

Research Article

# Elimination of Misconceptions about Percentages with the Cognitive Conflict Approach

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## Abstract

This research aimed to eliminate the misconceptions about percentages with the cognitive conflict approach. The sample of the research consists of 10 students studying in the 8<sup>th</sup> grade of a public school in the central district of Rize/Turkey in the 2020-2021 academic year. In the study, in which the action research method was adopted, a misconception diagnosis test was developed by conducting a pilot study. In the light of the data collected after the pretest was applied, a lesson plan was prepared in accordance with the stages of the cognitive conflict approach and the application lasting four lesson hours was carried out with the students. The posttest was administered 2 weeks after the application. Data collection tools are two-stage diagnostic test, reflective diaries and video recordings. According to the findings, it was observed that the misconceptions of some students were eliminated, and the misconceptions continued in a student.



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## Introduction

A percentage is a common component of all forms of communication. It occurs on a continuum from small-scale decisions (e.g., tipping after a meal) to large-scale decisions (e.g., deciding whether to evacuate after a natural disaster). However, the concept of percentage is not simple. A percentage is a functional number and derives its conceptual meaning from its functional context (Tomson, 2021). Understanding and learning percentages, which are part of daily life, is important in mathematics. In order to understand the concept of percentages, students are expected to form their thinking patterns correctly. It is necessary for them to understand the multiple meanings and relationality of percentage (Parker & Leinhardt, 1995). This subject, which is difficult to learn and teach, can be structured in minds as weak conceptual knowledge. As a result, students may experience some difficulties in solving problems and exercises without considering the multiple meanings and representations of percentages (Akpınar, 2018; Özbey & Köyceğiz-Gözeler, 2020).

In Turkey, different ways of teaching percentages are offered in courses and textbooks (MONE, 2018). These ways are summarized as follows.

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Figure 1. Different ways to teach percentages

Researchers have developed some successful strategies for teaching percentages, such as APOS (Bayraktar, 2020), PGBE (Mula & Hodnik, 2020), RME (Özçelik, 2015), and STEM (Macun, 2019). In addition, some studies have found that students have difficulties dealing with percentages, make mistakes, and have difficulties in understanding and solving problems related to percentages (Koay, 1998; Özbey & Köyceğiz-Gözeler, 2020). Erdem, Özçelik, and Gürbüz (2018) found in their study that students had difficulties in understanding and interpreting the concept of percentage, finding a quantity with a certain percentage, writing a quantity as a percentage of another quantity, finding the amount corresponding to a certain percentage of a quantity, writing different representations as a percentage, and distinguishing the difference between the amount and the percentage ratio. Akpınar (2018) found in his study that many students have misconceptions about percentages. In this study, four learning difficulties related to percentages were identified. These were determined to be learning difficulties due to perceptual reasons, biases, incomplete learning, and misconceptions.

The teacher's task is to teach students who do not yet know a subject. This task is the most important characteristic that distinguishes teachers from other professionals. However, it is difficult for teachers to eliminate this alternative concept of a student with misconceptions, provide the correct information, and bring the student to the level of scientific knowledge. One way to make this job easier is to create a cognitive conflict (CC). As long as those who are wrong do not face their own mistakes and see that the truths they know create contradictions, they do not give up that truth easily. An alternative way for teachers to overcome these percentages of misconceptions is through CC.

CC is a perceptual situation in which a person's cognitive structure detects inconsistency among scientific knowledge (Lee & Kwon, 2001). It has been observed that researchers use different words with similar meanings for CC. These words were found to be "balanced" (Smedslund, 1961), "cognitive dissonance" (Festinger, 1957), and "conceptual conflict" (Hewson & Hewson, 1984). In Festinger's theory of cognitive dissonance, the disagreement between the individual's cognitions is thought to cause discomfort, and the individual tends to resolve this situation (Festinger, 1957). The conflict created by this discontent among students is considered the first step of conceptual change. In the dissatisfaction stage, students must recognize that they must restructure, reorganize, or change their conceptions. For these conceptions to change, students must recognize that they must change their minds and want to do so (Posner et al., 1982). According to the concept change model, the first step that initiates the conceptual change process is to create a CC (Posner et al., 1982). There are several ways to create this conflict. Abnormal data, analogies, and similes are some of these methods. Abnormal data plays an important role in the process of concept change (Thagard, 1992). In some studies, it is found that reactions to abnormal data are classified. These reactions can be seen as ignoring, rejecting, excluding, waiting, reinterpreting, environmental, and theory changes (Chinn & Brewer, 1998). Addressing students' interests in teaching methods or using surprising visuals to arouse students' motivation is compared to abnormal data that create CC in students (Biggs, 1990).

There are some studies on the subject in the literature. It was found that the success of the classes in which the CC method is used is higher than that of the classes in which the concept change text is used (Toka & Aşkar, 2002), that physics instruction based on CC is more effective than traditional physics instruction (Başer, 2006), that CC interventions can significantly improve high school student's understanding of algebra, but not among the weakest students (Fraser, 2007). Although some students recognize the conflict and develop new concepts when learning the acidic concept with a CC, efficiency is not present when these students are exposed to later experiences (Baddock & Bucat, 2008). It has been observed that CC activities prepared for science teachers, most teachers experience CC (where their prior knowledge is incorrect or insufficient) (Akpınar, Erol, & Aydoğdu, 2009); it is an important factor in initiating steps toward CC resolution that students produce evidence (Moody, 2010); that CC in learning (from incomprehensible to understandable, from understandable to reasonable, from reasonable to efficient) is effective in algebra

learning (Chow & David, 2013). CC-based instruction on heat and temperature produces more conceptual change than traditional instruction (Madu & Orji, 2015). It was also found that a realistic model of mathematics instruction based on CC significantly increased the ability to understand the concept (Herawaty & Rusdi, 2016), first graders changed their alternative concepts about Volta cells by creating disequilibrium with the CC strategy (Sumarna & Yulistiana, 2016); that the importance of CC-based scaffolding in correcting students' errors in algebra materials (Maharani & Subanji, 2018), that false-analog structures are effective in CCs experienced by students while performing a non-routine mathematical task (Wyrasti, Sadijah, As'ari, & Sulandra, 2019). It has been found that CC occurs during information processing when the information received from affective memory and transferred to short-term memory cannot directly connect with the information in long-term memory (Pratiwi, Nusantara, Susiswo, Muksar, & Subanji, 2019). It was found that misconceptions about polygons and quadrilaterals could be overcome by creating a CC with activities prepared using GeoGebra dynamic software (Yılmaz, 2019) and that the CC method is effective in eliminating misconceptions about force and energy (Gökçe-Erdem, 2021). In his study, Yaman (2013) showed that students successfully learned force and motion and eliminated misconceptions using the CC and bridging method. He applied the CC method in 6 steps. 1) Activate the misconception 2) Demonstration and appropriation 3) Deepening the contradiction 4) Presentation of theoretical information 5) Extension/Expansion of the Concept 6) Conclusion-Summary. According to Rahim, Noor, and Zaid (2015), the CC strategy is a part of the psychological theories of conceptual change. This strategy is effective in correcting a misconception and improving performance. This study conducted an extensive literature review using the meta-analysis technique. After a qualitative analysis, five elements of the CC strategy were identified: 1) Multimedia learning materials based on the CC strategy should present meaningful information. 2) It must challenge existing concepts in students. 3) It should be eye-catching. 4) It should be motivating and 5) it should be easy to use. Güveli, Baki and Güveli (2022) conducted a study investigating the effect of the 5-step CC approach (CCA) on eliminating misconceptions in rooted numbers. This study caused some transformations between categories (scientific knowledge, misconception, lack of knowledge and lack of confidence). The biggest transformation was from misconception to scientific knowledge.

Resolving misconceptions is a difficult task. Creating CC is an alternative method for changing the concept instead of retelling in traditional methods. The literature states that while this method cannot eliminate all misconceptions, it greatly reduces the frequency of misconceptions. However, no study was found that eliminated the misconceptions about percentages of students using the CCA. It is believed that this study will fill this gap in the literature. This study will also provide teachers with a diagnostic test to identify misconceptions about percentages and provide material to clear up misconceptions with a different approach.

In this study, the effect of the CCA on students' misconceptions about percentages is examined, and the results are discussed. For this purpose the research problems of this study are:

1. What is the CCA's effect according to the pre- posttest results?
2. How does the CCA work in classroom practice?

## Method

This study is an action research. Action research is an approach to research that involves identifying a problem in an instructional process, developing solutions before or during the resolution of that problem, and collecting and analyzing data in response. The research performer may be the person conducting the research or another person. In this research design, the data can be collected qualitatively or quantitatively (Yıldırım & Şimşek, 2018). One of the reasons for conducting the study according to the action research design is that the person conducting the application is both a researcher and a teacher. Another reason is that the problem is identified at the beginning, and then a solution to this problem is developed.

### *Study Group*

The study group of this research consists of 10 8th-grade students studying at a public secondary school in the central district of Rize/Turkey. The study occurred during the period when the courses were taught under the pandemic conditions. In the spring semester of 2020-2021, the overcrowded classes were divided into two groups of 10 students each by the school administrators according to the class list. For this reason, the researcher conducted the pilot study with one of these groups and the main study with the other group.

### *Operation*

A literature review was conducted at the beginning of the study after the problem situation was identified. Then, the misconception diagnostic test was created to detect possible misconceptions. This test was developed considering the test preparation steps of Baykul (2015). This test was applied to the pilot group. Item analyzes were conducted based on the test results, and it was decided that the test was suitable for the main study. This study used the developed percentage diagnostic test as a pretest. The developed percentages diagnostic test was used as a pretest in this study. According to the results obtained from the pretest; lesson was taught with 5-stage CCA, developed inspiring by Yaman's (2013) CC stages. After the lesson, the same diagnostic test was used as a posttest.

### *Data Collection Tool*

Data collection tools are two-stage diagnostic test, reflective diaries and video recordings. A two-stage diagnostic test consisting of 10 questions was used in this study. The first stage of the test consists of open-ended questions. The second stage consists of the part asking whether he is sure of solving the task. In developing the pretest, the purpose of the test, the scope of the test, the writing of the items, the processing of the items, the test form, the evaluation of the application results, the item analysis, and item selection, and the results of the final test statistics were considered (Baykul, 2015).

Objective of the test: the diagnostic test was developed to identify misconceptions about percentages.

*Scope of the test:* all questions on the diagnostic test are M.7.1.5.4. (Solving problems related to percentages) (MONE, 2018). The entire test consisted of questions about percentages. No off-topic questions were asked.

*Writing the items:* First of all, a pool of questions was prepared by taking questions from 8th-grade mathematics textbooks, supplementary books, and guidebooks. Then, questions were prepared similar to the questions in this question pool. The prepared test consists of questions designed to uncover eighth-grade students' misconceptions about percentages. Illustrative materials and problems from daily life were used in preparing the questions.

*Item editing:* it was checked whether each prepared item has the qualification to measure the behavior to be measured, whether it contains a scientific error, whether it is linguistically understandable, whether it contains grammatical errors, and whether the test and the items are technically flawed. The items were processed by obtaining expert opinions.

**Table 1.** Features of the expert group

Characteristic		Frequency
Gender	Male	-
	Female	8
Educational background	Licence	-
	Degree	6
	Doctorate	2
Job	Academician	2
	Teacher	6

The experts who assessed the prepared diagnostic test happened to be all females. 6 of the experts had a Master's degree and 2 of them a PhD. 2 of the experts worked as academics in a government university and 6 of them worked as teachers in government secondary schools. Evaluation of the expert opinions (3-point rating)

a) the item is necessary b) the item is helpful but not sufficient c) the item is unnecessary  
Content Validity Ratio (CVR) =  $\frac{N_G}{N/2} - 1$

$N_G$ : number of experts who say it is necessary

$N$ : total number of experts who participated in the survey

Content Validity Criteria (CVC): The table of minimum CVR values at a significance level of  $p=0.05$  is shown in Figure 2.

number of experts	minimum value
5	0,99
6	0,99
7	0,99
8	0,78
9	0,75
10	0,62
:	:
:	:
35	0,31
40	0,29

**Figure 2.** CVC (Yurdugül, 2005)

*Content Validity Index (CVI):* The average of all CVRs gives the CVI.

*Content validity is statistically significant ( $p=0,05$ ) as  $CVI \geq CVC$*

**Table 2.** Evaluation of the test according to expert opinion

	necessary	beneficial/inadequate	unnecessary	CVR
Item 1	8	-	-	1
Item 2	8	-	-	1
Item 3	7	1	-	0,75
Item 4	7	1	-	0,75
Item 5	7	1	-	0,75
Item 6	8	-	-	1
Item 7	8	-	-	1
Item 8	8	-	-	1
Item 9	8	-	-	1
Item 10	8	-	-	1
Mean (CVI)				0,92

As can be seen from the Table, 8 experts rated items 1, 2, 6, 7, 8, 9 and 10 as "necessary" while 7 experts rated items 3, 4 and 5 as "necessary". When the CVR of the individual items was calculated, the CVR average (CVI) was 0,92 for all items.

Since  $CVI=0,92 > CVC=0,78$  content validity is significant ( $p=0,05$ ).

*Trial design:* A trial application was conducted with the redacted items in the pilot study.

Scoring of application results: The test used in the pilot study was scored according to the following scoring criteria.

**Table 3.** Diagnostic test scoring criteria

Stage	Evaluation	Score
Part 1	True	2
	Partially true	1
	False	0
Part 2	I am sure	1
	I am not sure	0

In this case, the lowest test score in the 10-question test is 0, and the highest test score is 20. Two experts from different fields scored the test, and a strong positive correlation was obtained ( $r=0,975$ ;  $p < 0,05$ ).

**Table 4.** Expert scoring correlation

			Expert 1	Expert 2
Spearman's rho	Expert1	Correlation Coefficient	1,000	0,975**
		Sig.(2-tailed)	.	<0,001
		N	10	10
	Expert 2	Correlation Coefficient	0,975**	1,000
		Sig. (2-tailed)	<0,001	.
		N	10	10

\*\* . Correlation is significant at the 0,05 level (2-tailed).

Final test statistics and item analysis: an item analysis was performed on the pilot study diagnostic test, which was scored according to the scoring criteria. The item analysis yielded the following results.

**Table 5.** Item difficulty and discrimination indices

Items	Item Discrimination Index	Item Difficulty Index
1	1	0,55
2	1	0,55
3	0,7	0,585
4	0,8	0,44
5	1	0,55
6	0,4	0,22
7	0,8	0,44
8	0,5	0,275
9	0,8	0,44
10	1	0,55

If the difficulty index of the test items is 0,29 and below, it is a difficult test; if it is between 0,30-0,49, it is a moderately difficult test; if it is between 0,50-0,69, it is an easy test; and if it is between 0,70-1, it is a very easy test. If the discrimination index of the test items is 0,40 and above, it is a very good item; if it is between 0,30-0,39, it is quite good but can be improved; and if it is between 0,20-0,29, the item that needs to be corrected and improved is 0. If it is 19 and below, it is a very weak item that needs to be removed (Baykul, 2015).

Based on the calculated item discrimination indices, it was found that all items were very good, as they were above 0,40. The item difficulty indices found that items 1, 2, 3, 5, and 10 were easy, items 4, 7, and 9 were moderate, and items 6 and 8 were hard. Given these results, it was concluded that no item needed to be deleted from the test and that each item would increase the validity and reliability of the test. The reliability of the test (Cronbach's alpha) was reported as 0,971.

**Table 6.** Correlation between item scores and being sure scores

Part 1	Part 2	Correlation®	Sig.(2tailed)	N
1	1	0,218	0,545	10
2	2	1	0,000	10
3	3	0,546	0,103	10
4	4	0,535	0,111	10
5	5	0,816	0,004	10
6	6	0,327	0,356	10
7	7	0,894	0,001	10
8	8	0,786	0,007	10
9	9	0,142	0,696	10
10	10	0,408	0,242	10

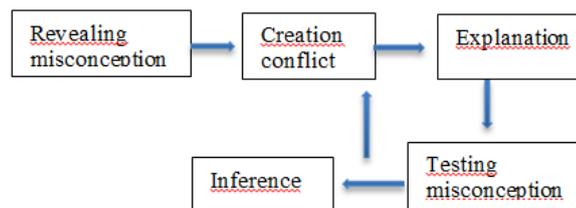
The low correlation in some questions is due to the misconception in these questions.

Item selection: considering the item analysis, it was considered appropriate not to delete any question items and to use the test used in the pilot study in the main study.

During the implementation of the prepared lesson plan in the classroom, the classroom environment was video recorded. The lesson was recorded both on the smartboard and with video cameras. In this way, all situations, such as the conflicts experienced by the students, their reactions to them and the recognition of their misunderstandings, were recorded one by one. In this way, an attempt was made to complete the implementation process without losing any data. In addition, the researcher made notes in their diary after the lesson.

#### *Development of a Lesson Plan Prepared According to the CCA*

In the classroom where the CCA will be applied, the course was taught in 5 stages (Figure 3).



**Figure 3.** The 5-Stage of CCA

The stages of the CCA are as follows, as shown in Figure 3:

First stage: Misconceptions are revealed and shown. The teacher writes on the board the students' misconceptions about the topic that she uncovers with the diagnostic test.

For example, "It trades between the percentage amount and the stated multiple without considering the percentage." In other words, the 40% discount for 80 TL is written as 80-40.

Second stage: CC arises. The student is put into conflict by giving contradictory examples for each error.

For example 50% discount for 50 TL

Would it be  $50-50=0$ ? If 50% means half, then half of 50 equals 25. it is  $50-25=25$ . There is a contradiction here! Where does this contradiction come from?

Third stage: The reasons for the error are given, and scientific knowledge is explained. After explaining the topic, where scientific knowledge about the topic is given,

the reasons for the errors are given. Techniques such as concept change, refutation, etc., can be used.

*Confuting Text Example 1:*

- ❖ Most students add when they think the percentage given is increasing and subtract when they think it is decreasing. For example, what is the 30% price increase for a product with an 80 TL price? When asked, the answer is  $80+30=110$ . This is because a multiple means the same as the percentage given. If this thought had been true, for example, a 50% price increase for a product worth 70 TL would have been thought to increase the product to  $70+50=120$  TL. However, 50% means half. In other words, the product will increase by half the price. Half of 70 TL (50%) is 35 TL. In this case, the increased price would be  $70+35=105$  TL. There is a contradiction between these two results. The contradiction arises from the idea that the percentage captures the majority. This idea is not true. At the same time, the price of 80 TL is found with a 30% increase, first  $80 \cdot \frac{30}{100}=24$  TL is found first. Adding them,  $80+24=104$  TL is found as the increased price for the product.

Fourth stage: Whether the error persists is tested with more examples. Examples are used to try to understand whether the student continues his error or not. If the error persists, it is returned to the second stage, generating a contradiction.

Fifth stage: a conclusion is drawn, and an evaluation is made.

Concept change and rebuttal texts effectively achieve conceptual change using the CCA. Corrupt and concept-change texts identify students' thinking, identify existing deficits and refute them, and learn scientific knowledge with explanations and examples. There is a distinct difference between the concept change text and the refutation text. The concept change text begins with a question, and students are asked to guess that question. After the guesses are made, the error is mentioned. Solutions are worked out to eliminate the error, and examples are presented. There is no question and prediction section in the refutation text. It is clearly shown with contradictions and examples that the error is wrong (Akbaş, 2008). In this study, it was preferred to use refutation texts. The study is limited to the acquisition of "Solving problems related to percentages".

*Analysis of Data*

The percentage diagnostic test, created following the test development steps of Baykul (2015), was administered to 10 8th-grade students before the pretest was used. The students' answer sheets were examined according to the response categories of the two-step diagnostic test, and their misconceptions were identified. The results of the two-step test were analyzed according to 6 different situation categories (Table 7). We see that these

categories are mostly used in 3-stage tests in the literature (Bulut, Güveli & Güveli, 2021). Since it creates a similar situation, it was decided to use these categorical names in this study.

**Table 7.** Two-stage diagnostic test response categories

true	I am sure	Scientific knowledge(SK)
	I am not sure	lack of confidence(LC)
partially true	I am sure	lack of knowledge(LK)
	I am not sure	lack of knowledge(LK)
false	I am sure	Misconception (M)
	I am not sure	lack of knowledge(LK)

A lesson plan was created based on the misconceptions identified in the percentage diagnostic test. In creating the lesson plan, the stages of generating the CC, the rebuttal texts, and the sample questions to determine the persistence of the contradiction was prepared according to the misconceptions identified in the pretest. After the lesson plan was prepared, the application was conducted. The application spanned four lessons. After two weeks, the posttest was administered, which was identical to the pretest. The posttest results were also analyzed according to the established response categories.

The categories of pretest and posttest results are presented in frequency tables. Coding students analyzed data as S1, S2,..., and S10.

The pretest and posttest results were analyzed according to the established response categories. This study used descriptive analysis because the data were analyzed by establishing categories. The purpose of descriptive analysis is to organize and interpret the results. In this way, the data are interpreted clearly and regularly, and some results are reached in a cause-effect relationship (Yıldırım & Şimşek, 2018). In addition to the pretest and posttest results, video recordings and reflective notes in the teacher's diary made were also utilized during the implementation. In this study, the information obtained from the data was analyzed by comparing it with each other. In educational research, this analysis is called data triangulation. This method is also called data diversification. It is not limited to one data collection method, analysing the data using more than one data collection method. It can be argued that this method increases the validity and reliability of the results obtained in a research study (Yıldırım & Şimşek, 2018).

### Validity and Reliability of the Research

According to Yıldırım and Şimşek (2018), the detailed record of the results collected in qualitative studies and the explanation of how the researcher reached the conclusions are important components of validity. They stated that it is necessary to study validity in two areas, namely internal validity and external validity. Internal validity means the study is consistent, and external validity means the study is transferable. Some measures were taken to increase the validity and reliability of the research. These are: 1) A pilot study was conducted. 2) Expert opinion was sought in developing the test and creating the lesson plan to ensure content validity. 3) The item analysis calculated each test item's difficulty index and item discrimination index. Each item was retained in the test. 4) The correlation of the scores obtained with the test was high. 5) The results obtained were internally consistent and formed a meaningful whole. 6) The results were considered realistic by the students participating in the study. 7) Data analyzed by triangulation method. 8) Each stage of the application was video recorded. 9) The research explained the sample, data collection instruments, and application stages in detail. 10) Research is a study that can be easily applied to other fields. It can be applied wherever opportunities and possibilities are scarce.

### Finding

The diagnostic test was administered before and after the application of the lesson plan created according to the CCA. According to the pre-post test results, the student answers were divided into categories (SK, LK, LC, M) and shown in table 8.

**Table 8.** Categorical transformations of pretest and posttest results

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10
Students	Pre test	Post test								
S1	M	SK	LK	SK	LK	SK	LK	SK	LK	SK
S2	LK	LK	M	M	M	LK	LK	LK	M	LK
S3	LK	LC	M	M	LC	M	LK	LK	M	LK
S4	SK	SK								
S5	LC	SK	LC	SK	LK	SK	LK	LK	LK	LK
S6	SK	SK								
S7	SK	SK								
S8	LK	LK	M	M	LK	LK	LK	LK	M	LK
S9	SK	SK								
S10	M	LK	SK	SK	LK	LK	LK	LK	SK	LK

### Findings on the Lack of Knowledge Category according to the Pre-Post Test Results

According to Table 8, 41 responses of 10 students fell into the LK category in the pretest, while 45 responses fell into the LK category in the posttest. 12 Ms, 4 SKs, and 1 LC from the pretest became LKs in the posttest. 28 responses were in the LK category on the pretest and remained in the same category on the posttest.

### Findings of Scientific Knowledge Category according to Pre-Post Test Results

Table 8 shows 35 responses in the SK category in the pretest. At the same time, this number increased to 50 in the posttest. Except for the 7th question, it was observed that the responses in the SK category increased in the posttest compared to the pretest. 4 Ms, 12 LKs, and 3 GEs from the pretest turned into SKs in the posttest. 31 responses were in the SK category in the pretest and remained in the same category in the posttest.

Below is an example of student work that was scored in the "misconception" category on the pretest and the "scientific knowledge" category on the posttest.

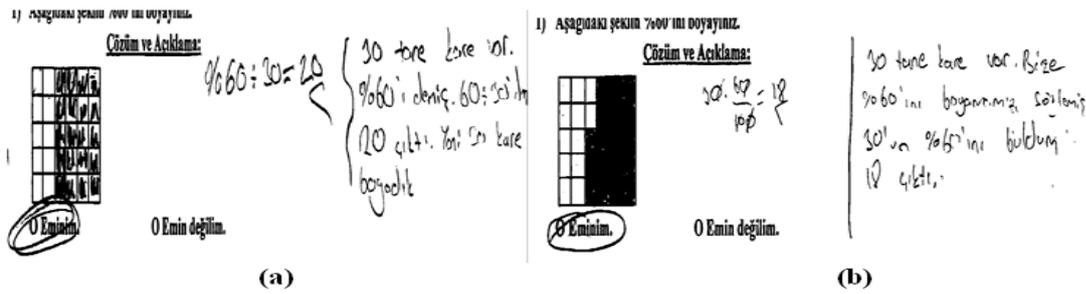


Figure 4. S1's 1st question pretest (a) and posttest (b)

S1 tries to find 60% of 30 squares in the pretest by dividing 60 by 30. In doing so, he does not take the percentage into account and makes a calculation error. In the posttest, he correctly calculates 60% of 30 squares as 18. S1's response was scored in the "Misconception" category because he answered incorrectly in the pretest and said "I am sure," and in the "Scientific Knowledge" category because he said "I am sure" after he solved it correctly in the posttest.

### Findings on the Lack of Confidence Category According to the Pre-Post Test Results

Table 8 shows 4 responses of 10 students in the GE category in the pretest. At the same time, this number decreased to 2 in the posttest. 1 LK in the pretest and 1 M in the posttest were converted to GE. There has yet to be a response from the student who was in the GE category in the pretest but remained in the same category in the posttest.

When examining the student's pre-post test, Table 9 below shows which student answered each question according to the lack of confidence category.

**Table 9.** Pretest and posttest lack of confidence category frequency table

Items	Pretest	f	Posttest	f
Item 1	S5	1	S3	1
Item 2	S5	1	S3	1
Item 3	-	0	-	0
Item 4	-	0	-	0
Item 5	S5	1	-	0
Item 6	-	0	-	0
Item 7	-	0	-	0
Item 8	-	0	-	0
Item 9	-	0	-	0
Item 10	S5	1	-	0

Table 9 shows that S5, who showed a lack of self-confidence in the pretest, did not feel a lack of self-confidence in the posttest. It was found that S3, who lacked self-confidence in the pretest, showed a lack of self-confidence in questions 1 and 2 of the posttest.

*Findings on the Misconceptions Category According to the Pre-Post Test Results*

Table 8 shows that 20 responses of 10 students fell into the M category in the pretest. At the same time, this number decreased to 3 in the posttest. There were no student responses that became M on the posttest. Three students remained in the M category in the pretest and posttest, i.e., they did not change their misconception.

**Table 10.** Pretest and posttest misconception category frequency table

Items	Pretest	f	Posttest	f
Item 1	S1, S10	2	-	0
Item 2	S2, S3, S8, S10	4	S2	1
Item 3	S2, S8	2	S2	1
Item 4	S3, S8	2	-	0
Item 5	-	0	-	0
Item 6	S2, S8, S10	3	S2	1
Item 7	-	0	-	0
Item 8	S2	1	-	0
Item 9	S2, S3, S8, S10	4	-	0
Item 10	S2, S10	2	-	0

According to Table 10, only S2 maintained misconception in questions 2, 3 and 6. The other students had no misconceptions in the posttest. According to the pretest results, the students' misconceptions can be represented as follows.

M1: It is traded between the percentage amount and the indicated multiplicity without considering the percentage. In the following example, the student who wanted to find 40% of the number 80 subtracted 40 from 80 without considering the percentage.

**Cözüm ve Açıklama:** 80 - 80'nin yüzünün yüzü  
%40  $\frac{40}{100}$  40'dür yüzden

Eminim.  Emin değilim.

Figure 5. S2's answer

M2: Takes the percentage of the given multiple and converts it to fractions (adds, subtracts, or divides). In the following example, the student who wanted to find 10% of 80 converted the number 80 into a fraction by writing  $\frac{80}{100}$ .

**Cözüm ve Açıklama:** paydaları eşitledim ve 80'ni 10'a böldüm

  $\frac{80}{100} : \frac{10}{100} = \frac{8}{100} = \%8$  0-1  
Kuvvetin 10'a 10'dür

Eminim.  Emin değilim.

Figure 6. S10's answer

M3: The percentage of a product changes depending on the number of products.

In the following example, shirts worth 50 TL are sold at a discount of 20%. To find out how much the person who buys two shirts will pay, the student thinks those who buy two shirts will buy shirts worth 100 TL with a 40% discount when adding 20% to 20%.

**bir kişi toplamda kaç TL ödemesi gerekir?**

**Cözüm ve Açıklama:** İki tane gömlek alıyor toplamda 100 TL ödemesi gerekiyor ama bir gömlekte için toplamda %40 indirim oluyor 1.20 indirim olduğu oluyor

  $\frac{100}{100} : \frac{40}{100} = \frac{4000}{100} = \%40$   $\frac{100}{40} = 2.5$   $\frac{4000}{100} = 40$

Eminim.  Emin değilim.

Figure 7. The answer of S10

When examining the diagnostic test on the percentages of students, Table 11 below shows which students answered each question according to the misconception category.

**Table 11.** Distribution of pre-post test questions according to misconceptions

Misconceptions	Items	
	Pre test	Post test
M1	1, 2, 3, 4, 6, 8, 9, 10	2, 3
M2	2, 4, 6, 9, 10	6
M3	10	-

According to Table 11, in the pre-test, M1 is seen in the answers to questions 1, 2, 3, 4, 6, 8, 9 and 10. M2 is seen in the answers to questions 2, 4, 6, 9 and 10, and M3 is seen in the answer to the 10th question. In the post-test, M1 is seen in the answer to the 2nd and 3rd questions. M2 is seen in the answer to the 6th question. M3 was not found in any response in the posttest. It is seen that misconceptions (M1, M2, M3) decreased in the post-test.

*Findings from on the CCA in Classroom Practices*

The following are some of the data obtained from the video recordings and teacher diaries in each stage of the 5SCC.

First stage: The misconceptions (M1, M2, M3) identified in the first stage of the 5SCCA through the pretest were written on the board.

The teacher asked the students to think about whether these statements written on the board were true or not. In order to better understand the misconceptions written on the board, these misconceptions were explained with an example. When the teacher wrote these misconceptions on the board, The following dialogue took place with the students.

S1: *I'm sure I did it (laughing).*

Teacher: *Another misconception is that the percentage amount in a product varies according to the number of products. For example, if there is a 20% discount on a product, some of you thought there was a 40% discount when two pieces of that product was bought.*

S4: *This was in the shirt question.*

Teacher: *We have 3 misconceptions like this. Do you remember them?*

S1: *There are indeed, teacher. There must be.*

S9: *I didn't do that.*

S4: *(surprised) I congratulate them.*

S3: *(laughing) I might have done the last one.*

The teacher recorded the following statements in the observation notes during the first stage of the CCA:

*“In the first lesson, the students did not find it strange that I recorded the lesson with a camera. When I wrote the misconceptions on the board, a few of the students who had misconceptions gave themselves away. Some of them were surprised by the misconceptions. There was laughter in the class.” (Extract from the teacher diary, 2021).*

As the teacher revealed the misconceptions, the students who had misconceptions realized that they might have fallen into these misconceptions. It is understood from the reactions of S1 and S3 that they have some of these misconceptions. Some students showed reactions indicating that they had misconceptions similar to the misconceptions written on the board. The students who did not fall into misconceptions were surprised that these misconceptions were made. Some of these students laughed. In order to prevent students who made mistakes from feeling bad, the teacher stated that it was possible to make mistakes and gave the necessary warnings. The teacher did not talk about the students who made mistakes, but rather about the mistakes themselves.

Second stage: In the second stage of the CCA, a cognitive contradiction was created. Based on the misconceptions written on the board, three different contradictions were tried to be created. The teacher started the second stage by saying that if the thought of  $40+30=70$  with a 30% profitable sale price of a 40 TL product were correct, the 50% profitable sale price of a 40 TL product would be  $40+50=90$ . Subsequently, a dialogue took place between the students as follows.

*Teacher: Friends, what does 50% mean?*

*S1: Half of it*

*Teacher: If 50 per cent profit is half as much profit, what is half of 40?*

*S4: 20*

*Teacher: Then what is the profitable selling price?*

*S9: It would be 60 TL.*

*Teacher: At first we said 90. Now we say 60. Can we see the contradiction?*

*S8: Yes.*

*Teacher: Where did this contradiction originate from?*

*S8: I think he may have performed addition operation because he thought he had to add it to something there is profit involved.*

A cognitive contradiction was created for students with M1. While creating the CC, the percentages that students use most in daily life were utilized. While creating the first CC, the expression 50% was used to create a conflict for the students. As can be understood from the dialog, many students knew the meaning of 50%. S1 is among these students. When the teacher asked about the profitable selling price, it was understood that S9 knew the meaning

of profit according to his answer. The answer of S8 revealed what students with misconceptions thought and why they had these misconceptions.

Creating the second contradiction, the teacher said a product worth 40 TL would be sold at a price of 39,4  $[\frac{40}{1} - \frac{60}{100} = \frac{4000}{100} - \frac{60}{100} = \frac{3940}{100}]$  with a 60% loss according to the second misconception. The teacher said if this thought were true, which would mean the selling price of 40 at a 50% loss would be  $\frac{40}{1} - \frac{50}{100} = \frac{4000}{100} - \frac{50}{100} = \frac{3950}{100} = 39,5$ . When the teacher had the students calculate based on half of 40, the answer was 20. The dialogues between the teacher and the students were as follows.

*Teacher: At first we said 39,5 and now it is 20, so is there a contradiction here? Did we see the contradiction?*

*S9: Yes, we did. Since there is 60% loss, he converted it to a fraction and subtracted it.*

*Teacher: We found two different results for one question. Which one do you think is correct?*

*S9: 2.*

*S4: Because it is the right answer.*

*S8: I didn't see the contradiction.*

*Teacher: In the first solution, we had 39,5 TL and in the second solution we had 20 TL. Which one do you think is correct? Why did we find different results?*

*S9: In the first one, he subtracted the number from the loss.*

*Teacher: In the 2nd solution, didn't he subtract the number from the loss?*

*S4: He subtracted it with 60.*

*S9: He wrote the denominator directly to the percentage and subtracted it. He should have found 60% of it first and then subtracted it. Here, he wrote the denominator to the percentage and subtracted it.*

*Teacher: Do 40 TL and 60% have the same meaning?*

*S7: They are not, teacher.*

*Teacher: When he says 50%, he means an amount, half of it.*

*T4: If we divided by 2, we would find the number correctly. We would find 50% of it.*

*Teacher: S8 did you see the contradiction?*

*S8: (He nodded his head in the sense of yes.)*

In the dialog that emerged when the teacher created the second cognitive contradiction with the students, it was seen that S8 tried to see the difference between misconception and truth. S8's confusion led to the formation of a contradiction. Based on his answer, it was thought that he realized that percentage and multiplicity did not have the same meaning and he could see the contradiction. According to the dialog above, it was seen that S4, S7 and S9 understood how the students who had misconceptions realized their misconceptions. It was understood that these students knew the meaning of 50% and what to do in loss calculations.

After giving the third misconception, the teacher directed the students towards the contradiction by saying "if this thought were true". The teacher stated that if a product of 40 TL was sold with a 10% discount and the discount would be 20% if 2 of these products were bought, and when this product of 40 TL was sold with a 25% discount and if 2 of these products were bought, there would be a 50% discount. The following dialogues took place between the teacher and the students.

*Teacher: Is there a contradiction here? Did we see the contradiction?*

*S8: It is the same thing here as above. He took a shortcut.*

*S9: The contradiction is the same again, teacher. He added the discount prices. Then he found their total price.*

*Teacher: What would this person say if 3 products had been bought?*

*S8: He would say 75% then.*

*Teacher: What if he had bought four?*

*T4: 100% discount.*

*T7: Free.*

*(Students laughed.)*

*T9: He would make a huge profit if he could slip it past.*

According to the dialogue above, when the third cognitive contradiction was created, it was understood that S8 realized the contradiction more easily. It was determined that the students who answered the questions asked by the teacher were mostly S4 and S9. The students realized that the idea that 4 products would be free was wrong. In the second stage of the CCA, generation of cognitive contradiction, it was determined that the students expressed themselves more. As seen in the dialog above, it was observed that the students both experienced conflict and started to overcome CC by having fun and commenting comfortably in the process. In the second stage of the CCA, the teacher's observation notes were as follows:

*"Some students did not speak at all in this lesson. I asked questions to S1, S2, S3, S5 and S10 who did not speak. They know what 50% was. Most of them answered my questions. There were some who answered when I asked questions. Students who had no misconceptions participated more in the lesson. These students were S4, S7, S9. Misconceptions created funny situations. Students laughed." (Excerpt from the teacher's diary, 2021).*

As can be understood from the teacher's observation notes and dialogues, some students were more active while creating contradictions and some students remained silent. It is understood that the teacher created a contradiction by guiding these students with questions. It was observed that these students knew that 50% means half and could easily find half of any multiplicity. All students were asked whether they noticed the contradiction.

The contradiction was tried to be created again with the students who did not notice it. At this stage of the CCA, a cognitive contradiction was formed with all students participating in the process.

Third stage: At this stage of the CCA, students were given scientific information about percentages. First, students were shown how to write the percent as a fraction, followed by the method of multiplying by the numerator and dividing by the denominator (Figure 1). After this method was explained to the students, the method of multiplying the percent converted into a fraction by a multiple was explored with the students. It was emphasized that simplifying the percent converted to fraction would provide convenience for the students. Afterwards, the students were read the rebuttal texts prepared for them.

Four stage: In the fourth stage of the CCA, students were given questions that showed that their new knowledge worked in different examples. While solving the questions, the students solved the questions by acting them out in accordance with the storyline of the questions. In the fourth stage, when it was understood whether the new knowledge worked or not, the following dialogues took place between the teacher and the students.

After the store question was read, students were given time to solve the question. Then, two students were chosen as sellers and one student was chosen as a customer to act out the problem. S3 was chosen as the customer, S9 and S8 as the seller. Since the product price was not given in the question, it was decided that the product purchased was a jacket and its price was 100 TL for the sake of convenience. The following conversation took place between S3 and S9.

*S3: Hello, I couldn't calculate how much this jacket costs, how much does it cost? (20%+20% discount)*

*S9: Okay, let's calculate it right away.*

*S9: That is 64 TL. (he is trading on smart board with processor knowledge)*

*S3: Thank you. Let me think about it and decide.*

When S3 went to the other store, the conversation between him and the seller (S8) was as follows:

*S3: Hello, I liked a jacket and it was 100 liras. I couldn't calculate the discount(40% discount)*

*S8: Ok, let's calculate now. (computes on smart board with processor information). Discount 40 TL discounted price 60 TL*

The teacher tried to create a contradiction by asking questions to these students. Therefore, the teacher chose these two students to check whether their misconceptions persisted. The students were asked to both act out and solve the question. Although they were not enthusiastic at first, it was observed that they did not have any problems while solving and acting out the question. Students solved the question with mutual dialogs. During the role-playing, it was observed that the students who did the role-playing along with the other students had fun moments.

The teacher asked the students to solve the shirt question (If a 10% discount is applied to a 60 TL shirt, how much would a person who buys 5 of these shirts pay?) and gave them time. While solving the question, a dialog took place as follows.

*S7: If the man buys 5 shirts, there is no need for a discount, he is already rich.*

*Teacher: Did you calculate? S8?*

*S10: First I found 10% of 60 TL. We will subtract 6 from 60 and multiply by 5.*

*Teacher: How much was 10% of it?*

*S10: 6 liras of discount.*

*Teacher: So, how much does a shirt cost?*

*S10: If we subtract 6 from 60, we get 54. Then we multiply 54 by 5.*

*S1: 270.*

It was observed that students were more willing and active in the shirt question. It was observed that students such as S1, S3, S10, who were silent in the previous stages, answered the questions more.

In the fourth stage of the CCA, students solved a total of 9 questions by both discussing and role-playing. At this stage, the aim was to test whether the existing misconceptions persisted or not. All students participated in the class during the role-playing and solving stage. The students' participation in the questions, the methods they used while solving the questions and the teacher's observations showed that the students' cognitive contradictions did not persist. No student was found to use the methods that were initially presented as misconceptions. Therefore, the conclusion stage was started after this stage.

Fifth stage: In the fifth stage of the CCA, conclusions were drawn. At this stage, the following dialogues took place between the teacher and the students.

*Teacher: In conclusion, what have you learned today? When finding the percentage of a multiplicity, do you add the multiplicity and the percentage? Is it subtracted? Is it divided?*

*Students: (in unison) No.*

*Teacher: Can the given multiplicity and percentage amount (converted to a fraction) be added as you do with fractions? Is it subtracted? Can it be divided?*

*Students: (in unison) No.*

*Teacher: Does the percentage in a product vary according to the number of products?*

*S4: No. We find it and multiply it by 2 (to find the discounted price of one product and calculate the total discounted price of two products).*

*S9: It remains the same.*

*S1: No, teacher.*

It was unanimously confirmed that multiplicity and percentage would not be added, subtracted and divided; multiplicity and percentage will not be added, subtracted and divided (by converting to fraction); and percentage would not change according to the number of products. Although they showed that the misconceptions were eliminated by answering the questions collectively, the teacher wanted to verify this determination individually. For this reason, the posttest was administered to the students 2 weeks after the implementation.

## **Discussion and Conclusion**

### *Discussion and Conclusion About Pretest Posttest Results*

The data obtained from the pretest and posttest were analyzed in four different categories. Discussion and conclusion are presented according to these categories.

Discussion and conclusion on the category of lack of knowledge: After applying the CCA to the students, it was found that the level of missing knowledge increased in the posttest compared to the pretest. However, this transformation should not be interpreted negatively. Because 12 M transformed into LK in the posttest. According to Güveli et al. (2022), lack of knowledge is better than misconception. Because the lack of knowledge can be corrected. However, clearing up the misconception is a difficult task. Students may be resistant to misconceptions. In the case where 4 SKs transformed into LK, students' responses were examined. It was found that students experienced this transformation because they answered the questions partially correctly, mostly through operator error. Similarly, it is suspected that the conversion from the 1 GE category to the LK category was partly caused by students' incorrect answers. Misconceptions and contradictions that students see during instruction with the CCA may have caused them to go back and forth. This situation may have caused them to need clarification on their information. These students may need more time and more practice.

Discussion and conclusion of the scientific knowledge category: In the pretest, it was found that the level of scientific knowledge was low. After applying the CCA to the students, it was found that the level of scientific knowledge increased in the posttest. The students had

less knowledge about percentages, but they learned the topic better and increased their scientific knowledge level after the activities with the CCA, the problems they solved, and the misconceptions they recognized. Some students' solutions fell into other categories. Ten students' responses changed from the lack of knowledge category to the scientific knowledge category, three students from the lack of confidence category to the scientific knowledge category, and four from the misconceptions category to the scientific knowledge category. This change shows that the course taught with the CCA is effective in learning. Because the students better structured their knowledge with the practices they did, the contradictions they saw, the rebuttal texts they read, and they were able to convert the correct answers that they were not sure of into "I'm sure" answers. Studies show that the CC method is effective in learning and increases learning success (Başer, 2006; Chow & David, 2013; Güveli et al., 2022; Herawaty & Rusdi, 2016; Toka & Aşkar, 2002).

Discussion and conclusion of the lack of confidence category: In the pretest, it was found that the level of lack of confidence was at a low level. After applying the CCA to the students, it was found that the level of lack of confidence decreased even further in the posttest. Looking at the pretest results, only one student's response to 4 questions fell into the lack of confidence category. It was observed that this student no longer answered the same questions in the lack of confidence category in the posttest responses. Only the student's two responses coded as S3 on the posttest fell into the lack of confidence category. It was noted that one of this student's pretest responses fell into the lack of confidence category fell into the lack of knowledge category, and the other fell into the misconception category. Lack of confidence is a condition of not being sure whether to answer correctly or not. The transformation of the student's response from a lack of knowledge and misconception to a lack of confidence can be seen as a positive transformation. However, the fact that the student is not sure of the answer suggests that the student needs a little more time to internalize the information. In the study of Güveli et al. (2022), some misconceptions and lack of knowledge turned into a lack of confidence in the posttest. Similar results were found in this study as well.

Discussion and conclusion of the misconception category: The pretest identified 20 responses that belonged to the misconception category. After applying the CCA to the students, it was found that this number decreased significantly in the posttest of scientific knowledge level. Although the students had less knowledge about percentages, they learned

the topic better after the activities using the CCA and the tasks they solved, and their misconceptions decreased. It was found that 3 responses identified in the posttest fell into the misconception category. The student who continued the misconception was S2. It was observed that this student continued his misconceptions on questions 2, 3, and 6. Eliminating misconceptions is a difficult task. Studies show that misconceptions decrease but do not completely disappear (Chan, Burtis, & Bereiter, 1997; Güveli et al., 2022; Sumarna & Yulistiana, 2016). Efforts should be made not to eliminate misconceptions, but to prevent misconceptions from occurring. This is because when a misconception occurs, the student may retain that misconception even after graduation from the university. His misconceptions as a teacher candidate may be transferred to the student when he enters the profession. The reason for the persistence of the misconception may be that the student does not listen well, does not participate in the activities, and does not create CCs. Akpınar, Erol, and Aydoğdu (2009) argue that students' level of knowledge, achievement, interest, and motivation in the subject affect their engagement in CC.

In this study, misconceptions similar to those in the literature were found. It can be seen that students who focus more on the rules and methods than the concept in teaching the errors and percentages detected are stuck on the rules (Koay, 1998). This study found that students stuck to one rule and overgeneralized in the pretest and posttest responses. It is observed that students make an error in overgeneralization, especially by using the rule "multiply the amount by the percentage and divide by 100" in questions (Koay, 1998). In this study, it was found that S10 solved questions in the same way in both the pretest and posttest and overgeneralized by converting to fractions and equating the denominator. This study found that some students did not know the gain and loss status. It can be said that these students have a misconception of the limited perception type. Some studies in the literature encountered similar difficulties (Risacher, 1992).

The shirt question asked in the pretest, where misconceptions were found, was a question that misled the students. Students' assumption that there was a 20% discount for one product and a 40% discount for two products in the shirt question resulted in error M3 (The percentage of a product changes according to the number of percentages). It is also seen in the literature that students have problems with questions that include "discounts". A similar problem belongs to the questions solved in the 4th stage of the CCA. A question that reveals a similar misconception is found in the study of Bingölbali and Özmantar (2010).

They concluded that the CCA developed for this study caused a difference in students' pretest and posttest scores. On the posttest, students' responses increased in the SK category and decreased in the LC and M categories. The lack of self-confidence, decreased misconceptions, and increased scientific knowledge is positive outcomes of the CCA. Studies on CC (Akgün & Deryakulu, 2007; Chaw & David, 2013; Gökçe-Erdem, 2021; Güveli et al., 2022; Herawaty & Rusdi, 2016; Madu & Orji, 2015; Sumarna & Yulistiana, 2016; Yaman, 2013; Yılmaz, 2019) concluded that this method has a positive effect on conceptual change.

#### *Discussion and Conclusion on the CCA in Classroom Practice*

The misconceptions identified were tried to be eliminated using the lesson plan prepared according to the five stages of the CCA. It is possible to say that most of these misconceptions were eliminated as a result of the posttest. The positive effect of the CCA in eliminating misconceptions revealed the effectiveness all of the stages. Students saw the contradiction between their old knowledge and new knowledge in the second stage. It was thought that students experienced conceptual change thanks to the contradiction formed at this stage. Limon (2001) revealed that conceptual change can be realized by comparing students' prior knowledge and new knowledge. There have also been studies that consider experiencing CC between old knowledge and new knowledge as the first step towards conceptual change (Moody, 2010; Posner et al., 1982).

In the traditional method, students are told repetitions when misconceptions are encountered. Students are made to learn a subject they do not understand using the same method. With this method, individual misconceptions are taken into account and a contradiction is created for each one and misconceptions are tried to be addressed. Although the misconceptions are not completely removed, contradictions create awareness in students and push them to do more research. And this is the first door to learning. The CCA used in this study was more effective in eliminating misconceptions than the traditional method. Some studies have shown that it is difficult to eliminate misconceptions with traditional methods and that CC is more effective in eliminating misconceptions (Toka & Aşkar, 2002; Niaz, 1995; Madu & Orji, 2015; Başer, 2006). The most entertaining part of the application was the parts where the discussion questions were played out. It was observed that students made jokes, laughed and had fun over the questions. As in Chow and David's (2013) study, this situation prepared the environment for students to develop a positive attitude towards mathematics. It was observed that students were most active in the 2nd and 4th stages of the

lesson. The second stage was the stage in which the cognitive contradiction was formed, and it was a stage in which students made comments and expressed the contradictions they experienced. The fourth stage was the stage where it was understood whether they would fall into contradiction again after structuring new knowledge. At this stage, the questions were solved by the students. Students were active in almost every stage of the CCA. A few students who were silent in the lesson were animated with the intervention of the teacher. It was found that this study increased the interaction between students and teachers. It can be said that the fact that students are so active in the stages of cognitive contradiction contributes positively to their processes of generating contradictions, recognising contradictions and constructing scientific knowledge. Akar's (2003) idea that students should actively participate in the learning process in order to construct their own knowledge supports this situation. Although the use of this approach requires some preparation on the part of the teacher, it is considered useful in creating cognitive contradictions in students, creating awareness and attracting their attention. The fact that the students in the study group had prior knowledge of the topic of percentages had a positive effect on all stages of the CCA. When selecting the topic for CC-based applications, it should be taken into account that the students have a certain level of knowledge about the topic (Akpınar, Erol, Aydoğdu, 2009). Otherwise, it will be difficult for them to experience CC. It is also possible to apply this approach in overcrowded classes.

### **Suggestions**

CCA can be applied to students who have misconceptions in mathematics lesson. Rejection texts can be included in source books. Teachers should receive in-service training to teach with this approach. The effect of the CCA can also be studied in other mathematics topics where misconceptions occur. The CCA can be supported by various techniques (analogy, concept cartoons, concept change texts, etc.). It is recommended that the CCA be used to address misconceptions at different grade levels.

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#### *Ethical Committee Permission Information*

*Name of the board that carries out ethical assessment: Recep Tayyip Erdoğan University  
Social and Humanities Scientific Research Ethics Board*

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Author Contribution Statement

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**Ebru GÜVELİ:** Conceptualization, literature review, methodology, data analysis, translation, and writing.

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