



## Co-Teaching Effects on Algebra I Achievement of Students With Disabilities

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### Abstract

The purpose of this study was to determine the effectiveness of co-teaching versus inclusive non-co-teaching for students with disabilities (SWD) using algebra I end-of-course scores (EOC) and whether these effects differed by gender. Participants included 244 ninth-grade algebra I SWD. The research design consisted of a posttest only with a control group and a test group. Analysis of covariance (ANCOVA) was used to analyze the results. Results showed that co-teaching did not significantly benefit either male or female SWD in algebra I. The fact that SWD in inclusive settings who did not receive co-teaching scored higher than those in inclusive settings who did receive co-teaching is significant and has important implications for practice and research. Future research should investigate studies with larger sample size and proficiency of teachers in co-taught classes.

**Keywords:** *Co-teaching, students with disabilities, algebra*

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### Introduction

This study aimed to examine the effects of co-teaching versus an inclusion setting with no co-teaching on algebra I achievement among ninth-grade high school students with disabilities (SWD). An achievement gap has been demonstrated between ninth-grade SWD and students without disabilities (SWOD) (Bottge et al., 2018). Thus, effective math instructional strategies are important to discover and implement. It has been

hypothesized that the co-teaching model is more effective than non-co-teaching in narrowing a math achievement gap between SWD and SWOD (Blazer, 2017; Elliott et al., 2017; Spooner et al., 2019).

## Literature Review

Co-teaching is defined as a collaborative teaching practice rooted in the inclusive education philosophy with a belief that all children can learn given opportunity, effective teaching, and appropriate resources (Chitiyo, 2017; Drescher, 2017). In the typical co-teaching model, general education and special education teachers collaborate on providing instruction for SWD. While some have suggested that co-teaching in the inclusive setting is a promising approach for optimal achievement among SWD, the actual outcomes of co-teaching rarely have been directly studied (Bingham, 2019). A second goal of the study was to examine if any differences between gender exist among SWD and algebra I achievement. A large number of studies have demonstrated the moderating effect of gender differences on the mathematics achievement of students in general (males outperforming females). However, there is insufficient evidence in terms of how co-teaching practices influence the algebra I achievement of students based on gender, especially among SWD (Stevens & Schulte, 2017; Stewart et al., 2017).

Academic achievement between SWD and SWOD has continued to show significant gaps, especially in mathematics. For instance, 68% of all eighth grade SWD scored below the basic grade-level achievement mandated by the United States Department of Education, compared to 29% of SWOD (Bottge et al., 2018; Moeller & McLeod, 2017). Math achievement has gained an additional spotlight of importance with the recent focus on STEM achievement (i.e., achievement in science, technology, engineering, and math) acting as a catalyst for a detailed inquiry into math achievement variables.

The Individuals with Disability Education Act (IDEA, 2004) advocates inclusive education in the least restrictive environment. As a result, co-teaching has evolved quickly as one of the main strategies for ensuring that SWD have access to the same curriculum as SWOD (Friend et al., 2010). In a co-teaching model, the special education teacher and general education teacher coordinate instructional practices to support SWD in the inclusion setting (Friend et al., 2010).

## Purpose of the Study, Research Questions, and Hypotheses

RQ1: Is there a significant difference in EOC scores for male SWD enrolled in Grade 9 inclusion algebra I who receive instruction in co-taught algebra I classes as compared to male SWD who receive instruction in classes without co-teaching?

RQ2: Is there a significant difference in EOC scores for female SWD enrolled in Grade 9 inclusion algebra I who receive instruction in co-taught algebra I classes as compared to female SWD who receive instruction in classes without co-teaching?

## Methods

The population in this IRB-approved study included female and male SWD in both co-teaching and non-co-teaching inclusion classrooms. All participants were in ninth-grade algebra I. Algebra I was chosen as the math course variable due to its lower reliance on prior knowledge of math concepts, as all students are near the same level when beginning the course (Givvin et al., 2019).

In this study, teachers employed the typical model for co-teaching (Drescher, 2017). In other words, the general education teacher took the lead for direct instruction of algebra I. The role of the special education

teacher provided one-on-one or small group instruction when SWD appeared distracted or did not comprehend the content. Collaboration between the general education teacher and special education teacher took place as needed.

Teacher qualifications for general education teachers were state certification for teaching algebra I. Special education teachers held state certifications for teaching in all subject matter. The average level of teaching experience for all teachers was 10 years.

We adopted an ex post facto design with posttests only. A pretest–posttest design was considered, but archival records lacked pretest data for algebra scores. Algebra I scores were drawn from 3 years (between 2016 and 2019) of anonymized student records at a single southeastern U.S. high school, which used both co-teaching and non-co-teaching approaches. Per a G\*Power analysis, there was a minimum requirement of 128 algebra scores from SWD. A total sample for the study included 244 algebra I exam scores, which exceeded the minimum required  $N$ . A state-mandated final benchmark exam in algebra I (i.e., EOC exam) was used as the dependent variable and had a good reliability value (Cronbach's alpha between 0.90 and 0.92). These EOC exam scores were used to operationalize the outcomes of the algebra course, as they were more easily analyzed than categorical letter grades. Furthermore, EOC exams are designed as a comprehensive measure of course material comprehension. These exams are essentially final exams meant to cover the entirety of the course material.

General school data of population percentages were drawn from the state's education public database. This ensured that the socioeconomic and diversity percentages were the same or similar for the school for all 3 years. Data were exported into the Statistical Package for the Social Sciences (SPSS) statistical analysis software for the data analysis. An analysis of covariance (ANCOVA) was conducted with the following covariates: gender, algebra I with and without co-teaching and academic year of the EOC exam.

Table 1 illustrates a demographic breakdown of 244 ninth-grade algebra I SWD. EOC exam scores were drawn from 3 different academic years. One hundred scores (41%) were from the 2017–2018 school year, 89 (36.5%) EOC exam scores were from the 2016–2017 school year, and 55 scores (22.5%) from the 2015–2016 school year. The majority (192; 78.7%) of SWD received co-teaching versus non-co-taught algebra I classes. In terms of gender, 69.7% of students were male and 30.3% were female.

**Table 1.** Frequency and Percentage Summaries of Demographics of SWD ( $N = 244$ )

	$N$	%
Grade Level		
9	244	100.0
Academic Year		
15–16	55	22.5
16–17	89	36.5
17–18	100	41.0
Instructional Model		
Inclusive Non-Co-Taught Classes	52	21.3
Co-taught Algebra I	192	78.7
Gender		
Male	170	69.7
Female	74	30.3

## Data Analysis

An ANCOVA was run to test both RQs. ANCOVA with between-subjects factors (independent variables) of gender and co-taught algebra I groupings after controlling the effects of the covariate of the academic year was conducted. The required assumptions of this analysis included no presence of outliers (not present), normality of the data of the dependent variable, and homogeneity of variance. Normal distribution was tested through the Shapiro-Wilk test and the requirement was met ( $SW [243] = 0.99, p = 0.006$ ). Levene's test showed that the variance of SWD EOC exam scores ( $F[3, 240] = 1.41, p = 0.24$ ) was homogeneous ( $p > 0.05$ ) across the different categories of the independent variables of gender and co-taught algebra I groupings. A level of significance of 0.05 was used for the ANCOVA. The ANCOVA results are shown in Table 2.

## Results

The ANCOVA results showed that the EOC exam scores ( $F[1, 239] = 21.57, p < 0.001, \eta^2 = 0.08$ ) were significantly different between the two algebra I groupings after controlling for the effect of academic year among the ninth-grade algebra I SWD. The comparisons in Table 3 show that the mean EOC exam scores among ninth-grade SWD who received instruction in co-taught algebra I classes ( $M = 71.60; SD = 9.29$ ) were significantly lower as compared to mean EOC exam scores among ninth-grade algebra I SWD who received instruction in classes without co-teaching ( $M = 64.54; SD = 8.04$ ). Thus, ninth-grade algebra I SWD who received instruction in inclusive classes without co-teaching had better EOC exam scores than ninth-grade algebra I SWD who received instruction in inclusive co-taught algebra I classes. ANCOVA interaction effects results showed that there was no significant difference among EOC exam scores ( $F[1, 239] = 0.92, p = 0.34, \eta^2 = 0.00$ ) between male and female ninth-grade algebra I SWD after controlling for the academic year.

**Table 2.** Results of ANCOVA of Significance of Difference of EOC Scores by Gender and Co-Taught Algebra I Groupings Controlling for Academic Year

Source	Sum of Squares	df	Mean Square	F	p	Partial Eta Squared
Corrected Model	2220.64	4	555.16	8.01	0.00*	0.12
Intercept	118,457.78	1	118457.78	1708.81	0.00*	0.88
Academic year	32.47	1	32.47	0.47	0.49	0.00
Gender	63.62	1	63.62	0.92	0.34	0.00
Co-Taught Algebra I	1,495.12	1	1495.12	21.57	0.00*	0.08
Gender* Co-Taught Algebra I	5.25	1	5.25	0.08	0.78	0.00
Error	16,567.87	239	69.32			
Total	1,083,105.00	244				
Corrected Total	18,788.50	243				

a. R Squared = 0.12 (Adjusted R Squared = 0.10)

Dependent Variable: EOC Score

\*Significant difference at level of significance of 0.05

**Table 3.** Descriptive Statistics Summaries of EOL Scores by Gender and Co-Taught Algebra I Groupings

Gender	Instructional Model	<i>M</i>	<i>SD</i>	<i>N</i>
Male	Inclusive Classes	71.33	9.79	40
	Co-Taught Algebra I	63.95	8.12	130
	Total (Both Inclusive Classes and Co-taught Algebra I)	65.69	9.07	170
Female	Inclusive Classes	72.50	7.69	12
	Co-Taught Algebra I	65.77	7.80	62
	Total (Both Inclusive Classes and Co-taught Algebra I)	66.86	8.12	74
Total (Both Genders)	Inclusive Classes	71.60	9.29	52
	Co-Taught Algebra I	64.54	8.04	192
	Total (Both Inclusive Classes and Co-Taught Algebra I)	66.05	8.79	244

As an additional test for significant differences among gender scores, an independent sample *t*-test was conducted. A level of significance of 0.05 was used. The independent sample *t*-test results are shown in Table 4. Similar to the results of the ANCOVA, the results of the independent sample *t*-test showed that there was no significant difference in the EOC exam scores ( $t [242] = -0.96, p = 0.34$ ) between male and female ninth-grade algebra I EOC scores across the 3-year span of testing.

**Table 4.** Results of Independent Sample *t*-test of Significance of Difference of EOL Scores by Gender Only

Dependent Variable	<i>t</i> -test for Equality of Means						
	<i>T</i>	<i>df</i>	<i>p</i> (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
EOC Score	-0.96	242	0.34	-1.18	1.23	-3.59	1.24

## Discussion

The findings showed that ninth-grade SWD who received instruction in co-taught algebra I classes scored significantly lower as compared to those who received instruction in inclusive classes without co-teaching. These data suggest that ninth-grade algebra I SWD who received instruction in inclusive classes without co-teaching had better EOC exam scores than those who received instruction in co-taught algebra I classes. These results are somewhat counterintuitive based on the premise that co-teaching leads to stronger achievement outcomes for SWD. The difference between male and female EOC scores was not significant. Thus, female and male SWD scored equally well on average on the EOC algebra I exam. This finding contradicts previously held beliefs that males tend to outscore females in math-related content (Cunningham, 2016).

Co-teaching is an approach that is expected to raise the quality of special education by capitalizing on shared skills and specializations among collaborating educators to enhance teaching quality for learners (Hamdan et al., 2016). However, our results suggest that the inclusion model may be more appropriate than co-teaching in the case of algebra I. It is unclear why SWD did not benefit from co-teaching in this study. One possible

explanation is that there is no standard process between general education and special education teachers for inclusion instruction, leading to a wide diversity of co-teaching applications. In this study, the implementation of co-teaching styles may not have been conducive to the specific algebra I instructional needs of these particular SWD. For example, Moeller and McLeod (2017) found that the expertise of teachers is crucial to planning math lessons for students to support their math achievement. Secondly, it is possible that co-teaching created an unnecessary distraction among SWD students (Chitiyo, 2017).

## Limitations

Several limitations were present in this study. One limitation was that the results might only represent the individual school that was included in the study and not the wider population of SWD students. Therefore, the generalizability of the data is limited by the focus on SWD from a particular grade level and their algebra I achievement within a single study site. Further research is needed to determine the effects of co-teaching on SWD algebra I achievement in other settings and contexts along with more analysis of gender differences or lack thereof.

The results from this study may be skewed because teacher quality and co-teaching quality may have influenced results. There was no measure taken of teacher quality. Teacher quality should be considered when evaluating student outcomes (Brendle et al., 2017). While co-teaching has been demonstrated to be effective in other studies, the potential reason students did not benefit from this model in this study could be partially due to specific teacher characteristics.

## Implications for Theory and Practice

In classes that are already inclusive, SWD may be able to adapt successfully to these environments without further being isolated or segregated from their peers vis-a-vis co-teaching. The fact that SWD in inclusive classes without co-teaching scored higher than those with co-teaching is noteworthy and has important implications for practice and research. These findings contradict much of the literature that supports co-teaching for SWD.

The second research question pertained to whether there was a significant difference in EOC scores for female versus male SWD enrolled in grade 9 algebra I who received instruction in co-taught algebra I classes versus classes without co-teaching. Prevailing literature has often suggested that males outscore females in math content areas (Brendle et al., 2017). Our results, however, showed that there was no significant difference between female and male students' EOC exam scores. There was no significant difference even after controlling for the effect of the academic year among the ninth-grade algebra I SWD. These results support Iqbal and Shams' (2018) recommendations for more research on female students and factors related to math achievement. It is possible that more female students have taken an interest in STEM courses, and this is borne out by increasing numbers of female students entering professional STEM-related careers (The United States Census Bureau, 2021).

## Conclusion

Despite the current co-teaching inclusion model of instruction for SWD, few studies have examined actual achievement outcomes for these students when compared to a traditional classroom environment. In this study, such an analysis was conducted with grade 9 high school students enrolled in an algebra I course and did not find a benefit supporting the co-teaching model of instruction. It is possible that high school students do not wish to be singled out as SWD and might perform equally well in a traditional setting. Secondly, the results of our study contradicted notions that males outscore females in math-oriented content. This finding is viewed as a welcomed advancement in math-oriented courses among female high school students.



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