What's Happening

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Technology use in instruction and teacher perceptions of school support for technology use in Iowa high schools

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Key findings

This study examined two main topics: the extent to which teachers in Iowa high schools have integrated technology with instruction in ways that support the development of 21st century skills among students, and how teachers perceive school support for technology use in instruction.

On technology use:

- 44–51 percent of teachers asked students to use technology for collaboration and critical thinking, while 22–27 percent asked students to use technology for communication and creativity.
- Math teachers were among the least likely to ask students to use technology for collaboration, communication, and creativity.
- 78 percent of teachers agreed that technology enhances student learning and that they have the ability to integrate technology with instruction.

On school support for technology use:

- 93 percent of teachers reported having access to computers for student use, and 64 percent reported that technical support is above average or excellent.
- 36 percent of teachers rated the quality of technology-focused professional development as above average or excellent.

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This report is available on the Regional Educational Laboratory website at http://ies.ed.gov/ncee/edlabs.

Summary

The rural districts served by the Central Rivers Area Education Agency (Central Rivers AEA)[1] in Iowa have invested in technology to assist teachers in supporting the development in students of the 21st century skills emphasized by the Iowa Core Standards. Central Rivers AEA and three high schools in its service area have raised several questions about technology use. They asked Regional Educational Laboratory Midwest to conduct a descriptive research study on how much teachers have integrated technology with instruction in ways that are believed to support the development of 21st century skills among students and how teachers perceive school support for technology use in instruction.

This study used data from a survey administered in 2017 in 26 public high schools in the Central Rivers AEA service area.

Three research questions concerned teacher use and perceptions of technology. They examined how frequently teachers ask students to use technology in ways that are believed to support the development of the 21st century skills of collaboration, communication, creativity, and critical thinking; how much teachers perceive that technology enhances student learning; and how much teachers believe that they have the ability to integrate technology with instruction.

Three research questions concerned school support for technology use. They examined how much schools provide technology infrastructure and support, how much teachers participate in high-quality professional development on using technology to support instruction, and how much school leaders encourage classroom technology use.

The findings indicate that the proportion of teachers asking students to use technology in ways that are believed to support the development of 21st century skills differs across skills, subject taught, and years of teaching experience. Key findings on classroom technology use include:

- 89 percent of teachers reported that their students use technology almost daily or weekly.
- 44–51 percent of teachers asked students at least monthly to engage in at least two different uses of technology for collaboration and critical thinking, while 22–27 percent asked students at least monthly to engage in at least two different uses of technology for communication and creativity.
- Math teachers were among the least likely to ask students at least monthly to engage in at least two different uses of technology for collaboration, communication, and creativity.
- Teachers with 4–9 years of teaching experience were the most likely to ask students at least monthly to engage in at least two different uses of technology for collaboration and creativity, and teachers with 20 or more years of teaching experience were the least likely.

Most teachers believe that technology has specific benefits for student learning and that they can integrate technology with instruction. Key findings on teacher perceptions of technology include:

- 78 percent of teachers agreed or strongly agreed that technology enhances student learning. Science teachers, career and technical education teachers, and world

language teachers were the most likely to agree, and arts teachers and math teachers were the least likely.
- 78 percent of teachers agreed that they have the ability to integrate technology with instruction. Science teachers and teachers with 4–9 years of teaching experience were the most likely to agree.

Most teachers have access to computers, the Internet, and adequate technical support but limited access to technology-focused professional development. Key findings on school support for technology use include:

- 93 percent of teachers reported that they could access computers for their students' use all the time.
- 64 percent of teachers rated technical support as above average or excellent.
- The typical range for the total number of hours of technology-focused professional development that teachers participated in over the last year was 1–8 hours.
- 36 percent of teachers rated the quality of technology-focused professional development as above average or excellent.
- About 50 percent of teachers indicated that they discuss technology in professional settings more than half the time or all the time.

Although teachers use classroom technology frequently, they are not consistent in using it in ways that are believed to support the development of 21st century skills among students and may need additional support and encouragement. Math teachers, in particular, may need additional professional development in how to use technology to address specific learning objectives. Teachers with 3 or fewer years of teaching experience and those with 20 or more years also appear to need additional training on using technology for instruction. School leaders planning technology-focused professional learning may wish to consider sustained approaches embedded in teachers' ongoing professional responsibilities rather than intermittent approaches. To this end, school leaders may consider using such formal settings as departmental meetings, evaluations, and classroom observations for reflection and planning to reinforce their vision for technology use.

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Why this study?

There is growing national consensus on the need for education systems to prepare students to succeed in the work environments and society of the 21st century (Partnership for 21st Century Skills, 2009; see Voogt & Roblin, 2012, for a review). Recognizing this need, a team of Iowa educators and business representatives identified a set of skills essential for 21st century success (Iowa Department of Education, n.d.). Based on that work, the Iowa Core Standards were recently revised to emphasize the following skills related to learning and innovation:

- *Collaboration:* working within and across personal and global networks to achieve common goals.
- *Communication:* sharing information through multiple means, including visual, digital, verbal, and nonverbal interactions, leading to an accurate exchange of information and ideas.
- *Creativity:* generating new or original thoughts, interpretations, products, works, or techniques.
- *Critical thinking:* accessing and analyzing key information to develop solutions to complex problems that may have no clear answer.

Technology can connect students with learning opportunities for developing and practicing these skills (Voogt, Erstad, Dede, & Mishra, 2013). Specifically, it can engage students in activities that develop collaboration, communication, creativity, and critical thinking. Examples of such student activities include:

- Collaborating online with students at other schools.
- Writing online reviews, blog posts, and constructive comments.
- Creating art, music, movies, or webcasts using technology.
- Collecting and analyzing data from online sources.

Iowa school districts have invested in technology to address the Iowa Core Standards expectations for 21st century skills. For example, the rural districts served by the Central Rivers Area Education Agency (Central Rivers AEA)[2] have provided a tablet or laptop for every student and teacher.

To promote effective technology use, Central Rivers AEA and three high schools in its service area formed the Iowa Learning and Technology Networked Improvement Community (Iowa NIC) in partnership with Regional Educational Laboratory (REL) Midwest. In spring 2017 the Iowa NIC began testing strategies to help high school educators understand how technology can enhance teaching and learning. Along with these efforts, Iowa NIC participants raised several questions about technology use in their schools. They asked REL Midwest to conduct a descriptive research study on how much teachers in schools such as theirs integrate technology with instruction in ways that are believed to support the development of 21st century skills among students and on how teachers perceive school support in three areas that promote technology use in instruction (these areas are described in box 1).

The study findings were expected to show the Iowa NIC participants whether teachers were using technology in the ways envisioned by the Iowa Core Standards, how much school support is available to teachers, how much teachers believe that they have the ability to integrate technology with instruction, and how much they believe that doing so enhances learning.

Box 1. Previous research on school support for technology use and teacher perceptions of school support for technology use

Three critical school supports for instructional technology use are technology infrastructure, opportunities for professional learning, and encouragement by school leaders (Valiente, 2010).

A robust technology infrastructure ensures that computer use is reliable and that technical problems can be quickly addressed. Technology infrastructure includes broadband Internet access, wireless network connectivity, computing device access, and technical support for teachers. School districts must also ensure appropriate website filtering policies so that students can reliably access the websites they need for class assignments. Teachers who know that their students can reliably access devices and the Internet are more likely to plan lessons that incorporate digital resources (Argueta, Huff, Tingen, & Corn, 2011; Center for Promise, 2013; Inan, Lowther, Ross, & Strahl, 2010; Valiente, 2010).

High-quality professional learning opportunities help teachers integrate technology with instruction in ways that support the development of 21st century skills among students (Argueta et al., 2011). Sporadic training sessions on how to use devices and software are unlikely to support technology integration in ways that enhance the effectiveness of instruction (Center for Public Education, 2013; Kopcha, 2012). But professional development sustained throughout the school year and embedded in the school day (for example, through mentoring) is associated with changes in teachers' instructional technology practices (Duran, Brunvand, Ellsworth, & Şendağ, 2012; Scott & Mouza, 2007).

Encouragement by school leadership can prompt teachers to use technology in student-centered practices that support the development of 21st century skills (Anderson & Dexter, 2005; Inan et al., 2010; Zhao & Frank, 2003). School leaders need to communicate how they expect teachers to use technology. Opportunities for professional discussion, reflection, and feedback in existing school routines, such as departmental meetings, evaluations, and classroom observations are also critical (see Davies & West, 2014, and Lawless & Pellegrino, 2007, for reviews).

In addition to school supports, teachers' own perceptions of technology are associated with technology use. To the extent that teachers perceive technology in instruction as directly relevant to their curriculum goals (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012) and favorable to student learning (Hur, Shannon, & Wolf, 2016), they are likely to integrate it. And teachers' confidence in their ability to integrate technology with instruction is associated with their likelihood of doing so (Anderson, Groulx, & Maninger, 2011; Hur et al., 2016).

Both school and teacher factors influence teacher perceptions of technology integration with instruction. School factors include enrollment size and student composition. Teachers in smaller schools (Hsu, Wu, & Hwang, 2007) and teachers in schools with a higher proportion of economically disadvantaged students (Perrotta, 2013) have more positive beliefs about the potential benefits of technology use. Teacher factors include subject taught and years of teaching experience. Different subjects vary in how they are supported by technology, so subject taught is likely to influence perceptions (Howard, Chan, Mozejko, & Caputi, 2015; Perrotta, 2013). Years of teaching experience is negatively associated with teachers' confidence in their ability to integrate technology (Inan & Lowther, 2010; Liu, Ritzhaupt, Dawson, & Barron, 2017).

What the study examined

The study used data from a survey about technology use for instructional purposes, school support for technology use, and teacher beliefs and attitudes that was administered in 2017

by the Central Rivers AEA to 26 public high schools in its service area. Six research questions in two broad categories guided the study:

On technology use

- How frequently do teachers ask students to use technology in ways that are believed to support the development of the 21st century skills of collaboration, communication, creativity, and critical thinking among students?
- How much do teachers perceive that technology enhances student learning?
- How much do teachers believe that they have the ability to integrate technology with instruction?

On school support for technology use

- How much do schools provide technology infrastructure and support?
- How much do teachers participate in high-quality professional development on using technology to support instruction?
- How much do school leaders encourage classroom technology use?

The study reports findings across all responding teachers and across groups of teachers classified by:

- Subject taught.
- Years of teaching experience.
- School size.
- School Title I status.[3]

The study team conducted a statistical analysis to identify group differences. See box 2 for a summary of the data and methods and appendix A for details.

Box 2. Data and methods

Instrument and data

The study used data collected in 2017 through the Clarity Technology and Learning Survey of teachers, an instrument included within an online school management system. Central Rivers AEA provides all schools with access to this system for monitoring and supporting instructional technology practices. The survey includes 132 items related to four domains: access to technology resources, teacher technology skills, classroom technology practices, and the school technology environment. Forty-five of these items related to the study's research questions and topics (see appendix A for a description of topics and items).

The survey covered 11 topics, each of which was associated with one or more survey items (see table A1 in appendix A). For each research question, the survey team examined responses for one or more topics. For example, for the research question about school leaders encouraging classroom technology use, the study team examined responses for two topics: frequency of discussions of technology use and overall perception of whether the school encourages technology use. The topic of frequency was associated with three survey questions, and the topic of overall perception was associated with one survey question.

Subject taught and years of teaching experience were determined based on teachers' survey responses. School size and Title I status were determined based on publicly available data.

(continued)

Box 2. Data and methods *(continued)*

Survey sample

All high schools in the service area of the Central Rivers Area Education Agency (Central Rivers AEA) have access to the Clarity Technology and Learning Survey. In 2017 the Central Rivers AEA communicated with all high schools to remind them of the survey's availability. Each school decided whether to administer the survey to its teachers and chose how to encourage teacher participation. The Central Rivers AEA shared deidentified data from the survey for 2017 with the study team.

Of the 57 high schools in the Central Rivers AEA service area, 26 administered the survey in 2017, for a school response rate of 46 percent. Of 792 possible respondents at those 26 schools, 524 teachers responded, for a response rate of 66 percent. Survey respondents represented a range of subjects taught and years of teaching experience, and they belonged to schools that differed in size, Title I status, and locale (see table B1 in appendix B).

Analysis of nonresponse bias

Schools that administered the survey were compared with schools that did not on school-level academic proficiency, demographics, graduation rates, attendance rates, and college enrollment rates. None of these variables was related to whether a school administered the survey (see table A3 in appendix A). Furthermore, among responding schools, the teacher response rate at a school was not significantly correlated with survey topics related to technology use or perceptions of technology use (see table A4 in appendix A).

Teacher response rates differed significantly by subject taught, with teachers in core subjects (math, English language arts, science, and social studies) most likely to respond to the survey (see figure A1 in appendix A). To account for the possible bias introduced by differences in participation rates by subject taught, the subsequent survey analysis examined whether responses differed by subject taught.

Data analysis

The study team performed preliminary analyses to determine whether the survey items in each topic could be combined to form a reliable and valid measure, meaning that the individual survey items are closely related and measure a single topic. The study team found that items for the four 21st century skills (collaboration, communication, creativity, and critical thinking) could not be combined to form reliable measures but that items for the following topics could: teacher beliefs about how much technology enhances student learning, teacher beliefs about how much they have the ability to integrate technology with instruction, quality of technical support, duration of technology-focused professional development, quality of technology-focused professional development, and frequency of discussions of technology use. Therefore, the study team treated the survey data with two different approaches: reporting raw frequencies and proportions for the four 21st century skills items and for the topics for which there was a single survey item and reporting numerical scale scores for the other topics.

The study team examined the frequency of teacher responses to the items addressing technology use for the development of the four 21st century skills. The study team also calculated the proportion of teachers emphasizing each skill, defined as asking students at least monthly to engage in two or more uses of technology for a given skill, for all teachers and for groups of teachers classified by subject taught, years of teaching experience, school size, and school Title I status. The study team performed additional tests to determine which groups differed in their responses.

(continued)

Box 2. Data and methods *(continued)*

For the topics for which a reliable scale score could be calculated, the study team categorized respondents according to the response option they were most likely to select for the topic. These categorizations were used to describe the pattern of findings for each topic. The study team tested whether the mean scale scores of groups of teachers differed significantly (using a one-way analysis of variance) and performed additional tests to determine which groups of teachers differed in their responses for a given topic. The study team did not examine differences by school locale because a large proportion of schools were classified as rural (73 percent) or town (19 percent) (see table B2 in appendix B).

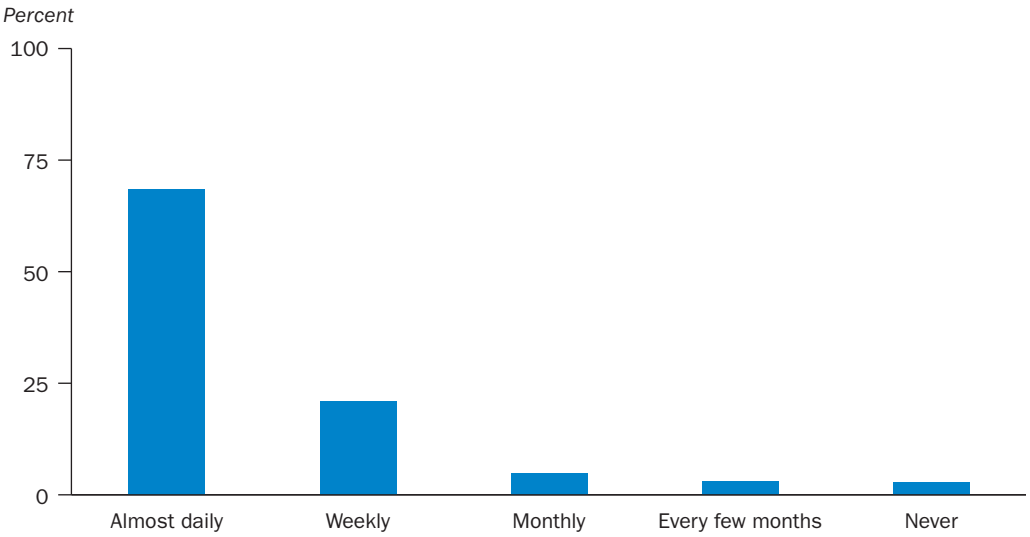
What the study found

The proportion of teachers asking students to use technology in ways that are believed to support the development of 21st century skills differs by skill and across subjects taught and years of teaching experience. Most teachers believe that technology enhances student learning and that they have the ability to integrate technology with instruction. Most teachers have access to computers, the Internet, and adequate technical support but limited access to technology-focused professional development. About half of teachers reported that discussions of classroom technology use occur frequently in professional settings.

Most teachers report that students use technology in the classroom almost daily or weekly

About 89 percent of teachers reported that students use classroom technology, such as desktop computers, laptops, or tablets, almost daily or weekly (figure 1; see also table C1 in appendix C).

Figure 1. Nearly 9 in 10 teachers reported that students use classroom technology almost daily or weekly



Note: Data presented in the figure are raw survey results. No statistical testing was performed on these data.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Between 22 percent and 51 percent of teachers asked students at least monthly to use technology to promote skills of collaboration, communication, creativity, and critical thinking

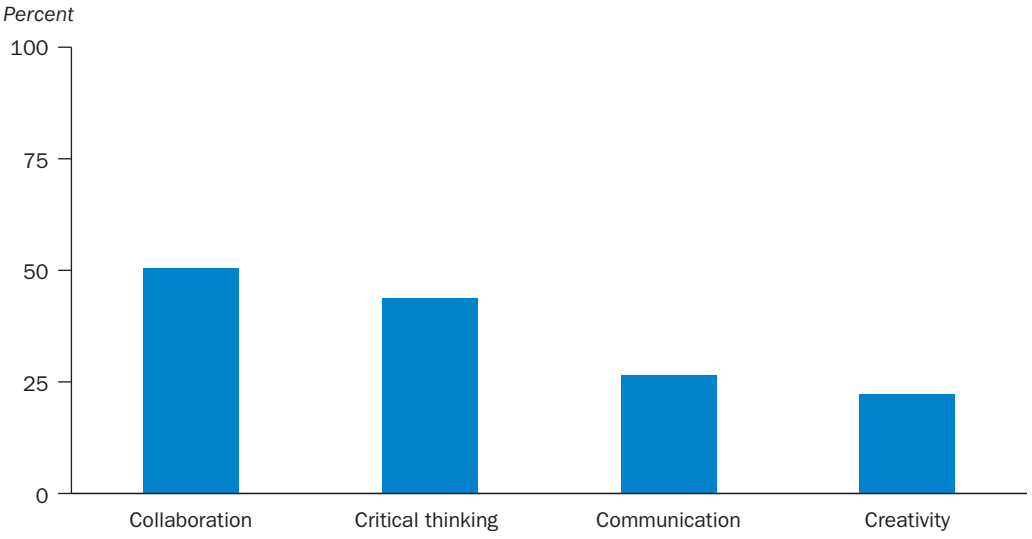
About 51 percent of teachers asked students at least monthly to engage in at least two different uses of technology for collaboration, and 44 percent of teachers asked students to do so for critical thinking (figure 2). By contrast, about 27 percent of teachers asked students at least monthly to engage in at least two different uses of technology for communication, and 22 percent of teachers did so for creativity.

About 62 percent of teachers asked students at least monthly to collaborate using online documents, and 45 percent of teachers asked students to collaborate online with classmates (with the medium of collaboration unspecified; figure 3). By contrast, 37 percent of teachers reported asking students at least monthly to collaborate online with the teacher, and 7 percent of teachers asked students to collaborate with students in other schools.

Fewer than 20 percent of teachers asked students at least monthly to use technology to engage in direct communication—including receiving feedback from classmates or an outside source, writing for an online audience, and chatting online (figure 4). With respect to indirect means of communication, 35 percent of teachers asked students to post schoolwork online, and 25 percent asked students to use web tools to receive information.

About 37 percent of teachers asked students at least monthly to develop multimedia presentations. By contrast, fewer than 20 percent of teachers asked students to use technology to create art, music, movies, or webcasts (18 percent); use a digital camera (15 percent); or create online models, simulations, and animations (13 percent) (figure 5).

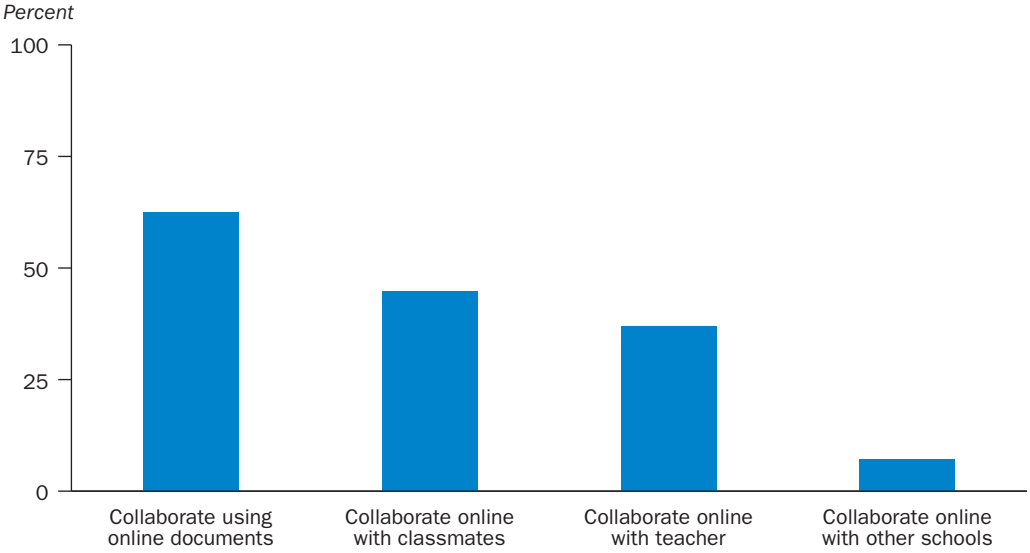
Figure 2. Between 22 percent and 51 percent of teachers asked students at least monthly to engage in at least two different uses of technology related to collaboration, communication, creativity, and critical thinking



Note: Data presented in the figure are raw survey results and refer to the percentage of teachers who reported asking students weekly or monthly to engage in at least two different uses of technology. No statistical testing was performed on these data.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

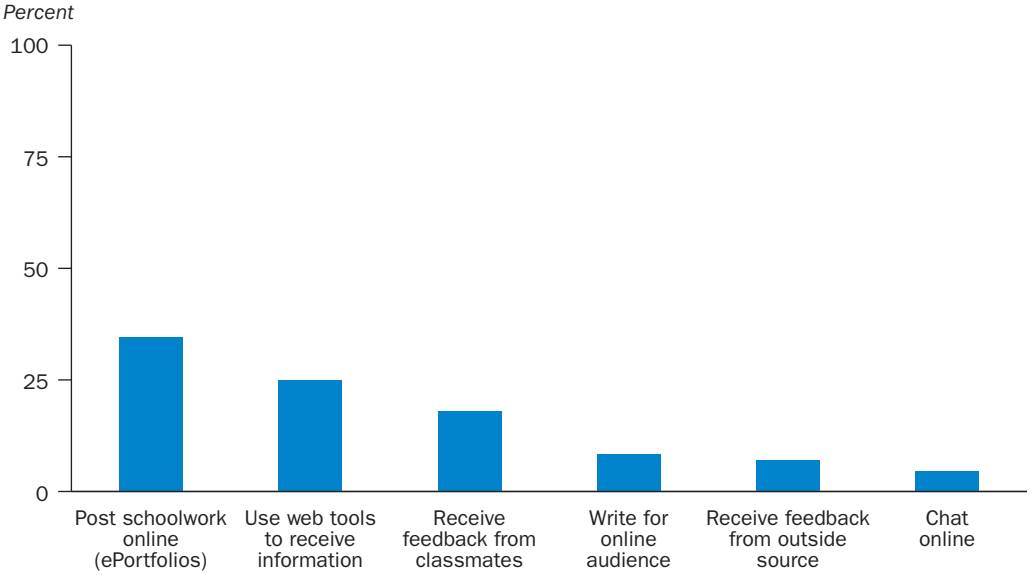
Figure 3. Between 7 percent and 62 percent of teachers asked students at least monthly to collaborate online in various ways



Note: Data presented in the figure are raw survey results and refer to the percentage of teachers who reported asking students weekly or monthly to engage in each use of technology for collaboration. No statistical testing was performed on these data.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

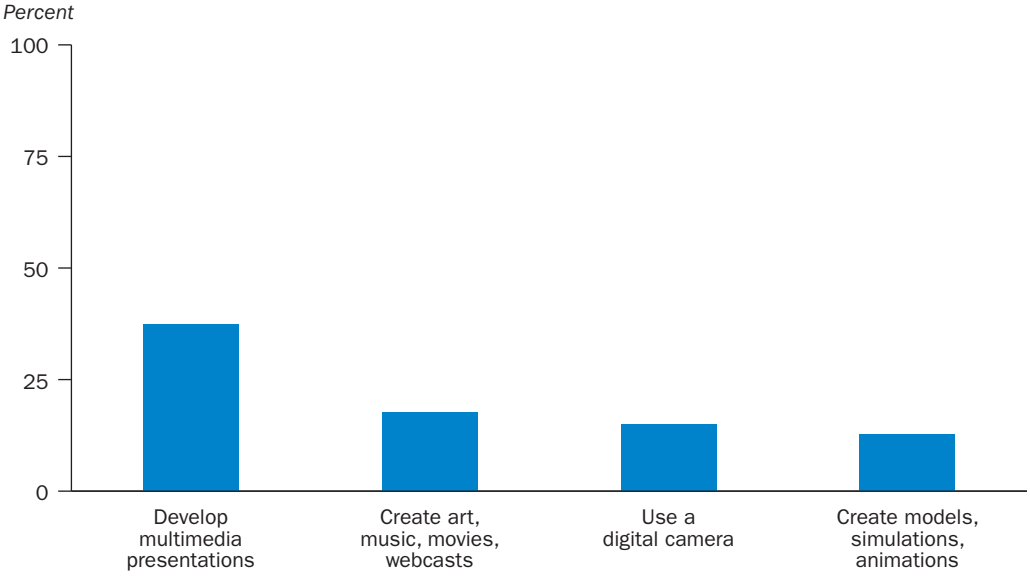
Figure 4. Between 5 percent and 35 percent of teachers asked students at least monthly to use technology to communicate in various ways



Note: Data presented in the figure are raw survey results and refer to the percentage of teachers who reported asking students weekly or monthly to engage in each use of technology for communication. No statistical testing was performed on these data.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Figure 5. Between 13 percent and 37 percent of teachers asked students at least monthly to use technology to create various types of products



Note: Data presented in the figure are raw survey results and refer to the percentage of teachers who reported asking students weekly or monthly to engage in each use of technology for creativity. No statistical testing was performed on these data.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

About 62 percent of teachers asked students at least monthly to use technology for critical thinking by conducting research online, and about 35 percent of teachers asked students to do so by collecting and analyzing data or by identifying and solving authentic problems. About 24 percent of teachers asked students at least monthly to use technology for critical thinking by taking measurements or conducting experiments (figure 6).

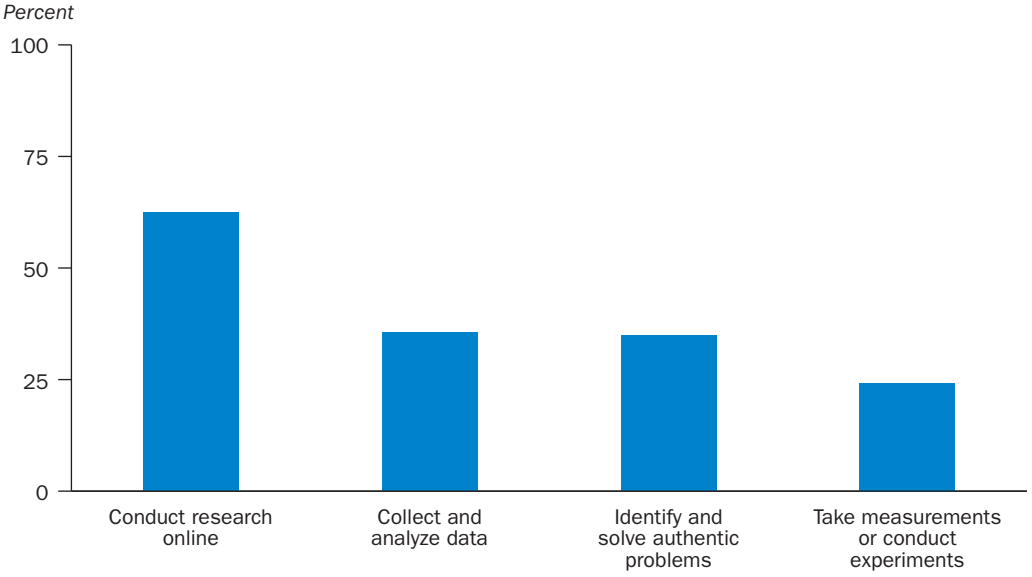
Math teachers and teachers with the most years of teaching experience were the least likely to ask students to use technology in ways that are believed to support the development of 21st century skills

For all four 21st century skills the frequency of teachers asking students to use technology varied by subject taught (see table D1 in appendix D). And for collaboration and creativity the frequency varied by years of teaching experience. The frequency did not vary based on school size or Title I status.

Math, arts, and physical education teachers were the least likely to ask students at least monthly to engage in at least two different uses of technology for collaboration. Between 55 percent and 75 percent of career and technical education, science, world language, English language arts, and social studies teachers asked students at least monthly to use technology to collaborate in at least two different ways (figure 7; see also table C2 in appendix C). By contrast, 32 percent of physical education teachers, 17 percent of arts teachers, and 16 percent of math teachers did.

Math teachers were the least likely to ask students at least monthly to engage in at least two different uses of technology for communication. Between 22 percent and 46 percent of arts, career and technical education, science, world language, English language arts, and

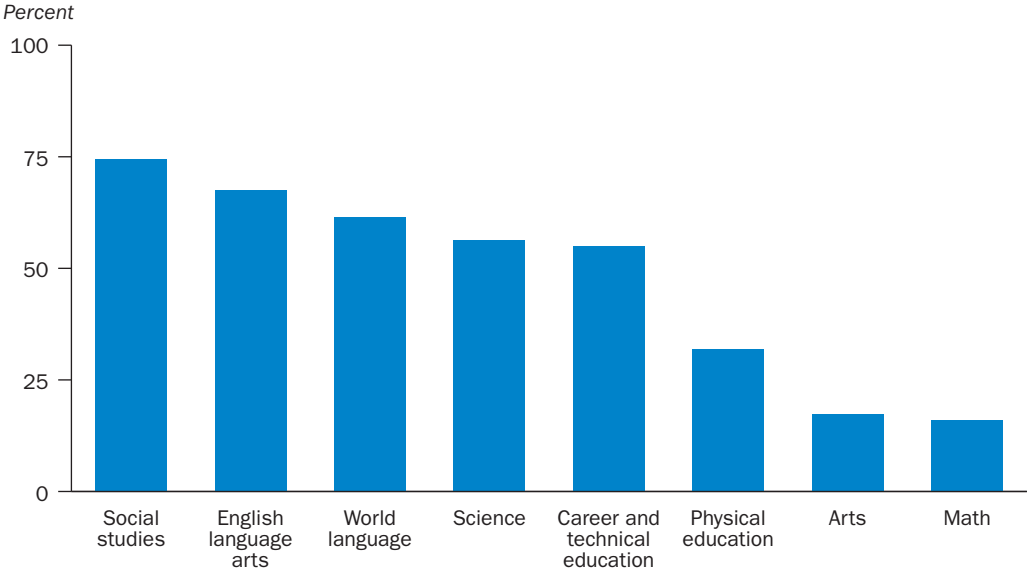
Figure 6. Between 24 percent and 62 percent of teachers asked students at least monthly to use technology for critical thinking in various ways



Note: Data presented in the figure are raw survey results and refer to the percentage of teachers who reported asking students weekly or monthly to engage in each use of technology for critical thinking. No statistical testing was performed on these data.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Figure 7. Math, arts, and physical education teachers were the least likely to ask students at least monthly to use technology for collaboration



Note: Data are raw survey results and refer to the percentage of teachers who reported asking students weekly or monthly to engage in at least two different uses of technology for collaboration.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

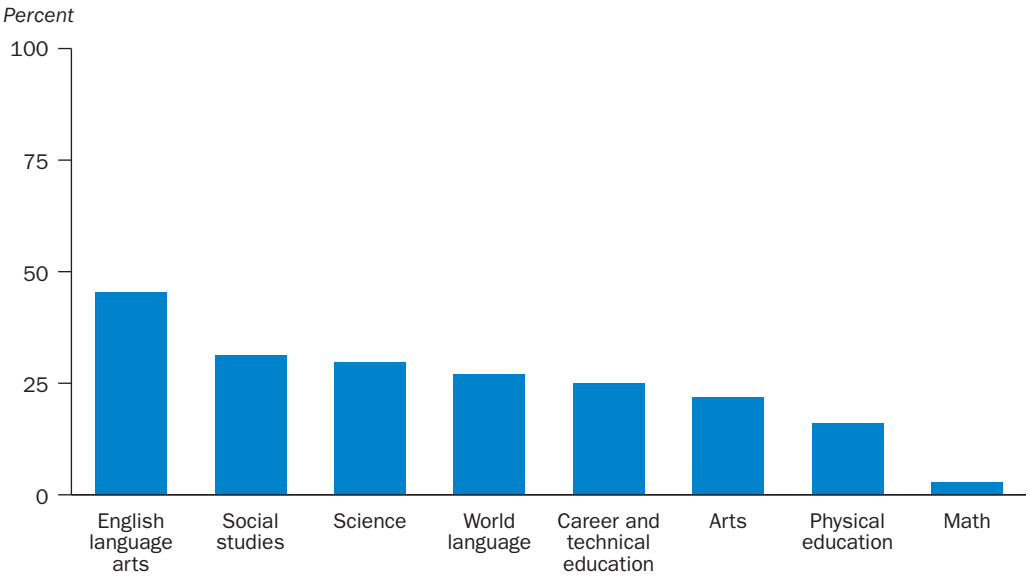
social studies teachers asked students at least monthly to engage in at least two different uses of technology for communication (figure 8; see table C3 in appendix C). By contrast, 16 percent of physical education teachers and 3 percent of math teachers did.

Math teachers were the least likely to ask students at least monthly to engage in at least two different uses of technology for creativity. Between 22 percent and 42 percent of arts, world language, social studies, career and technical education, and science teachers asked students at least monthly to engage in at least two different uses of technology for creativity (figure 9; see also table C4 in appendix C). By contrast, 12 percent of physical education and English language arts teachers and 3 percent of math teachers did.

Science teachers and career and technical education teachers were the most likely to ask students at least monthly to engage in at least two different uses of technology for critical thinking. About 72 percent of science teachers and 58 percent of career and technical education teachers asked students at least monthly to use technology for critical thinking (figure 10; see table C5 in appendix C). By contrast, fewer than 20 percent of physical education, world language, and arts teachers did.

Teachers with 4–9 years of teaching experience were more likely than teachers with 20 or more years of teaching experience to ask students at least monthly to engage in at least two different uses of technology for collaboration or for creativity. About 62 percent of teachers with 4–9 years of teaching experience asked students at least monthly to engage in at least two different uses of technology for collaboration, compared with 40 percent of teachers with 20 or more years of teaching experience (figure 11; see table C2 in appendix C). In addition, 57 percent of teachers with 3 or fewer years of teaching experience

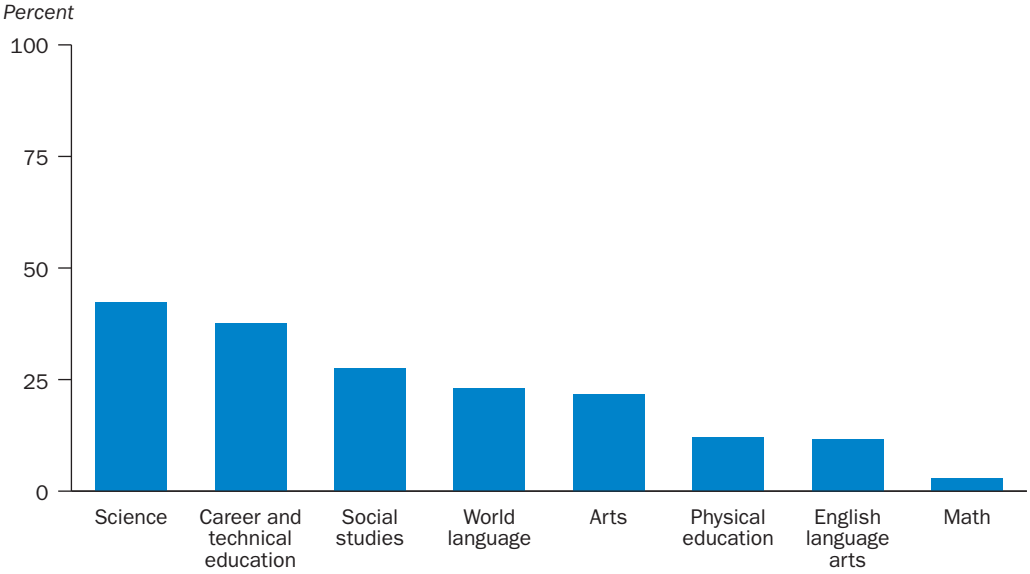
Figure 8. Math teachers were the least likely to ask students at least monthly to use technology for communication



Note: Data are raw survey results and refer to the percentage of teachers who reported asking students weekly or monthly to engage in at least two different uses of technology for communication.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

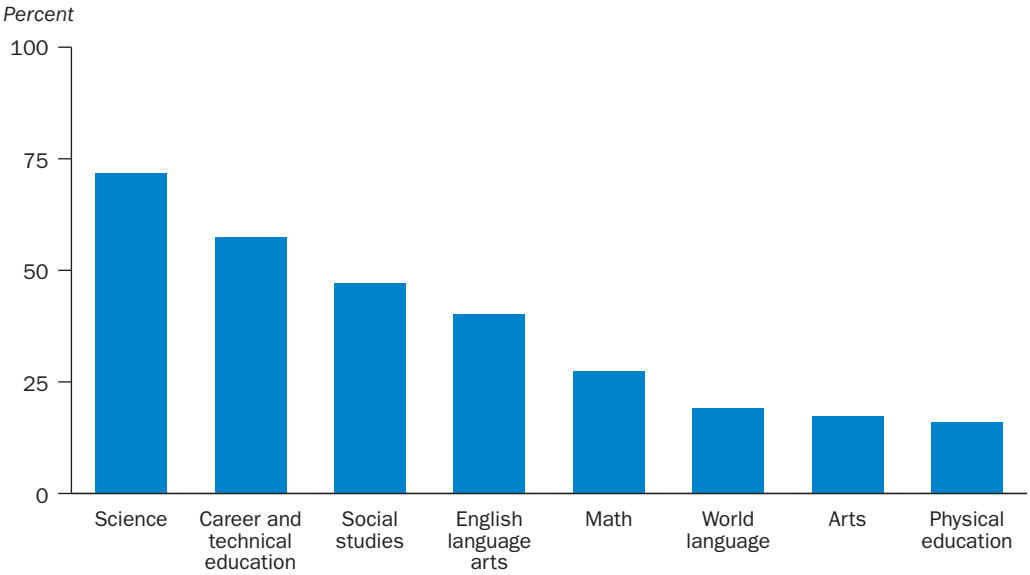
Figure 9. Math teachers were the least likely to ask students at least monthly to use technology for creativity



Note: Data are raw survey results and refer to the percentage of teachers who reported asking students to engage weekly or monthly in at least two different uses of technology for creativity.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

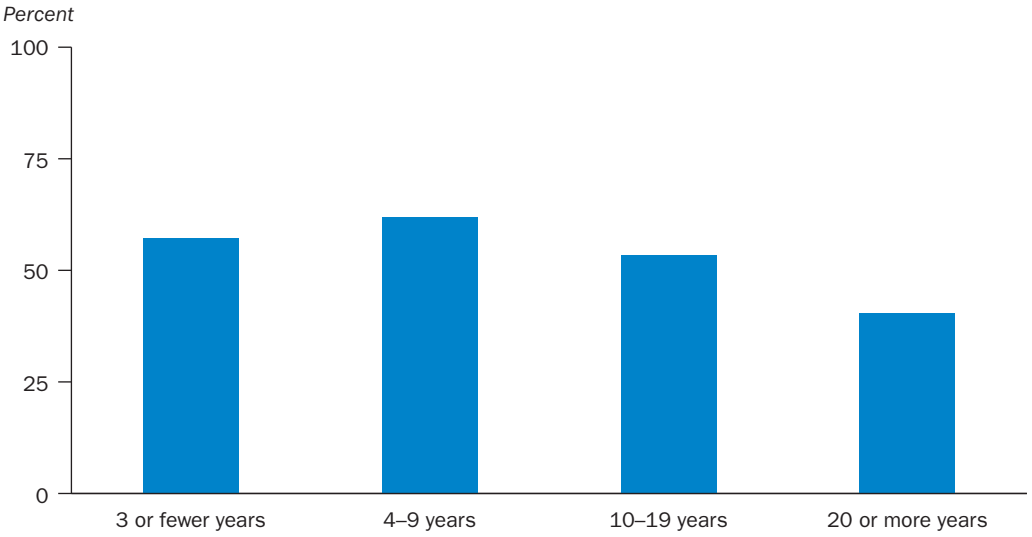
Figure 10. Science teachers and career and technical education teachers were the most likely to ask students at least monthly to use technology for critical thinking



Note: Data are raw survey results and refer to the percentage of teachers who reported asking students weekly or monthly to engage in at least two different uses of technology for critical thinking.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Figure 11. Teachers with 4–9 years of teaching experience were more likely than teachers with 20 or more years of teaching experience to ask students at least monthly to use technology for collaboration



Note: Data are raw survey results and refer to the percentage of teachers who reported asking students weekly or monthly to engage in at least two different uses of technology for collaboration.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

asked students at least monthly to engage in at least two different uses of technology for collaboration, as did 54 percent of teachers with 10–19 years of teaching experience.

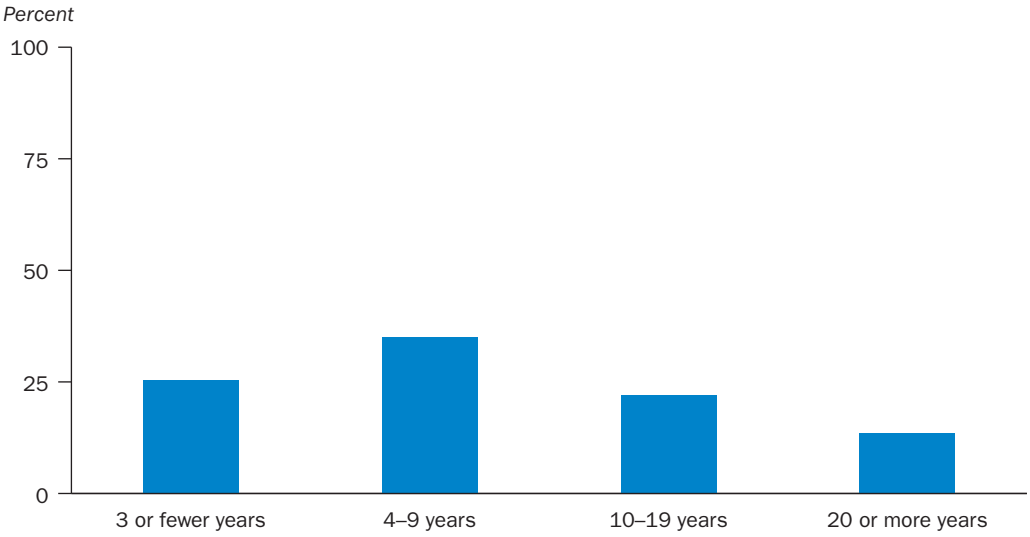
About 35 percent of teachers with 4–9 years of teaching experience reported asking students at least monthly to engage in at least two different uses of technology for creativity, compared with 14 percent of teachers with 20 or more years of experience (figure 12; see table C4 in appendix C). In addition, 25 percent of teachers with 3 or fewer years of teaching experience asked students at least monthly to engage in at least two different uses of technology for collaboration, as did 22 percent of teachers with 10–19 years of teaching experience.

Nearly four in five teachers agreed that technology enhances student learning and that they have the ability to integrate technology with instruction

About 78 percent of teachers agreed or strongly agreed that technology enhances student learning, 21 percent expressed a neutral opinion, and 1 percent disagreed or strongly disagreed (figure 13; see also table C6 in appendix C). In addition, 78 percent of teachers agreed or strongly agreed that they have the ability to integrate technology with instruction, 15 percent expressed a neutral opinion, and 7 percent disagreed or strongly disagreed (see figure 13; see also table C7 in appendix C).

Teachers' agreement that technology enhances learning differed by subject taught and school size (but not by years of teaching experience or school Title I status), and teachers' agreement that they have the ability to integrate technology with instruction differed by subject taught and years of teaching experience (but not by school size or Title I status) (see table D2 in appendix D).

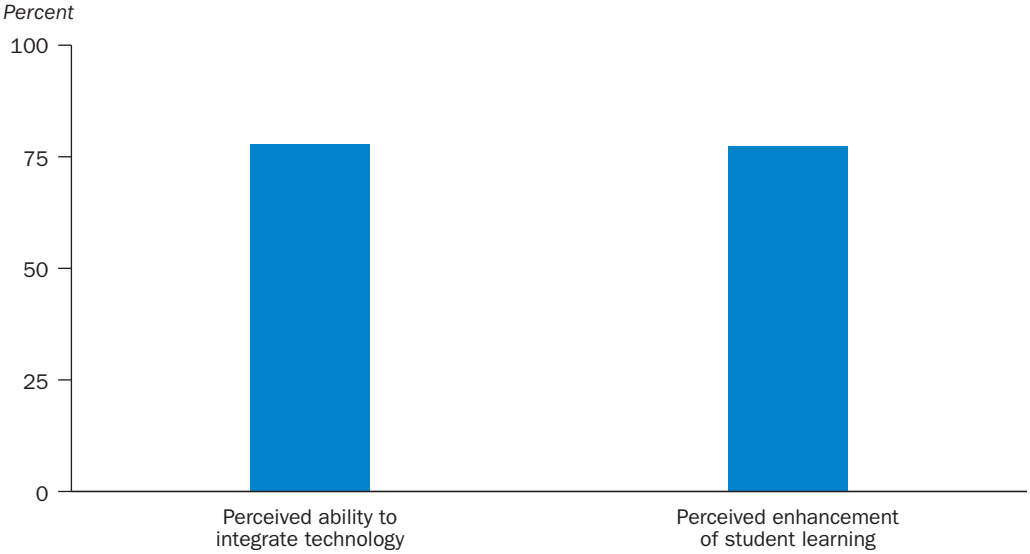
Figure 12. Teachers with 4–9 years of teaching experience were more likely than teachers with 20 or more years of teaching experience to ask students at least monthly to use of technology for creativity



Note: Data are raw survey results and refer to the percentage of teachers who reported asking students weekly or monthly to engage in at least two different uses of technology for creativity.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Figure 13. Nearly four in five teachers agreed that technology enhances student learning and that they have the ability to integrate technology with instruction



Note: Data presented in the figure are scale score summaries (see box 2) and refer to the percentage of teachers who answered agree or strongly agree on the scale. No statistical testing was performed on these data.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

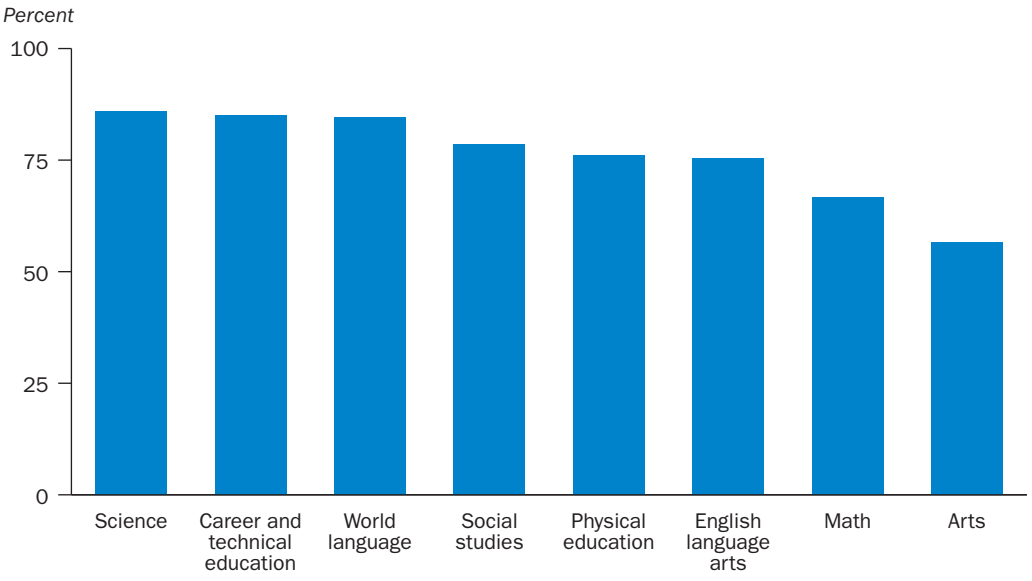
Science teachers were the most likely to agree that technology enhances student learning and that they have the ability to integrate technology with instruction. About 86 percent of science teachers and 85 percent of career and technical education teachers and world language teachers agreed or strongly agreed that technology enhances student learning (figure 14; see also table C6 in appendix C). By contrast, 57 percent of arts teachers and 67 percent of math teachers agreed or strongly agreed.

About 89 percent of science teachers agreed or strongly agreed that they have the ability to integrate technology with instruction, compared with 68 percent of math teachers (figure 15; see also table C7 in appendix C).

Teachers with 20 or more years of teaching experience were the least likely to agree that they have the ability to integrate technology with instruction. About 68 percent of teachers with 20 or more years of teaching experience agreed or strongly agreed that they had the ability to integrate technology with instruction (see table C7 in appendix C). By contrast, about 87 percent of teachers with 4–9 years of experience did.

Teachers at small schools were more likely to agree that technology enhances student learning than were teachers at large schools. About 83 percent of teachers at small schools (those with fewer than 300 students) agreed or strongly agreed that technology enhances student learning, compared with 70 percent of teachers at large schools (those with more than 500 students) (see table C6 in appendix C).

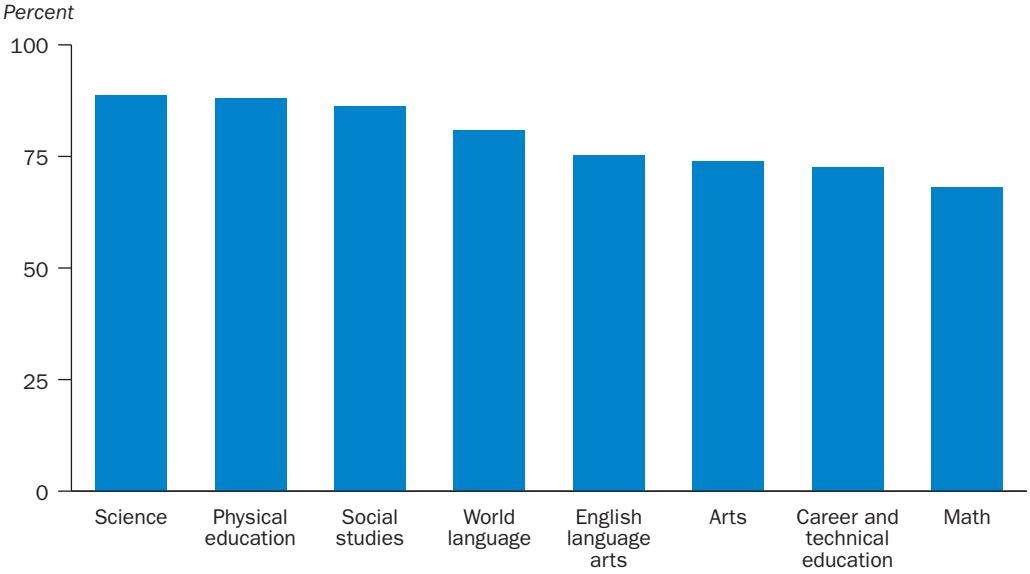
Figure 14. Science teachers were the most likely to agree that technology enhances student learning



Note: Data are scale score summaries (see box 2) and refer to the percentage of teachers who answered agree or strongly agree on the scale.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Figure 15. Science teachers were the most likely to agree that they have the ability to integrate technology with instruction



Note: Data are scale score summaries (see box 2) and refer to the percentage of teachers who answered agree or strongly agree on the scale.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Most teachers reported having access to computers and websites needed for student use

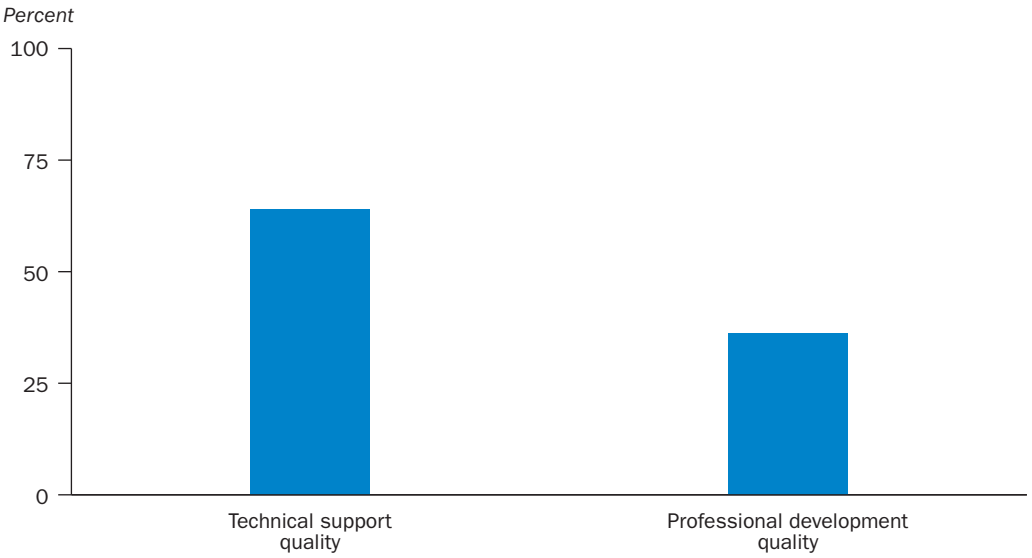
About 93 percent of teachers reported having access to computers for student use all the time (see table C8 in appendix C). School Internet filters do not appear to pose a barrier to technology use. Most teachers reported that their school's Internet filters rarely (49 percent) or never (14 percent) prevented access to websites needed for class. Most of the remaining teachers (27 percent) indicated that filters limited access less than half the time (see table C9).

A majority of teachers rated technical support as above average or excellent, but fewer than half of teachers rated technology-focused professional development as above average or excellent

About 64 percent of teachers rated the quality of technical support they received from their school on issues pertaining to Internet connectivity, hardware, and troubleshooting of disruptions to instruction as above average or excellent, and 35 percent rated the quality as average (figure 16). Teachers at small schools rated technical support higher than did teachers at large schools (see table C10 in appendix C and table D2 in appendix D). No differences were evident across subject taught, years of teaching experience, or school Title I status.

Teacher ratings of technology-focused professional development were lower than ratings of technical support. About 55 percent of teachers rated the quality of three types of formal and informal technology-focused professional development that they completed during the 12 months prior to the survey as average, while 36 percent rated them as either above average or excellent (see figure 16). Teachers with 4–9 years of teaching experience were the least likely to rate technology-focused professional development as above average or

Figure 16. About 64 percent of teachers rated as above average or excellent the quality of technical support from their school, whereas 36 percent of teachers rated as above average or excellent the quality of technology-focused professional development



Note: Data presented in the figure are scale score summaries (see box 2) and refer to the percentage of teachers who answered above average or excellent. No statistical testing was performed on these data.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

excellent (see table C11 in appendix C). No differences were evident across subject taught, school size, or school Title I status (see table D2 in appendix D).

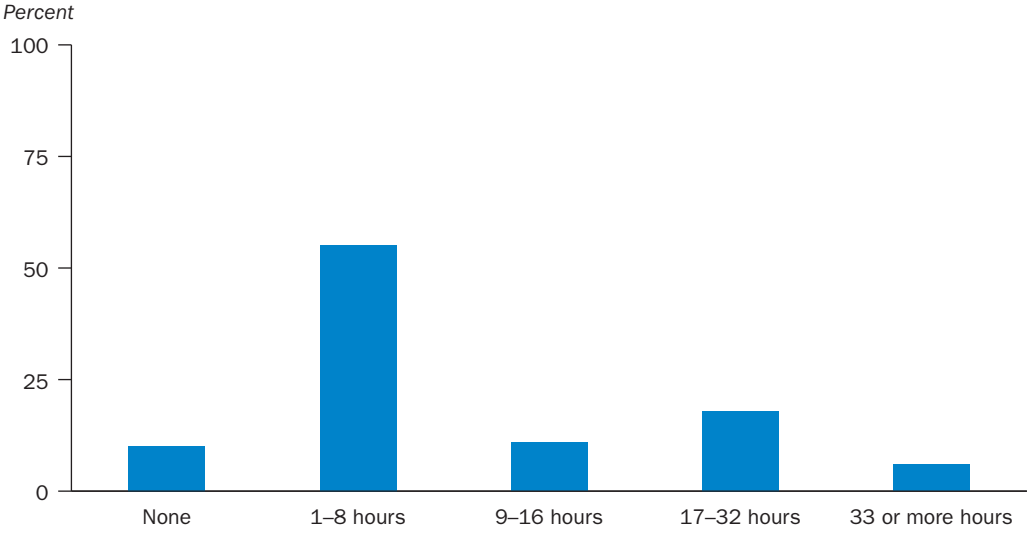
More than half of teachers reported spending 1–8 hours in technology-focused professional development during the past year

About 55 percent of teachers reported spending 1–8 hours in formal and informal technology-focused professional development during the 12 months prior to the survey, 18 percent reported spending 17–32 hours, and 11 percent reported spending 9–16 hours[4] (figure 17; see also table C12 in appendix C).

Half of teachers reported that discussions of instructional technology occur frequently

About 50 percent of teachers reported that discussions of technology in formal professional settings, such as department meetings, evaluations, and classroom observations or visits, occurred more than half the time or always. By contrast, 19 percent of teachers reported that such discussions rarely or never occur (figure 18; see also table C13 in appendix C). Science teachers, career and technical education teachers, and social studies teachers were the most likely to report frequent discussions of technology use. The perceived frequency of these discussions did not differ across years of teaching experience, school size, or school Title I status (see table D2 in appendix D).

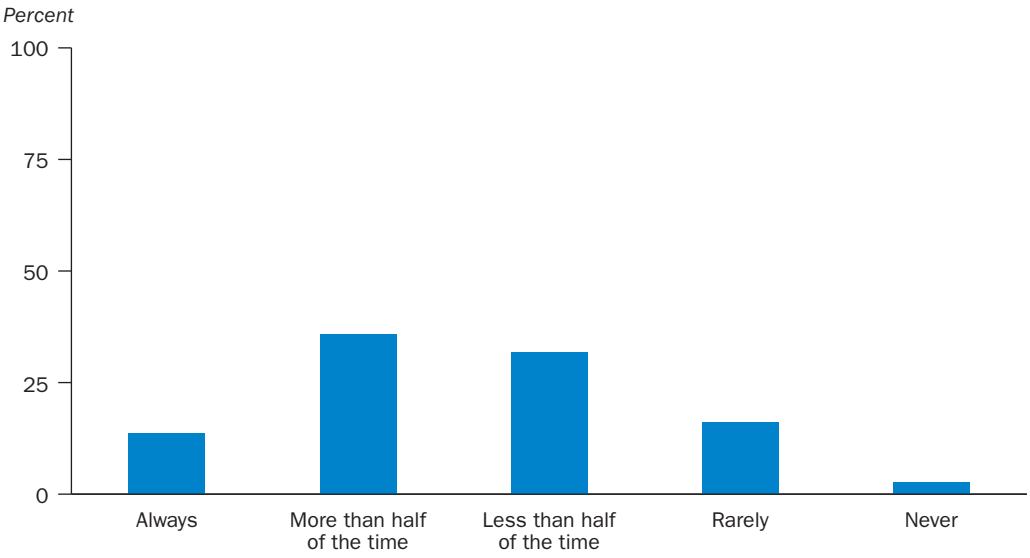
Figure 17. More than half of teachers reported spending 1–8 hours in technology-focused professional development during the past year



Note. Data are scale score summaries (see box 2). No statistical testing was performed on these data.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Figure 18. Half of teachers reported that discussions of instructional technology occur frequently in professional settings



Note: Data are scale score summaries (see box 2). No statistical testing was performed on these data.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Implications of the study findings

These findings suggest that although students frequently use technology in the classroom, they are not frequently using technology in ways that are believed to support the development of the 21st century skills of collaboration, communication, creativity, and critical thinking. Because the Clarity Technology and Learning Survey does not include a comprehensive set of technology uses, the study cannot describe how students use technology in the classroom for other objectives or how they use other technology for the same objectives. However, past research has indicated that teachers frequently use classroom technology to present instructional content, a use that is unlikely to support the development of 21st century skills (Inan et al., 2010). Focusing professional learning on building teachers' understanding and abilities to use technology in ways that support the development of these skills offers an important opportunity.

Math teachers reported lower levels of technology integration than did teachers of other subjects and may need additional professional development in using technology to address specific learning objectives. Teachers' ability to integrate technology with instruction requires specialized knowledge of how technology can support content-specific pedagogies or instructional goals (Voogt, Fisser, Pareja Roblin, Tondeur, & van Braak, 2013). Math teachers also may need support finding content-specific digital resources (Handal, Campbell, Cavanagh, Petocz, & Kelly, 2013).

Teachers with 4–9 years of teaching experience were the most likely to ask students to use technology in ways that are believed to support the development of 21st century skills and to agree that they have the ability to integrate technology with instruction, while teachers with 20 or more years of teaching experience were the least likely. This pattern may reflect that recently minted teachers have received more extensive training in the use of educational technology (Inan & Lowther, 2010) or that many current technologies did not exist when the most experienced teachers completed their preservice training. At the same time, teachers with 3 or fewer years of teaching experience were less likely to use technology in ways that are believed to support the development of 21st century skills. It is possible that their preservice training introduced them to technology applications but did not explain how to integrate them with pedagogical strategies (Chai, Koh, & Tsai, 2010). The findings suggest that both the least and the most experienced teachers need additional professional development and support for designing and teaching lessons that use technology to enhance the learning of subject matter content (Niess, 2011).

School and district leaders could provide teachers with ongoing technology-focused professional learning that is connected to their day-to-day classroom work. The finding that most teachers receive eight or fewer hours of technology-focused professional learning a year suggests that such professional learning is sporadic rather than sustained. A broad research consensus suggests that to be effective, technology-focused professional development must be sustained and directly relevant to teachers' content-specific instructional practice. For example, instructional coaches could help teachers consider how technology could support or enhance learning activities that are appropriate for teaching certain topics (Croft, Coggshall, Dolan, & Powers, 2010; Davies & West, 2014; Jang, 2010; Kopcha, 2012; see also Darling-Hammond & Rothman, 2015).

Similarly, school leaders have an opportunity to embed professional discussions of technology into such formal settings as departmental meetings, evaluations, and classroom observations. With only about half of teachers in the study indicating that they frequently discussed technology in these settings, this opportunity has not yet been fully realized. Such discussions could reinforce the school vision for technology use through reflection and planning.

The study findings indicate that technical infrastructure and support are adequate for supporting instructional technology practices. Most teachers reported high access to computing devices and the Internet. And most rated technical support as above average or excellent, with most of the remainder rating it as average. However, district and school leaders may want to consider whether technology resources and support are sufficient for technology use related to communication and creativity because those uses appeared to be less frequent than other uses evaluated in this study.

Whether ongoing and high-quality professional development is associated with better technology integration in instruction remains unknown, though past research suggests the importance of such school- and teacher-level factors (Hur et al., 2016; Inan & Lowther, 2010). Additional analysis of the Clarity Technology and Learning Survey data could help schools prioritize areas for improvement by examining what supports appear to be associated with higher rates of technology integration.

Limitations of the study

The sample of participating schools is not necessarily representative of all schools in the region served by the Central Rivers AEA. Individual schools decided whether to administer the survey to monitor technology implementation. Although the responding and nonresponding schools did not differ on demographic and academic characteristics for which data are publicly available, the two groups may differ on other characteristics, such as leadership style and school culture, that could be related both to a school's nonresponse and to its overall level of implementation of educational technology.

Similarly, the sample of teachers who responded to the survey may not be representative of the population of teachers within the participating schools. The only characteristic for which data were available for comparing the sample of teachers to the population of teachers was subject taught. Teachers in core subjects (math, English language arts, social studies, and science) were the most likely to respond to the survey. Data on other characteristics of nonresponding teachers (for example, gender, age, and attitudes about the school) were not available to the study team.

Differences in technology use by subject taught may be due partly to the design of the survey instrument rather than to actual differences in the frequency of teachers asking students to use technology in ways that are believed to support the development of 21st century skills. Specifically, several technology uses relate primarily to science instruction, such as "Take measurements or do experiments using technology." Since other subjects may not equally emphasize requiring students to take measurements or do experiments, teachers in those areas could be less likely to ask students to use technology for those tasks. So, the higher proportion of science teachers reporting technology use in the study may relate to the better match of their subject to the types of technology uses the survey addressed.

Appendix A. Study methodology

This appendix summarizes the study's methodology for collecting survey data, processing the data to create variables, examining response rates for bias related to school and teacher nonresponse, and analyzing survey data to identify meaningful differences across respondents from different groups.

Survey data collection

Questionnaire design. The Clarity Technology and Learning Survey is administered to both teachers and students through an online platform. The full teacher survey includes 140 items, of which 45 items aligned with the research questions of this study (see appendix E). Items correspond to a specific topic related to the research questions (table A1).

To summarize the topics:

- For frequency of student use of computing devices, the survey included a single item. Teachers could select from response options of almost daily, weekly, monthly, every few months, or never.
- For frequency of asking students to use technology in ways that support 21st century skills, the survey included 18 items referring to collaboration, communication, creativity, and critical thinking. Teachers could select from response options of weekly, monthly, every few months, or never.

Table A1. Topics addressing each research question and the number of survey items per topic

Research question	Survey topic	Number of items
How frequently do teachers ask students to use technology in ways that are believed to support the development of the 21st century skills of collaboration, communication, creativity, and critical thinking?	Frequency of student use of computing devices	1
	Frequency of asking students to use technology in ways that are believed to support the development of 21st century skills	18
	Items related to collaboration	4
	Items related to communication	6
	Items related to creativity	4
	Items related to critical thinking	4
How much do teachers perceive that technology enhances student learning?	Teachers' beliefs about how much technology enhances student learning	3
How much do teachers believe that they have the ability to integrate technology with instruction?	Teachers' beliefs about how much they have the ability to integrate technology with instruction	4
How much do schools provide technology infrastructure and support?	Access to computers for student use	1
	School filters preventing access to websites	1
	Quality of technical support	7
How much do teachers participate in high-quality professional development on using technology to support instruction?	Duration of technology-focused professional development	3
	Quality of technology-focused professional development	3
How much do school leaders encourage classroom technology use?	Frequency of discussions of technology use	3
	School encourages technology use	1

Source: Authors' compilation.

- For teachers' beliefs about the extent to which technology enhances student learning, the survey included three items referring to specific benefits (such as increased student engagement). Teachers could select from response options of strongly agree, agree, are neutral, disagree, or strongly disagree.
- For teachers' beliefs about their ability to integrate technology with instruction, the survey included four items about teacher confidence in performing related tasks (such as identify relevant digital resources). Teachers could select from response options of strongly agree, agree, are neutral, disagree, or strongly disagree.
- For access to computers for student use, the survey included a single item. Teachers could select from response options of all of the time, over half of the time, less than half of the time, rarely, or never.
- For school filters preventing access to websites, the survey included a single item. Teachers could select from response options of never, rarely, less than half of the time, more than half of the time, or all of the time.
- For quality of technical support, the survey included seven items asking teachers to rate the quality of support for different types of equipment or infrastructure. Teachers could select from response options of excellent, above average, average, below average, poor, or not applicable.
- For duration of technology-focused professional development, the survey included three items on different types of formal and informal activities. Teachers could select from response options of 33 or more hours, 17–32 hours, 9–16 hours, 1–8 hours, or none.
- For quality of technology-focused professional development, the survey included the same three items covered for duration of technology-focused professional development, but teachers rated their perceived quality of the professional development. Teachers could select from response options of excellent, above average, average, below average, poor, or I didn't do this.
- For frequency of discussions of technology use, the survey included three items on different professional settings (department meetings, evaluations, and classroom observations or visits). Teachers could select from response options of all of the time, more than half of the time, less than half of the time, rarely, or never.
- For school encouragement of technology use for teaching and learning, the survey included a single item. Teachers could select from response options of strongly agree, agree, are neutral, disagree, or strongly disagree.

Data collection. The Central Rivers Area Education Agency (Central Rivers AEA) service area contains 57 public secondary schools. All these schools had access to the Clarity Technology and Learning Survey and received communication from the Central Rivers AEA alerting them about the resource and its benefits. Each school decided whether to administer the survey to its teachers and how to encourage teacher participation. Of the 57 schools, 26 administered the survey to teachers in 2017. The Central Rivers AEA shared deidentified data from teacher surveys completed in 2017 with the study team in February 2018.

Data processing

The study team processed and cleaned the survey data in preparation for analysis. Post-collection processing included reviewing each survey item for internal consistency, consistency between related items, computation of scale scores, and nonresponse patterns. The

study team also reviewed missing data to identify whether survey nonresponse was associated with school and teacher characteristics.

Internal consistency. The study team used a Rasch measurement model to calculate person reliability statistics to determine whether items in a topic reflected the same underlying construct (Wright & Masters, 1982). Specifically, the study team calculated seven coefficient alphas for the seven topics that comprised three or more items. The benchmark for adequate internal reliability was set to .70 for the Rasch reliability coefficient. The reliability coefficient for most topics met or exceeded the benchmark. However, the two topics related to professional development (hours spent in technology-focused professional development and quality of technology-focused professional development) had internal reliabilities that were below but approaching .70. Those two scales have only three items, and scales with fewer items tend to have lower reliability estimates related to the way Rasch reliability is calculated. Given this consideration, as well as the fact that the coefficient alpha was high for the topic related to quality of technology-focused professional development, the study team calculated scale scores for these two topics.

The study team took a different approach regarding the frequency of asking students to use technology in ways that are believed to support the development of the four 21st century skills of collaboration, communication, creativity, and critical thinking. Three of the four skills had Rasch reliabilities far less than .70 (for example, .32 for communication), suggesting that an aggregate score would be unreliable because the Rasch model could not distinguish persons throughout most of the distribution. Therefore, the study team did not develop scale scores for this topic. Instead, the study team applied an operationalized definition of teachers "emphasizing a skill" as asking students at least once a month to engage in two or more uses of technology for that skill. With this definition, the study team calculated the proportion of teachers who emphasized a specific skill and the proportion who did not, providing an avenue for comparing teachers' responses regarding the 21st century skills topics across different groups.

Developing the scale scores. With the application of the Rasch model, the study team calculated scale scores for all topic areas in the teacher survey besides the four 21st century skills. The Rasch scores were created using a one-parameter rating scale model using Winsteps. The rating scale model was chosen instead of the partial credit model because all items in a scale have the same rating categories, and, therefore, it was reasonable to assume that the distances between categories were constant across items. Rasch scores were generated separately for each scale and for all teachers. Item threshold parameters were estimated simultaneously as the scores.

For the topics for which it was possible to calculate a reliable scale score, the study team categorized respondents according to the response option they were most likely to select for the topic. These categorizations were used to describe the pattern of findings for each topic. In each scale the study team generated threshold estimates for each item as part of the Rasch modeling and using the procedure described by Garet, Heppen, Walters, Smith, & Yang (2016). Because all the items have the same number of rating categories and thus the same number of threshold parameters, the study team calculated the average threshold parameter for each category across all items, generating an "average" item with the average threshold parameters for each scale. Using ability estimates (Rasch scores) and the threshold parameters for the "average" item, the study team generated—for each teacher and

for each scale—the probability of scoring at each rating scale level. The study team then categorized respondents by their highest probable response category. Rasch scores, which are conceptually equivalent to the most probable responses of a scale, were used to perform the between-group difference tests. The most probable responses of a scale were presented in charts to illustrate between-group differences.

Response rate and nonresponse bias analysis

The study achieved a school-level response rate of 46 percent (26 out of 57 possible schools) and a teacher-level response rate of 66 percent (524 out of 792 possible respondents). Because the school- and teacher-level nonresponse rates were greater than 30 percent, the study team conducted nonresponse bias analysis that focused on three questions:

- Do schools that participated in the survey differ from schools that did not?
- Do low response rates in a school reflect a sample biased toward more frequent users of technology?
- Do response rates differ as a function of subject area taught?

Do schools that participated in the survey differ from schools that did not? To evaluate whether school-level characteristics were associated with a school's nonparticipation in the survey, the study team used a logistic regression in which the predictor variables were school-level academic proficiency, demographics, graduation rates, attendance rates, and college enrollment rates (table A2). Treating whether schools administered the survey as a binary outcome, logistic regression was performed to determine whether school-level characteristics were associated with the outcome of administering the survey. The logistic regression results suggested that the overall model was not significant, $\chi^2(8) = 7.25$, $p > .05$. In addition, none of the school-level characteristics or variables was associated with school response status ($p > .05$ for all indicators; table A3).

Table A2. Means and standard deviations of school-level indicators, by survey response status, 2016/17

	Responding schools			Nonresponding schools		
Indicator	Mean	Standard deviation	*n*	Mean	Standard deviation	*n*
Percentage math proficiency	86	5	24	83	10	29
Percentage reading proficiency	83	6	24	81	9	29
Percentage of English learner students, students with an Individualized Education Program, and students eligible for free or reduced-price lunch[a]	37	9	23	36	14	26
Percentage college/career ready	42	7	24	41	12	29
Graduation rates (percent)	96	4	24	94	12	29
Attendance rates (percent)	94	2	25	93	4	29
College enrollment rates (percent)	73	11	25	71	10	28
School size (N of students)	390.5	335.5	25	352.4	301.2	29

a. The percentage of English learner students, students with an Individualized Education Program, and students eligible for free or reduced-price lunch were summed to create a single variable because of skewness present in the individual variables.

Note: Pairwise deletion was applied to missing data.

Source: Iowa Department of Education.

Table A3. Results of logistic regression examining school-level indicators predicting survey participation

Indicator	Beta	Standard error	Standardized beta	95 percent confidence interval	
				Lower	Upper
Percentage math proficiency	22.31	13.64	0.52	–4.43	49.04
Percentage reading proficiency	–10.03	13.84	–0.22	–37.15	17.09
Percentage English learner students	41.93	89.55	0.63	–133.58	217.44
Percentage eligible for free or reduced-price lunch	3.85	5.95	0.12	–7.82	15.52
Percentage with an Individualized Education Program	17.45	15.53	0.15	–12.98	47.87
Percentage college/career ready	–4.78	10.10	–0.16	–24.58	15.02
Graduation rate (percent)	–4.58	13.41	–0.05	–30.87	21.70
Attendance rate (percent)	22.14	25.18	0.24	–27.22	71.49
School size (N of students)	0.002	0.002	0.21	–0.002	0.005
College enrollment (percent)	4.87	5.05	0.16	–5.02	14.76
Constant	–31.57	26.29	—	–83.10	19.96

Note: N = 55 schools. School-level information was not present in the Common Core of Data 2015/16 dataset for two schools that were not in operation at the time of data collection. The model was not statistically significant, $F(8, 39) = .65$. All regression coefficients were not statistically significant ($p > .05$). The percentage of English learner students, students with an Individualized Education Program, and students eligible for free or reduced-price lunch were summed to create a single variable because of skewness present in the individual variables.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017 and data from the Iowa Department of Education.

Do low response rates in a school reflect a sample biased toward more frequent users of technology? This question is based on the premise that teachers who seldom use technology are less likely to complete a survey about their technology use because they do not perceive the survey as being relevant to their curriculum or instruction. If this were the case, it would suggest the possibility of a biased sample in schools with low response rates. The possibility for bias is further underscored by the fact that the teacher response rate across all schools was 66 percent, with a range of 23 percent to 100 percent. Nine of the 26 schools in the sample had a teacher response rate of less than 60 percent.

One way to test for this source of bias is to observe whether schools with low teacher response rates tend to have higher average scores for variables related to technology use. High nonresponse in such schools would lead to a biased sample of teachers who use technology more frequently. To this end, the study team tested the correlation of the school-level teacher response rate with the four scales related to technology use, the correlation of most relevance to the question of bias involving the frequency of using technology. The school-level teacher response rate was not statistically significantly correlated with any of the four scales related to technology use or perceptions about technology (table A4).

Do response rates differ as a function of subject area taught? Finally, one characteristic that may affect teachers' willingness to respond is the subject that they teach. If teachers of certain subjects are less likely to perceive the importance of educational technology and use it less frequently, they may be less likely to complete the survey. Their nonresponse may thus bias the results. For this reason, the study team examined whether the nonresponse rate differed as a function of subject taught. The study team compared the subjects taught by responders (as indicated by their survey responses) to information on subjects taught by all teachers in each school (publicly available through school websites). Of the 26 schools

Table A4. Correlations, means, and standard deviations between school-level teacher response rate and scales related to technology use

Scale	Correlation	Mean	Standard deviation
Frequency of computer use[a]	.19	1.71	.16
Perceived benefits of educational technology[b]	.08	3.82	.25
Perceived self-efficacy for instructional use of technology[b]	.09	3.75	.20
Perceived self-efficacy for technology use[b]	−.05	1.67	.18

Note: Correlation coefficients were not statistically significant ($p > .05$). The mean school response rate was 66.53, and the standard deviation was 19.94.

a. Analysis was performed on a raw score.

b. Analysis was performed on a summarized scale score.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

from which at least one teacher responded to the survey, 22 schools provided publicly available information about their teachers and the subjects they teach. Subsequent nonresponse analyses were restricted to the 22 schools with publicly accessible data.

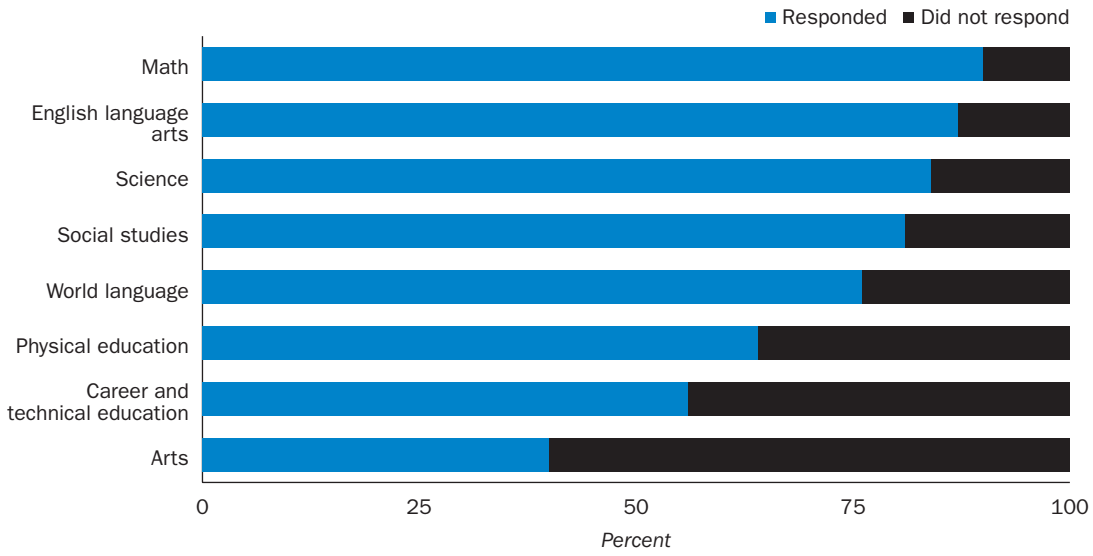
The study team categorized all the subjects into eight groups based on the nature of the subjects: four core subjects (math, English language arts, social studies, and science), career and technical education subjects (including computer programming and vocational technology), arts, physical education, and world languages. In the survey, fewer than one in seven teachers (13.5 percent) selected multiple subjects. Half of those teachers (7 percent) selected one core subject and one or more other subjects and were assigned to groups by the core subject they selected; the other half selected more than one core subject and were excluded from the analysis because it was difficult to assign them to a single group. In addition, one teacher reported more than two noncore subjects, and that record also was excluded from the analysis. One additional teacher's answer did not fall under the eight categories (psychology), so that response was excluded from the analysis as well.

The study team conducted a chi-square test to compare the response rates for these eight subjects. There was a significant association between subject taught and whether a teacher responded to the survey [$\chi^2(7) = 73.16$, $p < .05$; figure A1]. Post hoc tests indicated that teachers in core subjects were more likely to respond to the survey than career and technical education teacher and arts teachers. Arts teachers also were less likely to respond to the survey than physical education teachers. Therefore, the higher nonresponse from these teachers may bias the survey results. For this reason, the study team disaggregated the findings to highlight variations as a function of subject taught.

Data analysis

Because respondents were grouped into different schools, the similarity among members of a school may be larger than the similarity among schools, which is called a clustering effect of schools. In other words, teachers within the same school may be more similar to each other than teachers at different schools are similar to each other. Such a clustering effect, if not properly controlled for (for example, by using hierarchical modeling), may cause biased estimates of the associations among independent and dependent variables and can potentially lead to a Type I error—a false positive conclusion. However, if the

Figure A1. Core subject teachers were more likely to respond to the survey than non–core subject teachers



Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

differencs among schools are no greater than the differences among teachers within the same school, performing hierarchical modeling is unnecessary (Desai, Bryson, & Robinson, 2013).

To determine the magnitude of the clustering effects of schools, the study team estimated intraclass correlation coefficients (ICCs) among independent and dependent variables with school as a clustering factor. As a rule of thumb, an ICC of .06 or below indicates homogeneity among schools. The study team found that ICCs ranged from .007 to .051 among different school and teacher characteristics throughout the outcome variables, indicating that the school-level difference was unlikely to contribute to the teacher-level difference among the outcome variables. Therefore, the subsequent analyses included only teacher-level data that did not account for school-level clustering effects.

A series of between-group response difference tests was performed to answer the research questions in sequence. For the four 21st century skills that did not have reliable Rasch scores, the study team calculated the percentage of teachers from different groups (corresponding to the variables of subject taught, years of teaching experience, school size, and school Title I status) that emphasized each skill. The study team then calculated chi-square values for each of these four variables. A significant chi-square would indicate a significant difference among the groups within a variable regarding the extent to which teachers emphasized a skill. When there was a significant chi-square value for a specific variable, the study team performed post hoc tests to examine the extent to which different groups of teachers differed from each other.[5]

There are different approaches to performing the post hoc tests for nonparametric statistics —for example, the pairwise comparison approach and the partitioning approach (Sharpe, 2015). The pairwise comparison approach separates the groups into several 2 × 2 tables and compares the responses from the entities in pairs. However, because this procedure

introduces multiple contingency tables, it reduced the sample to small subsets, potentially leading to small cell values for some tables. As a rule of thumb, for a cell with a relatively small observed or expected value, pairwise approaches often are not reliable. Therefore, this approach is not recommended for a large number of groups with small expected cell values in the 2 × 2 contingency tables. In addition, the pairwise approach also increases the risk of Type I error (inflated alpha) while making multiple comparisons, which should be controlled for using a Bonferroni adjusted *z* test by dividing the overall significance p value by the number of contingency tables. Because this study involved 524 teachers in eight subjects, the pairwise approach would end up with twenty-eight 2 × 2 contingency tables and some expected cell values smaller than 5. Therefore, this is not an appropriate approach for testing groups of teachers by subject taught. However, teachers' years of teaching experience had only four groups associated with six 2 × 2 contingency tables. Therefore, the study team decided that the pairwise approach with Bonferroni correction was appropriate for testing groups of teachers by their teaching experience.

Another approach that involves dividing large contingency tables into a set of smaller 2 × 2 contingency tables is the partitioning approach, which was deemed appropriate by the study team for testing groups of teachers by subject taught. With this approach, the full chi-square contingency table was partitioned into several 2 × 2 contingency tables corresponding to the degrees of freedom in the full table. Thus, for the chi-square analyses involving subject taught, there were seven contingency tables, constructed by ordering the groups from highest to lowest by percentage of respondents. The first contingency table compared the two highest groups, the second contingency table compared the third highest group to the sum of the two highest groups, the third contingency table compared the fourth highest group to the sum of the three highest groups, and so on. Bonferroni-adjusted *z* tests also were applied to the analysis because of the increased risk of a Type I error.

For the remaining topic areas with reliable sum scores, the study team estimated grouping effects for teachers' subject taught, years of teaching experience, school size, and school Title I status on these topic areas using analysis of variance. If the grouping effect was significant for a specific grouping variable on an outcome scale, Bonferroni post hoc pairwise comparison tests were performed to examine which two groups scored statistically differently on the scale. Detailed results of the mean difference tests and post hoc tests can be found in appendix D.

Appendix B. Descriptive statistics

This appendix summarizes descriptive statistics about the composition of the study's sample.

Table B1. Number of teacher respondents, by teacher and school characteristics

Characteristic	Number	Percent of respondents	Standard error
All teachers	524	100	na
Subject taught			
Arts	23	4.4	0.9
Career and technical education	40	7.6	1.2
English language arts	77	14.7	1.5
Math	69	13.2	1.5
Other[a]	142	27.1	1.9
Physical education	25	4.8	1.0
Science	71	13.5	1.5
Social studies	51	9.7	1.3
World languages	26	5.0	0.9
Years of teaching experience			
3 or fewer	75	14.3	1.5
4–9	97	18.5	1.7
10–19	159	30.3	2.0
20 or more	161	30.7	2.0
Missing	32	6.1	1.0
School size			
Small (300 or fewer students)	214	40.8	2.1
Medium (300–500 students)	94	17.9	1.7
Large (501 or more students)	216	41.2	2.2
School Title I status			
No	363	69.3	2.0
Yes	153	29.2	2.0
Missing	8	1.5	0.5
School locale			
Rural	289	55.2	2.2
Town	180	34.4	2.1
City	47	9.0	1.2
Missing[b]	8	1.5	0.5

na is not applicable.

Note: Percentages may not sum to 100 because of rounding.

a. Includes special education teachers, psychology teachers, teachers with multiple subject areas, and teachers with no response, which were not included in the subsequent analysis.

b. School locale information was not present in the Common Core of Data 2015–16 dataset because schools were not in operation at the time of data collection.

Source: Survey data collected by the Central Rivers Area Education Agency in 2017 (teacher characteristics); U.S. Department of Education, National Center for Education Statistics, 2016 (school characteristics).

Table B2. Number of participating schools, by size, Title I status, and locale

Characteristic	Number	Percent of participating schools	Standard error
All schools	26	100	na
School size			
Small (300 or fewer students)	16	61.5	9.7
Medium (300–500 students)	4	15.4	7.2
Large (501 or more students)	6	23.1	8.4
School Title I status			
No	19	73.1	8.9
Yes	6	23.1	8.4
Missing[a]	1	3.9	3.8
School locale			
Rural	19	73.1	8.8
Town	5	19.2	7.9
City	1	3.9	3.8
Missing[a]	1	3.9	3.8

na is not applicable.

Note: Percentages may not sum to 100 because of rounding.

a. School locale information was not present in the Common Core of Data 2015–16 dataset because schools were not in operation at the time of data collection.

Source: U.S. Department of Education, National Center for Education Statistics, 2016.

Appendix C. Survey response frequencies

This appendix summarizes response frequencies for individual survey items and for groups of items reported together.

Table C1. Percentage of teachers reporting frequency of student use of classroom technology, by teacher and school characteristics

Characteristic	*N*	Never	Every few months	Monthly	Weekly	Almost daily
All teachers	507	2.8	3.0	4.9	20.9	68.4
Subject taught						
Arts	23	30.4	13.0	26.1	13.0	17.4
Career and technical education	40	0.0	0.0	0.0	15.5	84.5
English language arts	77	1.3	0.0	1.3	22.1	75.3
Math	69	1.5	8.7	15.9	24.6	49.3
Physical education	25	16.0	16.0	8.0	32.0	28.0
Science	71	0.0	0.0	0.0	15.5	84.5
Social studies	51	0.0	0.0	2.0	15.7	82.4
World languages	26	0.0	0.0	0.0	34.6	65.4
Years of teaching experience						
3 or fewer	75	4.0	1.3	9.3	22.7	62.7
4–9	97	2.1	2.1	3.1	22.7	70.1
10–19	159	2.5	4.4	1.9	20.8	70.4
20 or more	161	3.1	3.1	6.8	18.6	68.3
School size						
Small (300 or fewer students)	198	3.0	3.0	4.6	14.1	75.3
Medium (301–500 students)	94	1.1	2.1	6.4	21.3	69.2
Large (501 or more students)	215	3.3	3.3	4.7	27.0	61.9
School Title I status						
No	347	3.2	3.8	4.0	20.8	68.3
Yes	153	2.0	1.3	7.2	21.6	68.0

Note: Results are based on a single item asking "How often do your students use computer devices (desktops, laptops, tablets) in class?" Percentages may not sum to 100 because of rounding.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Table C2. Percentage of teachers asking students at least monthly to engage in technology use for collaboration, by number of technology uses and teacher and school characteristics

Characteristic	*N*	Number of different technology uses for collaboration				
		0	1	2	3	4
All teachers	524	30.3	19.1	22.7	24.6	3.2
Subject taught						
Arts[a]	23	43.5	39.1	17.4	0.0	0.0
Career and technical education[b]	40	30.0	15.0	17.5	35.0	2.5
English language arts[b]	77	15.6	16.9	24.7	41.6	1.3
Math[a]	69	63.8	20.3	11.6	4.4	0.0
Physical education[a]	25	44.0	24.0	16.0	8.0	8.0
Science[b]	71	19.7	23.9	28.2	21.1	7.0
Social studies[b]	51	11.8	13.7	35.3	37.3	2.0
World languages[b]	26	26.9	11.5	34.6	19.2	7.7
Years of teaching experience						
3 or fewer[c, d]	75	25.3	17.3	24.0	28.0	5.3
4–9[d]	97	22.7	15.5	32.0	25.8	4.1
10–19[c, d]	159	25.8	20.8	23.9	25.8	3.8
20 or more[c]	161	37.9	21.7	17.4	22.4	0.6
School size						
Small (300 or fewer students)	214	34.6	17.3	19.6	24.8	3.7
Medium (300–500 students)	94	21.3	20.2	24.5	31.9	2.1
Large (501 or more students)	216	30.1	20.4	25.0	21.3	3.2
School Title I status						
No	363	31.1	19.6	21.2	25.1	3.0
Yes	153	30.1	17.7	24.8	24.8	2.6

Note: Categories refer to the number of technology uses for collaboration, out of four, that teachers asked students weekly or monthly to use. Data are raw survey results. Percentages may not sum to 100 because of rounding.

a. Group means with footnote a are not statistically different from each other.

b. Group means with footnote b are not statistically different from each other.

c. Group means with footnote c are not statistically different from each other.

d. Group means with footnote d are not statistically different from each other.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Table C3. Percentage of teachers asking students at least monthly to engage in technology use for communication, by number of technology uses and teacher and school characteristics

Characteristic	*N*	Number of different technology uses for communication						
		0	1	2	3	4	5	6
All teachers	524	47.5	26.0	16.8	5.2	1.7	1.3	1.5
Subject taught								
Arts[a]	23	60.9	17.4	17.4	4.4	0.0	0.0	0.0
Career and technical education[a, b]	40	42.5	32.5	17.5	2.5	2.5	2.5	0.0
English language arts[b]	77	32.5	22.1	23.4	14.3	6.5	0.0	1.3
Math[c]	69	75.4	21.7	2.9	0.0	0.0	0.0	0.0
Physical education[a, b, c]	25	68.0	16.0	4.0	8.0	0.0	0.0	4.0
Science[a, b]	71	32.4	38.0	19.7	5.6	0.0	1.4	2.8
Social studies[a, b]	51	37.3	31.4	23.5	3.9	2.0	2.0	0.0
World languages[a, b]	26	34.6	38.5	11.5	7.7	0.0	3.9	3.9
Years of teaching experience								
3 or fewer	75	42.7	24.0	24.0	4.0	2.7	1.3	1.3
4–9	97	41.2	28.9	15.5	9.3	3.1	0.0	2.1
10–19	159	50.9	25.2	13.8	5.0	1.3	2.5	1.3
20 or more	161	48.5	29.2	15.5	3.7	1.2	0.6	1.2
School size								
Small (300 or fewer students)	214	50.5	22.4	16.8	5.6	1.4	2.3	0.9
Medium (300–500 students)	94	40.4	31.9	19.2	5.3	1.1	2.1	0.0
Large (501 or more students)	216	47.7	26.9	15.7	4.6	2.3	0.0	2.8
School Title I status								
No	363	49.9	25.6	15.7	4.1	1.9	1.1	1.7
Yes	153	43.1	26.8	19.0	7.2	1.3	2.0	0.7

Note: Categories refer to the number of technology uses for communication, out of six, that teachers asked students weekly or monthly to use. Data are raw survey results. Percentages may not sum to 100 because of rounding.

a. Group means with footnote a are not statistically different from each other.

b. Group means with footnote b are not statistically different from each other.

c. Group means with footnote c are not statistically different from each other.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Table C4. Percentage of teachers asking students at least monthly to engage in technology use for creativity, by number of technology uses and teacher and school characteristics

Characteristic	*N*	Number of different technology uses for creativity				
		0	1	2	3	4
All teachers	524	53.8	23.9	11.3	8.0	3.1
Subject taught						
Arts[a]	23	52.2	26.1	17.4	4.4	0.0
Career and technical education[a]	40	35.0	27.5	20.0	10.0	7.5
English language arts[b]	77	42.9	45.5	7.8	1.1	2.6
Math[b]	69	85.5	11.6	1.5	0.0	1.5
Physical education[a]	25	68.0	20.0	0.0	4.0	8.0
Science[a]	71	32.4	25.4	15.5	22.5	4.2
Social studies[a]	51	43.1	29.4	21.6	3.9	2.0
World languages[a]	26	53.9	23.1	11.5	11.5	0.0
Years of teaching experience						
3 or fewer[c, d]	75	46.7	28.0	16.0	8.0	1.3
4–9[c]	97	46.4	18.6	15.5	12.4	7.2
10–19[c, d]	159	52.2	25.8	12.0	7.6	2.5
20 or more[d]	161	60.3	26.1	6.2	5.6	1.9
School size						
Small (300 or fewer students)	214	51.9	22.4	14.0	8.9	2.8
Medium (300–500 students)	94	45.7	27.7	11.7	13.8	1.1
Large (501 or more students)	216	59.3	23.6	8.3	4.6	4.2
School Title I status						
No	363	54.0	25.1	11.0	6.9	3.0
Yes	153	54.9	21.6	10.5	11.1	2.0

Note: Categories refer to the number of technology uses for creativity, out of four, that teachers asked students to use. Data are raw survey results. Percentages may not sum to 100 because of rounding.

a. Group means with footnote a are not statistically different from each other.

b. Group means with footnote b are not statistically different from each other.

c. Group means with footnote c are not statistically different from each other.

d. Group means with footnote d are not statistically different from each other.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Table C5. Percentage of teachers asking students at least monthly to engage in technology use for critical thinking, by number of technology uses and teacher and school characteristics

Characteristic	*N*	Number of different technology uses for critical thinking				
		0	1	2	3	4
All teachers	524	30.2	26.2	15.5	13.0	15.3
Subject taught						
Arts[a]	23	69.6	13.0	8.7	8.7	0.0
Career and technical education[b]	40	25.0	17.5	12.5	22.5	22.5
English language arts[a]	77	19.5	40.3	23.4	15.6	1.3
Math[a]	69	59.4	13.0	14.5	7.3	5.8
Physical education[a]	25	60.0	24.0	4.0	4.0	8.0
Science[b]	71	8.5	19.7	18.3	12.7	40.9
Social studies[b]	51	15.7	37.3	13.7	23.5	9.8
World languages[a]	26	42.3	38.5	11.5	3.9	3.9
Years of teaching experience						
3 or fewer	75	28.0	29.3	16.0	14.7	12.0
4–9	97	17.5	33.0	14.4	11.3	23.7
10–19	159	28.9	22.6	13.8	15.7	18.9
20 or more	161	37.3	25.5	18.0	11.8	7.5
School size						
Small (300 or fewer students)	214	29.0	24.3	15.9	13.6	17.3
Medium (300–500 students)	94	28.7	24.5	12.8	16.0	18.1
Large (501 or more students)	216	31.9	28.7	16.2	11.1	12.0
School Title I status						
No	363	27.6	29.5	15.4	13.8	13.8
Yes	153	37.9	19.0	15.7	11.1	16.3

Note: Categories refer to the number of technology uses related to critical thinking, out of four, that teachers asked students weekly or monthly to use. Data are raw survey results. Percentages may not sum to 100 because of rounding.

a. Group means with footnote a are not statistically different from each other.

b. Group means with footnote b are not statistically different from each other.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Table C6. Percentage of teachers reporting agreement or disagreement that technology enhances student learning, by teacher and school characteristics

Characteristic	*N*	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
All teachers	524	0.4	1.0	21.2	51.0	26.5
Subject taught						
Arts[a,b]	23	0.0	4.4	39.1	39.1	17.4
Career and technical education[a,b]	40	0.0	0.0	15.0	57.5	27.5
English language arts[a,b]	77	1.3	0.0	23.4	50.7	24.7
Math[a]	69	1.5	4.4	27.5	46.4	20.3
Physical education[a,b]	25	0.0	0.0	24.0	60.0	16.0
Science[b]	71	0.0	0.0	14.1	53.5	32.4
Social studies[a,b]	51	0.0	2.0	19.6	47.1	31.4
World languages[a,b]	26	0.0	0.0	15.4	53.9	30.8
Years of teaching experience						
3 or fewer	75	0.0	1.3	20.0	52.0	26.7
4–9	97	0.0	2.1	13.4	57.7	26.8
10–19	159	0.0	0.0	22.6	49.1	28.3
20 or more	161	1.2	1.2	23.0	50.9	23.6
School size						
Small (300 or fewer students)[c]	214	0.5	0.5	16.4	51.4	31.3
Medium (301–500 students)[c, d]	94	1.1	1.1	16.0	57.5	24.5
Large (501 or more students)[d]	216	0.0	1.4	28.2	47.7	22.7
School Title I status						
No	363	0.3	1.1	22.0	48.8	27.8
Yes	153	0.7	0.7	19.0	56.9	22.9

Note: Data are scale score summaries derived from responses to three survey items. The study team performed post hoc tests on subgroup average scores to examine whether reported perceived benefits differed by subject taught, years of teaching experience, school size, or school Title I status. Percentages may not sum to 100 because of rounding.

a. Group means with footnote a are not statistically different from each other.

b. Group means with footnote b are not statistically different from each other.

c. Group means with footnote c are not statistically different from each other.

d. Group means with footnote d are not statistically different from each other.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Table C7. Percentage of teachers reporting agreement or disagreement that they are able to integrate technology with instruction, by teacher and school characteristics

Characteristic	*N*	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
All teachers	524	0.6	6.3	15.3	48.1	29.8
Subject taught[a]						
Arts	23	0.0	8.7	17.4	60.9	13.0
Career and technical education	40	0.0	7.5	20.0	42.5	30.0
English language arts	77	1.3	5.2	18.2	49.4	26.0
Math	69	1.5	5.8	24.6	39.1	29.0
Physical education	25	0.0	8.0	4.0	68.0	20.0
Science	71	0.0	5.6	5.6	40.9	47.9
Social studies	51	0.0	5.9	7.8	51.0	35.3
World languages	26	0.0	7.7	11.5	53.9	26.9
Years of teaching experience						
3 or fewer	75	1.3	1.3	13.3	53.3	30.7
4–9	97	0.0	1.0	12.4	43.3	43.3
10–19	159	0.0	3.8	14.5	50.9	30.8
20 or more[b]	161	1.2	13.7	17.4	46.0	21.7
School size						
Small (300 or fewer students)	214	0.9	6.1	13.1	49.1	30.8
Medium (300–500 students)	94	0.0	6.4	13.8	48.9	30.9
Large (501 or more students)	216	0.5	6.5	18.1	46.8	28.2
School Title I status						
No	363	0.6	7.7	15.7	46.0	30.0
Yes	153	0.7	3.3	14.4	53.6	28.1

Note: Data are scale score summaries derived from responses to four survey items. The study team performed post hoc tests on subgroup average scores to examine whether reported perceived self-efficacy for instructional use of technology differed by subject taught, years of teaching experience, school size, or school Title I status. Percentages may not sum to 100 because of rounding.

a. The means among the groups differed significantly with no statistically significant pairwise difference in groups.

b. The scale score is statistically different from that of groups that do not include footnote b.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Table C8. Percentage of teachers reporting access to computers, by frequency of access and teacher and school characteristics

Characteristic	*N*	Never	Rarely	Less than half of the time	More than half of the time	Always
All teachers	519	0.4	1.2	1.2	4.1	93.3
Subject taught						
Arts	23	4.4	13.0	0.0	4.4	78.3
Career and technical education	39	0.0	0.0	2.5	0.0	97.5
English language arts	73	0.0	1.3	0.0	2.6	96.1
Math	64	0.0	0.0	2.9	4.4	92.8
Physical education	25	4.4	4.4	8.7	8.7	73.9
Science	69	0.0	0.0	0.0	1.4	98.6
Social studies	51	0.0	0.0	0.0	0.0	100.0
World languages	23	0.0	0.0	0.0	11.5	88.5
Years of teaching experience						
3 or fewer	70	0.0	1.3	0.0	5.3	93.3
4–9	90	1.0	1.0	0.0	5.2	92.8
10–19	151	0.0	0.0	1.9	2.5	95.6
20 or more	141	0.6	2.6	1.9	5.1	89.8
School size						
Small (300 or fewer students)	200	0.5	0.5	0.5	4.7	93.9
Medium (300–500 students)	90	1.1	0.0	2.1	1.1	95.7
Large (501 or more students)	194	0.0	2.4	1.4	4.7	91.5
School Title I status						
No	335	0.3	1.4	1.7	3.9	92.8
Yes	142	0.7	0.7	0.0	4.0	94.7

Note: Results are based on a single item asking "How frequently can you access computer devices (desktop, laptop, tablet) for your students' use?" Percentages may not sum to 100 because of rounding.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Table C9. Percentage of teachers reporting that school Internet filters prevent access to needed websites, by frequency of blocking and teacher and school characteristics

Characteristic	*N*	Never	Rarely	Less than half of the time	More than half of the time	Always
All teachers	507	13.8	49.3	27.4	6.7	2.8
Subject taught						
Arts	23	13.0	30.4	43.5	8.7	4.4
Career and technical education	40	7.7	65.4	19.2	3.9	3.9
English language arts	77	13.7	56.9	21.6	5.9	2.0
Math	69	10.4	49.4	32.5	5.2	2.6
Physical education	25	24.0	44.0	24.0	4.0	4.0
Science	71	18.8	37.5	33.3	6.3	4.2
Social studies	51	11.3	50.7	26.8	7.0	4.2
World languages	26	10.4	49.4	32.5	5.2	2.6
Years of teaching experience						
3 or fewer	75	25.3	41.3	26.7	5.3	1.3
4–9	97	12.4	54.6	24.7	5.2	3.1
10–19	159	10.1	52.8	27.0	6.9	3.1
20 or more	161	12.4	45.3	31.1	8.1	3.1
School size						
Small (300 or fewer students)	198	9.1	53.5	24.8	7.1	5.6
Medium (300–500 students)	94	18.1	41.5	28.7	10.6	1.1
Large (501 or more students)	215	16.3	48.8	29.3	4.7	0.9
School Title I status						
No	347	13.0	52.5	24.2	6.6	3.8
Yes	153	16.3	42.5	33.3	7.2	0.7

Note: Results are based on a single item asking "When using the school's Internet, how often do school filters prevent you from accessing websites you need for classes?" Percentages may not sum to 100 because of rounding.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Table C10. Percentage of teachers reporting on perceived technical support quality, by perceived quality of support and teacher and school characteristics

Characteristic	*N*	Poor	Below average	Average	Above average	Excellent
All teachers	524	0.6	0.6	34.9	47.3	16.6
Subject taught						
Arts	23	0.0	0.0	47.8	39.1	13.0
Career and technical education	40	0.0	0.0	25.0	52.5	22.5
English language arts	77	0.0	0.0	33.8	45.5	20.8
Math	69	0.0	0.0	39.1	55.1	5.8
Physical education	25	0.0	4.0	16.0	52.0	20.0
Science	71	2.8	0.0	33.8	46.5	16.9
Social studies	51	0.0	0.0	35.3	47.1	17.7
World languages	26	0.0	0.0	50.0	34.6	15.4
Years of teaching experience						
3 or fewer	75	0.0	0.0	46.7	46.7	6.7
4–9	97	0.0	1.0	40.2	40.2	18.6
10–19	159	0.0	1.3	31.5	48.4	18.9
20 or more	161	1.9	0.0	30.4	48.5	19.3
School size						
Small (300 or fewer students)[a]	214	0.0	0.0	29.0	51.9	19.2
Medium (301–500 students)[a,b]	94	1.1	1.1	35.1	43.6	19.2
Large (501 or more students)[b]	216	0.9	0.9	40.7	44.4	13.0
School Title I status						
No	363	0.3	0.0	33.3	49.9	16.5
Yes	153	1.3	1.3	37.3	43.1	17.0

Note: Data are scale score summaries derived from responses to seven survey items. The study team performed post hoc tests on subgroup average scores to examine whether reported perceived technical support quality differed by subject taught, years of teaching experience, school size, or school Title I status. Percentages may not sum to 100 because of rounding.

a. Group means with footnote a are not statistically different from each other.

b. Group means with footnote b are not statistically different from each other.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Table C11. Percentage of teachers reporting on perceived quality of technology-focused professional development, by perceived quality and teacher and school characteristics

Characteristic	*N*	Poor	Below average	Average	Above average	Excellent
All teachers	524	2.5	5.9	55.3	28.6	7.6
Subject taught						
Arts	23	4.4	13.0	39.1	30.4	13.0
Career and technical education	40	7.5	5.0	52.5	30.0	5.0
English language arts	77	1.3	5.2	55.8	29.9	7.8
Math	69	1.5	11.6	46.4	37.7	2.9
Physical education	25	4.0	4.0	48.0	24.0	20.0
Science	71	1.4	4.2	59.2	28.2	7.0
Social studies	51	0.0	0.0	60.8	31.4	7.8
World languages	26	7.7	7.7	46.2	34.6	3.9
Years of teaching experience						
3 or fewer[a]	75	0.0	1.3	54.7	30.7	13.3
4–9[b]	97	2.1	5.2	65.0	21.7	6.2
10–19[a,b]	159	3.1	3.8	54.1	30.2	8.8
20 or more[b]	161	2.5	9.9	51.6	31.7	4.4
School size						
Small (300 or fewer students)	214	2.8	3.3	56.1	29.4	8.4
Medium (300–500 students)	94	2.1	10.6	53.2	30.9	3.2
Large (501 or more students)	216	2.3	6.5	55.6	26.9	8.8
School Title I status						
No	363	2.5	5.8	55.4	29.2	7.2
Yes	153	2.6	6.5	55.6	26.8	8.5

Note: Data are scale score summaries derived from responses to three survey items. The study team performed post hoc tests on subgroup average scores to examine whether the reported perceived quality of professional development differed by subject taught, years of teaching experience, school size, or school Title I status. Percentages may not sum to 100 because of rounding.

a. Group means with footnote a are not statistically different from each other.

b. Group means with footnote b are not statistically different from each other.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Table C12. Percentage of teachers reporting technology-focused professional development time, by hours spent and teacher and school characteristics

Characteristic	*N*	None	1–8 hours	9–16 hours	17–32 hours	33 or more hours
All teachers	524	10.1	55.2	10.9	17.9	5.9
Subject taught						
Arts	23	4.4	60.9	13.0	21.7	0.0
Career and technical education	40	17.5	42.5	15.0	15.0	10.0
English language arts	77	9.1	50.7	18.2	18.2	3.9
Math	69	13.0	56.5	10.1	14.5	5.8
Physical education	25	4.0	44.0	20.0	20.0	12.0
Science	71	7.0	59.2	7.0	23.9	2.8
Social studies	51	7.8	66.7	3.9	15.7	5.9
World languages	26	11.5	57.7	11.5	11.5	7.7
Years of teaching experience						
3 or fewer	75	9.3	50.7	10.7	25.3	4.0
4–9	97	12.4	56.7	13.4	14.4	3.1
10–19	159	8.8	56.6	8.8	17.6	8.2
20 or more	161	9.3	57.8	10.6	14.9	7.5
School size						
Small (300 or fewer students)	214	15.4	50.5	10.3	19.2	4.7
Medium (300–500 students)	94	5.3	52.1	16.0	20.2	6.4
Large (501 or more students)	216	6.9	61.1	9.3	15.7	6.9
School Title I status						
No	363	9.9	57.0	10.2	17.4	5.5
Yes	153	11.1	51.6	13.1	18.3	5.9

Note: Data are scale score summaries derived from responses to three survey items. The study team did not perform post hoc tests on subgroup average scores because the main effects of between-group difference tests were not significant across teacher and school characteristics. Percentages may not sum to 100 because of rounding.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Table C13. Percentage of teachers reporting on frequency of technology discussions, by frequency of discussion and teacher and school characteristics

Characteristic	*N*	Never	Rarely	Less than half of the time	More than half of the time	Always
All teachers	524	2.7	16.0	31.9	35.9	13.6
Subject taught						
Arts[a]	23	8.7	34.8	30.4	26.1	0.0
Career and technical education[b]	40	2.5	10.0	27.5	45.0	15.0
English language arts[b]	77	1.3	15.6	33.8	33.8	15.6
Math[a,b]	69	1.5	23.2	31.9	30.4	13.0
Physical education[a,b]	25	4.0	16.0	40.0	32.0	8.0
Science[b]	71	0.0	12.7	25.4	45.1	16.9
Social studies[b]	51	2.0	7.8	31.4	37.3	21.6
World languages[a,b]	26	3.9	15.4	38.5	30.8	11.5
Years of teaching experience						
3 or fewer	75	2.7	12.0	30.7	44.0	10.7
4–9	97	1.0	14.4	32.0	35.1	17.5
10–19	159	3.1	12.0	32.1	34.0	18.9
20 or more	161	3.7	20.5	31.1	35.4	9.3
School size						
Small (300 or fewer students)	214	2.3	15.4	29.4	38.3	14.5
Medium (300–500 students)	94	2.1	18.1	28.7	38.3	12.8
Large (501 or more students)	216	3.2	15.7	35.7	32.4	13.0
School Title I status						
No	363	1.9	15.7	33.6	36.4	12.4
Yes	153	4.6	17.7	27.5	34.6	15.7

Note: Data are scale score summaries derived from responses to three survey items. The study team performed post hoc tests on subgroup average scores to examine whether the reported prevalence of technology discussions differed by subject taught, years of teaching experience, school size, or school Title I status. Percentages may not sum to 100 because of rounding.

a. Group means with footnote a are not statistically different from each other.

b. Group means with footnote b are not statistically different from each other.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Appendix D. Summary of tests for mean differences

This appendix summarizes results of analyses testing differences across groups of teachers by subject taught, years of teaching experience, school size, and school Title I status.

Table D1. Chi-square tests of goodness of fit for proportions of teachers using technology to support 21st century skills, by skill and teacher and school characteristic

Skill and characteristic	Degrees of freedom		Chi square	*p* value
	Between groups	Within groups		
Collaboration				
Subject taught	7	374	36.9	<.001
Years of teaching experience	3	488	4.3	ns
School size	2	521	0.2	ns
School Title I status	1	514	1.7	ns
Communication				
Subject taught	7	374	69.7	<.001
Years of teaching experience	3	488	13.4	<.005
School size	2	521	3.0	ns
School Title I status	1	514	0.4	ns
Creativity				
Subject taught	7	374	44.4	<.001
Years of teaching experience	3	488	16.4	<.001
School size	2	521	5.8	ns
School Title I status	1	514	0.4	ns
Critical thinking				
Subject taught	7	374	54.6	<.001
Years of teaching experience	3	488	5.5	ns
School size	2	521	2.8	ns
School Title I status	1	514	0.0	ns

ns is not significant.

Note: Chi-square goodness of fit tests examine the proportion of teachers within different categories who ask students to engage in two or more technology practices at least monthly for each 21st century skill, compared with the overall proportion. *p* values less than .05 indicate statistically significant between-group differences.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Table D2. Mean difference tests, by survey topic and teacher and school characteristic

Topic and characteristic	Degrees of freedom		*F* value	*p* value
	Between groups	Within groups		
Perceived benefits of educational technology				
Subject taught	7	374	2.4	<.05
Years of teaching experience	3	488	1.2	ns
School size	2	521	6.0	<.01
School Title I status	1	514	0.2	ns
Perceived self-efficacy for instructional use of technology				
Subject taught	7	374	2.2	<.05
Years of teaching experience	3	488	10.3	<.001
School size	2	521	1.0	ns
School Title I status	1	514	0.5	ns
Professional development time				
Subject taught	7	374	0.5	ns
Years of teaching experience	3	488	0.8	ns
School size	2	521	1.4	ns
School Title I status	1	514	0.2	ns
Professional development quality				
Subject taught	7	358	0.8	ns
Years of teaching experience	3	468	4.3	<.01
School size	2	500	1.3	ns
School Title I status	1	493	0.03	ns
Prevalence of technology discussions				
Subject taught	7	374	3.9	<.001
Years of teaching experience	3	488	2.6	ns
School size	2	521	0.5	ns
School Title I status	1	514	0.3	ns
Technical support quality				
Subject taught	7	373	1.8	ns
Years of teaching experience	3	487	2.0	ns
School size	2	520	5.0	<.01
School Title I status	1	513	1.9	ns

ns is not significant.

Note: The *F* statistic is based on Fisher's test of between-group difference. Pairwise deletion was applied to missing data. *p* values less than .05 indicate statistically significant between-group differences.

Source: Authors' analysis of survey data collected by the Central Rivers Area Education Agency in 2017.

Appendix E. Survey items analyzed in the study

This section presents the items in the survey that were included in the analysis for this study.

1. How often do your students use computer devices (desktops, laptops, tablets) in class? (Response options: almost daily, weekly, monthly, every few months, and never)

2. How frequently do you ask a majority of your students to do the following? (Response options: weekly, monthly, every few months, and never).
   - Collaborate using online documents (for example, Dropbox, Google Docs).
   - Collaborate online with classmates.
   - Collaborate online with students at other schools.
   - Collaborate online with you.
   - Post schoolwork online (for example, use ePortfolios).
   - Use web tools to receive online information (for example, Twitter, news feeds).
   - Write for an online audience (for example, reviews, blog posts, comments).
   - Receive feedback digitally from classmates.
   - Receive feedback digitally from someone other than you (for example, an outside. expert, a student in another class or school).
   - Chat online (for example, Skype, Google Hangout, FaceTime).
   - Use a digital camera (photo or video).
   - Develop multimedia presentations using technology.
   - Create art, music, movies, or webcasts using technology.
   - Create online models, simulations, or animations.
   - Conduct research online.
   - Take measurements or do experiments using technology.
   - Identify and solve authentic problems using technology.
   - Collect and analyze data using technology.

3. Indicate how strongly you agree or disagree with the following statements. (Response options: strongly agree, agree, are neutral, disagree, and strongly disagree)
   - Technology use in the classroom enhances student learning.
   - I think that learning is more engaging when using technology.
   - My school encourages technology use for teaching and learning.
   - I want to learn more about effective technology use for teaching and learning.

4. Indicate how strongly you agree or disagree with the following statements. (Response options: strongly agree, agree, are neutral, disagree, and strongly disagree)
   - I learn technology easily.
   - When I am confronted with a technology-related problem, I usually find good solutions.
   - I easily find new technologies to meet my teaching goals.
   - I feel confident managing a classroom where students are using technology.

5. How many hours have you spent in the past 12 months participating in the following types of educational technology professional development? (Response options: 33 or more hours, 17 to 32 hours, 9 to 16 hours, 1 to 8 hours, none)
   - Formal PD sponsored by the school or district (for example, in-service days, mentoring).
   - Formal PD organized by someone other than the school or district (for example, degree programs, conferences).
   - Informal PD organized by someone other than the school or district (for example, blogs, social media).

6. What was the quality of the following types of educational technology professional development you've completed in the past 12 months? (Response options: excellent, above average, average, below average, poor, I didn't do this)
   - Formal PD sponsored by the school or district (for example, in-service days, mentoring).
   - Formal PD organized by someone other than the school or district (for example, degree programs, conferences).
   - Informal PD organized by someone other than the school or district (for example, blogs, social media).

7. How often are the following statements true for you? (Response options: all of the time, more than half of the time, less than half of the time, rarely, never)
   - My department or grade-level team discusses technology use at meetings.
   - I discuss technology use during my evaluations.
   - I discuss technology use during class observations or visits.

8. Rate the quality of support for the following. (Response options: excellent, above average, average, below average, poor, not applicable)
   - Internet speed.
   - Computer devices (desktops, laptops, or tablets).
   - Interactive whiteboards or display devices (for example, LCD projectors, large monitors).
   - Support for problems disrupting instruction.
   - Answers to routine questions.
   - Instructional technology planning.
   - Hardware repair.

9. When using the school's Internet, how often do school filters prevent you from accessing websites you need for classes? (Response options: never, rarely, less than half of the time, more than half of the time, all of the time)

10. How frequently can you access computer devices (desktop, laptop, tablet) for your students' use? (Response options: all of the time, more than half of the time, less than half of the time, rarely, never)

11. What subject(s) do you teach? Check all that apply.
    - Computer science, programming, or technology.
    - Language arts or English.
    - Math.
    - Physical education.
    - Performing arts (dance, music, theater, …).
    - Psychology.
    - Science.
    - Social studies or history.
    - World languages.
    - Visual arts.
    - Vocational technology.

12. How long have you been teaching?
    - 3 or fewer years.
    - 4 to 9 years.
    - 10 to 19 years.
    - 20 or more years.

Notes

The study team gratefully acknowledges the input from members of a stakeholder advisory group: Michelle Cowell (from the Central Rivers Area Education Agency, Iowa) and Chad Kliefoth and Janice Mertes (both from the Wisconsin Department of Public Instruction).

1. The Central Rivers AEA is one of nine Iowa area education agencies that provide consulting, leadership, professional development, and resource-sharing services to public and nonpublic districts in Iowa. Central Rivers AEA serves 53 public districts in 18 mostly rural counties in central and northeast central Iowa.
2. The Central Rivers AEA, previously known as AEA 267, is one of nine Iowa area education agencies that provide professional development, leadership, consulting, and resource-sharing services to public and nonpublic districts in Iowa. Central Rivers AEA serves 53 public districts in 18 mostly rural counties in central and northeast central Iowa. These 53 districts account for 14.4 percent of districts in the state. Of the 57 high schools in those districts, 40 are in rural locales, accounting for 6 percent of rural high schools in the state.
3. Schools receiving Title I funds either as a schoolwide program or as a targeted assistance program were compared with schools not receiving any Title I funds. Title I provides financial assistance through state educational agencies to local educational agencies and public schools with high numbers or percentages of students from low-income households to help ensure that all students meet challenging state academic content and student academic achievement standards.
4. These frequencies are based on scale scores and represent each respondent's most likely response across all three items about time spent in professional development (see box 2).
5. A chi-square test was not necessary for Title I status because there were only two groups in this variable.

References

Anderson, R. E., & Dexter, S. (2005). School technology leadership: An empirical investigation of prevalence and effect. *Educational Administration Quarterly, 41*(1), 49–82. https://eric.ed.gov/?q= EJ739206

Anderson, S. E., Groulx, J. G., & Maninger, R. M. (2011). Relationships among preservice teachers' technology-related abilities, beliefs, and intentions to use technology in their future classrooms. *Journal of Educational Computing Research, 45*(3), 321–338. https://eric.ed.gov/?id=EJ954953

Argueta, R., Huff, D. J., Tingen, J., & Corn, J. O. (2011). *Laptop initiatives: Summary of research across seven states*. Raleigh, NC: North Carolina State University, Friday Institute for Educational Innovation. Retrieved December 20, 2018, from https://www.fi.ncsu.edu/wp-content/uploads/2013/05/laptop-initiatives-summary-of-research-across-seven-states.pdf.

Center for Promise. (2013). *Wired to learn: K–12 students in the digital classroom* (White paper). Washington, DC: Author. Retrieved December 20, 2018, from http://www.americaspromise.org/sites/default/files/Wired%20to%20Learn%20K-12%20Students%20in%20the%20Digital%20Classroom.pdf.

Center for Public Education (2013). *Teaching the teachers: Effective professional development in an era of high stakes accountability*. Alexandria, VA: Author. Retrieved December 10, 2018, from http://www.centerforpubliceducation.org/system/files/Professional%20Development.pdf.

Chai, C. S., Koh, J. H. L., & Tsai, C.-C. (2010). Facilitating preservice teachers' development of technological, pedagogical, and content knowledge (TPACK). *Educational Technology & Society*, *13*(4), 63–73. https://eric.ed.gov/?id=EJ909933

Croft, A., Coggshall, J. G., Dolan, M., & Powers, E. (with Killion, J.). (April, 2010). *Job-embedded professional development: What it is, who is responsible, and how to get it done well* (Issue Brief). Washington, DC: National Comprehensive Center for Teaching Quality. https://eric.ed.gov/?id=ED520830

Darling-Hammond, L., & Rothman, R. (2015). *Teaching in the flat world: Learning from high-performing systems*. New York, NY: Teachers College Press.

Davies, R. S., & West, R. E. (2014). Technology integration in schools. In J. M. Spector, M. D. Merrill, J. Elen, & M. J. Bishop (Eds.), *Handbook of research on educational communications and technology* (pp. 841–853). New York, NY: Springer.

Desai, M., Bryson, S. W., & Robinson, T. (2013). On the use of robust estimators for standard errors in the presence of clustering when clustering membership is misspecified. *Contemporary Clinical Trials, 34*(2), 248–256.

Duran, M., Brunvand, S., Ellsworth, J., & Şendağ, S. (2012). Impact of research-based professional development: Investigation of inservice teacher learning and practice in wiki integration. *Journal of Research on Technology in Education, 44*(4), 313–334.

Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education, 59*(2), 423–435. https://eric.ed.gov/?q= EJ966988

Garet, M. S., Heppen, J., Walters, K., Smith, T., & Yang, R. (2016). *Does content-focused teacher professional development work? Findings from three Institute of Education Sciences studies* (NCEE Evaluation Brief 2017–4010). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance.

Handal, B., Campbell, C., Cavanagh, M., Petocz, P., & Kelly, N. (2013). Technological pedagogical content knowledge of secondary mathematics teachers. *Contemporary Issues in Technology and Teacher Education, 13*(1), 22–40. https://eric.ed.gov/?id=EJ1007045

Howard, S. K., Chan, A., Mozejko, A., & Caputi, P. (2015). Technology practices: Confirmatory factor analysis and exploration of teachers' technology integration in subject areas. *Computers & Education, 90*(1), 24–35.

Hsu, Y. S., Wu, H. K., & Hwang, F. K. (2007). Factors influencing junior high school teachers' computer-based instructional practices regarding their instructional evolution stages. *Educational Technology & Society, 10*(4), 118–130. https://eric.ed.gov/?q=EJ814897

Hur, J. W., Shannon, D., & Wolf, S. (2016). An investigation of relationships between internal and external factors affecting technology integration in classrooms. *Journal of Digital Learning in Teacher Education, 33*(3), 105–114. https://eric.ed.gov/?q=EJ1102191

Inan, F. A., & Lowther, D. L. (2010). Factors affecting technology integration in K–12 classrooms: A path model. *Educational Technology Research and Development, 58*(2), 137–154. https://eric.ed.gov/?q=EJ877921

Inan, F. A., Lowther, D. L., Ross, S. M., & Strahl, D. (2010). Pattern of classroom activities during students' use of computers: Relations between instructional strategies and computer applications. *Teaching and Teacher Education, 26*(3), 540–546. https://eric.ed.gov/?id=EJ872968

Iowa Department of Education (n.d.). *Universal constructs: Essential for 21st century success*. Des Moines, IA: Author. Retrieved December 20, 2018, from https://iowacore.gov/content/universal-constructs-essential-21st-century-success-0.

Jang, S.-J. (2010). Integrating the interactive whiteboard and peer coaching to develop the TPACK of secondary science teachers. *Computers & Education, 55*(4), 1744–1751.

Kopcha, T. J. (2012). Teachers' perceptions of the barriers to technology integration and practices with technology under situated professional development. *Computers & Education, 59*(4), 1109–1121. https://eric.ed.gov/?id=EJ986115

Lawless, K. A., & Pellegrino, J. W. (2007). Professional development in integrating technology into teaching and learning: Knowns, unknowns, and ways to pursue better questions and answers. *Review of Educational Research*, *77*(4), 575–614. https://eric.ed.gov/?id=EJ782050

Liu, F., Ritzhaupt, A. D., Dawson, K., & Barron, A. E. (2017). Explaining technology integration in K–12 classrooms: A multilevel path analysis model. *Educational Technology Research and Development, 65*(4), 795–813. https://eric.ed.gov/?id=EJ1148004

Niess, M. L. (2011). Investigating TPACK: knowledge growth in teaching with technology. *Journal of Educational Computing Research, 44*(3), 299–317. https://eric.ed.gov/?id=EJ929864

Partnership for 21st Century Skills. (2009). *Framework for 21st century learning.* Tucson, AZ: Author. Retrieved December 20, 2018, from http://www.p21.org/storage/documents/docs/P21_Framework_Definitions_New_Logo_2015.pdf.

Perrotta, C. (2013). Do school-level factors influence the educational benefits of digital technology? A critical analysis of teachers' perceptions. *British Journal of Educational Technology*, *44*(2), 314–327. https://eric.ed.gov/?id=EJ1009147

Scott, P., & Mouza, C. (2007). The impact of professional development on teacher learning, practice and leadership skills: A study on the integration of technology in the teaching of writing. *Journal of Educational Computing Research*, *37*(3), 229–266.

Sharpe, D. (2015). Your chi-square test is statistically significant: Now what? *Practical Assessment, Research & Evaluation, 20*(8): 1–10. Retrieved November 1, 2018, from http://pareonline.net/getvn.asp?v=20&n=8.

U.S. Department of Education, National Center for Education Statistics. (2016). Common Core of Data. Public Elementary/Secondary School Universe Survey, 2015–16. Retrieved May 23, 2018, from https://nces.ed.gov/ccd/pubschuniv.asp.

Valiente, O. (2010). *1–1 in education: Current practice, international comparative research evidence and policy implications* (OECD Education Working Paper No. 44). Paris, France: OECD Publishing. Retrieved December 20, 2018, from http://www.oecd-ilibrary.org/docserver/download/5kmjzwfl9vr2-en.pdf?expires=1513356878&id=id&accname=guest&checksum=FB6767E3E7D8ECDD96282F5789A81E8B.

Voogt, J., Erstad, O., Dede, C., & Mishra, P. (2013). Challenges to learning and schooling in the digital networked world of the 21st century. *Journal of Computer Assisted Learning, 29*(5), 403–413. https://eric.ed.gov/?id=EJ1026607

Voogt, J., Fisser, P., Pareja Roblin, N., Tondeur, J., & van Braak, J. (2013). Technological pedagogical content knowledge—a review of the literature. *Journal of computer assisted learning*, *29*(2), 109–121. https://eric.ed.gov/?id=EJ1009762

Voogt, J., & Roblin, N. P. (2012). A comparative analysis of international frameworks for 21st century competences: Implications for national curriculum policies. *Journal of Curriculum Studies, 44*(3), 299–321. https://eric.ed.gov/?id=EJ969718

Wright, B. D., & Masters, G. N. (1982). *Rating scale analysis: Rasch measurement*. Chicago, IL: MESA Press.

Zhao, Y., & Frank, K. A. (2003). Factors affecting technology uses in schools: An ecological perspective. *American Educational Research Journal, 40*(4), 807–840. https://eric.ed.gov/?id=EJ782325

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