

Effectiveness of the Cover–Copy–Compare (CCC) Procedure in Developing Fluency in Basic Multiplication Facts for a Student with Mathematics Difficulties

Halil Uysal^{1*}, Ahmet Serhat Uçar², Zuhâl Gizir³

¹ *Artvin Çoruh University, Education Faculty, Special Education Department, Türkiye, huysal@artvin.edu.tr, <https://orcid.org/0000-0001-5900-9497>*

² *Mersin University, Education Faculty, Special Education Department, Türkiye, asucar@mersin.edu.tr, <https://orcid.org/0000-0001-5910-8751>*

³ *Mersin University, Education Faculty, Preschool Department, Türkiye, zuhalgizir@mersin.edu.tr, <https://orcid.org/0000-0002-8014-8392>*

*Corresponding Author: huysal@artvin.edu.tr

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ABSTRACT

In this study, the effectiveness of the cover–copy–compare (CCC) procedure in building fluency with basic multiplication facts was examined for a student with a learning disability who performed below peers in mathematics. The study also sought to determine whether the student (a) maintained fluency on the mastered facts at 4-, 8-, and 12-day follow-ups; (b) generalized performance on these facts in line with the commutative property of multiplication; (c) approached the endline fluency levels obtained from typically developing peers; and (d) reported favorable views of the intervention. One 11-year-old student with a diagnosed learning disability receiving inclusive education participated. A single-case research design—specifically, a multiple-probe design—was employed. Findings indicated that CCC was effective in increasing the students' fluency with basic multiplication facts, that these gains were maintained at 4, 8 and 12 days post-instruction, and that high levels of generalization were observed with respect to the commutative property. By the end of the study, the students' fluency levels on basic multiplication facts approximated those of their typically developing peers. Social validity data further showed that the student viewed the CCC intervention as adequate and appropriate.

Keywords: Learning Disability; Mathematics Learning Disability; Cover–Copy–Compare (CCC); Basic Multiplication Facts; Fluency.

INTRODUCTION

In the elementary mathematics curriculum, the learning areas comprise four strands: numbers and operations, geometry, measurement, and data. In contrast, the middle school mathematics curriculum shall consist of five strands: numbers and operations, algebra, geometry and measurement, data processing, and probability (MEB, 2018). With the Türkiye Yüzyılı Maarif Model introduced in 2024, the themes in the Elementary Mathematics Curriculum were reformulated as “Numbers and Quantities,” “From Operations to Algebraic Thinking,” “Geometry of Objects,” “Data-Driven Inquiry,” and “Probability of Events and Data-Driven Inquiry” (MEB, 2024). The Common Core State Standards Initiative similarly treats the learning areas up to Grade 5 as Operations and Algebraic Thinking, Numbers and Operations, Measurement and Data, and Geometry. In both frameworks, the numbers and operations strand encompasses the foundational skills that students are expected to acquire first in mathematics (CCSSI, 2010; MEB, 2024). Beginning with digits in Grade 1 and extending to operations with

fractions, this strand supports learning in the remaining strands as well. Within “Numbers and Quantities” and “From Operations to Algebraic Thinking,” alongside skills such as computation and performing the four operations, one cross-grade expectation emphasized throughout is mental computation. In the curriculum, mental computation refers to students’ fluency with basic operations. Fluency in operations is a skill that facilitates individuals’ tasks frequently in both school and everyday life. A student’s ability to respond quickly and accurately to simple (fundamental) problems (e.g., $6+7=13$, $9-3=6$, $4\times7=28$, $48/6=8$) provides advantages at various times in academic and daily contexts. Instruction targeting simple operations that undergird the four operations in this strand is treated in the literature as “basic facts.” Basic facts are most simply defined as operations involving two single-digit numbers. Beyond acquisition, ensuring fluency with these facts benefits students in numerous ways—for example, performing computations rapidly when solving academic problems or calculating change quickly and accurately during daily shopping (Ysseldyke, 2005).

The basic facts encompass addition, subtraction, multiplication, and division. Problems in which the addends are single digits constitute basic addition facts; problems in which the subtrahend and difference are single digits constitute basic subtraction facts; problems in which the factors are single digits constitute basic multiplication facts; and problems in which the dividend and quotient are single digits constitute basic division facts. As this study focuses on basic multiplication facts, these facts are presented in Table 1.

Table 1. Basic Multiplication Facts

x	0	1	2	3	4	5	6	7	8	9
0	0	0	0	0	0	0	0	0	0	0
1	0	1	2	3	4	5	6	7	8	9
2	0	2	4	6	8	10	12	14	16	18
3	0	3	6	9	12	15	18	21	24	27
4	0	4	8	12	16	20	24	28	32	36
5	0	5	10	15	20	25	30	35	40	45
6	0	6	12	18	24	30	36	42	48	54
7	0	7	14	21	28	35	42	49	56	63
8	0	8	16	24	32	40	48	56	64	72
9	0	9	18	27	36	45	54	63	72	81

Source: Stein et al., 2006.

In the literature on teaching basic facts, three tiers of instructional activities are described: understanding, relating, and mastery (Ashlock, 1971). Understanding activities target students’ conceptual acquisition of operations, typically through the use of concrete objects to support the development of procedural skill. Relating activities are implemented after understanding and focusing on establishing connections among operations. While conducting relating activities, one may use sequence-based fact families (e.g., 5×2 , 5×3 , 5×4) and/or relation-based fact families constructed through equivalences (e.g., $6\times3=18$, $3\times6=18$, $2\times9=18$, $9\times2=18$) (Yücesoy-Özkan, 2017). Finally, instruction can proceed to mastery activities, which refer to attaining fluency with operations. Relational and mastery activities may proceed concurrently (Ashlock, 1971).

Fluency is the ability to retrieve and state or write the result of basic facts correctly and rapidly at the moment they are seen or heard. Building fluency contributes not only to solving operations quickly but also to performance in other mathematical skills and in everyday situations that require swift mental calculation (Shapiro, 2011; Wong, 1989). The Common Core State Standards Initiative (CCSSI) and the National Council of Teachers of Mathematics (NCTM) likewise emphasize the importance of accuracy and speed in computation; they stress that students must first learn basic facts to perform more complex operations, that fluency should be addressed through classroom activities and/or supplemental tools, and that some students may require more instruction or practice than others (CCSSI, 2010; NCTM, 2003). Efforts to build fluency with basic facts should begin with setting criteria, followed by providing sufficient practice and systematic review. Allocating adequate time, recording the number of correct responses across sessions, and delivering reinforcement at the end of sessions constitute a workable routine.

A wide range of methods and techniques exist for teaching mathematics. Some approaches may overlap for typically developing and special education populations, yet they also vary with learner characteristics and contextual affordances. Several interventions enable students with mathematics difficulties to perform well across skills. Focusing specifically on fluency, the literature frequently references flash cards, math to mastery, drill and practice, detect–practice–and–repair, and cover–copy–compare. The present study employed the cover–copy–compare procedure.

Cover–copy–compare (CCC) is a low-tech procedure requiring only a worksheet and a pencil. Students look at a problem and its answer on the worksheet, then cover the model (by folding the page or using a sheet of paper) and write the problem and answer in the adjacent space, and finally uncover the model to compare it with what

they wrote (Skinner, McLaughlin, and Logan, 1997, p. 297). Having students write both the problem and the answer, not just the answer, promotes retention and supports fluency. CCC provides frequent opportunities to rehearse designated facts, delivers immediate feedback by uncovering the model, and affords self-correction. In simple terms, the sequence—student looks at the model (1), teacher prompts the problem (2), student responds in writing (3), student uncovers to check (4)—gives at least four repetitions per item. Because frequent repetition is a fundamental principle of fluency development, the repetition embedded in CCC makes it especially well-suited to developing fluency. An example of a CCC worksheet is shown in Figure 1.

Cover–Copy–Compare Multiplication Worksheet		(CCC)	
Student:		Date:	
Item No.	Problem	Student Response	Check
1.	$6 \times 3 = 18$		
2.	$5 \times 4 = 20$		
3.	$7 \times 2 = 14$		
4.	$6 \times 5 = 30$		
5.	$8 \times 6 = 48$		
6.	$5 \times 8 = 40$		
7.	$7 \times 9 = 63$		
8.	$6 \times 7 = 42$		
9.	$8 \times 4 = 32$		
10.	$7 \times 5 = 35$		
Total Correct:			

Figure 1. CCC Worksheet

Attending to learner characteristics and planning instruction accordingly is critical for success in mathematics instruction, as individuals differ in their developmental and learning profiles (Fuchs & Fuchs, 2006). A student's need for concrete representations in a given skill may not be necessary for another student. Similarly, some students learn quickly, while others progress more slowly than their peers—a pattern often observed among students who experience difficulties with mathematics. Although these students generally learn more slowly than their peers, it would be inaccurate to claim that they are slow across all objectives. The methods, techniques, or materials employed may be ill-suited to the learner; given mathematics' cumulative structure, slow progress on early topics and objectives can delay transitions to subsequent skills, potentially leading to a persistent cycle of difficulty. To prevent this, students with mathematics difficulties should receive intensive, differentiated interventions. Owing to differences in learning characteristics and difficulties participating in instructional activities, these students require additional support (Algozzine, Ysseldyke, and Campbell, 1994). While some learn quickly and others slowly, some individuals require visual supports, while others require auditory supports. Although these differences necessitate individualized adaptations in instruction, they do not constitute barriers to learning (Hall et al., 2012).

When considering what must be done for students with mathematics difficulties, it is evident that, absent effective intervention, students who chronically earn low scores on mathematics assessments tend to continue exhibiting weak mathematics achievement over time (National Assessment of Educational Progress [NAEP], 2013). NAEP data indicate that approximately 60% of fourth graders perform below proficiency in mathematics, and about 67% of eighth graders do not reach proficiency (NAEP, 2015). Moreover, according to the National Mathematics Advisory Panel (NMAP, 2008), the instructional time and quality devoted to basic fact instruction in U.S. classrooms often fail to yield computational fluency for many students. The Panel underscores that few current curricula include sufficient and appropriate activities to develop operational fluency (NMAP, 2008). A lack of adequate opportunities for students to apply basic mathematics skills further compounds the problem (Daly, Martens, Barnett, Witt, & Olson, 2007). To learn a new concept, individuals first focus on acquisition, accuracy, and quality (Binder, 2003), and only then practice toward fluency and endurance before applying basic facts to more complex problem-solving. Binder (2003) argued that schools often fail to build fluency because students are not given sufficient time for practice (the stage following acquisition) before moving on to the next stage.

For students with a mathematics learning disability (MLD), the development of automatic retrieval of basic facts typically takes longer than for typically developing peers (Dennis, Sorrells, & Falcomata, 2016). For example, when solving single-digit addition problems, students with MLD are more likely than peers to use count-all strategies (e.g., in $1 + 2 = ?$, counting both addends from the start) or count-on strategies (e.g., in $3 + 4 = ?$, starting from the larger number and counting up). These strategies not only increase counting and retrieval errors but also constrain the development of fluency in basic facts (Geary, Hoard, & Bailey, 2012; Shrager & Siegler, 1998). By contrast, efficient rehearsal, supported by effective counting strategies, substantially aids the encoding of relations

between problems and solutions, and supports the consolidation of these relations in long-term memory (Goldman, Pellegrino, & Mertz, 1988).

A review of the literature shows studies on building fluency in basic facts using cover-copy-compare (CCC) among students with mathematics difficulties (Alptekin et al., 2016; Coddling, Eckert, Fanning, Shiyko and Solomon, 2007; Skinner, McLaughlin and Logan, 1997; Poncy vd., 2007; Poncy vd., 2012). These studies include participants who are typically developing, have behavior problems, or have ADHD, particularly with respect to multiplication fact fluency. However, research examining the effectiveness of CCC specifically for multiplication with participants who have learning disabilities is limited. In one such study, only effectiveness data were collected—no maintenance, generalization, or social validity data were obtained. Another study compared CCC to Error Drill + CCC (Coddling et al., 1996; Becker et al., 2009). Consequently, there is a need for research investigating the impact of CCC on developing multiplication-fact fluency among students with learning disabilities.

Fluency in basic mathematical operations forms the foundation for acquiring more advanced mathematical skills. Students who can perform operations fluently gain independence in areas such as problem solving, geometry, measurement, and functional skills (e.g., using money, telling time). Therefore, as fluency in basic addition is built through practice, it is assumed that this contributes to the social participation and independence of students with learning disabilities (Patton et al., 1997). In addition, because CCC inherently models the correct answer for students, provides feedback through checking, and affords self-evaluation, it is expected to support independent work, including for students with intellectual disabilities. Given that CCC for basic multiplication facts is both effective and readily implemented by teachers and pre-service teachers, the present study is expected to serve as a practical resource and guide for building fluency in basic multiplication facts.

Purpose and Research Questions. The purpose of this study is to examine the effectiveness of the Cover-Copy-Compare (CCC) procedure in building fluency with basic multiplication facts for a student with a learning disability who performs below peers in mathematics. To this end, four research questions were posed:

1. Is the CCC procedure effective in developing fluency with basic facts for a student who experiences mathematics difficulties?
2. Does the student maintain performance on the mastered basic multiplication facts at 4, 8, and 12 days after instruction?
3. Does the student generalize the mastered facts according to the commutative property of multiplication (i.e., reversals)?
4. What are the students' perceptions of the intervention used in the study?

METHOD

Research Model

A multiple-probe across tasks design, one of the single-subject research methods, was used. This single-case design evaluates the effectiveness of an instructional or behavior-change program across multiple dependent variables. In this model, the same individual is tested under equivalent conditions by applying the same intervention to three different behaviors, and effectiveness is determined accordingly (Alberto & Troutman, 2006).

The dependent variable was the student's fluency with basic multiplication facts. The independent variable was instruction delivered via the Cover-Copy-Compare (CCC) procedure. Basic multiplication facts refer to all multiplication problems whose factors are single digits (e.g., $3 \times 5 = 15$; factors 3 and 5) (Stein et al., 2006). Consistent with the multiple-probe design, three sets were created, each comprising basic multiplication facts of equivalent difficulty. Baseline data were collected for Set 1, while Sets 2 and 3 were probed. Once stable baseline data were established for Set 1, instructional sessions began on Set 1. During CCC instruction on Set 1, probe data continued to be collected for Sets 2 and 3. Once stable data were obtained for Set 1, a baseline was taken for Set 2, and probes were administered for Set 3. Similarly, CCC instruction proceeded on Set 2 while probe data were collected for Set 3. After achieving stability in Set 2, the baseline was initiated for Set 3, and instruction continued until stable responding was achieved.

Participant and Characteristics

Aytaç is an 11-year-old male student in general education with a diagnosis of learning disability; he was diagnosed at age 10 and is enrolled in Grade 4. In comparison to his peers, he exhibits particularly weak academic performance. He can read and write, though he sometimes reads disfluently and writes certain letters inaccurately or incompletely. He receives 10 hours per month of one-to-one instruction at the Guidance and Research Center (RAM). Teacher interviews indicated that he lags markedly behind peers in mathematics. The researcher's

preliminary assessment revealed that the individual had acquired the conceptual basis for addition, subtraction, multiplication, and division; could solve simple one- or two-step word problems; could read and write two- and three-digit numbers; and could perform mental computations of addition and subtraction. However, due to his limited fluency in skip counting, he was unable to answer multiplication and division problems quickly and accurately. The teacher reported that peers responded fluently to basic multiplication facts.

Prior to data collection, ethical approval was obtained from the Artvin Çoruh University Scientific Research and Publication Ethics Committee (Decision date/number: April 5, 2023– 87518). Written informed consent was obtained from the student and family; the consent form explained the study and clarified the right to withdraw at any time.

Practitioner

Intervention was delivered by the first author, who holds an MA and PhD in special education and has 10 years of experience teaching academic skills to students with special needs. The practitioner has extensive experience conducting systematic interventions and has previously implemented CCC in studies for which they served as the interventionist. They are currently a research assistant (PhD) in the Department of Special Education at a public university in Türkiye.

Setting

Baseline, probe, intervention, generalization, and maintenance sessions were conducted at the Special Education Practice and Research Center of Karamanoğlu Mehmetbey University. The instructional room was approximately 12 m² in size, furnished with a single table and two adjacent chairs. During all sessions, the practitioner and participant sat side by side. Only the worksheet, a pencil, and a timer were placed on the table. An observer with a PhD in special education was present to collect data on treatment integrity.

Measures and Materials

All sessions used CCC worksheets prepared from three sets of basic multiplication facts, baseline and probe data sheets, a timer, and a pencil. Each set consisted of 12 single-digit-factor multiplication problems (e.g., $3 \times 4 = 12$, $5 \times 9 = 45$) and was equivalent in difficulty. For each set, CCC worksheets used during intervention were prepared. To collect baseline, probe, and maintenance data, forms were prepared without answers, mixing the problems so that each set was repeated four times; this prevented artificially capping the number of problems the student could answer within one minute. For generalization sessions, data were recorded using forms that comprised the reversed versions of the taught facts (i.e., by the commutative property of multiplication). Correct responses to doubles embedded in the prepared sets (2×2 , 3×3 , 4×4) were excluded from generalization scoring, as the aim was to examine generalization specifically via the commutative property.

Validity and Reliability

Validity–reliability evidence comprised treatment integrity, interobserver agreement (IOA), and social validity. Treatment integrity data were collected using a checklist that specified the steps the practitioner was expected to implement for the independent variable (CCC). Integrity was collected in 40% of sessions for all sets. IOA for the dependent variable was collected in 40% of baseline, intervention, and maintenance sessions. Two special education academicians with PhDs obtained agreement data by independently coding video recordings of sessions.

Social validity was measured via student interviews using a social validity form. In addition, to establish a normative criterion, social comparison data were obtained from 32 fourth-grade students at the participant's school. Two classroom teachers were briefed on data collection procedures, and they administered the social comparison form before and after the study. These data characterized typical peer performance at the participant's grade level and served to contextualize the student's outcomes.

Implementation Process

Excluding maintenance sessions, the intervention phase lasted three weeks. For each set, baseline, probe, intervention, generalization, and maintenance sessions were conducted.

Baseline: For each set, three consecutive baseline sessions were conducted prior to intervention using forms that listed only the problems. The student was given 1 minute to respond. No reinforcement or correction was provided

during this minute. At the end, the student was thanked, and the session ended. After three baseline sessions for Set 1, the intervention began.

Intervention (CCC): Two sessions per day (~10 minutes each) were conducted. The practitioner first modeled CCC using the initial problems on the worksheet: “We will practice multiplication. In this section you see the problems with their answers. First I look at the model, then I cover it,” folding the page; “I say the problem and try to recall the answer... then I write the problem and answer in the ‘copy’ space... and check if I remembered correctly.” The practitioner intentionally modeled one error and demonstrated self-correction. After confirming the student’s understanding through guided trials, independent CCC trials proceeded. For each item: the prompt “Look at the problem” (4-s viewing), “Cover the problem,” write the problem and answer, then uncover and check. If the student attempted to mark the check box without verifying, the prompt “Check the problem” was given. Upon completing the worksheet, the student received reinforcement, and the session ended.

Probes: Conducted similarly to a baseline; the number of correct digits/problems per minute served as the data point.

Generalization: Pretests were administered concurrently with baseline for all sets; posttests followed the intervention on each set, using the commuted facts.

Maintenance: Conducted at 4, 8, and 12 days post-intervention for each set, using the same procedures as baseline/probes with a 1-minute timing.

Data Analysis

Effectiveness, maintenance, and generalization data were analyzed graphically and interpreted qualitatively. On the graphs, the x-axis represented sessions, and the y-axis represented the number of correct basic multiplication facts per minute. Social validity data obtained through subjective evaluation (student interviews) were analyzed descriptively; social comparison data were summarized using bar charts. Treatment integrity for the independent variable was calculated using the formula “Observed practitioner behaviors / Planned practitioner behaviors \times 100” (Erbaş, 2018). As shown in Table 2, the practitioner implemented all CCC steps with $\geq 96\%$ treatment integrity across sessions.

Table 2. Treatment Integrity Findings for CCC

Practitioner Behaviors	CCC	
	Sets	Intervention Sessions
Preparing Materials and Tools	Set A	%100
	Set B	%100
	Set C	%100
Securing Attention	Set A	%100
	Set B	%100
	Set C	%100
Delivering the Prompt “Look at the problem.”	Set A	%100
	Set B	%100
	Set C	%100
Providing an Appropriate Response for the Cover Step	Set A	%96
	Set B	%100
	Set C	%100
Delivering the Skill Prompt	Set A	%100
	Set B	%96
	Set C	%100
Providing an Appropriate Response for the Copy Step	Set A	%100
	Set B	%100
	Set C	%96
Providing an Appropriate Response for the Compare Step	Set A	%100
	Set B	%100
	Set C	%96
Responding Appropriately to the Problem Outcome	Set A	%96
	Set B	%100
	Set C	%100
Reinforcing Participation	Set A	%100
	Set B	%100
	Set C	%100

Two independent observers obtained interobserver agreement (IOA) for the dependent variable. IOA was calculated by comparing the student's number of correctly answered problems within one minute and analyzing the results using the formula "Agreement / (Agreement + Disagreement) \times 100" (Erbaş, 2018). The IOA data are presented in Table 3.

Table 3. Interobserver Agreement (IOA) Data

Sets	Baseline	Intervention	Maintenance
Set-A	%100	%98	%100
Set-B	%100	%100	%100
Set-C	%100	%100	%100

FINDINGS

This study reports effectiveness, maintenance, generalization, and social validity outcomes. As shown in Figure 1, during the baseline phase for Set A—with three consecutive data points—the student correctly answered at least eight and at most nine multiplication facts per minute ($M = 8.6$). In the intervention phase, by the fourth session, the student reached the peer benchmark of 18 correct per minute and maintained this performance for three consecutive sessions.

For Set B, baseline data likewise showed 8–9 correct facts per minute ($M = 8.6$). In the intervention phase, the student again reached the predetermined criterion by the fourth session and maintained the level for three consecutive sessions. Comparing the initial and final baselines indicates that the student maintained baseline performance on untreated sets while instruction was underway on the first set. For the last set, probe data showed that the performance observed at the first probe was maintained at the final probe.

For Set C, baseline performance ranged from 7 to 9 correct facts per minute ($M = 8.4$). In the intervention phase, the student met the fluency criterion by the fifth session and maintained it for three consecutive sessions. Across all sets, intervention data exceeded baseline data, and phase-by-phase comparisons demonstrated that the intervention was effective for each set. Baselines were stable for all sets; for example, while instruction proceeded on Sets A and B, the stable baseline in Set C supports the inference that observed changes in performance were attributable to the CCC intervention rather than extraneous factors. In sum, instruction implemented via Cover–Copy–Compare (CCC) was effective in increasing fluency with basic multiplication facts across all sets.

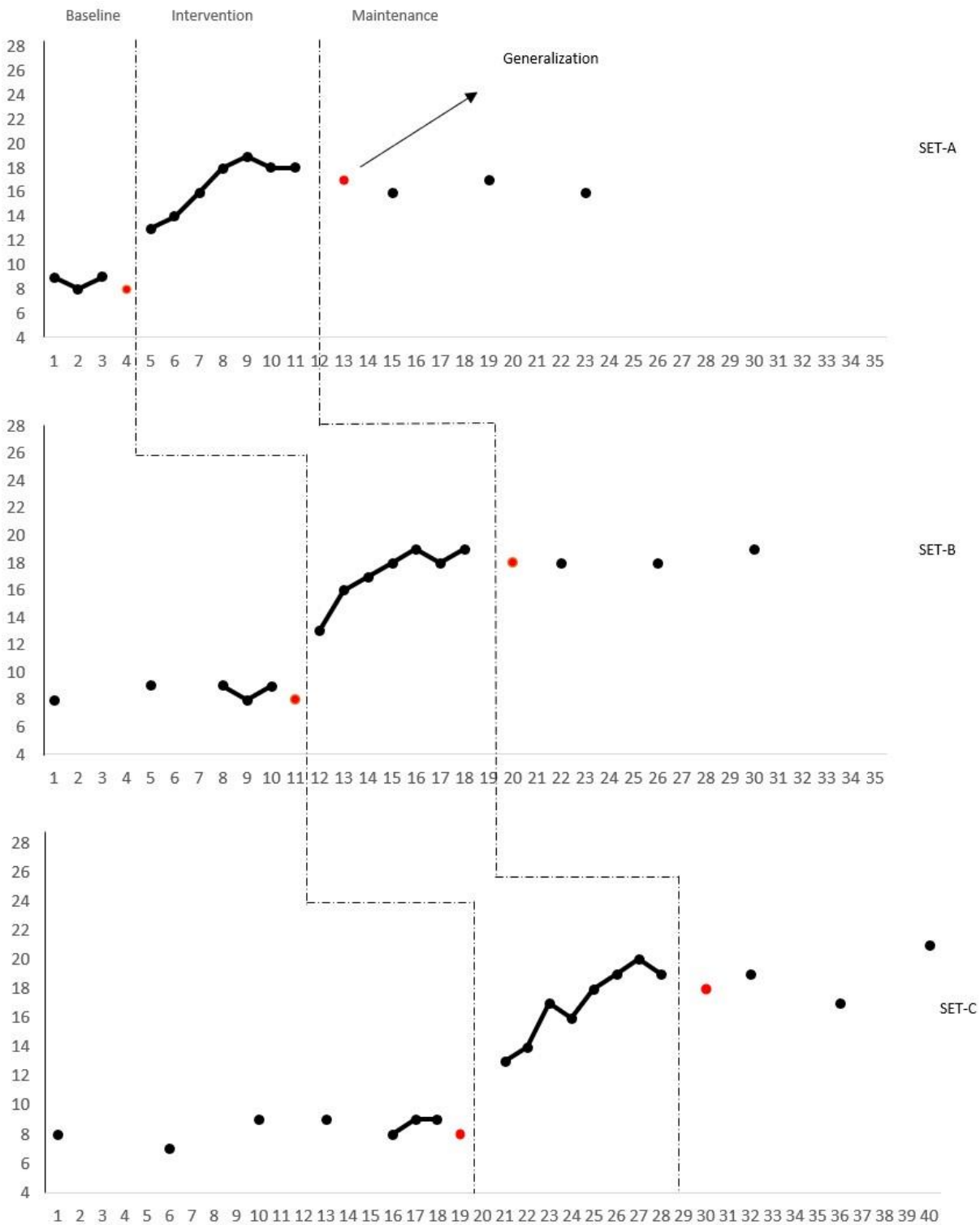


Figure 2. Aytaç’s number of correct basic multiplication facts per minute

To determine whether the student generalized the attained fluency in basic multiplication facts to their reversed forms i.e., in accordance with the commutative property ($3 \times 4 = 12$; $4 \times 3 = 12$) generalization sessions were administered immediately before and immediately after the intervention on each set. As shown in Figure 2, during the pre-intervention generalization (baseline) sessions conducted immediately prior to the CCC phase, Aytaç correctly answered eight facts per minute for all three sets. In the post-intervention generalization sessions, he answered 17 correct facts per minute for Set A, and 18 for Sets B and C. The fact that the student demonstrated comparable performance when asked the reversed facts indicates successful generalization consistent with the commutative property of multiplication.

To assess maintenance, data were collected 4, 8, and 12 days after the conclusion of CCC for each participant set. For Set 1, the student produced 16, 17, and 16 correct facts per minute at 4, 8, and 12 days, respectively. For

Set B, he produced 18 at both 4 and 8 days, and 19 at 12 days. For the final set, he produced 19, 17, and 21 correct facts per minute at 4, 8, and 12 days, respectively. Thus, Aytaç approached but did not fully match peer performance on Set 1. He sustained his end-of-intervention performance on Set B across all three maintenance probes and maintained fluency on Set C at both 4 and 12 days. Overall, maintenance was evident on two sets and was very close to the criterion on the remaining set.

Figure 3 presents the social comparison data. The fourth-grade peers' mean fluency in multiplication facts was 18 correct per minute before the intervention and 21 after the intervention. Aytaç's total correct responses increased from 8 pre-intervention to 20 post-intervention. In sum, the gap between Aytaç and his peers on basic multiplication fluency substantially narrowed by the end of the study.

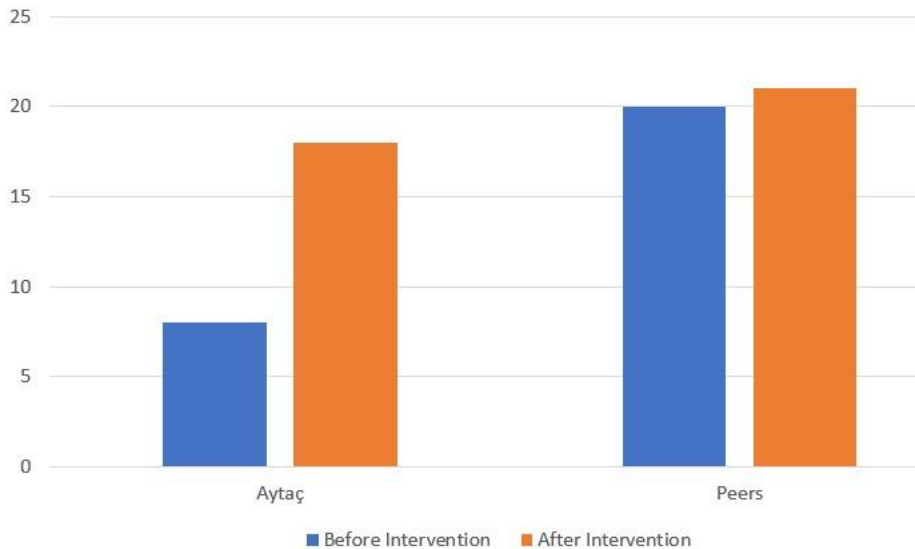


Figure 3. Pre- and post-intervention fluency levels of Aytaç and peers

At the end of the intervention, social validity data were collected via subjective evaluation. In response to closed-ended questions about whether the CCC activities were effective and practical, and whether the student would use CCC to build fluency with other operation types or skills in the future, the student gave positive answers. In an open-ended item probing perceived strengths and weaknesses, the student reported that he had previously responded slowly to problems, that he had become faster “like [his] friends,” that the sessions were short and enjoyable, that he felt capable of doing the work independently, and that he was happy to participate. Overall, the student characterized the intervention as practical, helpful, and simple to implement.

CONCLUSION AND DISCUSSION

This study demonstrates that the Cover–Copy–Compare (CCC) procedure enhanced a student’s fluency with basic multiplication facts, despite his below-peer mathematics performance associated with a learning disability. Across the three sets of facts, the student’s performance approached the peer benchmark. He also demonstrated generalization by performing comparably on the reversed (commuted) facts. Maintenance probes indicated that fluency gains were sustained at 4, 8, and 12 days post-intervention. Taken together, the student’s performance trajectory across phases supports the conclusion that CCC was adequate for building multiplication-fact fluency.

These effectiveness findings are consistent with prior research indicating that CCC improves mathematical fluency for students with learning difficulties (Alptekin et al., 2016; Carr, 2016; Poncy & Skinner, 2011; Stading et al., 1996). In line with the literature, features inherent to CCC—high opportunities to respond, ease of implementation, immediate feedback, and self-correction—likely contributed to the observed increases in fluency (Becker et al., 2009; Erion et al., 2009; Joseph et al., 2012; Skinner et al., 1997). The present study likewise found robust generalization consistent with multiplication’s commutative property, echoing prior evidence that CCC can support generalization (Uysal, 2017).

Maintenance data collected 4–8–12 days after instruction further indicated that the student retained fluency on the practiced facts. Similar maintenance outcomes have been reported in CCC studies (Alptekin, 2019; Coddling, 2007; Poncy, 2007; Saygılı, 2016; Skinner et al., 1989). Because fluency is fundamentally practice-dependent, frequent opportunities to rehearse are expected to support retention over time. Given CCC’s brief duration and minimal need for continuous teacher oversight, the literature suggests that 5–10 minutes of daily practice can help students maintain and even increase fluency (Alptekin, 2019; Stein et al., 2006). The current maintenance data support this view.

Subjective social validity data indicated that the student found CCC easy, enjoyable, and beneficial; he also expressed willingness to apply it to other operation types. These results converge with prior findings that students view CCC as acceptable, feasible, and important (Alptekin, 2019; Becker, 2009; Grafman & Cates, 2010; Uysal, 2017). Social comparison data indicated that the student approached peer levels, corroborating earlier reports that CCC helped narrow gaps with classmates (Alptekin, 2019; Uysal, 2017). The present social comparison findings extend the literature and underscore the practical significance of the results.

This study is limited to one student with a learning disability who exhibited low mathematics performance, and to multiplication among the four basic operations. Although the single-case design limits generalizability, the student's consistent gains across three sets nonetheless support the effectiveness of CCC.

Recommendations

To enhance generalizability, similar studies should be conducted with larger samples. Future research could examine CCC's effects across other basic operations or compare CCC with alternative strategies (or hybrids that combine CCC with other fluency-building techniques). Beyond mathematics, CCC is adaptable to subjects such as Turkish, English, and Social Studies; studies exploring its effects in these domains could broaden teacher uptake. For social comparison, the present study drew on peers from the students' own school. The literature indicates a need for grade-spanning datasets that report fluency levels for both typically developing and students with inclusive education. Establishing such benchmarks would strengthen the interpretation of outcomes and guide the setting of criteria in classroom applications.

REFERENCES

- Alberto, P. A., & Troutman, A. C. (2006). *Applied behavior analysis for teachers* (7th ed.). Pearson.
- Algozzine, B., Ysseldyke, J. E., & Campbell, P. (1994). Strategies and tactics for effective instruction. *Teaching Exceptional Children*, 26(3), 34–36. <https://doi.org/10.1177/004005999402600309>
- Alptekin, S. (2019). The effect of Cover-Copy-Compare interventions to enhance fluency in basic multiplication facts of a student with low performance in math. *Ondokuz Mayıs University Journal of Faculty of Education*, 48(2), 960–993. <https://doi.org/10.14812/cufej.463588>
- Alptekin, S., Vural, M., & Aksoy, Y. (2016). A sample activity for improving the addition fluency of students with poor mathematics performance: Cover-Copy-Compare. *Ondokuz Mayıs University Journal of Faculty of Education*, 35(1), 105–117. <https://doi.org/10.7822/OMUEFD.35.1.9>
- Ashlock, R. B. (1971). Teaching the basic facts: Three classes of activities. *The Arithmetic Teacher*, 18(6), 359–364.
- Baker, A. T., & Cuevas, J. (2018). The Importance of Automaticity Development in Mathematics. *Georgia Educational Researcher*, 14(2), 13-23. <https://doi.org/10.20429/ger.2018.140202>
- Becker, A., McLaughlin, T., Weber, K. P., & Gower, J. (2009). The effects of cover, copy, and compare with and without additional error drill on multiplication fact fluency and accuracy. *Electronic Journal of Research in Educational Psychology*, 7(2), 747–760. <https://doi.org/10.25115/ejrep.v7i18.1368>
- Binder, C. (2003). Fluency: Achieving true mastery in learning. *Performance Improvement*, 42(10), 8–15. <https://doi.org/10.1002/pfi.4930421003>
- Carr, J. E. (2016). The use of cover, copy, and compare in mathematics instruction: A review of the literature. *Journal of Behavioral Education*, 25(2), 213–226. <https://doi.org/10.1007/s10864-016-9247-0>
- Codding, R. S., Eckert, T. L., Fanning, E., Shiyko, M., & Solomon, E. (2007). Comparing mathematics interventions: The effects of cover-copy-compare alone and combined with performance feedback on digits correct and incorrect. *Journal of Behavioral Education*, 16(2), 125–141. <https://doi.org/10.1007/s10864-006-9006-x>
- Common Core State Standards Initiative. (2010). *Common Core State Standards for mathematics*. <https://www.corestandards.org/Math/>
- Daly, E. J., Martens, B. K., Barnett, D., Witt, J. C., & Olson, S. C. (2007). A comparison of methods for increasing math fact fluency. *Journal of Applied Behavior Analysis*, 40(4), 659–667. <https://doi.org/10.1901/jaba.2007.40-659>
- Dennis, M. S., Sorrells, A. M., & Falcomata, T. S. (2016). Effects of cover, copy, and compare on math fact fluency in students with learning disabilities. *Behavior Modification*, 40(5), 768–789. <https://doi.org/10.1177/0145445516648678>
- Erbaş, D. (2018). Güvenirlilik. In E. Tekin-İftar (Ed.), *Eğitim ve davranış bilimlerinde tek-denekli araştırmalar* (2. baskı, ss. 109–132). Anı Yayıncılık.

- Erion, J., Davenport, C., Rodax, N., Scholl, B., & Hardy, J. (2009). Cover-copy-compare and spelling: One versus three repetitions. *Journal of Behavioral Education, 18*, 319–330. <https://doi.org/10.1007/s10864-009-9095-4>
- Fuchs, L. S., & Fuchs, D. (2006). Introduction to response to intervention: What, why, and how valid is it? *Reading Research Quarterly, 41*(1), 93–99. <https://doi.org/10.1598/RRQ.41.1.4>
- Geary, D. C., Hoard, M. K., & Bailey, D. H. (2012). Fact retrieval deficits in low achieving children and children with mathematical learning disability. *Journal of Learning Disabilities, 45*(4), 291–307. <https://doi.org/10.1177/0022219410392046>
- Goldman, S. R., Pellegrino, J. W., & Mertz, D. L. (1988). Extended practice of basic addition facts: Strategy changes in learning-disabled students. *Cognition and Instruction, 5*(3), 223–265. https://doi.org/10.1207/s1532690xci0503_3
- Grafman, J. M., & Cates, G. L. (2010). The differential effects of two self-managed math instruction procedures: Cover, copy, and compare versus copy, cover, and compare. *Psychology in the Schools, 47*(2), 153–165. <https://doi.org/10.1002/pits.20459>
- Hall, T. E., Meyer, A., & Rose, D. H. (2012). Universal design for learning in the classroom: Practical applications. *Theory Into Practice, 51*(1), 1–8. <https://doi.org/10.1080/00405841.2012.636326>
- Joseph, L. M., Konrad, M., Cates, G., Vajcner, T., Eveleigh, E., & Fishley, K. M. (2012). A meta-analytic review of the cover-copy-compare and variations of this self-management procedure. *Psychology in the Schools, 49*(2), 122–136. <https://psycnet.apa.org/doi/10.1002/pits.20622>
- National Assessment of Educational Progress. (2013). The nation's report card: 2013 mathematics & reading. U.S. Department of Education, National Center for Education Statistics. https://nces.ed.gov/nationsreportcard/reading_math_2013/
- National Assessment of Educational Progress. (2015). The nation's report card: Mathematics 2015. U.S. Department of Education, National Center for Education Statistics. <https://nces.ed.gov/nationsreportcard/subject/publications/main2015/pdf/2016458.pdf>
- National Council of Teachers of Mathematics. (2003). Principles and standards for school mathematics. NCTM.
- National Mathematics Advisory Panel. (2008). Foundations for success: The final report of the National Mathematics Advisory Panel. U.S. Department of Education. <https://www2.ed.gov/about/bdscomm/list/mathpanel/report/final-report.pdf>
- Patton, J. R., Cronin, M. E., Bassett, D. S., & Koppel, A. E. (1997). A life skills approach to mathematics instruction: Preparing students with learning disabilities for the real-life math demands of adulthood. *Journal of Learning Disabilities, 30*(2), 178–187. <https://doi.org/10.1177/002221949703000205>
- Poncy, B. C., & Skinner, C. H. (2011). Enhancing academic performance using cover, copy, and compare: A review of the research. *Journal of Behavioral Education, 20*(1), 18–36. <https://doi.org/10.1007/s10864-010-9122-7>
- Poncy, B. C., Skinner, C. H., & Jaspers, K. E. (2007). Evaluating and comparing interventions designed to enhance math fact accuracy and fluency: Cover, copy, and compare versus taped problems. *Journal of Behavioral Education, 16*(1), 27–37. <https://doi.org/10.1007/s10864-006-9025-7>
- Poncy, B. C., Skinner, C. H., & McCallum, E. (2012). A comparison of class-wide taped problems and cover, copy, and compare for enhancing mathematics fluency. *Psychology in the Schools, 49*(8), 744–755. <https://doi.org/10.1002/pits.21631>
- Shapiro, E. S. (2010). *Academic skills problems: Direct assessment and intervention* (4th ed.). Guilford Press.
- Shrager, J., & Siegler, R. S. (1998). SCADS: A model of children's strategy choices and strategy discoveries. *Psychological Science, 9*(5), 405–410. <https://doi.org/10.1111/1467-9280.00076>
- Skinner, C. H., McLaughlin, T. F., & Logan, P. (1997). Cover, copy, and compare: A self-managed academic intervention effective across skills, students, and settings. *Journal of Behavioral Education, 7*(3), 295–306. <https://doi.org/10.1023/A:1022823522040>
- Stading, M., Williams, R. L., & McLaughlin, T. F. (1996). Effects of cover, copy, and compare on multiplication facts of elementary school students. *Journal of Behavioral Education, 6*(1), 27–38.
- Stein, M., Kinder, D., Gilbert, J., & Carnine, D. W. (2006). *Designing effective mathematics instruction: A direct instruction approach* (4th ed.). Merrill/Pearson Prentice Hall.
- Uysal, H. (2017). Zihin yetersizliği olan öğrencilere temel toplama işlemlerinde akıcılık kazandırmada iki farklı uygulamanın karşılaştırılması [Yayımlanmamış yüksek lisans tezi]. Anadolu Üniversitesi.
- Wong, P. S. K. (1989). Students' metacognition in mathematical problem solving [Research report/meeting paper]. Singapore: Plus Postage.
- Ysseldyke, J. (2005). Assessment and decision making for students with learning disabilities: What if this is as good as it gets? *Learning Disability Quarterly, 28*(2), 125–128. <https://doi.org/10.2307/1593610>
- Yücesoy-Özkan, Ş. (2017). Toplama işlemleri. In O. Gürsel (Ed.), *Özel gereksinimli öğrencilere matematik beceri ve kavramlarının öğretimini planlama ve uygulama* (ss. 239–278). Vize Yayıncılık.