

Confounding in Group Design Studies

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Webinar goals

Examine confounding in group design studies to build or enhance the following:

- Understanding of the topic
- Ability to identify confounding factors
- Ability to design or review studies using the WWC evidence standards



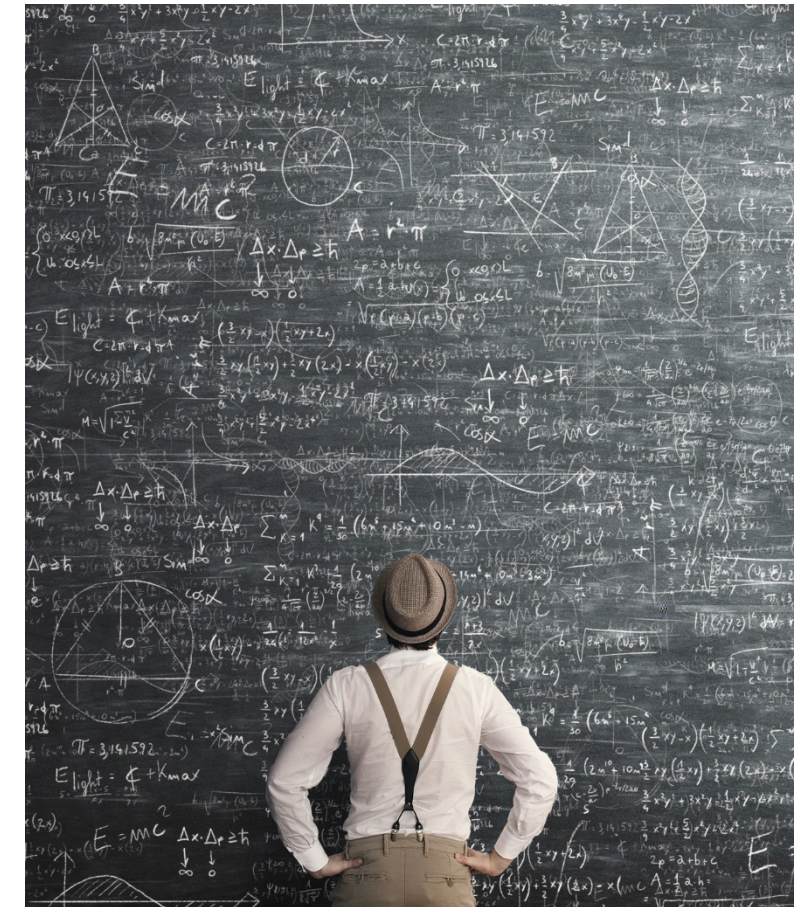
Webinar topics

- Overview of confounding in group design studies
- Review three types of confounds recognized by the WWC
 - Review each confounding factor
 - Consider examples from WWC-reviewed studies
 - Practice identifying each type of confounding factor
- Review questions and WWC resources

OVERVIEW OF CONFOUNDING

What is a confounding factor?

A confounding factor is an aspect of a study that makes it impossible to tell whether the difference in outcomes is due to the intervention, the confounding factor, or both.



What is a confounding factor?



- From the WWC perspective, a confounding factor
 - **is observed.** There must be evidence reported in the study that the confound exists.
 - **aligns completely with only one of the study's conditions.** The confound is present in one condition but not the other.
 - **is not part of the intervention under study.** There is a need to separate the effect of the confound from the effect of the intervention.

What are the consequences of confounding for the WWC study review?

- Studies with a confounding factor receive the *Does Not Meet WWC Group Design Standards* rating or are ineligible for review.
- A study that receives the *Does Not Meet WWC Group Design Standards* rating based on the confound cannot recover its rating.
- A study ineligible for review based on a confound under one WWC review protocol may be eligible for review under another protocol.



The WWC's definition of a confound has evolved since 2008

**Handbook 1.0,
May 2008:**

Definition focused on $n = 1$ teacher confound (p. 16).

**Handbook 2.1,
Sep 2011:**

Same definition as previous handbooks; expanded it to RDD (p. 15).

**Handbook 4.0, Oct
2017:**

Clarified and refined definitions for the three types of confounds and added more clarifying examples (pp. 81–83).

**Handbook 2.0,
Dec 2008:**

Same definition as Handbook 1.0 (p. 15).

Handbook 3.0, n.d: The definition of $n = 1$ confound refined and expanded to include (p. 19):

- Characteristics of a study or study unit differ systematically between groups with no overlap
- Combined (or bundled) interventions

Three Types of Confounds Recognized by the WWC

- Single unit ($n = 1$)
- Group or participant characteristics
- Combined (or bundled) interventions



TYPES OF CONFOUNDING FACTORS, EXAMPLES, AND PRACTICE

Confound: Single unit ($n = 1$)

- The intervention or comparison group contains a single study unit and that unit is not present in the other condition (known as $n = 1$ confounding factor).
- The effect of the intervention cannot be separated from the effect of that unit.



Confound: Single unit ($n = 1$)

Studies that contain $n = 1$ confounds receive the rating of
Does Not Meet WWC Group Design Standards.

Example of $n = 1$

Study Design	Confound Assessment	Decision
<p>A study has three intervention classrooms and three comparison classrooms. The intervention classrooms all had the same teacher, who had no interaction with the comparison classrooms.</p>	<p><u>Is teacher a confound?</u> Observed?</p> <ul style="list-style-type: none"> • Yes <p>Aligns completely with one condition?</p> <ul style="list-style-type: none"> • Yes <p>Part of the intervention?</p> <ul style="list-style-type: none"> • No 	<p>The study contains a confound. The WWC considers the one teacher for the three intervention classrooms a confound because that one teacher is perfectly aligned with the intervention classrooms.</p>

Example of $n = 1$

$n = 1$ confounding factor

Intervention	Comparison
Instructor: Emily	Instructor: Josh
Classroom 1 Classroom 2 Classroom 3	Classroom 4 Classroom 5 Classroom 6

A unit of study—instructor—is perfectly aligned with the intervention and comparison conditions.

Non-confounding factor

Intervention	Comparison
Instructor: Emily	
Classroom 1 Classroom 2 Classroom 3	Classroom 4 Classroom 5 Classroom 6

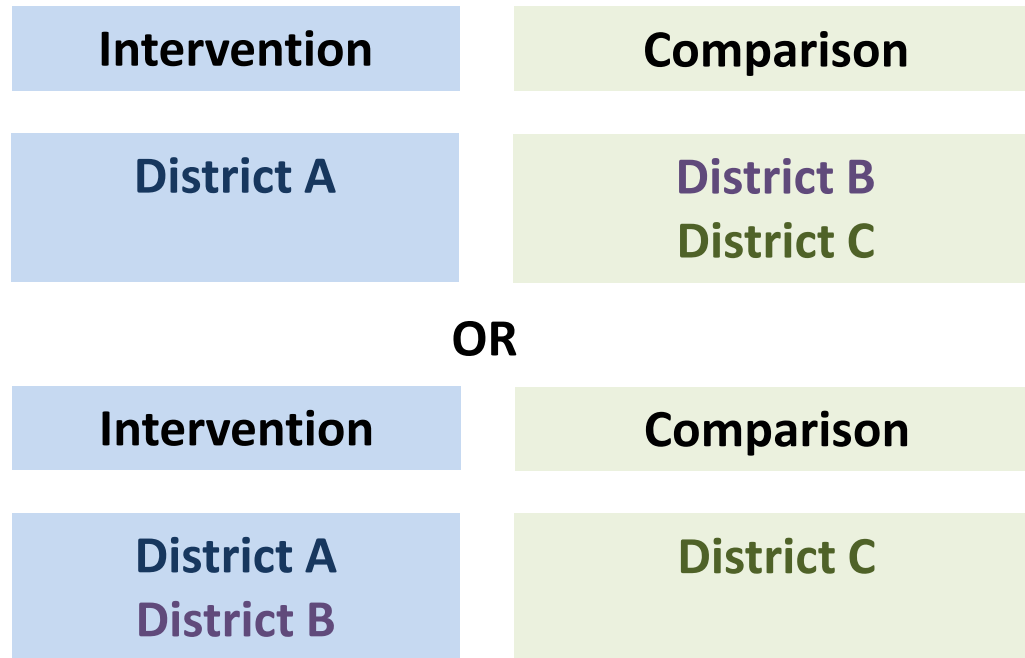
None of the study units is perfectly aligned with the intervention or comparison conditions: multiple classrooms in all conditions, the same instructor interacting with both conditions.

Example of $n = 1$

Example	Confound Assessment	Decision
<p>Three districts have schools participating in the study. Districts A and B have schools in the intervention and comparison conditions. District C has schools only in the comparison condition.</p>	<p><u>Is district a confound?</u></p> <p>Observed?</p> <ul style="list-style-type: none"> • Yes <p>Aligns completely with one condition?</p> <ul style="list-style-type: none"> • No <p>Part of the intervention?</p> <ul style="list-style-type: none"> • No 	<p>District is not a confound. The WWC does not consider district to be a confounding factor because districts A and B are represented in both conditions.</p>

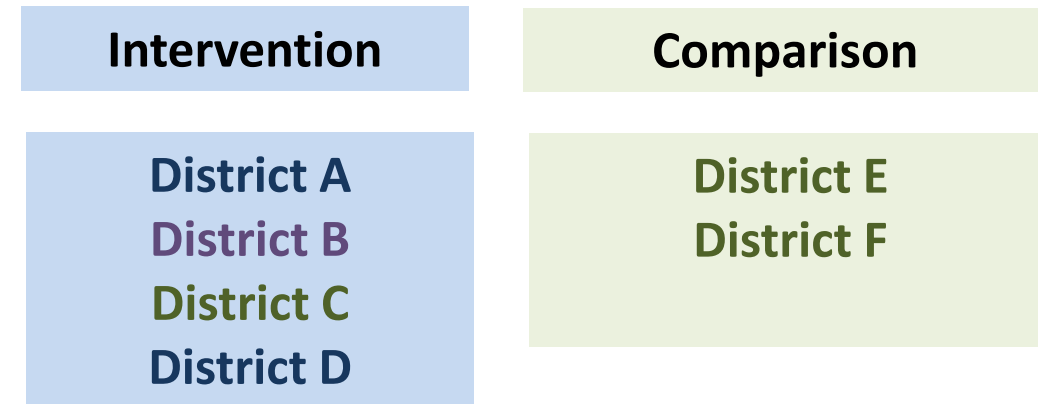
Example of $n = 1$

$n = 1$ confounding factor



A unit of study—district—is perfectly aligned with one condition, which could be the intervention or comparison condition.

Non-confounding factor



None of the study units are perfectly aligned with the intervention or comparison conditions: multiple districts are in both conditions.

Example of $n = 1$

Example	Confound Assessment	Decision
<p>A study examines the effectiveness of attending a career academy. Students in the intervention group attend a career academy, which is one whole school. Students in the comparison group attend multiple other traditional schools.</p>	<p>Is one school that houses <u>a career academy a confound</u>?</p> <p>Observed?</p> <ul style="list-style-type: none"> • Yes <p>Aligns completely with one condition?</p> <ul style="list-style-type: none"> • Yes <p>Part of the intervention?</p> <ul style="list-style-type: none"> • Yes 	<p>School that houses a career academy is not a confound, even though it is the only school that students in the intervention group attended. The WWC does not consider school to be a confounding factor in this case because the school is the intervention.</p>

Examples of $n = 1$ from WWC-reviewed studies

Description (WWC review ID 100291). Koedinger, McLaughlin, and Heffernan (2010) was a study that examined the effectiveness of ASSISTments—a web-based math tutor—on seventh-grade students' math achievement scores. Four schools were included in the study: three intervention schools and one comparison school.

Examples of $n = 1$ from WWC-reviewed studies

Does the study contain a confounding factor? Yes. A single school in the comparison condition makes it impossible to separate the counterfactual from the effect of that one school.

Study Rating. Does Not Meet WWC Group Design Standards.

Where was the needed information located?
In the Abstract and the Participants section.

Examples of $n = 1$ from WWC-reviewed studies

Description (WWC review ID 1901563). Holiday and Philip (2015) was a study that examined the effectiveness of COMPASS—a targeted professional development program for teachers and school support staff—on reading achievement of students in Grades 3–8. Included in the study were 21 intervention schools from the Iredell-Statesville district in North Carolina. The study’s 42 comparison schools were from neighboring school districts.

Examples of $n = 1$ from WWC-reviewed studies

Does the study contain a confounding factor? Yes. A single school district is a confounding factor, because the effect of the intervention cannot be separated from the effect of the school district.

Study Rating. Does Not Meet WWC Group Design Standards.

Where was the needed information located?
The Executive Summary, description of the impact evaluation design.

Examples of $n = 1$ from WWC-reviewed studies

Description (WWC review ID 190341). Kirby (2005) was a study that examined the effectiveness of I CAN Learn Algebra I, a self-paced educational software intervention. The study was conducted in one high school. Students enrolled in Algebra I were randomized to intervention and comparison groups. It is not clear how many classrooms were included in the study, nor how many teachers taught each classroom. The text sometimes refers to “the teacher” and other times to “teachers.” One paragraph states, “The I CAN Learn classes were taught by a teacher trained in its use ...”

Examples of $n = 1$ from WWC-reviewed studies

Does the study contain a confounding factor? Unclear, but a confound at the teacher level cannot be ruled out. An author query received no response.

Study Rating. Does Not Meet WWC Group Design Standards.

Examples of $n = 1$ from WWC-reviewed studies

Description (WWC review ID N/A). Strohm (2008) examined Cognitive Intervention Processing, an intervention intended to improve students' decisions about careers. The text suggests multiple implementers: "there were two school counselors assisting the researcher ..." Step-by-step description of the intervention consistently mentions the researcher: "the researcher referred ...," "the researcher summarized ..." This is how the text describes the involvement of school counselors: "One counselor assisted in administering the pretest/posttest instruments. The second counselor assisted in reconciling student schedules with intervention activities and in scheduling students for any needed make-up sessions."

Examples of $n = 1$ from WWC-reviewed studies

Does the study contain a confounding factor? Unclear. Although the text suggests that the intervention had multiple implementers, the involvement of school counselors was minimal and did not merit being considered part of the implementation. The leadership team decided that the intervention had an $n = 1$ confound at the implementer level.

Study Rating. Does Not Meet WWC Group Design Standards.

Where was the needed information located?
Method: Procedures, descriptions of interventions.

Knowledge check 1

Description (WWC review ID 72045). Beck and Chizik (2008) examined the effectiveness of using cooperative learning to teach a computer science course. The study was conducted at San Diego State University. The intervention condition included 34 students, and the comparison condition included 37 students. One instructor taught all students in the intervention condition, and another instructor taught all students in the comparison condition.

Does the study contain a confounding factor?

Yes

No

Answer to knowledge check 1

Does the study contain a confounding factor?

Yes, the study contains an $n = 1$ confounding factor.

Explanation

A single instructor in either condition is a confounding factor in this study, because the effect of the intervention cannot be isolated from the effect of the instructor. The single university site is not a confounding factor, however, because it is not completely aligned with either condition.

Where was the needed information located?

The Methodology section.

Knowledge check 2

Description (WWC review ID 71927). Murphy et al. (2014) examined the effectiveness of blended learning, which combines traditional classroom instruction with online instruction. The study was conducted in FirstLane charter organization's four elementary schools. One school implemented the blended learning model in Grades K–8 for one academic year. Three other schools served as the comparison condition.

Does the study contain a confounding factor?

Yes

No

Answer to knowledge check 2

Does the study contain a confounding factor?

Yes, the study contains an $n = 1$ confounding factor.

Explanation

A single school in the intervention condition is a confounding factor in this study, because the effect of the intervention cannot be separated from the effect of the school. Note that the school in this study is the site for a year-long intervention, it is not the same as the intervention.

Where was the needed information located?

The Introduction and the Sample section.

Knowledge check 3

Description (WWC review ID N/A). Van Cura (2010) was a study that examined the effectiveness of school-based health centers. The study was conducted in two high schools. School A had a school-based health center and a nurse. School B only had a nurse, who was the same nurse as in School A. Students from either school were included in the study if they received medical services within the study period. The intervention group included students from School A who received medical services from the school-based health center at that school. The comparison group included students who received medical services from a school nurse at either School A or School B.

Which $n = 1$ does this study contain? Choose all that apply.

- $n = 1$: School
- $n = 1$: Nurse
- $n = 1$: Health center
- None

Answer to knowledge check 3

Does the study contain a confounding factor?

Yes, the study contains an $n = 1$ confounding factor for a single school-based health center.

Explanation

A single school-based health center is a confounding factor in this study because the effect of the intervention cannot be isolated from the effect of that one center. School is not a confound in this study because neither school is perfectly aligned with the study's conditions. One school nurse is a possible confound, although it is not clear from the text if students who received medical services from the school-based center also interacted with the nurse. If they did, one school nurse would not be considered a confound.

Where was the needed information located?
The Methodology and Participants sections.

Confound: Group or participant characteristics



- Group or participant characteristics that plausibly affect outcomes differ systematically with no overlap between the intervention and comparison groups.
- Group or participant characteristics should not be a part of the intervention.
- When overlap between characteristics exists but is imperfect, the WWC does not consider the study to have a confound.

Confound: Group or participant characteristics

Studies that contain group or participant characteristic confounds receive the rating of
Does Not Meet WWC Group Design Standards.

Example of characteristics confound

Example	Confound Assessment	Decision
<p>In study of a new social studies curriculum, a small group of teachers with a master's degree implements the curriculum, whereas students in the comparison group are taught by teachers with bachelor's degrees.</p>	<p><u>Is teachers' credentials a confound?</u> Observed?</p> <ul style="list-style-type: none"> • Yes <p>Aligns completely with one condition?</p> <ul style="list-style-type: none"> • Yes <p>Part of the intervention?</p> <ul style="list-style-type: none"> • No 	<p>Teachers' educational credentials is a confound. The teachers' educational credentials differ systematically between the intervention and comparison groups, with no overlap. Having a master's degree is not part of the intervention.</p>

Example of characteristics confound

Example	Confound Assessment	Decision
<p>Classrooms in the intervention condition have much lower rates of students who are eligible for free or reduced-price lunch compared to those in the comparison condition.</p>	<p>Is <u>lunch eligibility a confound</u>? Observed? • Yes Aligns completely with one condition? • No Part of the intervention? • No</p>	<p>Lunch eligibility is not a confound. The WWC does not consider this characteristic to be a confounding factor because there is some overlap between the groups on lunch eligibility.</p>

Non-confounding factor: Volunteering

- In experimental studies, volunteering is not a confounding factor if volunteers are randomly assigned to conditions.



Non-confounding factor: Volunteering



- In quasi-experimental studies, volunteering is not a confounding factor. The selection mechanism and differences in unobserved characteristics are a concern to the WWC. Therefore, the highest possible rating for quasi-experiments is *Meets WWC Group Design Standards With Reservations*.

Confounding factor: Time

- Time is a confounding factor when the intervention and comparison groups are observed at different times.
- Studies in which time is a confound are often labeled as a successive-cohort or cohort design.
 - For example, an intervention group includes fifth graders in 2010, and the comparison group includes fifth graders in 2009.



Examples of characteristics confound from WWC-reviewed studies

Description (WWC review ID 69601). Sheldon and Krieger (2007) examined the effectiveness of an “autonomy-supportive” law school environment, which relates students’ interests and priorities to professional training. The study was conducted in two law schools. The intervention group included students from School A, and the comparison group included students from School B. Students in the intervention condition were from the cohort that started in 2002 (final assessment 2005), and students in the comparison condition were from the cohort that started in 2001 (final assessment 2003).

Examples of characteristics confound from WWC-reviewed studies

Does the study contain a confounding factor? Yes. Time is a confound. Both cohorts are observed at different times, therefore the impact may be confounded with any changes that occurred between the time periods. A single school in each condition is also an $n = 1$ confound in this study, because it is impossible to separate the effect of the intervention from the effect of school.

Study Rating. Does Not Meet WWC Group Design Standards.

Examples of characteristics confound from WWC-reviewed studies

Description (WWC review ID 1901680). Fauth (2007) examined the effectiveness of a middle-school mathematics curriculum, the Connected Mathematics Project. The intervention group included seventh graders in the 2006–07 school year, and the comparison group included seventh graders from the same school in the 2003–04 school year. Students in the intervention condition were the “second highest group of math students” in the school based on state standardized test scores. The same teacher taught all students.

Examples of characteristics confound from WWC-reviewed studies

Does the study contain a confounding factor? Yes. Time is a confound in this study: Students were observed in different school years. Therefore, the effect of the intervention is confounded with changes that might have occurred over time. Another possible confound is the math achievement of students in the intervention group, who were the “second highest group of math students.” The reviewer pointed out that the study’s description had no indication that the comparison group included students with the same characteristics.

Study Rating. Does Not Meet WWC Group Design Standards.

Knowledge check 1

Description (WWC review ID 71892). McGrath and Burd (2012) examined the effectiveness of the Pathway to Success program, which provided supplemental services, such as college skills training, to incoming college freshman enrolled in developmental coursework. The study was conducted in one 2-year college. The comparison group included students from the 2003–04 academic year, and the intervention group included students from the 2008–09 academic year.

Does the study contain a confounding factor?

Yes

No

Answer to knowledge check 1

Does the study contain a confounding factor?

Yes, the study contains a time confound.

Explanation

The intervention and comparison groups are observed at different times with no overlap. Therefore, the impact may be confounded with any changes that occurred between the two time periods.

Where was the needed information located?

The Setting and Participants sections.

Knowledge check 2

Description (WWC review ID 71865). Burris, Heubert, and Levin (2006) examined the effect of accelerated math on student-level and school-level achievement in high school. The intervention condensed 4 years of math taught in Grades 6–9 to 3 years taught in Grades 6–8. For student-level outcomes, the intervention group included 508 students who entered high school in 1998, 1999, and 2000. The comparison group included 477 students who entered the same high school in 1995, 1996, and 1997. For school-level outcomes, the intervention group included one high school that enrolled students who received accelerated math, and the comparison group included six similar high schools from the same county.

Does the study contain a confounding factor?

Yes

No

Answer to knowledge check 2

Does the study contain a confounding factor?

Yes, the study contains a time confound and an $n = 1$ confound.

Explanation

The study contains a time confound for student-level outcomes, because students in the intervention and comparison groups were observed at different times. Therefore, the impact may be confounded with any changes that occurred between the two time periods. The study also contains an $n = 1$ confound for school-level outcomes, because only one high school was included in the intervention group. Therefore, the impact of intervention cannot be isolated from the effect of that school.

Where was the needed information located?
The Data and Design and the Results sections.

Confound: Combined intervention

- When a study combines interventions and only one of included interventions is of interest to the WWC, the WWC will consider the combined intervention ineligible for review.
- Combined interventions that are ineligible for review do not receive a WWC rating.



Confound: Combined intervention



- The WWC will not consider a combined intervention a confound if both the intervention and comparison groups received the ineligible intervention. In that case, the effect of the intervention of interest to the WWC can be separated from the effect of the ineligible intervention.

Example of combined interventions

Example	Confound Assessment	Decision
<p>The focus of the review is a math software program that is <i>eligible</i> under the review protocol. Students in the intervention condition were exposed to the math program and a reading software program. The study reported the effects of the two software programs combined.</p>	<p>Is the intervention of interest combined with <u>another</u> intervention?</p> <ul style="list-style-type: none"> • Yes <p>Is the combined intervention eligible for review?</p> <ul style="list-style-type: none"> • No <p>Is the intervention <u>not</u> of interest delivered to the comparison group?</p> <ul style="list-style-type: none"> • No 	<p>The study is <u>ineligible</u> for review. The math software program that is eligible for the review is delivered with a reading software program that is not eligible. The study will <u>not</u> receive a WWC rating.</p>

Example of combined interventions

Example	Confound Assessment	Decision
<p>The focus of the review is a math software program that is <i>eligible</i> under the review protocol. Students in the intervention condition were exposed to the math program and a reading software program. Students in the comparison condition were also exposed to the reading program.</p>	<p>Is the intervention of interest bundled with <u>another</u> intervention?</p> <ul style="list-style-type: none"> • Yes <p>Is the bundled intervention eligible for review?</p> <ul style="list-style-type: none"> • No <p>Is the intervention <u>not</u> of interest delivered to the comparison group?</p> <ul style="list-style-type: none"> • Yes 	<p>Because <u>all</u> students (in the intervention and comparison conditions) received the reading software program, the only difference between the two groups is the math software program that is eligible for review.</p>

Examples of combined interventions from WWC-reviewed studies

Description (WWC review ID 71930). Murphy et al. (2014) examined the effectiveness of a blended supplement for teaching middle school math using a quasi-experimental design. During the 2011-2012 school year, two intervention schools blended a supplemental “online math” program with a year-long Algebra and Geometry course. Teachers encouraged students to use the program to personalize their math learning during the course. In two comparison schools, students participated in a traditional math course, enrolling in either an Algebra or a Geometry course, during that same school year. The supplemental “online math” program was the focus of the review.

Examples of combined interventions from WWC-reviewed studies

Does the study contain a confounding factor?

Intervention schools implemented the “online math” program at the same time the new year-long Algebra and Geometry course was implemented. It is not possible to separate the effects of the program, which was the focus of the WWC review, from the effects of the year-long course.

Study Rating. No rating. Ineligible for review.

Where was the needed information located?

Design Overview and Limitations Sections.

Examples of combined interventions from WWC-reviewed studies

Description of study design (WWC review ID 1901682). Kramer, Cai, and Merlino (2015) conducted a multi-year quasi-experimental study that examined the effect of NSF curriculum on middle student math achievement. In two suburban districts in NJ and PA, 20 intervention schools used Math in Context (MiC) or the Connected Mathematics Project (CMP) whereas 118 comparison schools continued using a preferred math curriculum other than MiC or CMP. WWC reviewed the study under the Primary School Mathematics Protocol 3.0 for the CMP intervention report.

Examples of combined interventions from WWC-reviewed studies

Does the study contain a confounding factor?

Yes. The CMP curriculum of interest to the WWC is combined with another math curriculum that is ineligible for review. Therefore, the combined intervention is ineligible for review.

Study Rating. No rating. Ineligible for review.

Where was the needed information located?
The Design and Impact Analysis sections.

Knowledge check 1

Description (WWC review ID 1901694). Tarr et al. (2008) conducted a quasi-experimental study that examined the effect of three textbooks developed with funding from the National Science Foundation (NSF) on the student achievement of 2,533 students in 10 middle schools across multiple public school districts in the U.S. In six intervention schools, either the Connected Mathematics Project textbook or one of two other NSF-funded textbooks was used. In four comparison schools, publisher-developed textbooks were used. The study was reviewed for the Connected Mathematics Project intervention report using the Primary Mathematics 3.1 protocol.

Does the study contain a confounding factor?

- Yes
- No

Answer to knowledge check 1

Does the study contain a confounding factor?

Yes, the combined intervention is a confound.

Explanation

This study examines the combined effect of three NSF-funded curricula used in the six intervention schools. The effects of the Connected Mathematics Project, which is the intervention of interest to the WWC, are confounded with the two additional curricula used in the intervention group. Thus, the effects cannot be attributed solely to the intervention of interest: the Connected Mathematics Project.

Where was the needed information located?

The Methods, Samples, and Textbook Description sections.

Knowledge check 2

Description (WWC review ID 33704). Alfassi (2004) examined the effectiveness of reciprocal teaching (RT). Forty-nine freshman students enrolled in two intact heterogeneous English language arts classes in a suburban high school in the Midwest were randomly assigned to an intervention ($n = 29$) and a comparison group ($n = 20$). The teachers of both groups had comparable academic training and years of experience. The teacher of the intervention group implemented the RT and the direct explanation model (DEM), while the teacher in the comparison group used traditional reading instruction.

Which confounding factors does the study contain (choose all that apply)?

- $n = 1$
- Combined intervention
- Both
- Neither

Answer to knowledge check 2

Which confounding factors does the study contain (choose all that apply)?

The study contains two confounding factors.

Explanation

First, the study contains an $n = 1$ confound at the unit of assignment: There is only one teacher in the intervention group and only one teacher in the comparison group. Second, the intervention of interest (RT) to the WWC is bundled with another intervention (DEM). Therefore, the effect of RT cannot be disentangled from the effect of DEM.

Where was the needed information located?

The Procedures subsection of the Methodology section.

Q & A, ADDITIONAL RESOURCES AND CONTACTS

Additional resources

WWC Standards Handbook 4.0 (pp.80–83)

- https://ies.ed.gov/ncee/wwc/Docs/referenceresources/wwc_standards_handbook_v4.pdf

WWC Standards Brief

- https://ies.ed.gov/ncee/wwc/Docs/referenceresources/wwc_brief_confounds_101117.pdf

WWC Certification Module on Confounds (including transcript)

- https://ies.ed.gov/ncee/wwc/Docs/OnlineTraining/wwc_training_m4.pdf
- https://ies.ed.gov/ncee/wwc/Docs/OnlineTraining/wwc_training_m4_transcript.pdf

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WWC Help Desk: <https://ies.ed.gov/ncee/wwc/help>

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