RESEARCH ARTICLE
MATHEMATICS AND SCIENCE EDUCATION

Applıcatıon of The Cooperatıve Catalyst Method in Educatıon Research in The 21st Centur

ABSTRACT

The aim of this study is to explain the applicability of the Cooperative Catalyst Method, one of the methods used in interdisciplinary courses in the 21st century education. Firstly, a relevant literature review was conducted about the Cooperative model. Then, the most frequently used methods of the cooperative learning model in lessons were included. Emphasis was placed on how to implement the newly implemented Cooperative Catalyst Method. The application of the Cooperative Catalyst Method is carried out in four steps. The first of these steps is to determine the catalysts involved in the Cooperative Catalyst Method, the second step is to create learning groups, the third step is to determine the study topics, and the fourth step is to carry out the application. Each of these steps is explained in detail. Additionally, the application is made schematic so that researchers can understand it better. A sample application was included in our study. In this sample application, the necessary in formation was given, considering the steps of the Cooperative Catalyst method. In the conclusion, what researchers should pay attention to was mentioned

Keywords: Cooperative learning,Training method, Cooperative catalyst method

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INTRODUCTION

The positive and negative aspects of traditional learning need to be reviewed to ensure that teachers and administrators can make healthy and informed decisions about the effectiveness of traditional teaching methods in the modern education system. Generally, traditional education is a teaching/learning process that is accepted as an appropriate learning process. For many students, learning requires more than listening to a lecture or watching a presentation to process and remember information (Rapti, et.al., 2023). The use of interactive procedures and student-centered learning techniques can make the difference between learning and educational failure for many students. The traditional classroom begins with a learning process that emphasizes basic skills and strict adherence to a fixed curriculum that includes textbooks and lectures. In traditional learning, the teacher assumes a guiding and authoritative role while the teacher presents the information and the students receive the information. Therefore, traditional learning engage students into passive learning from lectures or occasional discussions dominated by the teacher. In the teacher-centered learning process, the teacher distributes knowledge to students who are now responsible for understanding and managing what is presented. Students work in competition with each other rather than in cooperation (Vallée, et al, 2023)

Many educational institutions use a defined curriculum in a teacher-centered environment that allows the teacher to control the learning material, the learning process and the learning pace at which students acquire and memorize information. In some cases in teacher-centered learning, they participate in individual discussions between students and the teacher. If the teacher is lecturing and is a good conveyor of information, students believe they know and understand the information and may even retain the information presented during the lesson. Research shows that hands-on activities such as group discussion, questioning, projects and other learning techniques create higher levels of student learning and data retention. Teacher-centered (traditional) learning methods that focus on memorization should bring a more holistic approach to learning and focus more on student-centered learning. Islam et.al. (2023) states that the teacher-centered approach may not provide students with significant learning skills or knowledge that will last until the end of the semester.

Improving the quality of teaching and learning should require the use of non-traditional methods such as active, Cooperative and problem-based learning. However, to Ford et.al (2023), teachers who were not trained in establishing nontraditional goals and objectives had difficulty implementing student learning methodologies and assessment techniques and were likely to be ineffective when using these strategies in the classroom. For supporters of non-teacher-centered learning to establish a progressive form of teaching, teachers need to reflect on their personal goals, student goals, student needs, and the level and purpose of what is to be taught. He notes that traditional education focuses on teaching, not learning, and that this learning process incorrectly assumes that every minute spent on teaching is a minute of student learning. The teaching methods used in

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traditional education generally consist of lessons learned through direct instruction (listening to lectures), observation, reading textbooks and individually written assignments, providing the focal point that determines the students' achievement. Therefore, the level of achievement is determined by objective individual performance; The passing score here may not often lead to a significant increase in knowledge. Abdigapbarova et.al, (2023) stated that traditional education ignores and restricts student responsibility in student-centered learning.

In the traditional classroom, students are usually placed in a classroom based on their age, and sometimes ability, and they are all taught through the same material. Teaching methods used in traditional teacher learning consist of direct instruction, lectures, desk study, listening and observation. Instruction is generally based on textbooks, lectures and individual written assignments. The main role of the teacher is to teach and present information to students to study and memorize in school or for homework (Alhija, 2017).

It can be argued that much of today's education is based on outdated educational theories and philosophies that may no longer be effective. Considering that the most important element is student education, it is constantly stated that teaching alone is inadequate. It turns out that teaching and learning are not necessarily synonymous with each other. It is necessary to understand that simply being an expert in a field of study and presenting a set of materials in an orderly manner does not mean that learning has occurred. Learning is students' access to knowledge. It is a skill or ability that enables one to understand and retain information. According to some studies, problems occur in traditional education, because student needs and readiness levels change significantly and education cannot always meet these changing needs. In order for today's education to be successful, students' needs should be met through changes in the teaching-learning process (Ghafar, 2023). Many psychologists state that a teacher-centered philosophy of learning requires that student learning be the primary goal of teaching, as opposed to learning and education being the primary goals. As research shows, students thrive kinesthetically in ways that involve experiencing the material they need to learn through touch and feel, and through cooperative learning that encourages interaction between the student, the instructor, and the information to be studied. Many studies show that students prefer a non-traditional approach to learning. Moreover, university-level cooperative learning research has reported higher test scores in active and cooperative learning classrooms than in traditional learning (Doymus, 2008a).

Today's student needs and preparedness have changed dramatically; this situation is challenging and often creates barriers that impede student academic achievement. These changing needs of students require an education system and teaching to effectively seek solutions that meet these basic needs. Similarly, research shows that there should be a transition to student-centered learning as the basic approach in educating students.

In the traditional learning process, the teacher is the primary source of knowledge and the motivation for learning is to gain the knowledge presented to the student by the teacher. This process provides the rationale for the memorization and memorization of notes and lectures presented by the teacher, which has become the educational norm. In today's educational methodologies, student-centered classes are preferred and active learning is strongly encouraged. Teaching is defined as the ability to transfer knowledge and develop competence through instruction, study and experience. However, transferring knowledge or skills does not ensure the acquisition of wisdom. For years, teachers have taught in an environment where their students are responsible for learning the material presented by the teacher (Zhang, et.al. 2023).

Cooperative learning (CL) is an instructional form of team/group work in which students pursue common goals while being assessed individually or as a team. This process includes individual interaction and responsibility, interdependence, face-to-face interpersonal skills, and regular personal and group evaluations of how the team/groups is functioning (Alyar & Doymuş, 2020).

Below is a summary of the research and why scientists have concluded that it is one of the most important aspects of cooperative learning and an effective teaching methodology. Cooperative learning is based on the premise that cooperative is more effective than competition between students in producing positive learning outcomes. Below are two brief definitions of cooperative learning:

1) The act of working in harmony with others,

2) Association with others for mutual benefit towards a common goal; the aim here is to make things easier and improve understanding.

Cooperative groups work face-to-face in four or five while working as a team to share their strengths and improve their weaknesses. As students learn to deal with conflict in their groups, they develop interpersonal

skills and are guided by clear goals. Students engage in a variety of activities that will enhance their understanding of the subject matter being studied.

Cooperative learning is also an educational approach that organizes academic and social experiences into classroom activities. Cooperative learning is defined, from an educational perspective, as a structured form of group work in which students pursue common goals while being assessed individually and as a group. Cooperative learning is the process of exchanging and mixing individual thoughts and ideas. It is based on the premise that student cooperative in learning activities is more effective than student competition in creating constructive learning experiences and outcomes (Akçay & doymuş, 2014).

Additionally, research shows that cooperative also supports interpersonal relationships, increases social support, and improves self-confidence. The research also shows that there are three requirements that groups must achieve to create an environment where cooperative learning can occur (Yang,2023). First, students need to be challenged in a safe environment that provides a sense of security. Second, small groups should be formed in which all participants can and should contribute, and third, a clear definition should be made of the task that students will work on together. According to Doymuş (2004), cooperative learning is a learning approach in which small heterogeneous groups are formed both in the classroom and in other environments, and help each other to learn about an academic subject towards a common goal, increase their self-confidence, improve their communication, problem solving and critical thinking skills, and actively participate in the learning-teaching process.

There are two types of cooperative learning: formal and informal. In formal Cooperative learning, educators must develop a structured, facilitated, and monitored process. The goal of this process is to achieve group goals and assigned tasks in groups that can range from two to six students. In group presentations and discussions, learning strategies include laboratory or experimental assignments followed by groups' critical thinking, problem solving, decision making, or peer evaluations.

Formal cooperative learning peer groups often stay together for an extended period of time, allowing them to regularly contribute to each other's knowledge and mastery of the subject matter. This occurs when groups of students discuss material, encourage each other, and support individual and group academic and personal success. Informal cooperative learning involves group learning with passive instruction. The results of this procedure allow students to process, integrate, and retain more learned information. These groups are temporary and may vary from course to course.

The most commonly used cooperative learning methods in classrooms are: (Johnson, Johnson, Stanne 2000) Complex Instruction (CI), Constructive Conversation (CC), Joint Integrated Reading and Composition (CIRC), Processed Structures (CS), Group Research (GI), Jigsaw, Learning Together (LT), Student Team Achievement Units (STAD), Teams-Games-Tournaments (TGT) and Team Assisted Individualization (TAI). Which Jigsaw technique to apply may be doubted (Doymus, 2022). Given the relevant studies there is an incompatibility between the main application instructions of the technique. Six jigsaw techniques were applied in scientific studies. The techniques applied are as follows: Jigsaw I developed by Aronson (1978), Jigsaw II developed by Slavin (1980), Jigsaw III developed by Stahl (1994), Jigsaw IV developed by Holliday (2000), Reverse jigsaw developed by Hedeen (2003), and Subject Jigsaw developed by Doymuş (2007). As education moves towards an interdisciplinary approach in the 21st century, educational institutions must also keep up with this trend. For this reason, it seems that some current applied methods and techniques are not compatible with the systems applied in the 21st century. Therefore, it seems that the method that works well is Cooperative methods. The method we put into practice in 2023 is the Cooperative Catalyst Method (C2M). The application of this method is explained in the method section.

METHOD

Research model

In the study, introductory research method was used from research methods. This method is a type of research that aims to reveal some of the characteristics of a particular set of information that are of interest. The purpose of introductory research is not to investigate cause and effect relationships, but to determine the general characteristics of situations or events (Doymus, 2022).

Cooperative catalyst method application

More than 5 methods and 6 techniques in cooperative learning have been applied in scientific studies. The Cooperative Catalyst Method (C2M) developed by Doymuş (2023) which has been put into practice in 21st Century education and research is implemented in four main stages. The first stage is to identify the current

Catalysts in the study, the second stage is to create Cooperative groups, the third stage is to determine the topics and the fourth step is to carry out the application.. These steps will be explained in detail with a brief overview followed by examples.

Identifying catalysts

Catalysts are people who are educated in upper grades who know the subject or are trained by teachers or researchers from the same class. Before the study begins, the Catalysts' knowledge of the study subjects or disciplines in which they are assigned is determined. If there are any deficiencies in information, they are corrected. Then, information is given about the groups and the conduct of the study. Catalysts stay focused on their subject/discipline. Catalyst helps the group, and tries to eliminate the thresholds seen in the group's work. As for the teachers or researchers, they eliminate the deficiencies in the work of the groups and the contributions of the Catalysts to the groups.

Cooperative learning groups

The researcher or teacher determines groups of 2-6 people, taking into account the number of students in the class creating heterogeneous groups by taking into account the knowledge levels of the students assigned to groups for academic achievement. Then, general information is given about what the groups should do during the working process. Each group designates group leaders, group announcer and group reporter as needed. It is also said that all students in the groups will actively participate in the learning process (Doymus, 2008 b).

Determination of subtopics or disciplines

Sub-topics of the unit to be studied: It is divided into sections based on the number of cooperative groups formed in the classroom or study. If there are many Cooperative groups, subtopics can be given to two groups. Additionally, if the number of subtopics is high for the number of groups, the subtopics can be combined in a single subtopic. The group students go to the relevant catalyst and start working on the sub-topics given to the groups. Materials related to sub-topics are presented to students by the teacher. General information is given about how to work with subtopics. All groups are taken to the exams after completing their studies on the catalysts at the beginning of the relevant sub-topic. In the 21st century, when a subject is studied interdisciplinaryly, they go to the catalyst on that subject in each discipline and complete the interdisciplinary study.

Exams

Exams are held in three ways.

1) Module Test: Members of each group take this test individually. The questions of the test are generally open-ended. Module tests are designed to generate 4 questions about each sub-topic or topic-related discipline. The aim is to determine in which sub-subjects or disciplines related to that subject that students are inadequate.

2) Academic Achievement Test: The questions of this test are prepared to constitute the entire unit. The purpose of this test is to determine how much students have learned. If subjects are to be studied across disciplines, the tests should also cover disciplines.

3) Interview Test: In this test, two students are randomly selected from each group and questions are asked about sub-topics. The purpose of this test is to determine students' self-confidence, knowledge and verbal expressions. Test results are evaluated in two dimensions that are on individual and group basis. The group that is successful on a group basis is rewarded.

This type of study allows the student to learn by making connections between ideas and concepts from different disciplines. Students who learn this way can apply knowledge gained in one discipline to another, different discipline, as a way to deepen the learning experience. The most effective approach to interdisciplinary study allows students to create their own interdisciplinary path by choosing courses that are meaningful to them. For example, it is not difficult to find a theme that transcends the boundaries of disciplines in literature, art, history or science and mathematics. Examining topics thematically is a way to bring ideas together and enable meaningful learning. This can happen by allowing students to choose their own subjects, and their learning deepens as they reflect on the connections between what they learn indifferent disciplines. The application of the cooperative catalyst method is presented in Tables 1, 2, 3,4 and Figure 1.

Table 1: C2M's work plan

Name of the Subject	Matter and heat
Number of students in the class:	20
Class grade level:	High school 9th grade
Weekly lesson hours	4 hours
Application time:	week 4
Interdisciplinary application of matter	1. Science 2. Economy 3. Social 4. Geography and 5. Heat

Kaynak: Yazar tarafında üretilmiştir

Table 2: Creating collaborative groups in C2M

Since the topic of matter and heat will be studied under four disciplines, the class is divided into four cooperative heterogeneous groups of five students each.To create heterogeneous groups, give students a Preliminary Knowledge Test that includes questions on matter and heat, or take into account their course success grades in previous semesters.
Group 1 (A1, A2, A3, A4, A5)
Group 2 (B1, B2, B3, B4, B5)
Group 3 (C1, C2, C3, C4, C5)
Group 4 (D1, D2, D3, D4, D5)

Kaynak: Yazar tarafında üretilmiştir

Table 3: Determination of the Catalysts in C2M

Catalysts are determined in two ways; either students are selected as many as the number of groups in the same class. For example, if there are four groups, four students are selected. or, students from upper grades who have studied the subject are selected as many as the number of groups. Selected Catalysts; they receive training on the subject to be studied in their free time outside of class. Each student learning the subject is assigned to a sub-topic or a discipline.

Kaynak: Yazar tarafında üretilmiştir

Table 4: Designing the Group Activity in C2M

A plan should be carefully considered and prepared for how students will be physically arranged in groups. Students should also be informed about how the layout of the classroom will affect the sound level. Establish clear rules for behavior among students to respect people's differences and create an inclusive environment. Determine instructional goals. Determine what you want to achieve through the small group activity, both academically (i.e.,. knowledge of a subject) and socially (e.g. listening skills). The activity should be closely related to the learning goal(s) and classroom content, and should be designed to help students learn, not just occupy their time.
Necessary materials and resources related to the subject should be ready in the classroom and easily accessible to students. Group tasks that encourage participation, interdependence, and fair division of labor should be assigned. All group members must feel a sense of personal responsibility for the success of their teammates and realize that their individual success depends on the success of the group. Johnson and Smith (2014) call this positive interdependence and suggest that this type of Cooperative learning tends to result in students supporting each other's success.

Kaynak: Yazar tarafında üretilmiştir.

Application of the cooperative catalyst method

Indicated in Figure 1; the catalyst student no. 1 managing science discipline, the catalyst student no. 2 managing economics discipline, the catalyst student no. 3 managing social discipline and catalyst student no. 4 managing the geography discipline. Every catalyst starts to work with these groups.
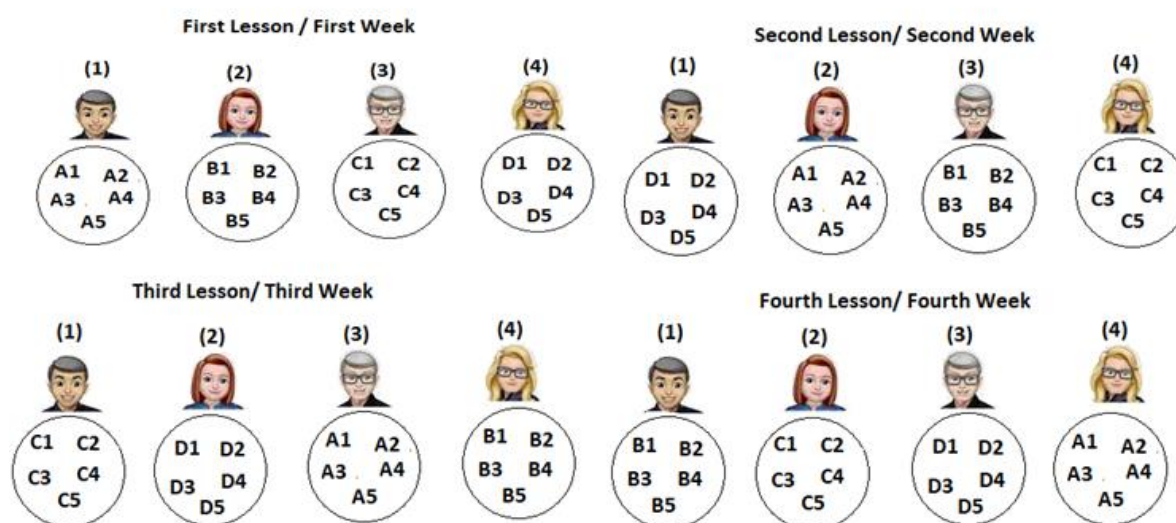

Figure 1. Application of the working groups with catalysts (Note: Pictures represent catalysts, numbers in parentheses represent relevant disciplines, and letters in circles represent students).
Kaynak: Yazar tarafında üretilmiştir.

Depending on the course or subject, duration may be 4 hours or four weeks, or it may be longer or shorter. In the first week or first lesson, the groups go to the catalyst in charge of the sub-topic or discipline and continue their work. As seen in Figure 1 the application ends after all groups finish their work with the catalysts respectively.

CONCLUSION AND RECOMMENDATIONS

Although cooperative learning methods have many common points, each method also has its own unique and different aspects. Although Cooperative methods are mostly used in 21st century education, there is a problem of preference on the part of teachers and students. Some of the Cooperative methods also lead students to passivity rather than activation. The chief reason for this is that the teacher does not have mastery over all groups, and some students do not work to gain mastery in the group. It can be said that in some studies, the application schemes and application contents are different from each other and are completely incompatible with the method used. C2M can be used effectively in most subjects and grade levels. It not only increases students' motivation and performance, but also improves their social skills for group work. Unlike other Cooperative methods, C2M implementation can be easier and more effective for both practitioners and students. The most important differences of C2M from other Cooperative methods are that it is compatible with 21st century education and that it works interdisciplinary. The widespread use of student-centered methods in the last thirty years has moved societies from the industrial age to the information age, and social norms regarding communication, socialization, obtaining information and learning are changing. Considering such changes, today teachers try to find an answer to the question of how they can make education suitable for 21st century students. For example, Perignat, et.al. (2023) lists the skills required for the information society as follows: 1) knowledge structuring, 2) adaptability, 3) finding, organizing and retrieving information, 4) knowledge management, 5) critical thinking and 6) teamwork. The C2M we have implemented covers all of the 6 items mentioned above that have been implemented in Europe and America. On the other hand, the main theme of 21st century education is interdisciplinary teaching. Interdisciplinary teaching requires the use and integration of methods and analytical frameworks from more than one academic discipline to examine a theme, question, or topic. C2M is at the forefront of interdisciplinary practice, as given in the study example. When Cooperative groups are created in C2M practice, teachers or researchers are advised to show a certain degree of flexibility in structuring heterogeneous groups so that they can learn from each other. The issue that the researchers will implement in their studies is to give the necessary information about C2M to the application students in advance and to explain the application process step by step. It is also important to inform students about how success will be evaluated at the end of the process. Otherwise, students in the groups may lose time during the application process, be unable to fulfill group tasks and individual work because they do not know how the process will proceed. They may encounter negative situations. The seriousness of the Catalysts who are in charge of the subjects and disciplines during the implementation of C2M, because when the groups come to the Catalysts, the Catalyst has to play an important role in directing the groups and eliminating knowledge deficiencies. Another issue that researchers and teachers will pay attention to is the scores students receive from the Module test of the sub-topics or disciplines they study. The group or groups that do not receive sufficient points in the sub-subjects or discipline must re-work on the relevant subjects or discipline. I believe that C2M will make a useful contribution to the national and international education community because it is an easy-to-apply method used in both 21st century education and interdisciplinary education.

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