524-536.
Coştu, B., Karataş, F. Ö., & Ayas, A. (2003). Using worksheets in concept teaching. *Pamukkale University Faculty of Education Journal, 14*(14), 33-48.
Çavuş-Güngören, S., & Hamzaoğlu, E. (2020). Science teacher candidates' opinions about the common knowledge constrution model]. *Kastamonu Journal of Education, 28*(1), 107-124.
Çepni, S. (2010). *Introduction to research and project studies,* Trabzon: Celepler Publishing.
Davidson, S. K., Passmore, C., & Anderson, D. (2010). Learning on zoo field trips: The interaction of the agendas and practices of students, teachers, and zoo educators. *Science Education, 94*(1), 122-141.
Demir, E. (2020). *Analyzing of effects of flipped classroom practices on environmental consciousness in the fifth grade sciences lesson human and environment unit* (Doctoral dissertation), Kastamonu University, Institute of Educational Sciences, Kastamonu, Turkey.
Demircioğlu, H., & Vural, S. (2016). The effect of the common knowledge construction model (CKCM) on the attitudes of gifted students at the eighth grade level towards the chemistry course. *Journal of Hasan Ali Yücel Faculty of Education, 13*(1), 49-60.
Dervişoğlu, S. (2010). Value orientations of university students towards living species. *Journal of Hacettepe University Faculty of Education, 39*, 132-141.
Dikmenli, M. (2010). Biology student teachers' conceptual frameworks regarding biodiversity. *Education, 130*(3), 479-489.
Doran, R. L. (1972). Misconceptions of selected science concepts held by elementary school students. *Journal of Research in Science Teaching*, *9*(2), 127-137.
Driver, R., & Easley, J. (1978). Pupils and paradigms: A review of literature related to concept development in adolescent science students. *Studies in Science Education*, *5*(1), 61-84.
Duschl, R. A., & Osborne, J. (2002). Supporting and promoting argumentation discourse in science education. *Studies in Science Education*, *38*(1), 39-72.
Ebenezer, J., Chacko, S., & Immanuel, N. (2004). Common knowledge construction model for teaching and learning science: Application in the Indian context. Paper presented at the *An international conference to review research on Science, Technology and Mathematics Education International Centre (epiSTEME-1)*, Dona Paula, Goa, India.
Ebenezer, J., Chacko, S., Kaya, O. N., Koya, S. K., & Ebenezer, D. L. (2010). The effects of common knowledge construction model sequence of lessons on science achievement and relational conceptual change. *Journal of Research in Science Teaching, 47*(1), 25-46.
Ebenezer, J. V., & Connor, S. (1998). *Learning to teach science: A model for the 21st century*: Upper Saddle River, New Jersey: Prentice-Hall, Inc., Simon and Schuster/A. Viacom Company.
Ebenezer, J. V., & Fraser, D. M. (2001). First year chemical engineering students' conceptions of energy in solution processes: Phenomenographic categories for common knowledge construction. *Science Education, 85*(5), 509-535.
Efe, R. (2010). *Biogeography* (2nd edition). Bursa: Marmara Book Center.

Ertuğrul, N. (2015). *The effect of common knowledge construction model on learning products in science teaching* (Master's thesis). Kırıkkale University, Institute of Educational Sciences, Kırıkkale, Turkey.

Fıstıkeken, N. (2017). *Investigation of attitudes of secondary school students towards decrease of biodiversity and the importance of biodiversity education* (master's thesis), Akdeniz University, Institute of Educational Sciences, Antalya, Turkey.

Gayford, C. (2000). Biodiversity education: a teacher's perspective. *Environmental Education Research, 6*(4), 347-361.

Hewson, M. G., & Hewson, P. W. (1983). Effect of instruction using students' prior knowledge and conceptual change strategies on science learning. *Journal of Research in Science Teaching, 20*(8), 731-743.

İyibil, Ü. (2011). A new approach for teachıng energy concept: the common knowledge constructıon model *World Conference on New Trends in Science Education (WCNTSE), Kuşadası, Turkey*.

Karasar, N. (1999). *Scientific research metho],* Nobel Publishing, 9th Edition, Ankara.

Keating, M. (1993). The Earth Summit's agenda for change: a plain language version of Agenda 21 and the other Rio agreements. *Centre for Our Common Future*.

Keleş, F., & Özenoğlu, H. (2017). Designing a lesson plan on biodiversity for secondary school students. *Adnan Menderes University Faculty of Education Journal of Educational Sciences, 8*(2), 41-65.

Kellert, S. R. (1985). Attitudes toward animals: Age-related development among children *In Fox M.W. & Mickley, L.D (Eds.) Advances in animal welfare science 1984* (pp. 43-60): Springer.

Kibar, H. (2019). *Analyzing effects of the argument-based inquiry approach on teaching the subject of heredity and bio-diversity to 10th grade students.* (Doctoral dissertation). Marmara University, Institute of Educational Sciences, Istanbul, Turkey.

Kiryak, Z. (2013). *The effect of common knowledge construction model on grade 7 students conceptual understanding of water pollution subject* (Master's thesis). Karadeniz Technical University, Faculty of Educational Sciences, Trabzon, Turkey.

Kuhn, T. S. (1962). *The structure of scientific revolutions*. Chicago (University of Chicago Press).

Kurt, Ü. G. (2018). *Investigation of the awarness of the secondary students on biodiversity* (Master's thesis). Akdeniz University, Institute of Educational Sciences, Antalya, Turkey.

Lindemann-Matthies, P. (2002). The influence of an educational program on children's perception of biodiversity. *The Journal of Environmental Education, 33*(2), 22-31.

Marton, F. (1981). Phenomenography—describing conceptions of the world around us. *Instructional Science, 10*(2), 177-200.

Ministry of National Education [MoNE]. (2018). *Elementary education institutions (primary and secondary schools) science courses (3, 4, 5, 6, 7 and 8 grades) curriculum*. Ankara, Turkey.

Noddings, N. (2005). What does it mean to educate the whole child? *Educational Leadership, 63*(1), 8-31.

Nussbaum, J., & Novick, S. (1982). Alternative frameworks, conceptual conflict and accommodation: Toward a principled teaching strategy. *Instructional Science, 11*(3), 183-200.

Orion, N., Hofstein, A., Tamir, P., & Giddings, G. J. (1997). Development and validation of an instrument for assessing the learning environment of outdoor science activities. *Science Education, 81*(2), 161-171.

Osborne, R., & Freyberg, P. (1985). *Learning in science. The implications of children's science*. Published by Heinnemann Education.

Öner, C. (2011). *Genetic concepts* (8th Edition). Ankara: Palme Publishing.

Özden, B. (2019). *The effect of science teaching based on common knowledge construction model on cognitive, affective and psychomotor learning of seventh grade students* (Master's thesis). Aydın Adnan Menderes University, Institute of Science, Aydın, Turkey.

Payne, M. R. (1985). *Using the outdoors to teach science: a resource guide for elementary and middle school teachers*: Educational Resources Information Center, Clearinghouse on Rural Education and Small Schools, New Mexico State University.

Posner, G. J., Strike, K. A., Hewson, P. W., & Gertzog, W. A. (1982). Accommodation of a scientific conception: Toward a theory of conceptual change. *Science Education, 66*(2), 211-227.

Schulte, P. (2001). *Pre Service primary teacher alternative conceptions in science and attitudes toward teaching science*. Unpublished Doctoral Dissertation, New Orleans Üniversity, New Orleans.

Sontay, G., Tutar, M., & Karamustafaoğlu, O. (2016). "Student opinions about "teaching science with out of school learning environments": Planetarium trip. *Journal of Research in Informal Environments, 1*(1), 1-24.

Sütlüoğlu Dursun, R. (2019). *Developing and evaulating a teaching material based on common knowledge construction model for 5th grade on sun, earth and moon* (master's thesis). Recep Tayyip Erdoğan University, Institute of Science, Rize, Turkey.

Tatar, N., & Bağrıyanık, K. E. (2012). Science and technology teachers' views on out-of-school education. *Elementary Education Online, 11*(4), 882-896.

Treagust, D. F. (1988). Development and use of diagnostic tests to evaluate students' misconceptions in science. *International Journal of Science Education, 10*(2), 159-169.

Treagust, D. F., & Mann, M. (1998). A pencil and paper instrument to diagnose students' conceptions of breathing, gas exchange and respiration. *Australian Science Teachers Journal, 44*(2), 55-59.

Trowbridge, J. E., & Mintzes, J. J. (1985). Students' alternative conceptions of animals and animal classification. *School Science and Mathematics, 85*(4), 304-316.

Uzun, N., Özsoy, S., & Keleş, Ö. (2010). Pre-service teachers' views on the concept of biological diversity. *Journal of Biological Sciences Research, 3*(1), 85-91.

Uzunkaya, M. (2019). *The influence effect of the common knowledge construction model basic teaching students' academic success: A case of sound unit* (Master's thesis). Necmettin Erbakan University, Institute of Educational Sciences, Konya, Turkey.

Van Weelie, D., & Wals, A. (2002). Making biodiversity meaningful through environmental education. *International Journal of Science Education, 24*(11), 1143-1156.

Vural, S., Demircioğlu, H., & Demircioğlu, G. (2012). The effect of a teaching material developed in accordance with the general knowledge constructuring model on the understanding of acid base concepts of gifted students]. *Oral presentation, IV. Turkey International Educational Research Congress. Ankara university, Ankara.*

Walsh, L. (2009). *A phenomenographic study of introductory physics students: approaches to problem solving and conceptualisation of knowledge.* (Doctoral dissertation), Dublin Institute of Technology, Ireland.

Wood, L. C. (2012). *Conceptual change and science achievement related to a lesson sequence on acids and bases among african american alternative high school students': ateacher's practical arguments and the voice of the" other".* (Doctoral dissertation), Wayne State University, Michigan.

Yıldırım, A., & Şimşek, H. (2008). *Qualitative research methods in the social sciences*. Ankara: Seçkin Publishing.

Yıldırım, İ. (2018). *Determining the effect of science teaching based on common knowledge construction model on eightg grade students: structure and properties of matter unit sample* (Master's thesis). Yüzüncü yıl University, Institute of Educational Sciences, Van, Turkey.

Yıldızbaş, H. (2017). *The effect of education based on common knowledge construction model on students' academical success and critical thinking skills* (Master's thesis). Necmettin Erbakan University, Institute of Educational Sciences, Konya, Turkey.

Yörek, N. (2006). *Investigation of secondary school students' conceptual understanding of the topic of biological diversity (biodiversity)* (Master's thesis). Dokuz Eylül University, Institute of Educational Sciences, İzmir, Turkey.

Yüce, Z., & Önel, A. (2015). Conceptual association levels of science teacher candidates regarding biodiversity. *Abant İzzet Baysal University Journal of the Faculty of Education, 15*(1), 326-341.

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