

# The Effectiveness of Concrete-Pictorial-Abstract Learning Strategy in Teaching Mixtures of Science Subjects to Students with Intellectual Skills Disabilities

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**Abstract:** The aim of this research is to examine the effectiveness of the concrete-pictorial-abstract learning strategy presented with the direct teaching method in teaching the subject of mixtures, which is one of the science subjects, to students with intellectual skills disabilities. The study used multiple-probe model with a probe phase, one of the single-subject research models. While the dependent variable of the research was the level of showing the mixtures of the students participating in the study; the independent variable is the concrete-pictorial-abstract learning strategy presented with the direct teaching method. The research was conducted with two girls and one boy living in Bolu, diagnosed with intellectual disability, and attending primary school. The data collected in the study were analyzed through visual analysis. As a result of the research, it has been observed that the concrete-pictorial-abstract learning strategy is effective in teaching the subject of mixtures to students with intellectual skills disabilities, that the permanence of this subject learned by the students can be maintained one and three weeks after the end of the education, and that all students can generalize this learning to different environments and tools.

**Keywords:** Special Education, Intellectual Skills Disabilities, Science Teaching, Mixture, Concrete-Pictorial-Abstract Learning Strategy.

## 1. Introduction

Science education plays a key role in terms of the future of societies in today's information and technology age, where scientific knowledge is constantly increasing, technological innovations are advancing at the same pace, and the effects of science are evident in all areas of our lives (Bilgiç & Şafak, 2021). Science includes regularly examining the events in nature and discovering new connections with a planned study (Karabulut, 2020). Within education science, education has an essential place in the development and progress of societies (Çepni & Çil, 2009). Science education aims to realize a science-conscious information society in the information age and to develop human resources that have acquired the knowledge, skills, attitudes, and behaviors required by that age (Sözbilir, Gül, Okçu, Yazıcı, Kızılaslan, Zorluoğlu & Atilla, 2015). In addition, science education aims to raise individuals who can think, research, question, and solve problems using their knowledge. (Yücel, 2009). The mixture, which is a science subject, is a collection of substances formed by the combination of more than one substance in such a way that its chemical properties do not change.

### 1.1. Problem Statement

All students in different disability groups (vision, mind, autism, hearing, etc.) can receive science education (MEB, 2013). It is emphasized that individuals with intellectual disabilities, one of these disability groups, should be taught academic skills in primary school and used in the future (Heward, 2003). For these individuals to adapt to life quickly and be successful, they need to learn the ways of benefiting from science as well as knowing the world of science they live in (Hançer, Şensoy, & Yıldırım, 2003). When children with intellectual disabilities associate the information they learn with daily life, it becomes easier to understand the data, and this information becomes more concrete (Düşkün & Ünal, 2015). For this reason, teachers should make various adaptations and designs in the classroom learning environment while working with individuals with intellectual disabilities (Gözmen, 2008). Cawley, Foley, and Miller (2003)

emphasized that teachers working with students with special needs should choose the right method while transferring knowledge, concepts, and skills to students in science teaching.

While determining these methods, teachers should consider students' differences, interests, and needs and the characteristics of the knowledge, concepts, and skills to be taught (Yılmaz, 2017). Individuals with intellectual disabilities gain knowledge, ideas, and skills; they need more time, practice and practice, and the use of concrete materials in teaching (Topsakal, 2005). In this direction, to eliminate the difficulties experienced in the science teaching of children with disabilities, concretization of concepts and information and systematic teaching methods suitable for the developmental characteristics of the student should be preferred (Bilgiç & Şafak, 2021). Increasing the intelligibility of the sciences, which contain complex, difficult, and abstract concepts is thought to be possible with the use of systematic and effective methods. Its effectiveness has been proven in teaching the Science course to individuals with intellectual disabilities; Many methods, including layered, error-free, activity-based, direct, schematic organizers, and concrete-pictorial-abstract teaching methods strategies, are used.

## 1.2. Related Research

Research results also show that the concrete-pictorial-abstract (CPA) learning strategy effectively teaches academic skills and concepts. Research by Witzel (2005) concluded that the CPA learning strategy positively affects students' learning outcomes in algebra. The study by Flores (2010) reported that the CPA learning strategy is effective in learning to subtract. Fourth, Sarfo et al. (2014) stated that the CPA learning strategy improves students' understanding of geometry and algebra. Fifth, Watt (2013) revealed that the CPA learning strategy helps students understand more complex algebra concepts. Based on the above, it can be concluded that the CPA learning strategy significantly impacts students' conceptual understanding, learning outcomes, and academic subjects. However, when we look at the studies, these studies are generally the ones that the CPA learning strategy affects improving students' math skills; the number of studies examining whether science teaching influences children with special needs is very limited; In addition, it is seen that there is no science teaching study with the CPA learning strategy for primary school children. However, the fact that the content of science includes a lot of information and technology involving the individual and the environment shows that this field is of great importance for the mentally disabled. (Karabulut, Uçar & Uçar; 2021). Developed countries in terms of education, in contrast to the idea that individuals with special needs will not learn science subjects due to their inadequacy (McLoughlin & Lewis, 2004), adopt the understanding of "science for individuals" while giving science education. Although many studies emphasize the importance of science in international and national literature and the necessity of developing research in this field, it is noteworthy that there are limited studies in our country to teach science subjects to students with intellectual disabilities. For this reason, it is thought that more research is needed on teaching science to individuals with intellectual disabilities. Considering all this information, it is believed that this research, which examines the effectiveness of the CPA learning strategy presented with the direct instruction method in teaching the subject of "mixtures," one of the science subjects, to students with intellectual disabilities, will be necessary. The results of this research will contribute to the literature and the education of individuals with intellectual skills disabilities.

## 1.3. Research Objectives

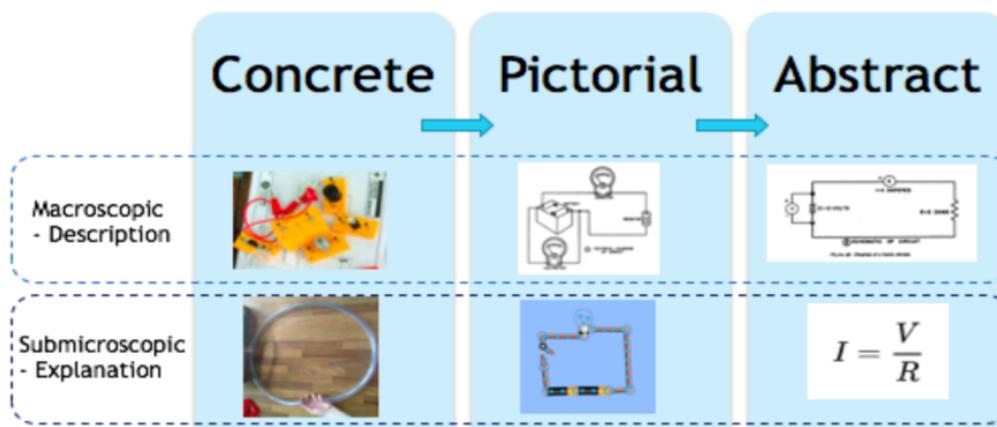
This research examines the effectiveness of the CPA learning strategy, which is presented with the direct instruction method, in teaching the subject of mixtures, one of the science subjects, to students with intellectual skills disabilities. In line with this main purpose, the research questions to be answered are given below:

1. Is using the CPA learning strategy effective for students with intellectual skills disabilities in teaching the subject "mixtures"?
2. Can the permanence of this gain be maintained several weeks after teaching?
3. Can this teaching be generalized between environments, tools, and materials?

## 2. Theoretical Framework

The Direct Teaching Method is a method in which the teacher and then the students are active, and the students develop their skills gradually by taking the teacher as a model by systematizing them using regular programs and tools (Dağseven - Emecen, 2011). This method aims to create an effective teaching process for students in a short time. Thus, since the students' performances can be observed instantly, teaching organization becomes easier. In international and national literature, many research findings show that the direct teaching method is an effective method used in science teaching (Karabulut, 2020; Yılmaz, 2017; Knight, Smith, Spooner & Browder, 2012; Spooner, Knight, Browder, Jimenez and DiBiase, 2011; Marrow, 2009 & Mr, Staver, Bryan & Hale, 1992).

CPA learning strategy is based on Bruner's theory of learning and consists of three stages; (1) concrete (learning through real objects); (2) pictorial (learning through image representation); and (3) abstract (learning through abstract writing) (Putri et al., 2020). This strategy is designed to make abstract concepts concrete and enable students to understand abstract subjects more easily using manipulative objects (Witzell, 2005). The CPA learning strategy is a strategy in which the number of senses used is reduced gradually so that the teaching appeals to more than one sense organ, and it is also based on approaches and views that emphasize conceptual learning rather than rote learning.



**Figure 1:** Concrete, pictorial and abstract stages according to the CPA learning strategy (Kenrick, 2019).

## 3. Method

### 3.1. Research Design

In this study, to determine whether the CPA learning strategy presented with the direct instruction method is effective in teaching the mixtures subject, which is one of the science subjects, to students with intellectual disabilities, the "multiple probe model with probe phase between subjects" was designed and applied, which is one of the multiple probe models among the single -subject research approaches. Baseline data for all participants of the applied model are collected in the same period. After the collected baseline data reaches a certain percentage of stability, the application phase starts for the subject's teaching in the first participant. After the criteria are met in the first participant, data is collected for three consecutive sessions for all participants, and the probe phase is included. At this stage, it is expected that the probe data meet the criteria in the first participant and that the other participants have similar characteristics with the baseline level.

After the attendance phase, the teaching phase is started for the second participant. If the criterion reaches the desired level in the second participant, the probe phase is applied to all participants. The attendance data of the first two participants will be expected to meet the criterion, and the other participant will be at the baseline level. After the probe phase of the research, the teaching phase begins with the third participant, who is the last. In the previous probe session, which was applied after the third participant's subject teaching was completed,

all three participants are expected to meet this criterion and have similar characteristics (Gast, 2010).

The independent variable of this study is the CPA learning strategy, which consists of three stages: a) concrete teaching stage, b) pictorial teaching stage, and c) abstract teaching stage. While the dependent variable is the mixture level of students participating in the study. In this study, teaching with the CPA learning strategy was carried out in a one-to-one teaching arrangement for each stage. In this direction, students must demonstrate a mixture of material with 100% accuracy when requested.

### **3.2. Participant**

The participants of this research are two female and one male student who attended a Special Education and Rehabilitation Center and were diagnosed with intellectual disability. The administration department of the institution was informed about the research, and necessary permissions were obtained to carry out the research. The families were informed about the study following the determination of the participants participating in the research. Necessary work permits were obtained from the families on behalf of the three participants who were accepted to participate in the study. In addition, the teachers and mothers of the selected participants were interviewed and informed about not doing any practice that would affect their ability to demonstrate the intended mixtures during the study period. Participants in this research has certain characteristics: The individual who is a participant in the study; was expected to meet the prerequisite skills such as (a) answering questions, (b) being able to maintain attention for at least twenty minutes during the activity, (c) reading the written number, (d) visual perception and auditory perception skills.

Instead of the real names of the students participating in the research, code names that were not like those of the students in the institution where the study took place were used. The characteristics of the participants are listed below:

Battal is a ten-year-old male student with an intellectual disability diagnosed by the guidance research centre. Battal has been studying in general education classes for four years. Battal is someone who can follow the instructions given to him, read the words, and communicate with his peers. He is a student with the necessary preparation skills for reading and writing.

Zeynep is an eleven-year-old female student with an intellectual disability diagnosed by the guidance research centre. Zeynep has been studying in general education classes for five years. Zeynep can follow the instructions given to her, read the words, and communicate with her peers. He is a student with the necessary preparation skills for reading and writing.

Öykü is an eleven-year-old female student with an intellectual disability diagnosed by the guidance research center. Öykü has been studying in general education classes for five years. Öykü can follow instructions, read the words, and communicate with his peers. He is a student with the necessary preparation skills for reading and writing.

Apart from the research participants, the researcher and the observer are the other participants who support the research. While the entire application process of the research was carried out by a single practitioner who has a doctorate in the special education department, the application reliability and inter-observer reliability data in the research were collected by two special education specialists who graduated from the special education department and completed their master's degree in the special education department.

### **3.3. Implementation Process**

The application phase of this study, in which the effectiveness of the CPA learning strategy applied with the direct teaching method in teaching the subject of mixtures, to students with intellectual disabilities; For the mixture topic, firstly, collective probe sessions followed by daily probe sessions, teaching sessions and finally follow-up sessions were held with three students. The sessions in the study were held in an individual classroom in a Special Education and Rehabilitation Center, five days a week, between 12:00 and 14:00. The CPA learning strategy implemented in the study, consists of three stages: (1) The concrete stage, in which movable and tactile materials are used, (2) the pictorial stage, where the pictures of the materials used

are included, and (3) the abstract stage, where the names of the objects are included. The sessions at all stages of the CPA learning strategy implemented with the direct teaching method were implemented by performing the steps of being a model, guided practices, and independent practices. Baseline data were collected until all participants in the study obtained stable data for three sessions on the subject to be taught. After obtaining stable data in the baseline sessions, the CPA learning strategy, which was applied with the direct teaching method, was started to be used for the subject taught in each subject.

Participants were determined as the intermediate criterion required in the transitions to the concrete, pictorial, and abstract teaching stages. The students reached 100% criteria in the probe sessions held at the end of the teaching sessions and obtained stable data in three consecutive sessions. All students follow the pictorial teaching stage when the required intermediate criterion is reached in the concrete teaching stage. The abstract teaching stage starts when the intermediate criterion is reached in the pictorial teaching stage. In the abstract teaching phase, the teaching was terminated after the students who participated in the study reached the 100% criterion in the probe sessions taken after the teaching sessions and showed determination for at least three consecutive sessions. Follow-up sessions were held one and three weeks after the completion of the teaching process. Subsequently, generalization sessions were taken a right after the second, third, and fourth full probe sessions. All sessions held during the study were organized in the practitioner one-to-one teaching model. The data obtained from all the practice sessions in the research were recorded on the data recording forms by the practitioner and these sessions were recorded with the help of video.

### **3.3.1. Polling Sessions**

In this study, probe assessments were made to determine the participants' performance before implementing the CPA learning strategy, which was applied with the direct teaching method. The study's probe sessions include daily, collective, and generalization probe sessions. With the CPA learning strategy, whether this teaching took place was determined by the probe sessions held after the teaching sessions. Information on how the sessions in the study progressed is given below.

### **3.3.2. Mass Polling Sessions**

Four full probe sessions were held to determine the performance of the participants on the taught subject before the participants started the teaching phase on the subject being studied when the 80% criterion showing that the teaching took place during the teaching phase was met. After this criterion was reached in three consecutive sessions, a stable data was obtained. In the first collective probe session, at least three sessions about mixtures, one by one with three participants, were continued until stable data were obtained. After the stable data were obtained, a teaching session on the subject was started with the first participant. After performing at a rate that met the criteria and obtaining stable data on this issue, all participants were transferred to the second full probe session. Then, after the second full roll call was completed, the teaching phase of the second participant was started. After the teaching phase was completed, the second participant met the criteria, and when stable data were obtained, the third collective probe sessions were started. The teaching phase was started for the third participant when the stable data in the third collective probe sessions were obtained. If the participant met the criteria and stable data were obtained, collective probe sessions were held for the last time for all participants. The collective probe sessions were held in the individualized education classroom. First, the implementer prepared the material, registration form, and video camera for the probe session. Afterward, the participants were informed about the study. ("I will ask you to show the mixture when I ask which of the objects, I am going to show you now is a mixture"), certain tips were provided to motivate the participants to study (Are you ready? Shall we start?). The participants' reactions showing that they were ready for the study were reinforced verbally (congratulations, well done, etc.) At the end of this stage, the researcher presented the target stimulus to the student. ("show me whichever of the objects I am going to show you is a mixture") The participants did not respond to the correct or incorrect answers to the instructions and was unresponsive to the study participants. After the study was completed, the subsequent trials were started.

### **3.3.3. Generalization Sessions**

In the study, generalization studies were carried out between tools, materials, and environments. Generalization sessions and collective probe sessions in the study were continued together. Generalization sessions were held after all collective probes. The sessions were in the form of pretest-posttest, this session; As soon as the first full probe phase was over, the posttest session was held as soon as the teaching activities and the criteria for the taught subject in each participant were completed. In the study, the participants' correct responses in the generalization probe sessions were reinforced with verbal reinforcements, like the phase in the teaching sessions. For the skills that the participants showed correctly in the generalization sessions, they were reinforced verbally with a continuous reinforcement schedule. In addition, at the end of all generalization sessions, food reinforcement was given to the participants (candy, crackers, jellybeans, etc.).

### **3.3.4. Environment**

Daily and collective attendance, monitoring, and teaching sessions in the research were carried out in an individual classroom at the Special Education and Rehabilitation Center. Each classroom has a desk, two chairs, and a book cabinet. A video camera system was kept ready to obtain research data records for this class.

### **3.3.5. Tools**

Reinforcers to be used to reinforce the correct responses of the participants in the research, a functional reinforcer determination form for the student was created and used for each participant, based on the opinion of the family and the teacher. In the concrete teaching phase, where the teaching starts from the substantial level, a material set consisting of 10 touchable and movable objects was created and used for teaching mixtures. In the pictorial teaching stage, the pictures of the objects representing the materials used in the concrete teaching stages were used. In the abstract teaching stage, the names of the objects used in the other stages are included on the paper. Expert opinion was sought about the teaching sets prepared at the stage before starting the application.

## **3.4. Data Collection**

The researcher collected the data that emerged in the research using the "Collective Probe, Daily Probe Generalization and Monitoring Sessions Data Collection Form". At this stage, the participants correct or incorrect responses in demonstrating the mixtures were recorded. Then the calculation of the correct response percentage was made. "Single Step Behavior Trial Record" was used in this study. Single-step behavior trial registration records the correct or incorrect response of a subject to the target stimulus and calculates the percentage and number of correct behavior (Gast, 2010). There are two answers in the implementation phase of the teaching carried out with the CPA learning strategy. (1) Correct response: The student shows a mixture of the presented objects. (2) Wrong response: It is accepted that the student does not show the mixture of the presented objects. The same data collection model was used in all parts of the study.

## **3.5. Data Analysis**

The analysis of the collected data on the effectiveness of the CPA learning strategy applied with the direct teaching method in teaching the skill of showing mixtures, a science subject, to students with intellectual disabilities was made through graphical analysis. The data obtained in all sessions during the implementation phase are processed on this graph. The horizontal axis in the created graph represents the numerical expressions of the number of sessions, and the vertical axis of the dependent variable. If there is an increase in the trend lines on the graphs created at the research's end, this increase indicates that the independent variable affects the dependent variable (Gast, 2010). Data on permanence in the study were also created through graphical analysis. The data about the generalization sessions in the research were analyzed with the pretest-posttest method and displayed on a bar chart.

### 3.6. Reliability

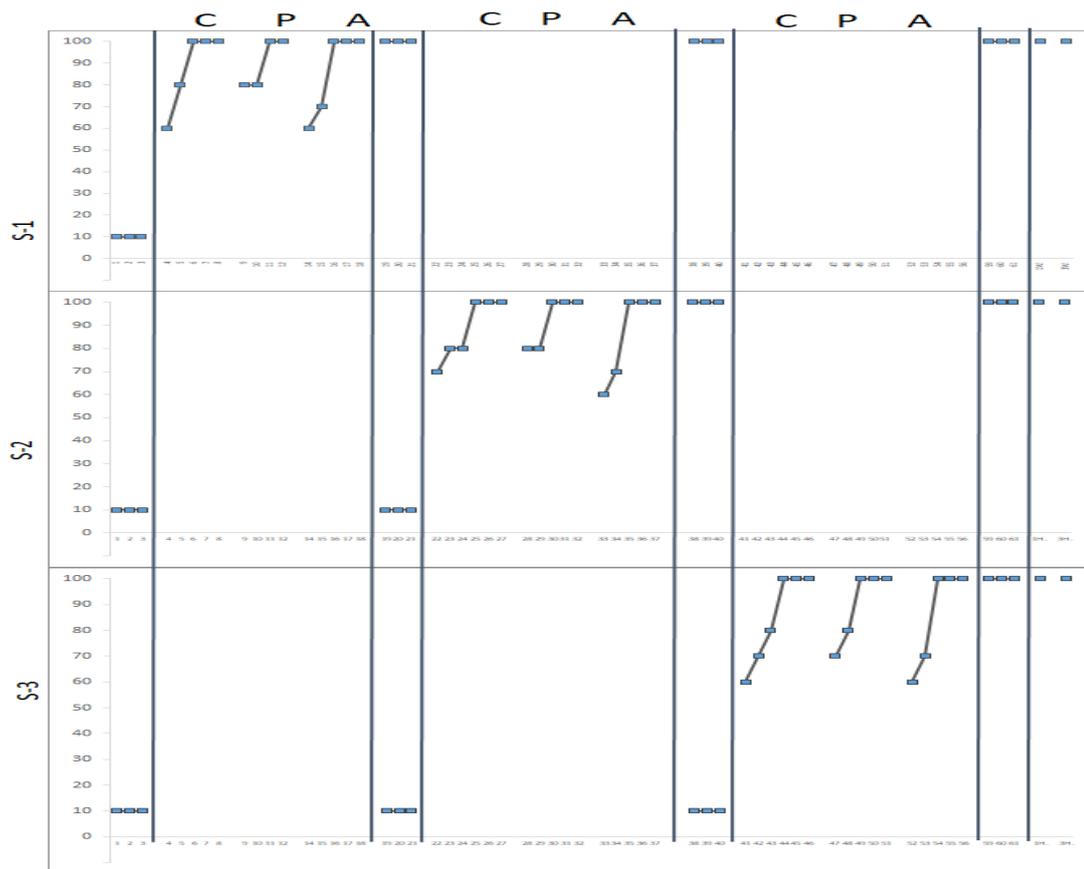
Two reliability data were collected in this study. These are inter-observer reliability and application reliability.

During the research's inter-observer reliability data collection stage, the recordings recorded by the observers with the video method were watched, and the data contained in the content was recorded in the registration forms. Since the observers in the research had sufficient information about the CPA learning strategy presented through direct instruction, these observers were not informed about this issue. Subsequently, the inter-observer reliability calculation was calculated using the formula  $[(\text{consensus}) / (\text{consensus} + \text{disagreement})] \times 100$  (Gast, 2010). All the study's probing, teaching, monitoring, and generalization, etc... Inter-observer reliability data were collected and recorded in 30% of the sessions. An inter-observer reliability coefficient of 80% in research reliability calculations is considered sufficient, but 90% and above are accepted as the ideal reliability coefficient (Gast, 2010). The inter-observer reliability of this study was 90% for each participant in showing mixtures.

To understand the extent to which the practitioner of the study carried out the teaching applied with the direct teaching method and the teaching carried out with the CPA learning strategy, the practitioner behaviors that should be in the implementation plan were determined. Then the application reliability form was prepared. For this study, application reliability data were collected in 30% of the collective probe, teaching, probe, generalization, and follow-up sessions. To calculate the application reliability coefficient, the observed practitioner behavior was divided by the planned practitioner behavior, and the percentage was calculated  $(\text{observed practitioner behavior} / \text{planned practitioner behavior} \times 100)$  (Gast, 2010). The people who made this application were selected using an unbiased assignment table, and there were two special education specialists, excluding the researcher, who watched the recordings of the sessions. These observers marked (+) if the implementer could successfully perform the steps in the application content and (-) if he could not. The application reliability findings of this study were found to be 90% for each participant in showing the mixtures.

## 4. Findings

The findings related to the effectiveness of the CPA learning strategy applied with the direct instruction method in teaching the mixtures of subject to students with intellectual disabilities are given in the graphs in Figure 2 for Battal, Zeynep, and Öykü. The horizontal axis in the graph shows the number of sessions, and the vertical axis shows the correct response percentages of the subjects. For all participants, at the baseline level, it was seen that they showed 10% performance in three consecutive sessions and only one of the ten different objects correctly. Teaching sessions were followed as concrete, pictorial and abstract teaching stages, and it was expected to reach 100% stable data in three consecutive sessions to pass from one stage to the next.



**Figure 2.** Initial, Concrete Teaching (C), Pictorial (P), Abstract Teaching (A), Probe and Monitoring Data on the Teaching of Mixtures by Battal, Zeynep and Öykü

In the first graphic in Figure 2, data regarding the teaching of the subject of mixtures taught with the CPA learning strategy applied with Battal's direct teaching method are given. According to the data presented here, Battal showed 10% successive performance in three sessions at the baseline level, and only one of the ten different objects was correct. After obtaining stable data for three consecutive sessions at the introductory level, the transition to the concrete teaching stage, which is in the first stage of the CPA learning strategy, was made. A total of 5 concrete teaching sessions were held with Battal. Battal showed a correct response at the rate of 60% in the first probe session, 80% in the second probe session, and 100% in the third, fourth, and fifth probe sessions of concrete teaching. Since Battal met the criteria in the last three concrete teaching sessions, pictorial teaching sessions were started. A total of 5 pictorial teaching sessions were held with Battal, and this pictorial teaching showed correct response in 80% in the first probe session, 80% in the second probe sessions, and 100% in the third, fourth and fifth probe sessions. Since Battal met the criteria in the last three pictorial teaching sessions, abstract teaching sessions were started. A total of 5 abstract teaching sessions were held with Battal. Battal showed a correct response at 60% in the first probe session, 70% in the second probe session, and 100% in the third, fourth, and fifth probe sessions of abstract teaching.

As a result of the analysis between the initiation level and the implementation phase, it was seen that the CPA learning strategy created the desired change in teaching the subject of mixtures. It is seen that Battal was successful at 100% and 100% in the follow-up sessions held one and three weeks after the practice sessions on teaching the blends subject with the CPA learning strategy. The data obtained show that Battal continues his education on mixtures.

In the second graphic in Figure 2, the data regarding teaching the blends subject taught with Zeynep's CPA learning strategy applied with the direct teaching method are given. According to the data presented here, Zeynep showed 10% successive performance in three sessions at the baseline level, and only one of the ten objects was correct. After obtaining stable data for

three consecutive sessions at the introductory level, the transition to the concrete teaching stage, the first stage of the CPA learning strategy, was made. A total of 6 concrete teaching sessions were held with Zeynep. Zeynep showed a correct response of 70% in the first probe session, 80% in the second probe session, 80% in the third probe session, and 100% in the fourth, fifth, and sixth probe sessions of concrete teaching. Since Zeynep met the criteria in the last three concrete teaching sessions, the pictorial teaching sessions were started. A total of 5 pictorial teaching sessions were held with Zeynep, and this pictorial teaching gave an accurate response of 80% in the first probe session, 80% in the second probe session, and 100% in the third, fourth and fifth probe sessions. Since Zeynep met the criteria in the last three pictorial teaching sessions, abstract teaching sessions were started. A total of 5 abstract teaching sessions were held with Zeynep. Zeynep showed a correct response at 60% in the first probe session, 70% in the second probe session, and 100% in the third, fourth, and fifth probe sessions of abstract teaching.

As a result of the analysis between the initiation level and the implementation phase, it was seen that the CPA learning strategy created the desired change in teaching the subject of mixtures. It is observed that Zeynep was successful at 100% and 100% in the follow-up sessions held one and three weeks after the practice sessions on teaching the blends subject with the CPA learning strategy. The data obtained show that Zeynep continues her education on mixtures.

In the third graphic in Figure 2, Öykü's CPA learning strategy applied with the direct teaching method and the data for teaching the mixtures he was taught are presented. According to the data, Öykü showed 10% successive performance in three sessions on teaching the subject of mixtures at the beginner level, and only one of the ten objects was correct. After obtaining stable data for three consecutive sessions at the baseline level, concrete teaching practice, the first step of the CPA instruction strategy, was started. A total of 6 concrete teaching sessions were held and implemented with Öykü. Öykü showed a correct response at 60% in the first probe session, 70% in the second probe session, 80% in the third probe session, and 100% in the fourth, fifth, and sixth probe sessions of concrete teaching. Since Öykü met the criteria in the last three concrete teaching sessions, the pictorial teaching phase sessions were switched. A total of 5 pictorial teaching sessions were held with Öykü, and this pictorial teaching showed a correct response at the level of 70% in the first probe session, 80% in the second probe session, and 100% in the third, fourth and fifth probe sessions. Since Öykü met the criteria in the last three pictorial teaching sessions, abstract teaching sessions were started. A total of 5 abstract teaching sessions were held with Öykü. Öykü showed a correct response at 60% in the first probe session, 70% in the second probe session, and 100% in the third, fourth, and fifth probe sessions of abstract teaching.

As a result of the analysis between the initiation level and the implementation phase, it was seen that the CPA learning strategy created the desired change in teaching the subject of mixtures. It is observed that Öykü was successful at the 100% level in the follow-up sessions held one and three weeks after the practice sessions for teaching the blends subject with the CPA learning strategy. The data obtained show that Öykü continues her education on mixtures.

## 5. Discussion

In this research, it has been tried to determine whether the CPA learning strategy is effective in teaching the subject of "mixtures", which is one of the science subjects, to students with intellectual disabilities, whether the students' learning about the subject is preserved after the end of the education, and whether this skill can be generalized to different environments and different tools. The research findings showed that the CPA learning strategy was effective and permanent in teaching the subject of "mixtures" to students with intellectual disabilities. The participants could generalize the subjects they acquired to different environments and tools.

In the study, at the end of the application in which the CPA learning strategy applied with direct instruction was used to teach mixtures to students with intellectual disabilities, it was seen that the CPA learning strategy was effective, resulting in an increase for all three of the participants compared to the baseline level. This study finding shows that the CPA learning strategy effectively teaches science subjects. For this reason, it is thought that enabling

educators to encounter such intervention examples and using the CPA learning strategy in teaching abstract science subjects will be important in improving practices.

In the research, it is thought that some factors play a role in the effectiveness of CPA learning strategy and teaching in acquiring science. The first of these factors is the concrete forms of the mixture of materials presented to the students and the visuals used; It is the fact that the abstract materials they read in the eyes of the students become concrete, motivate them, and actively participate in the lessons, and they strive more willingly to perform better than the previous day. It is thought that this may be due to the gradual use of concrete and pictorial materials prepared for teaching in a way that appeals to more than one sense organ (Witzell, 2005) and the fact that it emphasizes conceptual learning rather than rote learning. The second factor is the presentation of the CPA learning strategy and the direct teaching method, which is a systematic teaching method.

The direct teaching method is a method that enables the instructor to start teaching actively with small steps and consecutive sequences and to activate the student in the following stages. In addition, the direct teaching method contributes to each student's progress at his own pace and the permanence of the learned information by allowing the students to repeat frequently. In the study of Sola- Özgüç & Cavkaytar (2015), it was stated that carrying out the instructional activities with the direct instruction method, seen as a systematic and evidence-based teaching method, will positively affect the academic development of the students. In this study, the CPA learning strategy was presented together with the direct teaching method, which is a systematic teaching method.

Literature generally states that students with special needs perform less in science courses than their typically developing peers (Gözmen, 2008). This is since science contains complex and abstract concepts, and students with special needs have difficulty learning them (Karabulut & Yıkmiş, 2021). To eliminate the difficulties experienced in teaching science, the concretization of concepts and information and systematic teaching methods suitable for the developmental characteristics of the student should be preferred (Bilgiç & Şafak, 2021). It can be said that the CPA learning strategy, one of the systematic teaching methods used in this research, embodies the teaching, and positively affects the level of comprehension of the subject. For this reason, the CPA learning strategy used in the research is thought to be effective in concretizing abstract concepts. Considering all these, it is thought that the CPA learning strategy will effectively teach science to individuals with intellectual disabilities and that increasing similar studies will contribute to the literature. In addition, it is thought necessary to implement intervention programs using different methods and techniques that have been proven effective in teaching science to students with intellectual disabilities.

One of the most important problems experienced by students with an intellectual disability is the generalization of the cognitive skills they learn to their daily lives, different environments, people, and tools (Erez & Peled, 2001). Therefore, it is important to obtain generalization data. This study concluded that students with intellectual disabilities could generalize the subjects acquired with the CPA learning strategy to different environments and tools. When the literature is examined, it is seen that generalization data are collected in a limited number of studies conducted for the acquisition of science subjects (Karabulut & Yıkmiş, 2021; Bilgiç & Şafak, 2020; Yıkmiş & Varol- Özçakır, 2019; Akman-Yozgat, Özbek, & Afacan, 2018; Sazak -Pınar & Merdan, 2016). The study's generalization findings are like those of other studies. It can be said that the generalization of the subject of mixtures, learned with the CPA learning strategy, has been evaluated, and it can be said that it will contribute to the literature.

## **6. Conclusion**

In summary, the CPA learning strategy applied with the direct instruction method is effective in teaching science subjects targeted to students with intellectual disabilities; one and three weeks after the end of the application, the learning is preserved in the subjects taught; It has been observed that it can be generalized to different tools and environments.

## Limitations

What are the views on the importance of research objectives and the appropriateness of research methods at the end of teaching in research? Examining the question is important. The limitation of the study is that social validity data were not collected in this study.

## Recommendations

The following suggestions can be made for future research on the findings obtained from this study:

1. In this study, the CPA learning strategy was used in teaching the subject of mixtures to students with intellectual disabilities. In future research, the effectiveness of the CPA learning strategy in teaching different science subjects can be investigated.
2. Students diagnosed with intellectual disabilities were included as participants in this study. In future studies, it may be recommended to conduct similar research on students with different disabilities.
3. Social validity data were not collected in this study. In future studies, collecting social validity data from students with special needs, teachers and families may be recommended.

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## Conflict of Interest

The researchers declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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