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The Effects of Cover-Copy-Compare Interventions to Enhance Fluency in Mathematics: A Systematic Review Study

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Abstract

Systematic teaching techniques that offer a wide range of exercises need to be applied to enhance math fluency. Cover-Copy-Compare (CCC) is one of the most effective intervention used to increase the accuracy and fluency rate of students in basic facts. In the literature, it is noted that this intervention which is observed to be applied with different methods enable students to perform fluently and gain numerous math skills. This study aims to analyse studies using CCC for enhancing accuracy and fluency rate according to defined categories. In this study, 22 studies, which meet the inclusion criteria, were reviewed with document analysis. These studies were examined according to methodological and participant features, CCC interventions, effectiveness, maintenance, generalization, and social validity and the results were presented in tables within the scope of this study. The findings obtained through the document analysis were discussed together with limitations of the studies and suggestions for further studies. As a result, it can be said that CCC is a method that can easily be applied to enhance basic fact fluency of all students who are attending the first grade to tenth grade in general education and special education settings, all of whom are between the ages of 7-12. In this regard, when the implementers want to enhance fluency in basic facts, they can benefit from CCC, which is an evidence-based intervention and ensures systematic repetition.

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INTRODUCTION

Basic math skills include counting, addition, subtraction, multiplication, and division facts. Basic skills are required to be used effectively in appearing in daily life problems such as using money, clock reading, managing time, and possibility calculations (Hudson & Miller, 2006; Stein et al., 2006). Acquisition of these skills is as critical as self-care and daily life skills to ensure the full participation of all students with (Alptekin, 2019; Allsopp, Kyger & Lovin, 2017; Cawley & Miller, 1989; Hudson & Miller, 2006; Stein et al., 2006) and without (Reys et al., 2009; Sayelski & Paulsen, 2010; Van de Walle, Karp & Bay-Williams, 2004) special needs in social life. However, it is not enough to have basic skills to acquire these critical skills. At the same time, these skills need to be presented fluently (Cates & Ryhmer, 2003; Shapiro, 2011).

Math fluency is the ability of a student to give the correct response easily and repetitively to the basic math facts (Johnson & Layng, 1996; McCallum et al., 2006; Poncy, Skinner & Jaspers, 2007). The students who lack these skills (who cannot perform basic facts fluently) have difficulty when they move on to more complex math skills (Stocker & Kubina, 2017; Windingstad et al., 2009). For instance, a student who uses finger counting to calculate single-digit numbers with single-digit numbers (3+2=?) will try to use finger counting for adding two-digit numbers with regrouping (38+42=?) and exert more effort. In addition, when basic math skills are not performed quickly, correct responses to recently learned skills significantly decrease, and deficiencies occur in the skills of these students (Billington & Ditomaso, 2003; Bliss et al., 2010). Due to the hierarchical structure of mathematics, these deficiencies cause students to have difficulties in learning mathematics (Gürsel, 2010). These difficulties can be seen not only in students with special needs but also in all students, thus, enhancement of fluency in math skills becomes more important to prevent this problem.

Enhancing fluency in mathematics is possible through systematic teaching techniques that allow a student to do plenty of exercises. Cover-copy-compare (CCC) is one of the most effective interventions used to increase the accuracy and fluency rate of students in basic facts. CCC allows students to receive immediate feedback and increase the rate of their corrective feedback. It is because of the short interval in CCC between stimulus and response (Skinner et al., 1993; Skinner, Ford & Yunker, 1991). CCC offers students a wide range of exercises. Having plenty of exercises reinforce the behaviour at certain intervals to ensure permanence of these skills (Skinner et al., 1989; Skinner, McLaughlin & Logan, 1997). Since the student controls the accuracy of the response in CCC, it allows the student to evaluate themselves (Grafman & Cates, 2010; Stocker & Kubina, 2017). CCC is an intervention that is easy to apply, practical and requires simple preparations when it is considered in terms of implementers. CCC can be evaluated as time-efficient and cost-effective intervention (Poff et al., 2012; Skinner et al., 1992), which can be applied in different ways (Becker et al., 2009; Codding, Eckert, et al., 2007; Grafman & Cates, 2010; Johnson, 2014; Lee, 2014; Morton & Gadke, 2018; Skinner et al., 1991; 1992; Skinner, Belfiore et al., 1997) and can be combined with different techniques (Parkhurst et al., 2010; Poncy, Skinner & O'Mara, 2006).

CCC consist of five application steps. In the first step, the student reads the first fact and its answer on the worksheet prepared beforehand. In the second step, the student covers the part that s/he read. In the third step, the student responses to the fact on the right side of the page and in the fourth step, s/he opens the cover. In the last stage, the student compares his/her answer with the correct one. If the answer is correct, s/he moves on to the next fact. If the answer is wrong, s/he crosses out the wrong answer and writes the correct answer. The process is similarly repeated for all facts in the worksheet (Skinner et al., 1989; 1997). Stocker and Kubina (2017) indicated in their review study that CCC is applied in three different ways including verbal CCC (V-CCC), model CCC (M-CCC) and cognitive CCC (C-CCC). In the third step of V-CCC, a verbal response is given instead of a written response. In the second step of M-CCC, the student reads the fact and its answer once again before

covering it, and then writes the fact and its answer. Therefore, the student sees the fact and its answer twice. In the third step of C-CCC, the student gives a sub-vocal response.

In the literature, after Skinner et al. (1989) pioneered CCC intervention in the field of mathematics, many studies have been conducted to investigate the effects of CCC in the enhancement of accuracy and fluency in basic math skills. Some of these studies investigated; the effects of CCC on students with different characteristics (*i.e.,* Alptekin, 2019; Lee & Tingtorm, 1994; Skinner et al., 1989), the most effective CCC combinations to address different needs of the students (i.e., Skinner et al., 1997; Skinner, Belfiore et al. 1997), different effects of CCC combined with other techniques used for improving the fluency (*i.e.,* Codding et al., 2007; Mong & Mong 2012). In these studies, target behaviour, participant features, settings, application methods, research design, maintenance, generalization, reliability, and social validity data were analysed and the data collection method, CCC application steps and results (effects on students) were discussed in one study to allow people to have access to the information related to CCC interventions. Moreover, it is considered that identifying strengths and weaknesses on this subject according to these studies will shed light on new studies.

There are studies in the literature that examine related studies with CCC interventions. A meta-analysis study of Joseph et al. (2012), which examines the studies conducted with typically developing students and students with special needs in the settings (word spelling and mathematics) where CCC is used. The research covered by this study was analysed according to participant features, CCC methods, settings, research pattern and independence measurements. In the review study of Stocker and Kubine (2017), studies that are conducted to increase the fluency of students with disabilities, were analysed. The studies were analysed in terms of how fluency is measured and calculated, how the fluency criterion is determined in each study, which form of CCC is used and examined its effects on the participants. This study differs from other studies by focusing on various studies and new studies in terms of participant characteristics, settings, research designs, CCC interventions and obtained results as well as the target behaviours, application of CCC (one-to-one or group), maintenance, generalization and social validity data, reliability data and their comparison in comparative studies.

The aim of this study is to analyse the studies using CCC to enhance accuracy and fluency in mathematics in the light of defined categories. Research questions related to these categories are as follows:

1. What are the characteristics of participants and the dependent and independent variables of these studies? Which techniques have been compared with the CCC in comparative studies?
2. What are the characteristics of the method used in these studies?
3. What is the application (CCC intervention) features of these studies?
4. What are the results of effectiveness, maintenance, generalization, and social validity in these studies?

METHOD

RESEARCH DESIGN

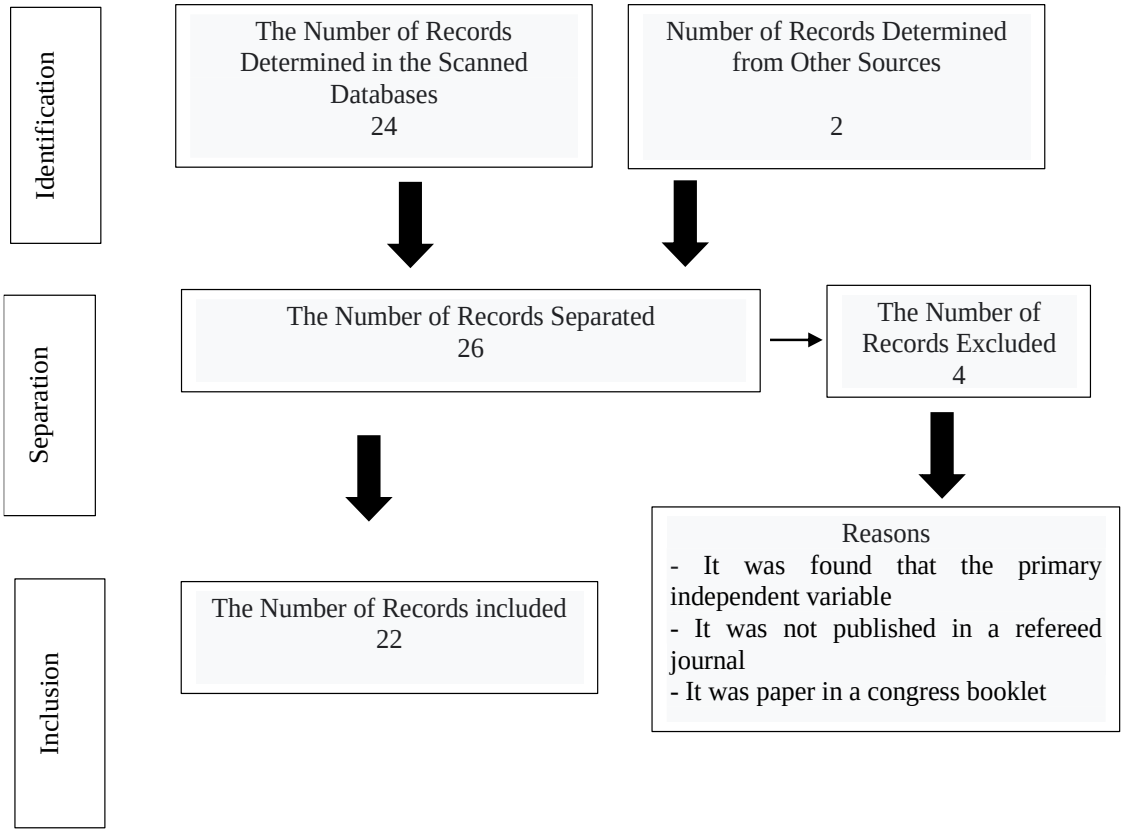
Document analysis, which is one of the qualitative research methods, was used in this study. Document analysis covers the analysis of written materials containing information on the phenomenon (Bowen, 2009; Yıldırım & Şimşek, 2011). In this research, the documents obtained about the CCC technique used in the enhancement of fluency in mathematics were analysed in the light of the determining variables.

To identify the studies to be included in this study, some criteria were determined first. These criteria are as follows (1) publication in a peer-reviewed journal, (2) experimental studies, (3) the primary independent variable (or one of the variables) is CCC, and (4) the target behaviours are math skills. Studies published in English or Turkish, from the first basic research conducted in 1989 until

2021, were included in the research. All studies that meet the purpose and the criteria were included in the evaluation.

The keywords were determined in this study to reach the relevant studies. Keywords were defined as 'cover-copy-compare', 'math fact fluency', and 'basic math facts'. Then, keywords were entered into EBSCO, ERIC, and Google electronics databases through data resources of a public university. To reduce the possibility of missing studies, among keywords, 'cover copy compare' together with the math fact fluency or similar 'basic math fact' keywords were entered into the databases and scanned. Searches were carried out by testing the keywords entered together and/or their operators separately. Figure 1 shows the process of identification, separation and inclusion of sources.

Figure 1. *Diagram detailing steps in the identification, separation and inclusion of sources*



As can be seen in Figure 1, 24 studies were reached in databases scanning. These studies were reviewed and pre-scanned. As a result of preliminary scanning, it was found that the primary independent variable in two of these studies was not CCC (Parkhust et al., 2010; Poncy et al., 2006), one of them was an exemplary practice rather than an experimental study (Alptekin et al., 2016) and one of them was not published in a refereed journal and was a full-text paper in a congress booklet (Cressey & Ezbicki, 2008). Therefore, these four studies were not included in this study. Then, references of the remaining 20 studies were examined and it was identified that there were 2 more studies to be included in this research. However, only the abstracts of these studies were reached in these electronic databases. Accordingly, the Turkish Academic Network and Information Center-ULAKBİM was used to check whether national information sources could be accessed, and it was determined that there were relevant studies in some university libraries. Then, a request was made through the system and the studies were accessed. These studies were reviewed, and it was determined to be eligible for the criteria. As a result, a total of 22 studies were found.

DATA ANALYSIS

The studies reached in this study have been enumerated in order, from the first date to the last date. Researchers examined these studies independently and determined their categories. Then, they gathered and evaluated the identified categories. Researchers agreed to use 5 categories including (1) dependent and independent variables, compared techniques, (2) participant features, (3) methodological features (educational setting, research design, maintenance, generalization, reliability, social validity), (4) features related to intervention (implementer, presentation style, application, and presentation of CCC) and (5) results (effectiveness, maintenance, generalization, social validity) to analyse the studies. A table was created to present data of the categories and the researchers' notes to analyse the data in each category. The researchers independently read the studies and made an analysis by entering the data into the table and took detailed notes. Then, the researchers gathered and re-evaluated data. The relevant categories were re-examined from different views. The researchers reached a consensus by explaining their reasons to each other and finalized the data. Then, intercoder reliability was calculated in 20% of these studies (5 studies selected randomly). To this end, another expert read the studies independently and recorded the results in the tables. Then, the reliability coefficient intercoder was calculated using the Agreement / Agreement + Disagreement x 100 formula (Miles & Huberman, 1994), and the result was found as 98.2%.

FINDINGS

The findings obtained from these studies were analysed within certain categories according to research objectives presented in this section.

PARTICIPANTS AND DEPENDENT/INDEPENDENT VARIABLES

The features of participants, dependent and independent variables were analysed in the categories of numbers, gender, class level, dependent variable(s), and independent variable(s). Table 1 presents the data of the analysed categories.

Table 1. *Data on Features of the Participants and Dependent-Independent Variables*

Resource	*Number/ Gender*	*Age*	*Diagnosis*	*Class Level*	*Dependent Variable(s)*	*Independent Variable(s)*
Skinner et al., 1989	1/F 3/M	N/S	BD	4 and 10	Multiplication	CCC
Skinner et al., 1991	2/M	9-11	BD	N/S	Multiplication	VCCC WCCC (Classical CCC)
Skinner et al., 1992	6/NS	N/S	TD	2	Multiplication	SDF+CCC PDF+CCC
Skinner et al., 1993	3/M	12.5,12.3, 9.9	BD	N/S	Division	C-CCC
Lee & Tingtrom, 1994	3/F 2/M	10-11	TD	5	Division	CCC
Stading, Williams & McLaughlin,, 1996	1/F	8	LD	N/S	Multiplication	CCC
Skinner, Belfiore et al., 1997	2/M	10-11	ADHD/DB	N/S	Multiplication	VCCC WCCC (Classical CCC)
Stone, McLaughlin & Weber, 2002	1/F	10	TD/LPM	N/S	Division	CCC+R FC+R
Codding et al., 2007	2/F 1/M	11-12	TD/LPM	6	Multiplication Addition	CCC PFDC+CCC PFDI+CCC

Poncy et al., 2007	1/F	10	ID	N/S	Addition	CCC TP
Codding, Shiyko et al., 2007	56/F 42/M	Averag e 7.7	TD	2 and 3	Subtraction	CCC ET
Becker et al., 2009	1/F	10	LD	4	Multiplication	CCC ED+CCC
Grafman & Cates, 2010	47/NS	7-8	TD	2	Subtraction	CCC Versus CCC
Mong & Mong, 2010	1/F 2/M	7-8	TD/LPM	2	Addition Subtraction	CCC MTM
Poncy & Skinner, 2011	9/F 11/M	6-8	TD	1	Addition	CCC+S+GR
Mong & Mong, 2012	1/F 2/M	7-8	TD	2	Addition Subtraction	CCC TP MTM
Poff et al., 2012	3/M	10-12	BD	6 and 4	Adding and subtracting fractions	CCC
Poncy, Skinner & McCallum, 2012	11/F 9/M	8-10	TD	3	Subtraction	CCC TP
Saygılı & Ergen, 2016	4/F 2/M	10	TD	4	Addition Multiplication	CCC CS
Morton & Gadke, 2018	3/NS	N/S	A	8, 5 and 3	TP/NS	CCC Versus CCC
Schrauben & Dean, 2019	3/M	9-10	BD	3 and 4	Multiplication	CCC
Alptekin, 2019	1/F	9	TD/LPM	2	Multiplication	CCC

N/S: Not Specified, G: Girl, Boy: B, TD: Typically Developing, A: Autism, LD: Learning Disability, BD: Behavioural Disorder, LPM: Low Performance in Math, ID: Intellectual Disability, Attention Deficit Hyperactivity Disorder, BMS: Basic Math Skills V-CCC: Verbal CCC, W-CCC: Written CCC, (SDF) +CCC: Self Delivered Immediate Corrective Feedback, (PDF) +CCC: Peer Delivered Immediate Corrective Feedback, CCC+R: CCC+Reward, FC+R: Flash Card + Reward, (PFDC)+ CCC: Performance Feedback Using Digits Correct Per Minute, (PFDI) + CCC: Performance Feedback Using Digits Incorrect Per Minute, ET: Explicit Timing, ED+CCC: Error Drill, Versus+CCC, MTM: Math to Master Y, CCC+S+GR: CCC+Sprint+Group Rewards, TP: Taped Problems, CS: Calculation Strategies

FEATURES OF THE PARTICIPANTS

As can be seen in Table 1, the related studies were conducted with a total of 236 participants. 93 of these participants were female, while 87 of them were male. The gender of 56 participants in total was not defined in three studies. When these studies were examined in terms of age, it was observed that the participants were between the ages of 7-12. When the participants were analysed, there were 205 "typically developing" participants without a diagnosis, 16 participants with "behavioural disorder"; 8 typically developing participants with low mathematics achievements; 3 participants with autism; 2 participants with "learning disability"; 1 participant with attention deficit and hyperactivity disorder and 1 participant with intellectual disability. When the participant characteristics were examined in terms of class levels, it was observed that the overall range in these studies is at the 2^{nd}-5^{th} grade level; 4 studies is at 6^{th}-10^{th} grade level; 1 study is at 1^{st} grade level. Moreover, the class level of participants was not indicated in 6 studies.

DEPENDENT AND INDEPENDENT VARIABLES

Secondly, the studies were analysed in terms of dependent and independent variables. As it can be seen in Table 1, all studies, except for 1 study, evaluated dependent variables, namely target behaviours, as basic facts (addition, subtraction, multiplication, and division). The dependent variable is adding and subtracting fractions in 1 study. When the independent variables were examined, the

effectiveness of CCC intervention with Written Responses in 6 studies; Cognitive CCC in 1 study; Sprint (S) + Group Rewards (GR) CCC in 1 study on the performance of students were investigated. Therefore, there are 8 studies in total in which the effect of the independent variable was analysed. Studies with more than one independent variable with CCC can be divided into two groups. The first one is the comparison of different CCC interventions (7 studies); the second one is the comparison of different CCC techniques (7 studies). In the studies where different intervention forms were compared with each other, independent variables other than classical CCC are V-CCC, Self-Delivered Feedback (SDF) +CCC and Peer Delivered Feedback (PDF) +CCC. The application forms are Performance Feedback Using Digits Correct (PFDC) and Performance Feedback Using Digits Incorrect (PFDI) +CCC, Error Drill (ED) +CCC and Versus (V)-CCC. In the studies where different techniques are compared, the independent variables other than CCC are Flash Card (FC) + Reward (Ö). The techniques are as follows: Taped Problems Interventions (TP), Explicit Timing (ET), Math to Mastery (MTM) and Calculation Strategies (CS).

METHOD-SPECIFIC FEATURES

Method specific features of the research evaluated within the scope of this study are examined in the categories of educational setting, research model, maintenance, generalization, reliability, and social validity. Data related to analysed categories are given in Table 2.

Table 2. *Data on Method Specific Features*

Resource	*Educational Setting*	*Research Model / Type*	*Maintenance*	*Generalization*	*Reliability*	*Social Validity*
Skinner et al., 1989	SE (a school affiliated to university serving students with BD)	Multiple baseline	(+) Weekly	(-)	IOR (+) AR (+)	(-)
Skinner et al., 1991	SE (a university-affiliated boarding school serving students with BD)	Adapted alternating treatments	(-)	(-)	IOR (+) AR (-)	(-)
Skinner et al., 1992	GE	Adapted alternating treatments	(-)	(-)	IOR (+) AR (+)	(-)
Skinner et al., 1993	SE (a separate primary school serving for students with BD)	A multiple-baseline-across tasks (sets)	(+) 8th month	(-)	IOR (+) AR (+)	(-)
Lee & Tingtrom, 1994	GE	A multiple-baseline-across tasks (sets)	UT	(-)	IOR (+) AR (+)	(-)
Stading et al., 1996	HB	A multiple-baseline-across tasks (sets)	(-)	(-)	IOR (+) AR (-)	(-)
Skinner, Belfiore et al., 1997	SE (segregated boarding school serving students with BD)	Multiple-phase alternating treatments	(-)	(-)	IOR (+) AR (+)	(-)
Stone et al., 2002	HB	A multiple-probes-across tasks (problem sets)	(-)	Generalization among sets	IOR (+) AR (-)	(-)
Codding et al., 2007	I	Alternating treatments	4th and 12th days	With carry 3DX1D With carry 3D+3D	IOR (+) AR (+)	Student SA
Poncy et al., 2007	SE	Adapted alternating treatments	14.	(-)	IOR (+) AR (+)	(-)

Codding, Shiyko et al., 2007	GE	Control group design	(-)	(-)	IOR (+) AR (+)	Student SA
Becker et al., 2009	SE	ABC	(-)	(-)	IOR (+) AR (-)	Student and Implementer SA
Grafman & Cates, 2010	GE	Pre-test Post-test	(-)	(-)	IOR (+) AR (+)	Teacher and Student SA
Mong & Mong, 2010	GE	Adapted alternating treatments	6.	Without carry 2D+2D Without carry 2D + 2D Without Decimal 2D-2D Without Decimal 2D-2D	IOR (+) AR (+)	(+) Student SA
Poncy & Skinner, 2011	GE	A multiple-probes(sets)-across task	Set A 10th day Set B 5th day Set C 1st day	(-)	IOR (+) AR (+)	(-)
Mong & Mong, 2012	GE	Brief experimental analysis/ Alternating treatments	5th and 15th days	1D+1D Without carry 2D+2D Without carry 2D+2D 1D-1D Without Decimal 2D-2D Without Decimal 2D-2D	IOR (+) AR (+)	(+) Student SA
Poff et al., 2012	I (GE Behaviour intervention class)	Multiple probes across AB and skills (sets)	(-)	(-)	IOR (+) AR (-)	(-)
Poncy et al., 2012	GE	Adapted alternating treatments (with control status)	(-)	(-)	IOR (+) AR (+)	(-)
Saygılı & Ergen, 2016	GE	Adapted alternating treatments	7th and 28th days	Subtraction and division	IOR (+) AR (+)	Student SA SI
Morton & Gadke, 2018	SE (a university-affiliated clinic serving students with A and ID)	Multiple probe single-subject experimental design (A/BC)	(-)	(-)	IOR (+) AR (+)	(-)
Schrauben & Dean (2019)	SE (public school attended by the students with BD)	A multiple-probes-across participants	(-)	(-)	IOR (+) AR (+)	(-)
Alptekin, 2019	SE (research centre in a public university)	A multiple-probes(sets)-across task	7th, 15th and 30th days	(-)	IOR (+) AR (+)	Student and Teacher SA SI

GE: General Education, SE: Special Education HB: Home Based I: Inclusion IOR: Inter-Observer Reliability: AR: Application Reliability, SA: Self-Assessment, UT: Undefined Time, SI. Social Inclusion, D: Digits BD: Behavioural Disorder, A: Autism, ID: Intellectual Disability

EDUCATIONAL SETTING

As it can be seen in Table 2, 9 of these studies were conducted in general education settings; 9 of them in segregated special education settings; 2 of them in home settings; and 2 of them in inclusion settings.

RESEARCH MODEL

When Table 2 is analysed, it is seen that 20 studies were conducted with single-subject experimental design and 2 of them with experimental design; 5 of them with single-subject experimental design, 3 of them with multiple probe design; 6 of them with adapted alternating treatments design; 2 of them with alternating treatments design; 1 of them with multiple-probes-across tasks design; 1 of them with ABC; 1 of them with multiple phases A/BC; 1 of them with both multiple prove AB design. Mong and Mong (2012) also made a brief experimental analysis in their study conducted with adapted alternating treatments.

MAINTENANCE

When the maintenance data given in Table 2 were examined, it was seen that maintenance data were collected from 10 studies. When the maintenance data were analysed in these studies, it was seen that maintenance data were collected in min. 1 day and max. 8 months after the application was completed.

GENERALIZATION

When the generalization data were examined in Table 2, it was seen that generalization data was collected in 5 studies. The other studies did not collect generalization data. As it is seen in Table 2, it was evaluated in these studies whether the target skills gained through CCC applications provide generalization between behaviours.

RELIABILITY

When the reliability data in these studies were examined, it was seen that inter-observer reliability data for a dependent variable were collected in all studies. While the application reliability data were collected for independent variables from 17 studies, it was found that 5 studies could not collect reliability data for the independent variable. It was not indicated in the table since the reliability coefficient of variables is above 95% in all studies.

SOCIAL VALIDITY

As it is given in Table 2, social validity data were collected in 8 studies. The social validity data were collected in 4 studies only through student self-assessment; in 2 studies through both teacher and student self-assessment; in 1 study through student self-assessment and social comparison, in 1 study through both student and teacher self-assessment and social comparison.

INTERVENTION-RELATED FEATURES

Intervention features of the studies, evaluated within the scope of this research, were examined in the categories of implementer, presentation style, the CCC intervention and application steps. Data on the analysed categories are given in Table 3.

Table 3. *Data on Application-Related Features*

Resource	*Implementer /Presentation Type:*	*CCC model*	*CCC 1*	*CCC 2*	*CCC 3*	*CCC 4*	*CCC 5*	*CCC + Additional Procedure*
Skinner et al., 1989	Rsr/one-to-one	CCC	Reads the fact and its answer.	Covers the fact and its answer.	Writes the fact and its answer.	Opens the covered section.	Compares the answer with their answer.	(-)
Skinner et al., 1991	Rsr/one-to-one	VCCC	Reads the fact and its answer.	Covers the fact and its answer.	Verbally responds to the fact.	Opens the covered section.	Compares the answer with their own answer.	(-)
		WRCC (Classical intervention)	(Same)	(Same)	Writes the response about the fact	(Same)	(Same)	(-)
Skinner et al., 1992	Rsr/one-to-one	SDF+CCC (Classical intervention)	Reads the fact and its answer.	Covers the fact and its answer.	Writes the fact and its answer.	Opens the covered section.	Compares the answer with their answer.	(-)
		PDF+CCC	(Same)	(Same)	(Same)	-	After writing the fact, the peer compares the index card and tells him/her to continue if the answer is correct; If it is wrong, it does not respond verbally by showing the operation and the answer again.	(-)
Skinner et al., 1993	T/one-to-one	C-CCC	Reads the fact and its answer.	Covers the fact and its answer.	Responses subvocal the fact and its answer.	Opens the covered section.	Compares it with his/her answer.	(-)
Lee & Tingtrom, 1994	Rsr and T/G	CCC	Reads the fact and its answer.	Covers the fact and its answer.	Writes the fact and its answer.	Opens the covered section.	Compares the answer with their answer.	(-)
Stading et al., 1996	P/one-to-one	CCC	Reads the fact and its answer.	Covers the fact and its answer.	Writes the fact and its answer.	Opens the covered section.	Compares the answer with their answer.	(-)
Skinner, Belfiore et al., 1997	Rsr/one-to-one	VCCC	Sees the fact and its answer and reads them aloud.	Covers the fact and its answer.	Verbally responds to the fact.	Opens the covered section.	Compares it with his/her answer.	(-)
		WCCC	(Same)	(Same)	Writes the response about the fact	(Same)	(Same)	(-)

Stone et al., 2002	P/one-to-one	CCC+R	Reads the fact and its answer loudly.	Covers the fact and its answer.	Writes the fact and its answer.	Opens the covered section.	Compares the answer with their answer.	Time-test is conducted after the intervention and if the student maintains a high level of performance is given reward.
Codding et al., 2007	Rsr/one-to-one	CCC	Reads the fact and its answer.	Covers the fact and its answer.	Writes the answer.	Opens the covered section.	Compares the answer with their answer.	(-)
		PFDC+CCC	(Same)	(Same)	(Same)	(Same)	(Same)	The graphical feedback to the number of correct facts performed by the student in 1 minute at the end of each session.
		PFDI+CCC	(Same)	(Same)	(Same)	(Same)	(Same)	The graphical feedback to the number of wrong facts performed by the student in 1 minute at the end of each session.
Poncy et al., 2007	SET and SP/one-to-one	CCC + repetition	Reads the fact and its answer.	Covers the fact and its answer.	Writes the fact and its answer.	Opens the covered section.	Compares the answer with their answer.	Verbally repeats the correct fact and its answer three times. Marks three circles in the table and moves on to the next fact.
Codding, Shiyko et al., 2007	Rsr/G	CCC	Reads the fact and its answer.	Covers the fact and its answer.	Writes the fact and its answer.	Opens the covered section.	Compares the answer with their answer.	(-)

Becker et al., 2009	Rsr/one-to-one	CCC CCC+ED	Reads the fact and its answer. (Same)	Covers the fact and its answer. (Same)	Writes the fact and its answer. (Same)	Opens the covered section. (Same)	Compares the answer with their answer. (Same)	After all facts are completed, the researcher identifies the wrong facts. And models the correct answer. The student verbally repeats and writes them many times. Reads the wrong answers once more.
Grafman & Cates, 2010	T/G	CCC Versus CCC	Reads the fact and its answer. (Same)	Covers the fact and its answer. Copies the fact and its answer from the written model and covers them.	Writes the fact and its answer. (Same)	Opens the covered section. (Same)	Compares the answer with their answer. (Same)	(-) (-)
Mong & Mong, 2010	Rsr/one-to-one	CCC	Reads the fact and its answer.	Covers the fact and its answer.	Writes the answer.	Opens the covered section.	Compares the answer with their answer.	(-)
Poncy & Skinner, 2011	Rsr and T/G	CCC+S+GR	Reads the fact and its answer.	Covers the fact and its answer.	Writes the fact and its answer.	Opens the covered section.	Compares the answer with their answer.	S: 5 minutes after the CCC, students are given sprint intervention worksheets and asked to do them in 2 minutes. GR: Reward is given to the students once a week, if there is an increase in their performances.
Mong & Mong, 2012	Rsr/one-to-one	CCC	Reads the fact and its answer.	Covers the fact and its answer.	Writes the answer.	Opens the covered section.	Compares the answer with their answer.	(-)

Poff et al., 2012	Rsr/one-to-one	CCC	Reads the fact and its answer.	Covers the fact and its answer.	Writes the answer.	Opens the covered section.	Compares the answer with their answer.	If the student gives the wrong answer, s/he re-writes the correct answer 3 times.
Poncy et al., 2012	T/G	CCC is implemented different from Classical CCC)	Reads the facts from the printed fact family triangle (7-12-5).	Closes the triangle.	Writes the possible fact and its answer to the first box (12-5=7)	Writes the other possible fact and its answer to the other box (12-7=5)	Controls and compares the facts and their answers from the model.	(-)
Saygılı & Ergen, 2016	Rsr/one-to-one	CCC	(Flashcards of the facts are shown to the students for 5 minutes and they were asked to read it aloud). Reads the fact and its answer.	Covers the fact and its answer.	Writes the answer.	Opens the covered section.	Compares the answer with their answer.	The student put a smiling face next to correct answers and move on to the next fact.
Morton & Gadke, 2018	Rsr/one-to-one	CCC	Reads the fact and its answer.	Covers the fact and its answer.	Writes the fact and its answer.	Opens the covered section.	Compares the answer with their answer.	(-)
		Versus CCC	(Same)	Copies the fact and its answers from the model. Then, covers the fact and its answer.	(Same)	(Same)	(Same)	(-)
Schrauben & Dean, 2019	RSR/one-to-one	CCC	Reads the fact and its answer.	Covers the fact and its answer.	Writes the fact and its answer.	Opens the covered section.	Compares the answer with their answer.	(-)
Alptekin, 2019	T/one-to-one	CCC	Reads the fact and its answer.	Covers the fact and its answer.	Writes the answer.	Opens the covered section.	Compares the answer with their answer.	(-)

G: Group, Rsr: Researcher, F: Family, T: Teacher, SET: Special Education Teacher, SP: School Psychologist

IMPLEMENTER AND PRESENTATION STYLE

According to Table 3, it is seen that the independent variables were implemented by *the researcher* in 13 studies; by *teacher* in 4 studies; by *the researcher and teacher* in 2 studies (together); by *the teacher and school psychologist* in 1 study (together). When the studies were analysed in a way CCC was presented to the participants, 17 studies were conducted *one-to-one*; and in 5 studies presented *according to the group*.

CCC MODEL AND APPLICATION STEPS

As it is seen in Table 3, CCC is applied in the classic form in 17 studies that identify effectiveness or compare different studies. 5 classic application steps of CCC, named as W-CCC in some studies, are as follows; (student) a) Reads the fact and its answer, b) Covers the fact and its answer, c) Writes the fact and its answer, d) Opens the covered section, e) Compares it with his/her answer. When the studies, in which CCC were applied differently were examined, it was seen that there were 4 different methods such as V-CCC; C-CCC (Skinner et al., 1993); Versus-CCC and PDF-CCC. Different from classic CCC, V-CCC has the third step where the student gives a verbal response to the fact instead of a written response. In the third step of C-CCC, the student gives a subvocal response to the fact instead of a written response. In the second step of Versus-CCC, the student copies the fact and its answer from the written copy instead of covering the fact and answer immediately. In the fifth step of PDF-CCC, the student compares his/her fact and answer with his/her peers' answer.

However, there are also studies investigating the effect of CCC by adding different procedures after classically applying the intervention steps. These procedures are defined as R; PFDC and PFDI; repetition; ED and S+GR. The implementation of these procedures is explained in Table 3. In addition, in the study of Poncy et al. (2012), CCC steps are applied in different ways. It consists of 5 steps including (student) a) reads the facts from the printed fact family triangle (7-5-12), b) covers the triangle, c) writes potential fact and its answer (12-5=7), d) writes the other potential fact and its answer to another box (12-7=5), e) compares the accuracy of these facts and answers from the model.

FEATURES ACCORDING TO THE RESULTS

The results of the studies considered within the scope of this research were examined in the categories of maintenance, generalization, and social validity. Data related to analysed categories are given in Table 4.

Table 4. *Data related to Features of Results.*

Resource	*Effectiveness Results*	*Maintenance Results*	*Generalization results*	*Social Validity Results*
Skinner et al., 1989	CCC is effective in increasing the fluency rate of all participants.	Two of three participants maintain their frequency, while 2 participant's level of fluency is decreased.	(-)	(-)
Skinner et al., 1991	The accuracy and frequency rate of both participants were increased in V-CCC. While the accuracy and fluency rate of the first participant increased, this increase is less in the second participant. Both interventions are effective in increasing fluency. However, V-CCC is slightly more effective than W-CCC.	(-)	(-)	(-)
Skinner et al., 1992	Both interventions increased the accuracy and fluency rate of all participants in multiplication facts. However, SDF+CCC is more effective in 4 participants, while PDF+CCC is more effective in 2 participants. Furthermore, SDF+CCC is more efficient than PDF+CCC in terms of time.	(-)	(-)	(-)
Skinner et al., 1993	C+CCC is effective in increasing the accuracy and fluency of the first and second participants. The third participant could achieve mastery during C-CCC intervention. To reach the level of expertise, goal setting + performance feedback is used together with C-CCC.	The first and the second participants maintain their performance achieved after 8 months in all sets. The third participant maintains the performance level reached Set A and Set C after 8 months, but fell below his/her performance in Set B.	(-)	(-)
Lee & Tingtrom, 1994	Four of five participants performed with accuracy and fluency above the mastery level. One participant performed with an accuracy and fluency rate below the master level in one set. CCC is effective in increasing accuracy and fluency rate when it is applied to the group.	While 3 out of 5 participants maintain their mastery in the following steps, 2 participants performed below the mastery level.	(-)	(-)
Stading et al., 1996	CCC is effective in increasing the accuracy rate of the participant in multiplication facts. Also, it is observed to be successfully applied by the families at the home.	(-)	(-)	(-)
Skinner, Belfiore et al., 1997	The fluency of both participants is increased. The increase in corrective response rates is more significant during V-CCC. V-CCC further increased the accuracy and fluency rate compared to W-CCC.	(-)	(-)	(-)
Stone et al., 2002	Both interventions are effective in increasing the accuracy rate; however, FC+R has a greater effect on increasing the accuracy rate in all sets than CCC+R. Both interventions are defined to be successful in-home environments.	(-)	CCC+R procedures provided generalizations for some materials.	(-)

Codding et al., 2007	The accuracy and fluency rates of participants increased in all three interventions. The increase in all interventions is similar. The third participant could not achieve mastery level but increased the fluency rate.	Participants maintained the achieved performances.	The participants were not able to generalize their performance to answer more difficult multiplication and addition facts (even though there were small increases).	1 Participant mostly preferred CCC, Participants 2 and 3 mostly prepared CCC+PFDC and CCC+PFDI.
Poncy et al., 2007	There is not much difference in both interventions in terms of effectiveness in increasing the accuracy and fluency rate. However, TP is more efficient than CCC in terms of time.	The participant maintains his/her performance similar to the rate that is achieved in both interventions.	(-)	(-)
Codding, Shiyko et al., 2007	The fluency and accuracy rate of participants increased in both interventions. However, fluency and accuracy rates in ET are higher in increasing educational objectives.	(-)	(-)	Participants mostly preferred to use ET in the rating scale.
Becker et al., 2009	CCC interventions are effective in increasing the accuracy rate. CCC introduced with Error drills has further increased this effect.	(-)	(-)	Generally, it was found to be successful and positive by the researcher. Its implementation took a short time such as 10-12 minutes. Participants are quite happy with their change and proud of their achievements.
Grafman & Cates, 2010	While both interventions have the same effect on the accuracy rate, the fluency rate is higher in CCC.	(-)	(-)	More participants choose to apply CCC. Both teachers preferred to apply Versus-CCC.
Mong & Mong, 2010	Both methods are effective in increasing the fluency and accuracy rate of all participants. However, MTM has a higher effect on 3 participants. CCC (shorter time than MTM) is more efficient than MTM.	The participants maintained their achieved performances on the 6th and 18th days.	While the accuracy rate of the participants increased, the error rate decreased according to the baseline level in the mixed tests applied for generalization.	CCC scored higher in the questionnaire applied to the participants. The participants liked CCC more and stated that it would help them at school. However, they underlined that CCC is not the best way to gain fluency, but MTM.
Poncy & Skinner, 2011	CCC+S+GR is effective in increasing the level of accuracy and fluency. However, it was not effective for 1 participant at all. There was a small increase in 2 participants.	Participants maintained the achieved performances. However, there was a certain increase in 4 four participants.	(-)	(-)
Mong & Mong, 2012	While CCC is effective in one of the three participants, MTM is effective in 2 participants. TP is found to be the most efficient method in the same 3 participants.	CCC and MTM are more effective methods than TP for maintaining the achieved performance.	While MTM is the most effective method in generalization, it is followed by CCC and TP.	TP is the most appealing intervention for all participants. All participants liked these three methods and indicated that it would help them at school.

Poff et al., 2012	While the accuracy rate of all participants increased, the error rate decreased.	(-)	(-)	(-)
Poncy et al., 2012	Both interventions are effective in improving fluency. However, TP is more effective in improving fluency and more efficient than CCC in terms of time.	(-)	(-)	(-)
Saygılı & Ergen, 2016	The fluency rate of participants increased in both interventions. Both have a similar effect in increasing the fluency rate.	The maintenance data of all participants, except for 6 participants, are above the overall average. Both interventions have a similar effect on maintenance.	While 5 out of 6 participants generalized the fluency gained in addition facts to subtraction facts, none of the participants could generalize their performance gained in multiplication facts to division facts. The accuracy rate in subtraction and division facts has increased in both interventions. However, CS was found to be more effective than CCC.	According to the subjective evaluation results, participants mostly preferred the calculation strategies presented through games and stories. According to social validity results, participants reached and even passed the level of their peers in both interventions.
Morton & Gadke, 2018	Both interventions have a similar effect on enhancing fluency in math facts.	(-)	(-)	(-)
Schrauben & Dean (2019)	CCC provided an increase in all participants (from baseline) but this increase did not show sufficient correlation for effectiveness within the framework of statistical measurements.	(-)	(-)	(-)
Alptekin, 2019	CCC is effective in all sets to increase the fluency rate of the participant.	The participant maintains his/her performance in all sets reached on the 7th, 15th and 30th days.	(-)	According to self-assessment results, the participant and teacher gave positive feedback about the use of CCC and the effects of its results on the participant. According to social comparison data, participant's fluency reached the level of his/her peers in multiplication facts and effective results were achieved; however, additional procedures had to be applied to allow a student to reach the specified criteria.

EFFECTIVENESS RESULTS

As it is seen in Table 4, according to 5 studies analysing the effect of classic CCC intervention (Alptekin, 2019; Lee & Tingtrom, 1994; Poff et al., 2012; Skinner et al., 1989; Stading et al., 1996), CCC was found to be effective in increasing the fluency and accuracy rate in basic math facts. In the study of Schrauben and Dean (2019), although CCC increased the fluency rate of participants, the results were not significant in terms of effectiveness. In the study, in which the effectiveness of Cognitive (C) - CCC (Skinner et al., 1993) was analysed, effective results were achieved; however, additional procedures had to be applied to enable one student to reach the defined criteria.

Analysing the effectiveness of S+GR +CCC (Poncy & Skinner, 2011) applied on participants, the intervention was found to be effective in increasing fluency of 2 participants while it was not effective in 1 participant.

In the studies where CCC was compared with various interventions, it was found that CCC was effective in increasing the fluency rates of participants in basic math skills. In two studies comparing V-CCC and W-CCC (Classical Intervention), both interventions were found to be effective, but participants presented a higher performance in V-SCCC (Skinner et al., 1991; Skinner, Belfiore et al., 1997). In another study comparing the effect of SDF+CCC and PDF+CCC, it was found that both interventions were equally effective; however, PDF+CCC was found to be more efficient in terms of time (Skinner et al., 1992). In the study where PFDC+CCC, PFDI+CCC, and CCC were compared, effective results were obtained in all three interventions, but it was observed that one participant could not reach mastery despite the significant increase in his/her performance (Codding et al., 2007). In another study where ED+CCC and CCC were compared, both interventions were found to be effective in increasing fluency, but it was found that ED increased the effectiveness of CCC even more (Becker et al., 2009). In the study where CCC and Versus-CCC were compared (Grafman & Cates 2010; Morton & Gadke, 2018), both interventions were found to be effective in increasing the accuracy and fluency rate. However, according to the study of Grafman and Cates (2010), it was found that CCC applied in a classic form was more effective in increasing the fluency rate.

In the studies comparing different techniques, CCC was found to be effective in increasing the fluency rate in basic mathematical facts. In the study where CCC was compared with FC+R, both were found to be effective, but it was observed that FC+R interventions had a greater effect. In two of the studies where CCC and TP were compared, it was found that CCC and TP interventions had similar effects, but TP was more efficient in terms of time (Poncy et al., 2007; 2012) In the study in which CCC and ET were compared, both interventions were found to be effective, but it was observed that ET had higher effectiveness (Codding, Shiyko et al., 2007). In the study in which MTM and CCC were compared (Mong & Mong, 2010), it was found the MTM was more effective, while CCC was more efficient. In the study where Mong and Mong (2012) compared MTM, CCC, and TP interventions, participant performances increased in all interventions, but MTM was found to be more effective, and TP was found to be more efficient. In the study of Saygılı and Ergen (2016) where they compared CS, both interventions were found to have similar effectiveness.

MAINTENANCE RESULTS

When the studies are examined under this study, as it can be seen in Table 4, although the results of some studies (Lee & Tingtrom, 1994; Skinner et al., 1993) vary according to the participants, it is observed in many studies (Alptekin, 2019; Codding et al., 2007; Mong & Mong, 2010; 2012; Poncy et al., 2007; Poncy & Skinner, 2011; Saygılı & Ergen, 2016; Skinner et al., 1993) that participants maintain their performances after a certain period. In the study of Skinner et al., (1989), 2 participants maintained their performance at a similar level, while 1 participant's performance decreased. In the study of Skinner et al., (1993), the first participant in three sets and the second participant in two sets maintained their level of fluency. In the study of Lee and Tingtrom (1994), 3 out of 5 participants maintained their level of mastery, while 2 of them failed. According to a comparative study conducted

by Mong and Mong (2012), CCC and MTM were found to be more effective than TP. In the other comparative studies (Codding et al., 2007; Mong & Mong, 2010; Poncy et al., 2007; Saygılı & Ergen, 2016), the effects of other interventions compared with CCC were found to be similar.

GENERALIZATION RESULTS

When the data were analysed in Table 4, participants received positive results in the generalization of acquired skills to the other behaviours (Mong & Mong, 2010; 2012; Saygılı & Ergen, 2016; Stone, et al., 2002). In the study of Codding et al., (2007), although small increases were observed, there was no generalization of performances in more difficult multiplication and addition facts. According to a study of Mong and Mong (2012), MTM was defined to be the most effective method in generalization, and then it was followed by CCC. According to the study of Saygılı and Ergen (2016) participants generalized their performances in addition facts to subtraction facts; however, they could not generalize their performance in multiplication to division facts. In addition, CS was found to be more effective than CCC in generalization.

SOCIAL VALIDITY RESULTS

When the social validity data of the studies were analysed in Table 4, it was seen that all of them were comparative studies (Becker et al., 2009; Codding et al., 2007; Codding, Shiyko et al., 2007; Grafman & Cates, 2010; Mong & Mong, 2010; Mong & Mong, 2012; Saygılı & Ergen, 2016) except for one study (Alptekin, 2019). Comparative studies were conducted to determine the methods generally preferred by the participants in self-assessment. In one study, 1 participant preferred the CCC, and the other 2 participants preferred PFDC+CCC and PFDI+CCC (Codding et al., 2007). In another study, the participants preferred ET more than CCC (Codding, Shiyko et al., 2007). In the study of Grafman and Cates (2010), most of the participants preferred CCC. In a study where TP and the CCC were compared, CCC got the highest score from the participants and participants stated that they would use it, but CCC was not the best way to enhance fluency (Mong & Mong, 2010). In another study of Mong and Mong (2012), TP, MTM, and CCC were compared, and the participants stated that they liked all methods, but chose TP as the most appealing intervention and they considered all three methods to be helpful. In the study of Saygılı and Ergen (2016), all participants preferred CS rather than CCC. Additionally, social comparison was made in the study, and it was observed that participants reached the level of their peers in both interventions. Alptekin (2019) and Becker et al., (2009) separately collected self-assessment data from teachers and participants in their studies, and as a result, both participants and teachers gave positive feedbacks on CCC interventions. Alptekin (2019) also collected social comparison data and found that the student reached the level of her peers.

DISCUSSION, CONCLUSION AND IMPLICATIONS

In this study, 22 studies conducted with the CCC, which are used to enhance accuracy and fluency in basic facts, were examined and analysed in the light of specified categories. In this section, the findings obtained for each category are discussed, respectively.

A total of 236 participants were included in these studies conducted with the CCC. Therefore, this is a significant number to generalize the obtained results. However, when the gender of these participants is examined, it can be said that the number of females and males are similar. None of these studies specifically noted that gender makes a difference. Therefore, the obtained results can be generalized to all students in terms of gender. It is identified that participants were between the ages of 7-12 in all studies enhancing fluency in basic facts with the CCC. In addition, when it is considered in terms of class level, it has been identified that 12 out of 16 participants were from the 2^{nd} and 5^{th} grade; 4 of them were from the 6^{th} and 10^{th} grade and 1 of them was from the 1^{st} grade. Considering that acquisition of basic math skills and enhancement of fluency in the curriculum starts at the 2^{nd} grade, namely between the ages of 8-9 and it gets more difficult in upper classes (MoNE, 2018; NCTM,

2000), it seems reasonable that these studies conducted with the students ranging from 2nd grade to 10th grade and between the ages of 7-12. Regarding these studies, only 1 participant continues to 10th grade in the study of Skinner et al. (1989) At the same time, this participant is a student with special needs diagnosed with BD. Regarding the students with special needs, it is necessary to adapt the curriculum and ensure that they benefit from educational services in line with their educational needs (Özyürek, 2010; Salend, 2001). Furthermore, because students with special needs are behind their typically developing peers (Freeman & Alkin, 2000), it may be better to focus on the needs (Fiscus & Mandell, 2002; Martin et al, 2006) rather than the age and class level of students with special needs in these studies. When the results of these studies were combined, positive results were obtained from the CCC interventions in the first and second-grade students and ages. Therefore, it can be said that the CCC is a method that can be easily used by implementers for increasing accuracy and fluency rate in basic facts.

When the findings were examined in terms of diagnosis, studies were conducted with a total of 205 typically developing participants, 23 students with special education needs, and a total of typically developing 8 participants who showed considerably lower mathematic achievements than their peers. Although typically developing students are evaluated in the category of students with special needs, it can be said that the number of participants, in the studies conducted for students with special needs, is quite limited. For the generalization of the results, it can be said that there is still a need to focus on studies conducted with students with special needs and investigate their results. However, regarding the results obtained in this study, it is considered that the CCC is a scientifically based intervention that can be easily used by all students both with typically developing and special needs.

The dependent variable in all studies, except one study, is basic facts (addition, subtraction, multiplication, and division) skills. In this study, adding and subtracting fractions were used as the dependent variable. Many researchers underline the importance of fluency in basic facts skills for acquiring high-level mathematics skills. (Aspiranti et al., 2011; Hinton, Strozier & Flores, 2014; Gurganus, 2017; Hudson & Miller, 2006; Kleinert et al., 2017; McCallum et al., 2010; Stein et al., 2006). This might be the reason for focusing on basic facts to enhance math fluency. Furthermore, the results obtained from the studies on calculation skills such as basic skills in fractions and decimal numbers may serve to determine whether the positive effects of the CCC are limited to the calculation skills in basic facts.

There are 8 studies with one independent variable while there are 14 comparative studies with more than one independent variable in these studies. While 7 comparative studies are compared with different CCC interventions, 7 of them compare different techniques applied in enhancing fluency. The independent variables will be discussed in the following paragraphs, along with the application and results.

When the educational settings were examined in these studies, the educational settings could be evaluated in three categories as general education, segregated special education schools and inclusive arrangements. Furthermore, these were studies conducted by parents in a home environment with positive results. 9 studies were conducted in general education settings, 9 of them were conducted in special education settings, 2 of them were conducted in inclusion settings and 2 of them were conducted in-home settings. According to these data, it can be considered that there is still a need for further studies with students with special needs who are studying at special education settings serving with inclusion arrangements and in-home settings. Furthermore, when the educational settings and findings of the research were combined with the results, it can be indicated that the CCC is a method that can be used but implementers in general and special education and home settings. Increasing such interventions in-home setting in the light of evidence-based data will allow parents to experience-qualified and successful lives while working with their children. In addition, considering the learning needs of students with special needs, it may not be possible for them

to acquire everything in the school setting (Özyürek, 2010; Wolery, Ault & Doyle, 1992). Basic, simple, and inexpensive interventions that enable systematic studies in the home environment can be taught to parents in a short time.

When the research models in which studies under this research were examined, it was identified that 20 studies were conducted with single-subject experimental designs, one-to-one or small groups of participants; 2 studies were conducted with experimental designs with larger groups of participants. Based on this finding, focusing on studies using experimental designs with larger groups of participants will help to further generalize the results obtained with the CCC.

The hierarchical structure of math skills follows an order from easy to difficult. Within this hierarchical structure, previously learned skills from the basis to a higher-level skill in more complex form to be learned later. Because of this structure of mathematics, it not enough to acquire these skills. It is also quite important to maintain the acquired skills, that is, to be permanent (Gurganus, 2017; Hasselbring, Goin & Bransford, 1987; Hinton et al., 2014; Reys et al., 2009; Shapiro, 2011; Woodward, 2006). It was seen that the effects of the CCC interventions on maintenance were reviewed in 10 studies. It is noteworthy that only 2 out of 10 studies whose maintenance data were collected, were carried out before 1990, while the others were carried out in the last decade. Planning and testing the process of determining the effects of CCC on maintenance in recent years is an indicator that the importance is given on maintenance of the skills acquired in mathematics is gradually increasing. The maintenance of the effect of the CCC is tested only in one study after 8 months and positive results are obtained. Conducting studies to determine the maintenance of effects can provide evidence-based data to increase the efficiency of the CCC interventions.

Generalization is the ability for a student to perform a behaviour that s/he has gained under different conditions. One of the purposes of the education is to generalize and use the important behaviours or skills gained in schools (Carnine, 1997; Carnine, Dixon & Kame'enui, 1994; Özyürek, 2010; Wolery et al., 1992). Therefore, implementers should prefer methods that allow generalization and examine the effects of applied methods while planning about the generalization of skills gained by the students. Generalization data were collected in only 5 out of 22 studies within the scope of the research, all these studies were conducted after the year 2000. The effect of the CCC interventions on generalization have been examined in recent studies. This situation shows that the importance of generalization in teaching has been better understood recently. It is seen that there is still a need for research to determine the effects of the CCC interventions on generalization due to limited number of studies which collects generalization data. Although it is limited, these studies were generally evaluated whether the participants generalize the skills that they gained to more difficult level of target skills. It was investigated only in one study, if the participant generalized one calculation skills to another skill (Saygılı & Ergen, 2016). The collection of such generalization data will determine the effectiveness of the CCC related interventions. In addition, it is important to note that there is no study that determines whether students generalize the "sprint" in basic facts to the "sprint" of performing more difficult facts. Investigating whether the speed affects the speed of more difficult calculations skills (whether they are generalized or not) can make an important contribution in terms of the CCC interventions.

Reliability means determining the same amounts because of the measurements of the dependent variable consecutively and by different people in a study (Erbaş, 2012; Horner & Odom, 2014; Horner et al., 2005; Kazdin, 1982; Miles & Huberman, 1994). In addition, Horner et al. (2005) stated that one of the most important criteria for a research to be scientifically based is the reliable implementation of the research. The data were collected for the dependent variable in all studies conducted with the CCC, and for the independent variable in 17 studies to determine if the CCC was performed as planned. More than 95% of these studies were found to be reliable. These values are above the acceptable reliability (Erbaş, 2012; Horner & Odom, 2014; Horner et al., 2005; Kazdin, 1982;

Miles & Huberman, 1994) values. In this case, it can be said that CCC meets an important criterion for being a scientifically sustainable intervention and the results obtained from these studies are reliable.

Social validity is an important indicator determine the social importance, appropriateness, and satisfaction level of the relevant people in the scientific studies about the intervention and obtained results (Kennedy, 2002; Kurt, 2012; Vuran & Sönmez, 2008). Therefore, it is remarkable that only social validity data were collected in 8 studies analysed within the scope of this research. Self-assessment and social inclusion are most common data collection methods in collecting data for social validity (Kennedy, 2002; Kurt, 2012; Vuran & Sönmez, 2008). In the studies evaluated within this scope, it was seen that mostly student self-assessment data were collected. Moreover, there are limited number of studies in which social validity data were collected by self-assessment of the teachers. Students or teachers applying the method are direct consumers who contribute to CCC interventions. Information directly received from consumers is a situation that increases the social importance of the studies (Kennedy, 2002). Although the number of social validity data is limited in the studies within the scope of this study, data collected directly from the consumers increased the importance of these studies. It is also noteworthy that social comparison data were collected in only 2 of the reviewed studies (Alptekin, 2019; Saygılı & Ergen, 2016). Mathematic is a study area where data related to fluency and social comparison can easily be collected in basic calculation skills. Social comparison is seen as an important data source for social validity in recent studies, as it serves to determine the effect of applied methods on approaching peers' performance (Kennedy, 2002).

When the implementation styles and steps were examined, it was observed that the CCC was applied differently from traditional style. V-CCC, C-CCC, V-CCC, PDF-CCC are evaluated as independent variables and their effects were analysed. As a result of these studies, positive results were also obtained in CCC interventions where the steps were different. In addition, positive results were obtained in studies where different procedures were added to the CCC such as R, PFD, PFDI, ED and S + GR. According to these findings, it can be said that the CCC can be used by making adaptations and it can be added to the end of the procedures that are based on reinforcement which will strengthen the effect of results to be obtained from CCC or provide more repetitions.

When the results of these studies were examined, although the performances of all 3 participants increased because of the traditional CCC intervention in only one study, the results were not found to be significant in terms of effectiveness (Schrauben & Dean, 2019). Furthermore, the results were not found to be significant in terms of effectiveness in one of the three participants of 3 studies (Codding et al., 2007; Poncy & Skinner, 2011; Skinner et al., 1993). However, it was concluded that CCC was effective in rest of the studies. For this reason, it can be concluded that CCC is effective in increasing the accuracy and fluency rate in basic facts skills in studies where it is compared with different techniques that were used in its classic form, adapted in its steps or additional procedures were added, and used in improving fluency. Similar results have been achieved in meta-analysis study of Joseph et al. (2012) and review studies of Stocker and Kubina (2017). When these results are combined with the participant characteristics, it can be said that CCC is effective in increasing the accuracy and fluency rate in basic math skills in both with typically developing students (whether they have low mathematics achievement or not). Although effective results were obtained with respect to CCC studies comparing different techniques, FC + R, MTM and ET methods have a higher effect than CCC in terms of efficiency and effectiveness in improving fluency. The application steps of these methods are based on numerous repetitions and error corrections may cause such result. In the study conducted by Mong and Mong (2010), where MTM and CCC is compared, CCC is found to be more efficient in term of time. However, it is not correct to state that CCC is more efficient than other methods based on single research result. Therefore, it might be said that further research is needed to compare effectiveness and efficiency.

8 out of 10 studies in which maintenance data were collected under this study, CCC was found to be effective in maintaining the performance achieved in target skills after a certain period. Based on this finding, it might be said that CCC ensures positive results for maintenance. However, it may be considered that there is still a need for research to determine the effect of CCC on maintaining the performance achieved in basic facts. It is possible to reach the same results for generalization data of the studies within the scope of this research. Because the number of studies with generalization data is quite low. Although positive results were obtained in these studies in terms of efficiency, it was deducted that CCC has similar or less effects compared to the other methods in comparative studies. Almost all the studies that collect data on social validity are comparative studies and the methods preferred by the participants were asked in these studies. The results were sometimes in favour of CCC or other methods in these studies. According to these data, it is not appropriate to say CCC is a more preferred methods than other methods.

As a result of these discussions, it can be said that CCC is a method that can be easily used for all students ranging from the first grate to tenth grade between the ages of 7-12, in general education and special education settings to enhance fluency in basic facts. In this regard, when the implementers want to enhance fluency in basic facts, they may benefit from CCC, which is an evidence-based intervention and ensures the systematic repetition. Furthermore, several research can be suggested in the light of these discussions. Conducting studies with students, especially with autism, intellectual disability and learning disability to identify the effect of CCC can contribute to generalize the results for students with special needs. It can be investigated whether CCC is effective in different skills that require calculation other than basic calculation skills. In addition, considering that studies conducted in home environment are quite limited, trainings can be provided for the parents on CCC application. Therefore, the researches can be conducted and results can be tested to define the effect of these studies and it might be an example of systematic interventions that increase the participation of parents in the education process of their children. CCC is applied one-to-one in most of the studies analysed within the scope of this study. It can be said that there is still a need for studies in relation to groups. Furthermore, it is seen that there is a need to investigate whether CCC interventions serve to generalize the skills acquired in basic facts skills to different conditions. When the studies were examined within the scope of the research, it was observed that effective results were obtained when additional procedures were added to CCC. While enhancing fluency in basic facts skills, the studies can be conducted to investigate the effectiveness and efficiency of CCC with other strategies such as goal setting, reinforcement, self-monitoring, self-management etc.

AUTHOR CONTRIBUTION

- First author have made substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data.

-The second author have been involved in drafting the manuscript or revising it critically for important intellectual content.

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