

# Summary of research on online and blended learning programs that offer differentiated learning options



What's Known

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This report summarizes the methodology, measures, and findings of research on the influence on student achievement outcomes of K–12 online and blended face-to-face and online learning programs that offer differentiated learning options. The report also describes the characteristics of the learning programs. Most of the examined programs used blended learning strategies, and all the examined programs offered some means to differentiate their content, difficulty level, or pacing. Some 45 percent of the blended learning programs studied (5 of 11) offered differentiation in the face-to-face component of instruction. In some of the most rigorous studies, statistically significant positive effects were found for four blended learning programs: Cognitive Tutor Algebra I, LeapTrack, READ 180, and Time To Know.

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## Why this study?

As more rigorous college and career readiness standards are established, new instructional models or practices—including online and blended learning programs—may be needed to help high school students learn and graduate with the knowledge and skills targeted by these standards (Knowledge Works, 2013). Members of the Regional Educational Laboratory Central College and Career Readiness Research Alliance asked Regional Educational Laboratory Central for a summary of research on K–12 online and blended learning programs that offer options for differentiated instruction, referred to in this report as differentiated learning options.

Differentiated learning options provide a variety of ways for students to engage with content and acquire knowledge and can be tailored to student interests and academic skills (Tomlinson, 2001). Proponents of

differentiated learning options argue that students differ in learning styles, knowledge and skills, and learning pace and that students learn best when instruction is aligned to their interests and needs (Tomlinson, 2000).

Online and blended learning programs can offer differentiated learning options. The programs can be fully online, meaning that content and instruction are delivered through the Internet, or blended, meaning that programs use both online and face-to-face instruction (Means, Toyama, Murphy, & Baki, 2013; Watson, Gemin, & Coffey, 2010). Some online and blended learning programs include proprietary packaged curricula or computer software that teachers use to offer differentiated learning options. For example, blended learning programs frequently use adaptive programs for the online component to assess students' knowledge and skills; adaptive programs can also monitor a student's progress and can tailor the content, pacing, or difficulty of the online instruction to a student's current needs. Online and blended learning programs can also allow students to progress through the online content at a flexible pace, giving students sufficient time to master the content. But not all online and blended learning programs offer differentiated learning options. Some online programs are organized like traditional face-to-face courses, where the sequence and pacing of topics are identical for all students.

Meta-analyses and literature reviews have generally found online and blended learning programs to be as effective as or more effective than traditional face-to-face instruction (Means, Toyama, Murphy, Bakia, & Jones, 2009; Sitzmann, Kraiger, Stewart, & Wisher, 2006; Wisher & Olson, 2003). However, the majority of research has been conducted with populations other than K–12 students, such as students at online universities and adult technical education programs. For example, in one meta-analysis of online and blended learning programs, only 5 of 176 studies that met the authors' eligibility criteria focused on K–12 schooling (Means et al., 2009). And no previous meta-analysis or literature review has focused on online and blended learning programs that offer differentiated learning options.

School and district leaders may be able to use the information in this report to inform their selection or design of online or blended learning programs to meet the needs of their students. And researchers may be able to use the information in this report to inform the design of future studies of online and blended learning programs that offer differentiated learning options.

### **What the study examined**

This study addressed two research questions:

- What are the characteristics of online and blended learning programs that offer differentiated learning options to K–12 students in the United States and that have been the subject of research?
- What are the methodologies, measures, findings, and strength of evidence of studies that have examined these programs using randomized controlled trials, quasi-experimental, or correlational research designs?

To answer these questions, the study team searched research journal databases, research organizations' websites, and the websites of online and blended learning program vendors to identify relevant studies. Studies were included only if they focused on online or blended learning programs that offered differentiated learning options (see box 1 for definitions of key terms used in the report). Programs were included regardless of whether they were used to provide a full curriculum (including content for a semester or year-long course) or to supplement an existing course curriculum.

Because this study focused on programs that offer differentiated learning options, studies of standalone programs that did not involve a classroom teacher were excluded. Studies were included only if the programs

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## Box 1. Key terms

**Blended learning program.** A program in which instruction occurs through a combination of face-to-face instruction and online learning. The online learning component frequently uses proprietary, online, adaptive software.

**Correlational research studies.** Studies that assess the relationship between the implementation of online and blended learning programs and student achievement outcomes for a single group of students.

**Differentiated learning options.** Educational opportunities in which course content or instruction is tailored to meet individual student learning needs. For the current study, differentiated learning options in online and blended learning programs included face-to-face, individual, or small-group instruction; teacher or computerized selection of student-individualized educational content or difficulty level; and flexible time for students to master course content.

**Full curriculum.** An online or blended learning program that provides a full course curriculum.

**Online learning program.** A program in which instruction occurs primarily online, with no face-to-face interaction between the teacher and students. Teachers monitor student progress throughout the program, provide feedback on assignments, and communicate with students through telephone or email.

**Quasi-experimental design studies.** Studies in which students or classrooms that used an online or blended learning program are compared with students or classrooms that did not use such a program and in which the students or classrooms are not randomly assigned to the treatment or comparison group.

**Randomized controlled trial studies.** Studies in which students or classrooms are randomly assigned to participate in an online or blended program and compared with students or classrooms that are randomly assigned to a comparison group.

**Standalone program.** A program in which a course instructor has no active role in the instruction provided. This includes supplemental and intervention programs that are intended to develop targeted knowledge or skills but that are not aligned to the in-class curriculum. Homework and pull-out programs are also classified as standalone programs. These programs were excluded from the current study.

**Supplemental curriculum.** An online or blended learning program that supplements an existing curriculum. Programs that were not integrated into the regular course curriculum (for example, those used as standalone interventions) were excluded from the study.

**What Works Clearinghouse (WWC) standards.** The WWC has described standards for determining whether a study is well conducted and whether causal inferences can be made from it (What Works Clearinghouse, 2014). For a randomized controlled trial study to meet WWC standards without reservations, student attrition in the treatment and comparison groups must be low. For a randomized controlled trial study with high attrition or a quasi-experimental design study to meet WWC standards with reservations, the treatment and comparison groups must be equivalent on the outcome measure prior to the treatment.

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they examined directly involved a teacher in the delivery and monitoring of instruction and the study report clearly stated that the online or blended learning program being examined was used to support differentiated instruction. Online programs that were completely software-driven and that did not have a teacher facilitator were excluded. See appendix A for details on the screening and review process.

The study team reviewed 162 unique studies. Seventeen of the studies met the current study's eligibility criteria. Of these, 15 used a randomized controlled trial or quasi-experimental design and 2 were correlational studies. Some online and blended learning programs were the subject of multiple studies, and some studies examined multiple programs. The 17 studies examined 14 different online or blended learning programs.

(See table B1 in appendix B for details about each of the programs, including program type, form of online or in-class differentiation, course content, and course grade level, and see table B2 for details about each of the studies, including research methods used, independent and dependent measures, study findings, and study design rating.)

The 15 studies that used a randomized controlled trial or quasi-experimental design were rated using an approach modeled after the U.S. Department of Education’s What Works Clearinghouse (WWC) evidence standards and procedures for identifying studies that support causal inferences (What Works Clearinghouse, 2014). Ratings were determined by WWC-certified members of the study team or taken from prior WWC intervention reports.<sup>1</sup> Each study was assigned one of three ratings: meets standards without reservations, meets standards with reservations, or does not meet standards. If a study already had a rating from a WWC intervention report, that rating was used for this study.<sup>2</sup> Each study that was rated by the study team as meeting WWC standards was also rated by a second WWC-certified member of the team to ensure inter-rater reliability.

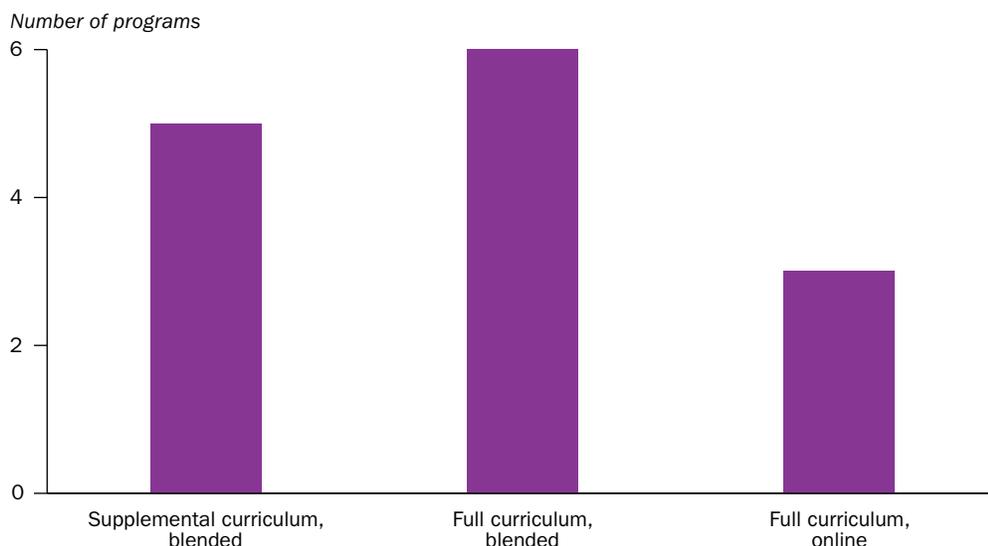
### What the study found

This section describes the characteristics of the 14 online and blended learning programs that were the subject of research studies that met the current study’s eligibility criteria, as well as the characteristics of the 17 studies that examined these programs.

#### Characteristics of online and blended learning programs

Of the 14 online and blended learning programs with studies that met the current study’s eligibility criteria, 11 used a blended learning strategy, either to supplement an existing in-class curriculum or to provide a full blended learning curriculum (figure 1). The other three programs used a full curriculum online model. Nine of the programs were developed for elementary grades, and five were developed for middle school or high school courses (for example, Algebra I). Five programs addressed only English language arts, three addressed only math, and six addressed multiple content areas.

**Figure 1. Of the 14 online and blended learning programs with studies that met the current study’s eligibility criteria, 11 used a blended learning strategy, and 3 used a full curriculum online model**



Source: Authors’ analysis in November 2015 following the procedures described in appendix A.

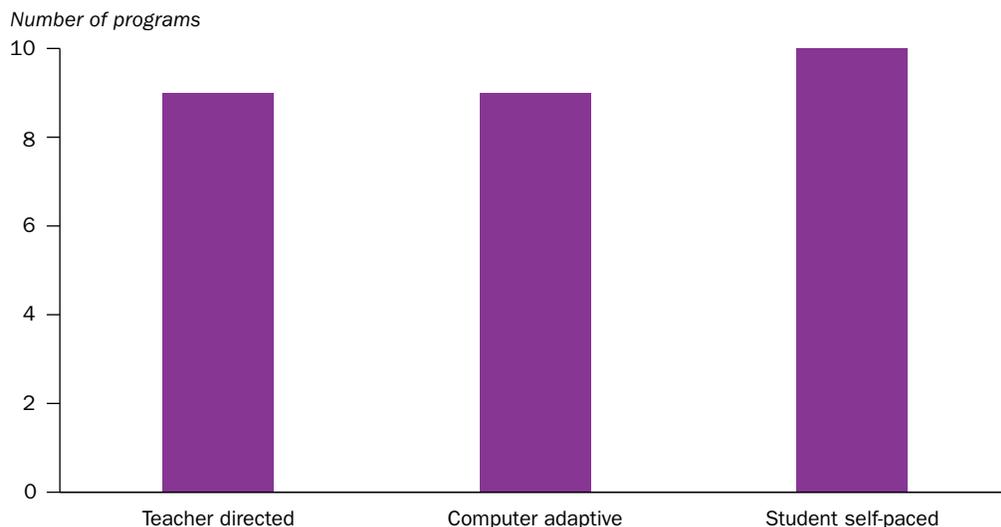
The online and blended learning programs were classified according to the involvement of the teacher and how the online and face-to-face components were integrated. In the 11 blended learning programs all communications between teachers and students were face to face (there was no online interaction). However, teachers received reports of student progress in the online portion of the course, which the teachers could use to inform the in-class instruction. In the three online programs, communication occurred only through telephone calls, email, or teacher notes on graded assignments (there was no real-time online or face-to-face student–teacher interaction). The five supplemental curriculum blended learning programs (for example, Waterford Early Reading) were frequently used to support the development of students’ early literacy skills within the face-to-face classroom. The six full curriculum blended learning programs provided online and in-class instructional materials. All three full curriculum online learning programs were completely online programs offered by virtual schools, with a teacher facilitating the course and providing feedback to students.

*Online and blended learning programs varied in how they offered differentiated learning options.* Each of the 14 online and blended learning programs was characterized by the types of online differentiation it offered. Ten programs offered multiple differentiated learning options. Nine programs provided teacher-directed differentiation of the online content, wherein teachers selected from multiple available programs or else controlled the content and difficulty level within a program to match a student’s learning needs (figure 2). Nine programs used adaptive software for differentiation, which monitors a student’s progress within the program and aligns the content, pacing, or difficulty of the material to a student’s individual needs. Six programs used both teacher-directed and computer adaptive differentiation. In 10 programs students were able to progress at a flexible pace so that they could take the time they needed to master the online content.

*All blended learning programs offered opportunities for the online component to inform the in-class curriculum.* All 11 blended learning programs with studies that met the current study’s eligibility criteria provided progress reports or skills assessments that classroom teachers could use to inform their instruction.

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**Figure 2. Of the 14 online and blended learning programs with studies that met the current study’s eligibility criteria, 9 provided teacher-directed differentiation of the online content, and 9 used adaptive software for differentiation**



**Note:** Of the 14 programs, 10 offered more than one type of differentiation.

**Source:** Authors’ analysis in November 2015 following the procedures described in appendix A.

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In eight blended learning programs the online component was intentionally sequenced with in-class instruction. Five blended learning programs used the online component to offer in-class differentiation: teachers either used the time students spent on the computers to provide individual or small-group support to students not online or used students' online performance to differentiate the in-class portion of the curriculum.

### Characteristics of studies of online and blended learning programs

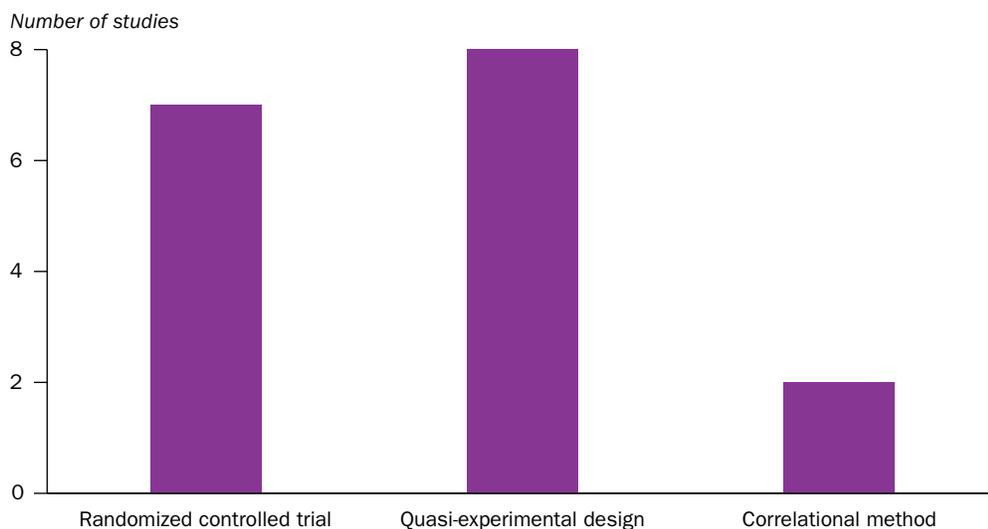
Of the 17 studies that examined online and blended learning programs and met the current study's eligibility criteria, 15 used a group comparison design (that is, a randomized controlled trial or quasi-experimental design; figure 3) and 2 were correlation studies. Among the 17 studies, the following student achievement outcomes measures were examined:

- Academic motivation.
- Attendance.
- Course completion.
- Course grade.
- Course-specific end-of-course assessments.
- CTB/McGraw-Hill Acuity proficiency exam.
- Disciplinary actions.
- Dynamic Indicators of Basic Early Literacy Skills.
- Educational Testing Service end-of course assessments.
- Math attitudes and confidence.
- Stanford Achievement Tests.
- State achievement tests.
- Terra Nova assessments.
- Test of Early Reading Ability-2.

The 17 studies were classified according to whether the outcomes reported by their authors indicated statistically significant positive, negative, mixed, or nonsignificant effects. Because most studies examined

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**Figure 3. Of the 17 studies that examined online and blended learning programs and met the current study's eligibility criteria, 15 used a randomized controlled trial or quasi-experimental design**



**Source:** Authors' analysis in November 2015 following the procedures described in appendix A.

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multiple outcomes, a study was classified as having mixed effects only if it reported statistically significant positive and negative effects across or within outcome domains. If a study had both nonsignificant and significant effects within an outcome domain, it was classified according to the direction of the significant effect (positive or negative). Thirteen studies reported a statistically significant positive effect, and one study reported a negative effect from the use of online or blended learning programs that offered differentiated learning options. Two studies reported mixed effects, and one study did not report any significant effects.

The quality of the 15 studies that met the current study's eligibility criteria and used a randomized controlled trial or quasi-experimental design varied. Interpretations regarding the causal effects of the programs examined should thus be made with caution.

*Seven group comparison design studies were rated by the study team as meeting WWC standards with or without reservations.* Fifteen group comparison design studies (those that used a randomized controlled trial or quasi-experimental design) either had been previously reviewed in WWC intervention reports or were rated by the study team using decision rules modeled after WWC criteria. For studies that were reviewed in WWC intervention reports that met the current study's eligibility criteria, this study used the rating reported in the intervention report. (There were other online and blended learning programs that were the subject of WWC intervention reports but that did not meet the current study's eligibility criteria.)

Of the 15 group design studies that met the current study's eligibility criteria, six met WWC standards without reservations, and one met WWC standards with reservations. Of these seven studies, four had been the focus of WWC intervention reports, and three were rated by WWC-certified members of the study team.

Two studies examined the effects of the Cognitive Tutor Algebra I blended learning program on students' Educational Testing Service Algebra I end-of-course assessment and final course grades (Morgan & Ritter, 2002; Ritter, Kulikowich, Lei, McGuire, & Morgan, 2007). Both studies were the focus of a WWC intervention report and were rated as meeting WWC standards without reservations. Both studies reported significant positive effect sizes related to assessment scores (0.29 and 0.38) and course grades (0.26 and 0.36). Effect sizes describe the size of a treatment effect—in this case the difference between the scores of students who participated in online or blended learning programs and the scores of those who did not. See box 2 for details on how to interpret effect sizes.

One study that the current study team determined met WWC standards without reservations assessed the impact of the Cognitive Tutor Geometry blended learning program (Pane, McCaffrey, Slaughter, Steele, & Ikemoto, 2010). The study reported a statistically significant negative effect size of  $-0.19$  on students' end-of-course assessment scores and nonsignificant effects on students' math confidence and attitudes.

Two studies, which were the focus of a WWC intervention report and were rated as meeting WWC standards without reservations, examined the effects of multiple blended learning programs on Stanford Achievement Test reading and algebra assessments. The second study (Campuzano, Dynarski, Agodini, & Rall, 2009) was conducted as a follow-up to the first (Dynarski et al., 2007). The studies assessed the following blended learning programs: Cognitive Tutor Algebra I, Destination Reading, LeapTrack, PLATO Focus, Read 180, and Waterford Early Reading. Dynarski et al. (2007) found no statistically significant effects. Campuzano et al. (2009) found a statistically significant positive effect of 0.09 of the LeapTrack program on students' Stanford Achievement Test reading scores, but no other statistically significant effects.

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## Box 2. Effect sizes

Effect size characterizes an effect against a common point of reference to allow for comparisons. The current study's effect sizes are characterized using the standard deviation of the outcome (Dynarski & Kisker, 2014). The standard deviation can be interpreted as the average distance in either direction between students' scores and the average score. A small standard deviation means that students are tightly clustered around the average score, and a large standard deviation means that students are spread more widely around the average score.

A useful way to understand effect sizes for an intervention is to compare them to effect sizes for other more commonly understood differences. One such difference is the amount of change one might expect to see in a year of schooling. In one year of schooling for students in grade 4, an effect size for the amount of growth is estimated at 0.36 in reading and 0.52 in math (Hill, Bloom, Black, & Lipsey, 2008 [add to reference list]). If an effect size for an online or blended learning intervention in reading is 0.30, it can be interpreted as meaningful because the gain associated with participating in the intervention is nearly as large as the gain one might expect, on average, from a year of schooling.

Statistical significance is a common way to judge the noteworthiness of the results of a research study. Statistical significance is influenced by both the effect size and the sample size. When the sample size is large, a small effect size will be significant. When the sample size is smaller, the effect size has to be larger to reach statistical significance. There can thus be some cases where a statistically nonsignificant finding has an effect size as large as 0.25 or  $-0.25$ .

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The study team determined that one study on the READ 180 blended learning program met WWC standards without reservations (Kim, Capotosto, Hartry, & Fitzgerald, 2011). The study found a statistically significant positive effect on students' Stanford Achievement Test assessment scores with an effect size of 0.32 for reading comprehension and 0.23 for vocabulary. The study found no significant effects on students' Stanford Achievement Test spelling or Dynamic Indicators of Basic Early Literacy Skills (fluency) scores.

A study on the Time to Know blended learning program (Rosen & Beck-Hill, 2012) was rated by the study team as meeting WWC group design standards with reservations, only for the grade 5 reading outcome. Results of the study showed a statistically significant positive effect on students' Texas Assessment of Knowledge and Skills reading scores, with an effect size of 0.23. Outcomes for math achievement, student attendance, disciplinary actions, and motivation to learn math and reading were rated as not meeting WWC group design standards.

*Two correlational studies examined the influence of student–teacher communication.* The two correlational studies assessed the association of student–teacher interaction with student achievement outcomes in fully online, self-paced, virtual schools. The first study found a significant positive correlation between the frequency and quality of student–teacher interactions and course completion and course grade (Hawkins, Graham, Sudweeks, & Barbour, 2013). In that study, the quality of student–teacher interaction was operationalized as the degree to which student–teacher interaction consisted of academic feedback, course logistics information, and interpersonal support. The second study found a significant positive association between the number of teacher comments provided and an Algebra I end-of-course assessment and significant negative association between the number of teacher comments provided and an Algebra II end-of-course assessment (Liu & Cavanaugh, 2012).

## **Implications of the study findings**

Of the 162 studies identified that examined the association of online and blended learning programs that offer differentiated learning options with student academic outcomes, only 17 met the current study's eligibility criteria. The remaining studies did not meet eligibility criteria because they did not focus on K–12 programs, assessed standalone online programs, or did not clearly offer differentiated learning options. Of the 17 studies only 7 used a rigorous group research design to assess the impact of online and blended learning programs, making it difficult to draw conclusions about the effectiveness of online and blended learning programs.

Even though the findings in this report do not allow for conclusions to be drawn about the effectiveness of these programs as a whole, educators may use the findings to consider individual online or blended learning programs for which there is evidence of influencing student achievement. The findings might also inform educators' decisionmaking about online and blended learning programs. For example, this report can help educators consider the form of online or face-to-face differentiation that they want an online or blended learning program to provide, as well as the role that the face-to-face teacher will play.

## **Limitations of the study**

The current study is limited to findings from studies identified using the keyword search process and screening criteria outlined in appendix A. This report summarizes only programs with studies whose report narratives clearly indicated that the programs were used to offer differentiated learning options. It is possible that programs that were not included in the current study could be used to support differentiated instruction, but the screening criteria used for the current study did not identify studies about those programs.

## Appendix A. Literature search procedures

To address the research questions, the study team conducted a comprehensive search to identify relevant articles. The search proceeded in two steps: an electronic database keyword search and a program search. After completing these two steps, the study team consulted with experts in the field, such as staff from the International Association for K–12 Online Learning, to identify any other articles that should be included.

### Electronic database keyword search

The first step in identifying research on online and blended learning programs was the electronic database keyword search. Three members of the study team used keywords to search three electronic databases, Academic Search Premier, ERIC, and PsycINFO, in February–May 2015. The members of the study team were trained to screen studies and keep those that met the following relevance criteria:

- Must be a study or a literature review of studies associated with student academic outcomes.
- Must use a quantitative research design, such as a randomized controlled trial, quasi-experimental design, or correlational method.
- Must examine an online or blended learning program (standalone programs were excluded).
- Must examine a program that allows students to proceed at their own pace through course content, individualizes course content or difficulty level, or supports face-to-face classroom differentiation (a program was included if it had at least one of these characteristics).
- Must involve a K–12 public school in the United States, including traditional schools, charter schools, and magnet schools.
- Must be published in 1995 or later.
- Must be written in English.
- Must be published in an academic journal or publicly available (dissertations and theses were excluded).

Search terms included 30 keywords related to online and blended learning, 5 keywords related to differentiated learning options or personalized instruction, and 9 keywords related to quantitative research. The initial keywords were developed in consultation with members of Regional Educational Laboratory (REL) Central's Technical Working Group, a standing group charged with providing advice or guidance on REL Central's work. As the keyword search progressed, additional keywords that were identified were added to the initial list (the final list of keywords is presented in box A1). Keyword searches were conducted using every combination of online/blended learning, differentiation, and quantitative research keyword.

The study team conducted an initial keyword search and screened the study titles and abstracts to determine whether the studies met the relevance criteria. If it was unclear from the information contained in the title and abstract whether a study met the relevance criteria, the study team included the study to be more closely reviewed in the second stage of screening. As a result of the electronic database keyword search and initial screening, 124 potentially relevant studies were identified (figure A1). Thirty-eight additional studies were identified through a subsequent gray literature search (see below), resulting in the review of a total of 162 studies.

The study team conducted a second screening of the potentially relevant reports. Before the screening, the study team screened a common set of 10 studies and compared their results. When decisions differed, the study team discussed the rationale for their decisions. An additional set of five studies were screened; for these studies the study team had no disagreement in the decisions.

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## Box A1. Final keyword search terms

### Online and blended learning terms

- “online learn\*”
- “blended class\*”
- “blended instruct\*”
- “blended learn\*”
- “blended school\*”
- “cyber class\*”
- “cyber instruct\*”
- “cyber learn\*”
- “cyber school\*”
- “e-learning”
- “electronic class\*”
- “electronic instruct\*”
- “electronic learn\*”
- “electronic school\*”
- “hybrid class\*”
- “hybrid instruct\*”
- “hybrid learn\*”
- “hybrid school\*”
- “intelligent tutoring”
- “online class\*”
- “online instruct\*”
- “online school\*”
- “virtual class\*”
- “virtual instruct\*”
- “virtual learn\*”
- “virtual school\*”
- “web-based class\*”
- “web-based instruct\*”
- “web-based learn\*”
- “web-based school\*”

### Differentiation terms

- differentiate\*
- individualize\*
- personalize\*
- “self-pace\*”
- “self-guide\*”

### Research terms

- “comparison group”
- “control group”
- “quasi-experiment\*”
- baseline
- correlation
- experiment
- random
- study
- treatment

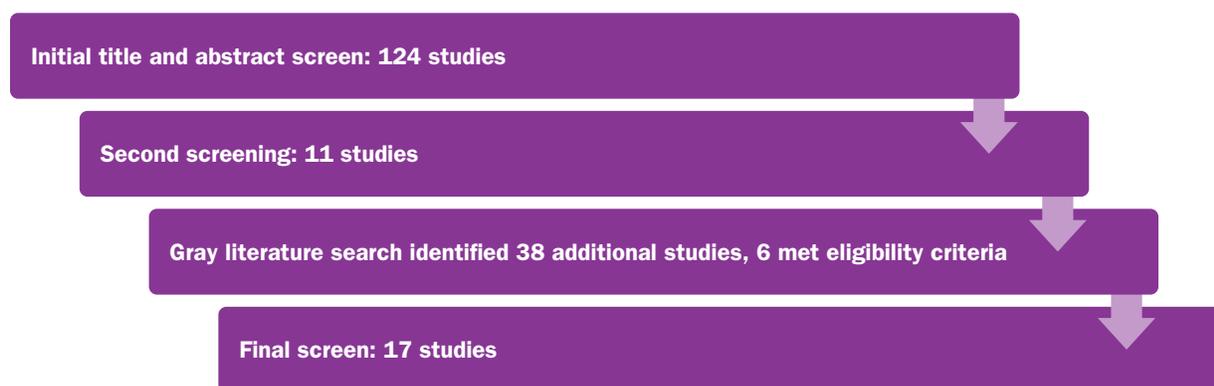
**Note:** Quotation marks indicate that the study team searched for the exact phrase (for example, “intelligent tutoring” was searched as one term in which both words in sequence needed to be present). Asterisks indicate wildcards, used so that words with different endings could be found (for example, “learn\*” would produce results that include the words “learner” and “learning”).

**Source:** Authors’ compilation.

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**Figure A1. Number of studies considered at each stage of the screening process**



**Source:** Authors’ analysis in November 2015 following the procedures described in appendix A.

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During the second screening stage, the study team consulted the full text of each document as necessary to determine whether it was indeed a report of a research study (defined as a study that presented quantitative data collected using clearly defined methods), whether the study was conducted with a sample of K–12 students in the United States, and whether the study addressed an online or blended learning program. Studies were screened out if the program was a standalone program or if there was no evidence that the

teachers integrated the program into their classroom curriculum. Studies were also screened out if the program was not designed to provide differentiated learning options or if there was no evidence that the program was used for this purpose in the study. When the screening decision was uncertain, the study team discussed the ways in which each study met or did not meet each criterion until they reached consensus about the final screening decision. During this round literature reviews and meta-analyses were screened out, but studies found within them that had not previously been identified were screened. Additionally, the names of online and blended learning programs examined by the screened studies or referred to in the study narrative were recorded. After this second screening, 11 articles were determined to meet all study criteria.

### Program search

On the basis of the review of studies in the second stage of screening and after consultation with Technical Working Group members, the study team developed a list of 37 online and blended learning programs (box A2). The study team searched the same three databases that were used for the keyword search for these names and also searched the websites of their vendors for additional possible studies. This process identified 38 additional documents, 6 of which met all screening criteria.

### Final screening

During the final screening, the study team carefully read each study in its entirety, summarized it, and identified the program type and research method categories. During this process the documents were again screened to ensure that the studies examined online or blended learning programs and not standalone programs and that the programs offered differentiated learning options. This identified the 17 studies examining 14 blended and online learning programs described in this report.

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### Box A2. Names of online and blended learning programs

- Academy of Reading
- Achieve Now
- Achieve3000
- Algebra I Online
- Alliance College-Ready Public Schools
- Apangea/ThinkThroughMath
- Apex Learning
- Assessment to Instruction
- BrainHoney
- Cognitive Tutor<sup>1</sup>
- Compass-Odyssey
- Destination Learning (was Destination Reading)
- Dream Box
- EdTech
- Firstline
- Headsprout
- Hybrid Learning Institute
- iLearn Math
- Istation
- Khan Academy
- KIPP Empower Academy
- Knewton
- Knowledgebox
- Larson Pre-Algebra I
- LeapTrack
- New Tech Network
- Plato Focus
- Read 180
- Reading Plus
- Revolution K12
- RocketShip
- ST Math
- SuccessMaker
- TenMarks
- ThinkPort
- Time To Know
- Waterford Early Reading Program

#### Note

1. Includes Cognitive Tutor Algebra I and Cognitive Tutor Geometry.

Source: Authors' compilation.

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## **Appendix B. Online and blended learning programs and research studies included in the literature summary**

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This appendix provides a summary of the 14 online and blended learning programs and the 17 studies examined in this report (tables B1 and B2). Each program is described in terms of its online and in-class characteristics. Each study is described in terms of the research design used, independent and dependent variables, and study findings.

**Table B1. Characteristics of the online and blended learning programs examined in studies that met the current study's eligibility criteria**

| Citation  | Online program characteristics             |                      |                                |                                |                    |                                     | In-class program characteristics    |   |                                   |                |                                |
|---|--|----------------------|--------------------------------|--------------------------------|--------------------|-------------------------------------|-------------------------------------|---|-----------------------------------|----------------|--------------------------------|
|   | Program name                               | Online communication | Teacher individualizes content | Program individualizes content | Students self-pace | Online assessment                   | Program data may inform instruction | Online integrated into class curriculum | Differentiation or skill grouping | Grade or topic | Content area                   |
| Full curriculum programs that use a blended learning approach   |  |                      |                                |                                |                    |                                     |                                     |   |                                   |                |                                |
| Campuzano et al. (2009)   | PLATO Focus                                | None                 | ✓                              |                                |                    | Progress report                     |                                     | ✓                                       |                                   | Elementary     | English language arts          |
| Campuzano et al. (2009); Dynarski et al. (2007); Morgan & Ritter (2002); Pane et al. (2014); Ritter et al. (2007) | Cognitive Tutor Algebra I                  | None                 |                                | ✓                              | ✓                  | Progress report<br>Skill assessment | ✓                                   | ✓                                       |                                   | Algebra        | Math                           |
| Murphy, Mislevy, Gallagher, Krumm, & Wei (2014)   | Alliance College-Ready Public Schools      | None                 | ✓                              | ✓                              | ✓                  | Progress report                     | ✓                                   | ✓                                       | ✓                                 | High school    | Math and English language arts |
| Murphy et al. (2014)  | Knowledge is Power Program Empower Academy | None                 |                                | ✓                              | ✓                  | Progress report                     |                                     |   | ✓                                 | Elementary     | Math and English language arts |
| Pane et al. (2010)  | Cognitive Tutor Geometry                   | None                 | ✓                              | ✓                              |                    | Progress report<br>Skill assessment | ✓                                   | ✓                                       |                                   | Geometry       | Math                           |
| Rosen & Beck-Hill (2012); Weiss & Rosen (2010)  | Time To Know                               | None                 | ✓                              | ✓                              |                    | Ongoing formative & summative       | ✓                                   | ✓                                       | ✓                                 | Elementary     | Math and English language arts |
| Supplemental curriculum programs that use a blended learning approach   |  |                      |                                |                                |                    |                                     |                                     |   |                                   |                |                                |
| Campuzano et al. (2009); Dynarski et al. (2007)   | Destination Reading                        | None                 | ✓                              |                                |                    | Progress report                     | ✓                                   |   |                                   | Elementary     | English language arts          |

(continued)

**Table B1. Characteristics of the online and blended learning programs examined in studies that met the current study's eligibility criteria (continued)**

| Citation  | Program name                | Online program characteristics |                                |                                |                    |                                     | In-class program characteristics    |   |                                   |                |                                |
|---|-----------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------|-------------------------------------|-------------------------------------|---|-----------------------------------|----------------|--------------------------------|
|   |                             | Online communication           | Teacher individualizes content | Program individualizes content | Students self pace | Online assessment                   | Program data may inform instruction | Online integrated into class curriculum | Differentiation or skill grouping | Grade or topic | Content area                   |
| Campuzano et al. (2009); Dynarski et al. (2007)   | LeapTrack                   | None                           | ✓                              | ✓                              | ✓                  | Skill assessment                    | ✓                                   | ✓                                       |                                   | Elementary     | English language arts          |
| Campuzano et al. (2009); Dynarski et al. (2007); Cassady & Smith (2003, 2005); Powers & Price-Johnson (2006); Tracey & Young (2007) | Waterford Early Reading     | None                           | ✓                              | ✓                              | ✓                  | Progress report<br>Skill assessment | ✓                                   | ✓                                       |                                   | Elementary     | English language arts          |
| Dynarski et al. (2007); Kim et al. (2011)   | Read 180                    | None                           |                                | ✓                              | ✓                  |                                     |                                     | ✓                                       | ✓                                 | Elementary     | English language arts          |
| Murphy et al. (2014)  | Firstline Schools           | None                           | ✓                              | ✓                              | ✓                  | Progress report                     | ✓                                   |   | ✓                                 | Elementary     | Math and English language arts |
| Full curriculum programs that use an online learning approach   |                             |                                |                                |                                |                    |                                     |                                     |   |                                   |                |                                |
| Hawkins et al. (2013)   | Utah Electronic High School | Asynchronous                   |                                |                                | ✓                  | Graded assignments                  | na                                  | na                                      | na                                | High school    | All                            |
| Liu & Cavanaugh (2012)  | Virtual School              | Asynchronous                   |                                |                                | ✓                  | Course assessments                  | na                                  | na                                      | na                                | Algebra        | Math                           |
| Shoaf (2007)  | Calvert School              | Asynchronous                   | ✓                              |                                | ✓                  | Course assessments                  | na                                  | na                                      | na                                | Elementary     | Math and English language arts |

na is not applicable because there is no in-class component in the online program.

**Note:** Asynchronous online communication refers to communications that are not conducted in real time (for example, communication that is conducted only over email).

**Source:** Authors' analysis in November 2015 following the procedures described in appendix A.

**Table B2. Characteristics of the 17 studies that met the eligibility criteria of the current study**

| Citation                    | Program name              | Program type | Independent variable | Outcome measure   | Findings or conclusions   | What Works Clearinghouse (WWC) rating, if applicable |
|-----------------------------|---------------------------|--------------|----------------------|---|---|--|
| Randomized controlled trial |                           |              |                      |   |   |  |
| Morgan & Ritter (2002)      | Cognitive Tutor Algebra I | Blended      | Group assignment     | Educational Testing Service Algebra I end-of-course assessment<br>Course grade  | Significant positive effects on both outcomes   | Meets WWC standards without reservation              |
| Pane et al. (2010)          | Cognitive Tutor Geometry  | Blended      | Group assignment     | End-of-course assessment. Student math confidence and attitudes   | Significant negative effect on end-of-course assessment<br>Nonsignificant effects on math confidence and attitudes  | Meets WWC standards without reservations             |
| Pane et al. (2014)          | Cognitive Tutor Algebra I | Blended      | Group assignment     | CTB/McGraw-Hill Acuity – Algebra Proficiency Exam<br>Student math confidence and attitudes  | Significant positive effect on high school math proficiency<br>Nonsignificant effects on math confidence and attitudes and middle school math achievement | Does not meet WWC standards                          |
| Ritter et al. (2007)        | Cognitive Tutor Algebra I | Blended      | Group assignment     | Educational Testing Service Algebra end-of-course exam<br>Course grade  | Significant positive effect on course grade<br>Nonsignificant effect on course exam   | Meets WWC standards without reservations             |
| Campuzano et al. (2009)     | Multiple Interventions    | Blended      | Group assignment     | Stanford Achievement Test – Reading<br>Education Testing Service – Algebra  | No significant effects for four interventions<br>Significant positive effect for one intervention (LeapTrack)   | Meets WWC standards without reservations             |
| Dynarski et al. (2007)      | Multiple interventions    | Blended      | Group assignment     | Stanford Achievement Test – Reading<br>Education Testing Service – Algebra  | No significant effect   | Meets WWC standards without reservations             |
| Kim et al. (2011)           | READ 180                  | Blended      | Group assignment     | Dynamic Indicators of Basic Early Literacy Skills – Oral Reading Fluency<br>Stanford Achievement Test – Reading comprehension, vocabulary, spelling | Significant positive effects on reading comprehension and vocabulary<br>No significant effects on reading fluency and spelling                            | Meets WWC standards without reservation              |
| Quasi-experimental design   |                           |              |                      |   |   |  |
| Shoaf (2007)                | Calvert School            | Online       | Group assignment     | Ohio State Achievement Test – math and English language arts  | No test of statistical significance available<br>Positive effects compared to comparison school, negative effects compared to state average               | Does not meet WWC standards                          |

*(continued)*

**Table B2. Characteristics of the 17 studies that met the eligibility criteria of the current study** (continued)

| Citation                      | Program name            | Program type | Independent variable | Outcome measure   | Findings or conclusions  | What Works Clearinghouse (WWC) rating, if applicable   |
|-------------------------------|-------------------------|--------------|----------------------|---|--|--|
| Murphy et al. (2014)          | Multiple interventions  | Blended      | Group assignment     | California Standards Test<br>Terra Nova – math and reading<br>Northwest Evaluation Association's Measurement of Academic Progress– English language arts and math   | No significant effect for three interventions<br><br>Significant positive effects for two interventions in math and English language arts (Firstline schools and Knowledge is Power Program Empower Academy) | Does not meet WWC standards  |
| Rosen & Beck-Hill (2012)      | Time To Know            | Blended      | Group assignment     | Texas Assessment of Knowledge and Skills – math and reading<br><br>Student attendance, disciplinary actions, motivation to learn math and reading<br><br>Teacher use of differentiated instruction                                  | Significant positive effects on all outcomes   | Meets WWC standards with reservations for grade 5 reading. All other outcomes do not meet WWC standards. |
| Weiss & Rosen (2010)          | Time To Know            | Blended      | Group assignment     | Texas Assessment of Knowledge Skills – math<br><br>Math reasoning assessment  | Significant positive effects on all outcomes   | Does not meet WWC standards  |
| Cassady & Smith (2003)        | Waterford Early Reading | Blended      | Group assignment     | Phonological Awareness Test<br><br>Concepts About Print   | Significant positive effects on both outcomes  | Does not meet WWC standards  |
| Cassady & Smith (2005)        | Waterford Early Reading | Blended      | Group assignment     | Terra Nova Comprehensive Test of Basic Skills   | Significant positive effect  | Does not meet WWC standards  |
| Powers & Price-Johnson (2006) | Waterford Early Reading | Blended      | Group assignment     | Dynamic Indicators of Basic Early Literacy Skills – initial sound fluency, letter naming fluency, word use fluency, phoneme segmentation fluency, nonsense word fluency<br><br>District Core Curriculum Standard Assessment reading | Significant positive effects on all outcomes   | Does not meet WWC standards  |
| Tracey & Young (2007)         | Waterford Early Reading | Blended      | Group assignment     | Test of Early Reading Ability 2<br><br>Lindamood Auditory Conceptualization<br><br>Waterford Reading Inventory  | Significant positive effects on Test of Early Reading Ability 2 and Waterford Reading Inventory<br><br>No significant effect on Lindamood Auditory Conceptualization   | Does not meet WWC standards  |

(continued)

**Table B2. Characteristics of the 17 studies that met the eligibility criteria of the current study** *(continued)*

| Citation               | Program name                | Program type | Independent variable                            | Outcome measure                    | Findings or conclusions   | What Works Clearinghouse (WWC) rating, if applicable |
|------------------------|-----------------------------|--------------|---|------------------------------------|---|--|
| Correlational          |                             |              |   |                                    |   |  |
| Hawkins et al. (2013)  | Utah Electronic High School | Online       | Student–teacher interaction frequency & quality | Course grade and course completion | Significant positive effect   | na   |
| Liu & Cavanaugh (2012) | Virtual School              | Online       | Number of teacher comments                      | End-of-course assessment           | Significant positive effect in Algebra I<br>Significant negative effect in Algebra II | na   |

na is not applicable.

**Source:** Authors' analysis in November 2015 following the procedures described in appendix A.

## **Notes**

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1. Only WWC-certified reviewers working on a WWC contract are able to complete WWC reviews that are recorded in the WWC reviewed studies database. For this study, if official WWC ratings were not available, certified reviewers applied the WWC standards to determine potential study ratings. Determinations made by researchers for this study are not official WWC ratings until the studies are reviewed by WWC contractors and recorded in the WWC database of reviewed studies.
2. WWC intervention reports contain reviews of multiple studies. Many of these studies were not addressed in the current study. WWC group design ratings were selected for only those studies examining online and blended learning programs that met the eligibility criteria of the current study.

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