Rural Elementary School Teachers' Technology Integration

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Based on survey responses from more than 500 third-grade teachers, this study addressed three research questions relating to technology integration and its impact in rural elementary schools. The first analyses compared rural with non-rural teachers, revealing that the rural teachers had more positive attitudes toward technology integration. Then analyses examined dynamics influencing technology integration (operationalized as the sophistication of students' technology use) in rural schools only. Regression results showed that attitudes, teachers' preparation for using technology, and the availability of technology had significant positive associations with technology integration, whereas the schools' remoteness and socioeconomic status did not have significant associations. Notably and in contrast to some recent reports, responses from a number of rural teachers indicated that their access to instructional technology continues to be limited and that their preparation for using technology has been inadequate to support the engagement of students with sophisticated technology applications.

Many educational leaders and policy makers claim that computers and related internet technologies represent important educational innovations with the potential for stimulating high-levels of student engagement and achievement. In the United States, moreover, various state and national planning groups also emphasize the role that such technologies need to play in contemporary classrooms (e.g., Connecticut State Department of Education, 2001; Johnson, 2009; Maryland State Department of Education, 2002; Massachusetts Department of Elementary and Secondary Education, 2009).

Whereas policy-makers and practitioners in the United States often claim that technology-mediated instruction is important in all locales across the nation, their counterparts in other countries point to the special role that technology can play in addressing the needs of rural students (e.g., Larson & Murray, 2008; Mason & Rennie, 2004; Mitra, Dangwal, & Thadani, 2008; Momanyi, Norby, & Strand, 2006). Some recommend distance education, for example, as a way to compensate for the remoteness of certain rural communities (e.g., Barbour, 2007; Mason & Rennie, 2004; McQuaide, 2009), and others cite evidence showing that distance education works to improve educational equity for impoverished rural students and their families (McQuaide, 2009). In some evaluations of technology-mediated instruction, researchers report the academic benefits of making computer kiosks available to children in rural villages (Inamdar & Kulkarni, 2007); and some studies document teachers' beliefs that technology integration will increase rural students' access to multiple methods of learning, cultivate their independence as learners, and expand their awareness of the wider world in which they live (Momanyi et al., 2006).

Even in the United States studies focus on the potential of various computer and internet technologies for addressing educational needs that result from the remote location of some rural schools, the increasing difficulty of recruiting teachers to work in these schools, and the reduction in funding to small rural districts (Howley et al,, 2010). Nevertheless, some U.S. educators also identify dilemmas and tensions associated with the choice to use technology-mediated instruction to replace or augment traditional forms of teaching in rural schools (e.g., Howley et al., 2010; Howley & Howley, 1995; Wheeler, & Amiotte, 2005).

Whether or not particular U.S. teachers or schools decide to integrate technology, by at least some accounts most seem to have access to adequate hardware, software, and connectivity. According to several sources, school districts

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throughout the United States have purchased and installed the sorts of equipment needed for effective instructional applications using various recommended technologies available to them (Becker, 2000; United States Department of Education, 2005). Nevertheless, despite the investments in infrastructure and widespread calls for teachers to integrate technology, many schools across the nation appear to be making limited use of the instructional technologies (e.g., Cuban, 2001; Whitworth & Berson, 2003).

Various researchers have developed and to some extent validated theories about why teachers tend to use instructional technologies in limited and unimaginative ways (e.g., ChanLin, Hong, Horng Chang, & Chu, 2006; Howley & Howley, 2008). According to Howley and Howley (2008), rural teachers reported technical difficulties, insufficient time, limited support, and the regimes of accountability testing as impediments to their integration of technology. Nevertheless, these researchers also found evidence that the rural teachers whom they studied both actively and passively resisted the sorts of technology-related professional development that their district offered and used instructional technologies only occasionally-especially for the purpose of helping students prepare for state tests. From the teachers' perspective, technologically mediated instruction was no more effective, but was more labor-intensive, than other instructional approaches (Howley & Howley, 2008).

The apparent disconnect between teachers' preferred approaches to technology integration and the approaches that are recommended may be particularly important because of the differences in outcomes associated with what teachers choose—either to reject instructional technologies, to use them sporadically and in unimaginative ways, or to use them systematically and in sophisticated ways (Hattie, 2009). Some writers, in fact, argue that underperforming schools, such as those in some rural communities, need to be especially attentive to the degree to which teachers integrate technology and the approaches they use (Cullen, Frey, Hinshaw, & Warren, 2004). Limited research, however, addresses questions about rural teachers'-especially elementary-school teachers'-integration of technology.

The current study seeks to contribute to a fuller understanding of rural teachers' integration of technology by using data from a survey to answer a set of related research questions. These questions first explore differences across locales in elementary teachers' perspectives on technology use, conceptualized in terms of the adequacy of technology, preparation for using technology, levels of support for its use, attitudes toward technology integration, and perceived sophistication of students' use of technology. Comparisons between teachers in rural and non-rural schools[1] precede comparisons between rural teachers in more and less remote locales and rural teachers in the Appalachian and non-Appalachian portions of the state. The final research question posits a model for predicting the sophistication of student technology use—a measure that functions as a proxy for the extensiveness of technology integration. The model incorporates independent variables measuring school resources, adequacy of technology, teacher attitudes toward technology integration, preparation for using technology, administrator support for technology integration, and school remoteness. We incorporated these variables based on findings from previous research on schools in general. The model we tested, however, used data from teachers in rural schools only.

1. Are there significant differences between elementary teachers in rural and non-rural schools with regard to: (a) perceptions of the adequacy of technology; (b) perceptions of preparation for using technology; (c) perceptions of the level of administrator support for technology integration; (d) attitudes toward technology integration, and; (e) perceptions of students' sophistication of technology use?

2. Across rural schools, are there significant differences between elementary teachers in more and less remote locales with regard to: (a) perceptions of the adequacy of technology; (b) perceptions of preparation for using technology; (c) perceptions of the level of administrator support for technology integration; (d) attitudes toward technology integration, and; (e) perceptions of students' sophistication of technology use?

3. Across rural schools, are there significant differences between elementary teachers in Appalachian and non-Appalachian schools with regard to: (a) perceptions of the adequacy of technology; (b) perceptions of preparation for using technology; (c) perceptions of the level of administrator support for technology integration; (d) attitudes toward technology integration, and; (e) perceptions of student sophistication of technology use?

4. To what extent does the combination of variables measuring school resources, adequacy of technology, teacher attitudes toward technology integration, preparation for using technology, administrator support for technology integration, and school remoteness predict the sophistication of student technology use in rural elementary schools?

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[1]To distinguish between rural and non-rural locales, the study used Johnson codes from the National Center for Education Statistics (2011). Three of those codes categorize rural locales—the codes for rural, fringe ("rural territory that is less than or equal to 5 miles from an urbanized area, as well as rural territory that is less than or equal to 2.5 miles from an urban cluster"), rural, distant ("rural territory that is more than 5 miles but less than or equal to 25 miles from an urbanized area, as well as rural territory that is more than 2.5 miles but less than or equal to 10 miles from an urban cluster"); and rural, remote ("rural territory that is more than 25 miles from an urbanized area and is also more than 10 miles from an urban cluster").

Related Literature

Although a number of studies have reported on programs intended to increase rural teachers' comfort with and use of technology, few studies have examined either the extent to which such teachers actually integrate technology or the conditions supporting their integration of technology. Existing literature points to some relevant themes, however, and we review this literature in three sections below: (1) studies of the extensiveness of and conditions affecting rural teachers' technology use; (2) studies examining why rural teachers choose to integrate or not to integrate technology, and; (3) studies of programs to increase technology use by rural teachers.

Extensiveness of Rural Teachers' Technology Use

As noted above, most schools—including those in rural communities—now have access to the kinds of technology that teachers need in order to make effective use of at least some instructional applications. Moreover, a United States Department of Agriculture (2009) study found that Internet access in rural areas is greater now than it was even a few years ago. Nevertheless, in many isolated or low-population areas, access to high-speed internet remains limited. As one rural teacher commented, "[b]andwidth, bandwidth, bandwidth!!! There is a vast amount of online material available... however, bandwidth limitations cause us to pick and choose" (Page & Hill, 2008, pp. 63-64). Lack of access still challenges technology integration in some rural schools, limiting the ability of those schools to deploy not only bandwidth-intensive practices such as distance education, videoconferencing, and use of streaming video, but relatively basic web-based applications as well (Hannum, Irvin, Banks, & Farmer, 2009).

Moreover, technology use in classrooms, especially in a rural context, is also dependent on capacity for maintaining equipment and infrastructure (Hawkes, Halverson, & Brockmueller, 2002; Howley & Howley, 2008). Whereas larger and more affluent districts can task specific personnel with the maintenance of equipment and troubleshooting of technical issues, small and often under-funded rural districts cannot support teachers in this way.

Despite challenges linked to infrastructure and support, some reports of rural schools where technology use is extensive have linked teachers' use of these tools to improved student achievement. Knezek and Christensen (2007), for example, reported increased reading comprehension levels among first and second grade rural students whose teachers used technologically mediated approaches. Other studies showed that technology integration had contributed to success in overcoming discrepancies in achievement between rural and non-rural students (Cakir, Delialioglu, Dennis, & Duffy, 2009; O'Byrne, Securro, Jones, & Cadle, 2006)

Why Rural Teachers Choose to Integrate or Not to Integrate Technology

Although access to an adequate and well-maintained technological infrastructure is one factor with a potential impact on rural teachers' use of instructional technology, other less tangible factors are also important. For example, some studies point to the potential influence of teachers' attitudes. Through a survey of 4,000 middle school children in North Carolina, Spires, Lee, Turner, and Johnson (2008), for example, found that students generally perceived their teachers as "out of touch"-failing to understand that technology has become a significant part of students' lives. These students observed a disjuncture between school and daily life in terms of technology use. They claimed that if their teachers understood this disjuncture, they would use technology more extensively in their classrooms.

Furthermore, according to some studies of teachers, confidence with technology influences whether or not they decide to use technologically mediated approaches. One teacher, for instance, succinctly summarized this issue by saying, "If the teacher doesn't feel comfortable using it [technology], they are not going to use it," (Cullen et al., 2004, p. 139). When teachers choose to avoid the of use technology, however, they may be distancing themselves from the world that their students now inhabit. Such decisions on the part of teachers help explain a reported disconnect between students' out-of school experience, which is technologically immersive and their in-school experience, which is technologically limiting (e.g., Spires et al., 2008). Like their students, many teachers are aware of the technological disconnect, reporting that their students would prefer to spend time learning via computers and internet-based technologies, but they nevertheless feel powerless to do anything about it (Palfrey & Gasser, 2008).

Although many teachers avoid using technology because they feel uncomfortable with that approach, others make a conscious decision to limit technological applications in favor of what they see as more effective or less distracting instructional approaches. Subramony (2007), for example, found that some teachers determined that the detriments of technology use eclipsed its benefits, especially in terms of student focus. As one teacher in the study commented,

> Of course, as an educator I would like to think that [students are] out there pursuing great thoughts … but generally speaking, when I wander over to see what they're looking at, it's snowmobile sites... There's a lot of non-educational uses … I wish they'd be more excited about learning. (p. 65)

Spires and associates' (2008) study also pointed to similar dynamics, suggesting that technology might actually detract from learning because many students would rather

use technology to play games, connect to social networks, or download music than to conduct research, practice new skills, or learn new software applications.

Another influence on technology use in rural schools is culture (Keefe, 2000; Page & Hill, 2008; Subramony, 2007). Adults in some communities, for example, believe that technology use interferes with rural values and ways of life. According to Page and Hill (2008, p. 61), such adults may "fear that members of the next generation will become so dependent on information technology that they will lose their innate ability to function in their pragmatic sensible world."

Keefe (2000) contends that there are similar concerns in rural Appalachia, suggesting Appalachians "see themselves as self-sufficient . . . trustworthy and morally upright," and people who respect tradition and physical labor and are therefore comfortable with "low-tech solutions"(pp. 7-8). Another rural population, the Amish, forbid the use of many technologies because of cultural injunctions to live a simple life devoted to family, community sustenance, and religious observance (Dewalt, 2006). Thus, rural educators aptly presume that at least in some rural contexts community members are reluctant to use certain technologies themselves and to allow their children to use those technologies (Howley & Howley, 1995).

Programs to Increase Technology Use by Rural Teachers

Many rural schools, of course, exist in places where families and communities accept or even encourage technology use (Howley et al., 2010). In these schools, efforts to increase teachers' integration of technology are similar to such programs in other places, although they often confront special challenges as suggested above. Research on programs to increase rural teacher technology use shows that such programs tend to focus on one of two objectives: obtaining technology, on the one hand, or using technology, on the other. Regarding the former, Cullen and associates (2004) pointed to federal and state technology grants as one means rural schools have had at their disposal for improving access to technology. Additionally, Park, Sinha, and Chong (2007) reported that government programs such as the E-Rate, which are designed to promote Internet access, do offer some benefits to rural schools but also require schools to fend for themselves in handling the procurement of computers and software and the training of teachers.

Once appropriate technologies are in place, programs designed to increase technology use generally involve mentoring (Dwyer, 1998; Falvo, 2003; Hawkes & Good, 2000; May, 2000) or explicit training (Cullen et al., 2004; Rakes, Fields, & Cox 2006). Both methods claim to help teachers overcome discomfort with technology. As Falvo (2003) noted in relation to Internet use, "there is a sense of hope for teachers who are learning to use the Internet when they are being mentored by Internet experts who were very much novices several years ago" (p. 24). Nevertheless, some researchers have reported that such programs prove ineffective in promoting technology use among teachers who are uncomfortable with technology or skeptical of its value. Rakes and associates (2006), for example, found that even in situations where grant money allowed for the purchase of current technology and the training of teachers in technology use and integration "an alarmingly high number of teachers…express[ed] a lack of technology use" (p. 419).

Gaps in the Extant Literature

As the discussion above suggests, some studies have begun to explore rural teachers' adoption of instructional technologies, and the factors influencing their adoption of these tools. Most of these studies (e.g., Cakir et al., 2009; Hall & Mantz, 2000; Hawkes & Good, 2000; O'Byrne et al., 2006; Rakes et al., 2006; Spires et al., 2008), however, have focused on teachers at the middle school level and above. The one exception is Knezek and Christensen's (2007) study, which investigated technology integration in first and second grade classrooms in rural schools.

Not only is the literature relatively silent on the experiences of elementary school teachers in rural schools, it tends to treat technology adoption in a rather superficial way. Much of the research concerns the adequacy of technology itself or the character of professional development programs. Few studies look at a combination of influences or the dynamic character of teachers' decisions about adopting technology. Exceptions to this general tendency include a study conducted by Hawkes and Good (2000) that looked at how students interacted with experts via technology, and a study conducted by Hannum and associates (2009) that provided a detailed analysis of the use of technology for distance-learning applications in rural schools.

The current study attempts to fill some of the gaps in the literature by focusing attention on elementary-school teachers and by examining both the separate and the combined influences of various conditions on teachers' technology integration, particularly in rural areas. Among those influences is the remoteness of the school—a condition examined in just a few other studies (Page & Hill, 2008; Subramony, 2007).

Furthermore, the study contributes to the extant literature in education by conceptualizing technology integration not in terms of teachers' self-reported use of particular approaches but rather in terms of teachers' perceptions of the sophistication of students' technology use in the classroom. Although we derived this construct empirically through factor analysis, we appreciated its theoretical alignment with measures used recently by other researchers. Their work, moreover, demonstrated that the construct of sophistication of technology use has several desirable properties: (1) it demonstrates variability (e.g., Colley, 2003; Peng & Zhu, 2011); (2) it reflects the multifaceted character

of technology use (Peng & Zhu, 2011), and; (3) it provides a subjective gauge of technology "richness" (Liu, Liao, & Pratt, 2009). We also found the construct useful because of its potential to limit the impact of social desirability bias on teachers' responses regarding technology integration.

At the same time, the conception of technology integration that guided the study was not as broad as some recent definitions, which focus on the persistent and intentional use of technologies to change instructional systems on behalf of student-constructed knowledge (e.g., Belland, 2009). Drawing on operational definitions and findings from earlier research with an emphasis on technology integration in elementary classrooms (e.g., El-Amin, Fordham, Hammond, O'Bannon, Vannett, & Gruber, 2002; Pope, Hare, & Howard, 2002), we based our questionnaire on a narrower conception. As discussed below, moreover, focus group interviews with elementary teachers from Ohio suggested that this narrower conception fit with their own instructional practice and the practices they had observed among colleagues, including those who were early adopters of various instructional technologies.

Methods

This research involved a survey of a random sample of third grade teachers in Ohio to which more than 500 teachers responded. The research team decided to develop a new instrument rather than using an existing one because the instruments used in earlier studies tended to address technology applications in middle and high schools.

Development of the instrument involved several procedures. First, the team prepared a preliminary instrument based on a review of related studies (Becker, 2001; Crook, Fisher, Graber, Harrison, & Lewin, 2008; Hohlfeld, Ritzhaupt, Barron, & Kemker, 2008; Kim & Bagaka, 2005; Mardis, 2009; Muir-Herzig, 2004; Selwyn, 2006; Smeets, 2005; Valadez & Duran 2007; Wood, Mueller, Willoughby, Specht, & Deyoung, 2005). This initial instrument was then refined through feedback from an expert in the field, an online pilot test, and focus-group interviews with elementary teachers.

The final instrument included 56, primarily close-ended questions, many of which could be aggregated into scales consisting of a number of different, but related variables. The items comprising each scale are presented in Appendix A along with alpha reliabilities for each scalar variable. To construct the models that the study tested, the researchers used, in addition to data from respondents, publicly available data from the National Center for Education Statistics (NCES, 2011) and the Ohio Department of Education (ODE)

Among the scales were several measuring conditions that previous research had identified as having an impact on rural teachers' technology integration (e.g., Howley & Howley, 2008). These scales measured teachers' perceptions of the adequacy of the technology available to them, their levels of preparation for integrating technology, the extent to which they were supported in their efforts to use technology[2],and their attitudes toward technology integration. One additional scale measured the sophistication of teachers' technology integration by combining responses to questions about the sophistication of the technology applications that their students were routinely using. Whereas earlier research has typically examined technology integration through items eliciting self-reports from teachers about their own instructional applications of technology (e.g., Gorder, 2008; Judson, 2006)—an approach that invites social desirability bias—our inferential measure drew teachers' attention away from their own performance by asking them about how students in their classrooms were using technology. This inferential approach is gaining popularity for measuring other classroom practices such as student-centered versus teacher-centered pedagogy (e.g., Valentine, Clark, Hackmann, & Petzko, 2004). As mentioned above, moreover, the resulting scale corresponds to other recent theoretical and empirical work on technology integration (e.g., Colley, 2003; Peng & Zhu, 2011).

In order to produce findings that could be generalized, the research team worked to gather responses from a representative sample of Ohio's third grade teachers. The team decided to focus attention on third grade classrooms for a number of reasons: (1) students at this grade level are impressionable, so their experiences with technology may have a lasting impact; (2) focus group discussions suggested that third grade is a time when students have the cognitive and fine-motor skills necessary to begin to use technology in sophisticated ways, and; (3) third grade is the last grade level in Ohio when students primarily work with one teacher and remain in one classroom for core coursework.

The researchers received from the ODE a list of third grade classroom teachers in the state, which we then used as the sampling frame. We asked that the list exclude specialist teachers such as art, music, physical education, and special education teachers. Taking into account these and other criteria, the final sampling frame included 3,712 teachers. Using a random sampling procedure, the research team then selected 1,000 teachers from the sampling frame. Like all other statistical procedures conducted in this research, the sampling procedure was accomplished using SPSS (version 16) for Windows (SPSS Inc., 2008).

With approval from Ohio University's Institutional Review Board, the research team distributed the survey via ground mail to the teachers in the sample. The team decided to take this approach in order to limit possible response bias

[2]Although the instrument included several items intended to measure support for using technology, the items did not combine to form a scale with adequate internal consistency. Therefore, we selected one item relating to administrator support for inclusion in the analyses we used to answer the research questions.

resulting from the use of the Internet to distribute a survey focusing on teachers' use of that same technology. The overall process involved a series of mailings that included an initial contact letter, followed by the first mailing of the survey, and then a second mailing of the survey to those who had not yet responded. All mailings included a personalized cover letter that noted, among other things, that all participants would remain fully anonymous, and mailings of the actual survey included return addressed, stamped envelopes. The mailings occurred during a three week span in May, 2009, primarily to coincide with the end of the school year, but also taking into account the timing of other matters, such as statewide standardized testing schedules, that might deter teachers from participating in the survey. The overall response rate was 51.6%, a rate that can be seen as average or slightly better than average (Dillman, Smyth, & Christian, 2009).

Findings

Usable responses to the survey came from a total of 514 teachers, 157 of whom were employed in rural schools and 357 of whom were employed in non-rural schools. Among the rural teachers, 72 (i.e., 46%) worked in remote schools. Not surprisingly, most of the responding 3rd grade teachers were female (92.4% among the rural teachers). The mean age of the rural teachers was 43.36, and the mean years of experience was 17.01 (SD=10.8). Average school enrollment of the rural schools represented in the sample was 476.01 (SD=176.34), and average class size was 21.96 (SD=3.02). Free and reduced lunch rates averaged 35% (SD=19%)[3].

In order to identify possible differences in rural and non-rural elementary teachers' (a) perceptions of the adequacy of technology, (b) perceptions of preparation for using technology, (c) perceptions of the level of administrator support for technology integration, (d) attitudes toward technology integration, and; (e) perceptions of student sophistication of technology use, the research team used one-way analysis of variance (ANOVA) as well as analysis of covariance (ANCOVA) to compare mean responses to scales constructed from clusters of related items (See Appendix A). The use of ANCOVA allowed the team to control for students' socioeconomic status (SES, operationalized as free and reduced-price lunch rate) because of the statistically significant difference we observed in this variable [$F(1, 464) = 5.53$, $p < .02$]. Notably the rural schools reported lower free and reduced-price lunch rates (i.e., higher SES) than the non-rural schools (i.e., rates of 35% and 41%, respectively).

Results of the ANOVA revealed one significant difference, namely in the attitudes of teachers toward technology integration. Rural teachers reported more favorable attitudes than non-rural teachers [$F(1, 504) = 8.62$, $p=.003$]. This difference remained even when the SES measure was introduced into the model. Moreover, no other significant differences between rural and non-rural teachers were evident, either in the model that included the SES covariate or the model that did not.

Whereas the analyses reported above made use of data from the entire data set, our next analyses used data from rural schools only. For these analyses, we used information from NCES to categorize the 157 responding teachers from rural schools as working either in remote rural schools (NCES category 42, n=72) or non-remote rural schools (NCES category 41, n=85). Again, significant differences in SES [$F(1, 127)=4.87$, $p=.029$] supported the use of both ANOVA and ANCOVA models in calculating mean differences[4]. A comparison of the models showed that the two differences that were evident in the simpler ANOVA model (i.e., in perceived adequacy of technology and in the sophistication of student technology use) disappeared when we introduced SES as a covariate. At least among Ohio teachers, remoteness alone did not compromise access to technology, support for technology integration, preparation for using technology, attitudes toward technology, or the sophistication of student use of technology.

In order to test the possible relationships between communities' cultural values and conditions supportive of teachers' technology integration, we also used ANOVA and ANCOVA to compare responses from rural teachers in Appalachian and non-Appalachian counties. Despite significant differences in free and reduced lunch rates across the categories (25% in non-Appalachian schools, n=57 and 48% in Appalachian schools, n = 49), none of the comparisons turned out to reveal a significant association. Moreover, the difference in the mean scores on the scale measuring the sophistication of student technology use also turned out to be non-significant.

Finally, to assess the separate and combined influences of various conditions on the perceived sophistication of student

[3]Ohio's rural schools are divided between rural Appalachian and rural agrarian locales, which differ with respect to terrain, economic history, and culture. Overall, these rural schools, however, are more like their counterparts in the Northeastern part of the United States than like schools in the Southeastern or Western parts of the nation. Their communities retain a strong commitment to local control-a commitment that has kept consolidation from being as widespread as it has been in the Southeast. At the same time, the population density of the communities they serve is greater than the population density of many rural communities in the West, and as a result, their enrollments tend to be larger than those of schools in the states of the Great Plains and Rocky Mountains. Although some rural communities in Ohio are experiencing demographic changes, diversity among school children is nowhere near as great as it is in communities in the Southeastern and Southwestern parts of the country. Rural schools in Ohio are most similar to rural schools in states like Pennsylvania and New York, and share many characteristics with rural schools in Indiana, Illinois, and Michigan.

[4]Remote rural schools reported higher free and reduced-lunch rates than non-remote rural schools.

technology use, the research team used the direct enter approach to construct an ordinary least square regression equation that incorporated two resource measures as control variables (i.e., free and reduced-price lunch rate and per pupil expenditure), four independent variables relating to teachers' perceptions (i.e., perceived adequacy of technology, perceived level of support, perceived preparation for using technology, and attitude) and one dichotomous independent variable indicating remoteness of the school (i.e., remote or non-remote). Altogether the model accounted for 52% of the variance in perceived sophistication of students' technology use. As Table 1 shows, three conditions were significant predictors: teacher attitudes toward technology had the strongest influence followed by perceived preparation for using technology and perceived adequacy of technology.

According to the model, rural elementary teachers reported that students used more sophisticated technology applications under three conditions: when attitudes toward technology were more positive, preparation for integrating technology was more extensive, and the available technology was better. Neither the support of administrators nor school resources had a significant influence.

Moreover, to a certain extent, the three conditions were related. Notably, we identified significant bivariate correlations between attitudes and the three other conditions (i.e., adequacy of technology, preparation for using technology, and administrator support. The correlation coefficients-all significant at the .01 level-were .45, .32, and .31 respectively. In addition, the bivariate correlation between adequacy of technology and administrator support, on the one hand, was .48, and between adequacy of technology and preparation for using technology, on the other was .29—both significant at the .01 level. Finally, the correlation between preparation for using technology and administrator support was .28 (also significant at the .01 level).

Taken together, these analyses suggest the following dynamics: the seeming similarity in the levels of sophistication of elementary-school students' use of technology in rural and non-rural schools may result from different influences in these locales. In rural schools, teacher attitudes toward technology tend to be positive, but these teachers lack adequate technology and preparation. Nevertheless, the adequacy of the technology available to them, their preparation for its use, and their administrators' support for its use all have positive associations with teacher attitudes. In non-rural schools, by contrast, technology resources and preparation for using technology may be more adequate, but the greater prevalence of negative attitudes places limits on the sophistication of the applications that elementary students use. A regression analysis using data only from the non-rural schools supported this claim. Teacher attitude was the only significant predictor variable in an equation explaining 49% of the variance. As was the case with rural schools, however, attitude was significantly associated with the three other conditions, although the association between adequacy of technology and teacher attitude was more modest (.37 in contrast to .45). Both in rural and non-rural schools, the patterns of association suggest that interactions exist among various conditions with the potential to be supportive of technology integration.

Discussion

Building on but also adding new insights to previous research, the current study suggested possible approaches for improving the sophistication of technology use among rural elementary-school students. At the same time, however, it demonstrated that students in rural schools were perhaps better positioned to benefit from such approaches than their counterparts in non-rural schools because their teachers already had more positive attitudes toward technology integration. As numerous studies over the past 20 years have shown (e.g., Christensen, 2002; Woodrow, 1992), teacher attitudes toward technology influence not only the extent to which they integrate technology into instruction but also the attitudes of their students toward using technology as a tool for learning.

Not only did the study show that rural locale was positively associated with teacher attitudes, it also found that remoteness of a rural school had little influence on Ohio teacher attitudes and other conditions supportive of their integration of technology. This result contrasts with findings from some studies in which the remoteness of schools did appear to decrease technology integration (e.g., Page & Hill, 2008; Subramony, 2007). We suspect that, in less urban states than Ohio, remoteness may still influence access to hardware, Internet connectivity, and appropriate professional development-all conditions with potential to impact technology integration. Similarly, our study did not seem to reveal the sort of cultural distrust of technology in Appalachian Ohio that authors such as Keefe (2000) and Dewalt (2006) suggested might be present there[5].

The study did, however, suggest that a predictable set of supports might still be needed in order to help rural teachers integrate technology in ways that promote the sophisticated engagement of their students. Despite reported improvements in recent years (e.g., USDA, 2009), some teachers judged the technology available to them as inadequate. Moreover, results from the regression analysis suggested that adequate technology and professional preparation were indeed predictive of technology

[5]Although most Amish communities in Ohio are located within Appalachian counties, many Amish children are not enrolled in public schools. Amish concerns about the secular impact of technology, therefore, probably were not represented in the responses of teachers in the Appalachian subset of our sample. Furthermore, the perspectives of teachers do not necessarily reflect those of the communities in which they teach.

Table 1
Predictors of Perceived Sophistication of Students' Technology Use

Independent Variables	*B*	*SE*	*β*
Constant	9.95	5.64	
Attitudes	.54	.11	.44**
Preparation for using technology	1.3	.38	.27**
Adequacy of technology	.26	.11	.22*
Support for technology integration	-.35	.65	-.05
Remoteness	-1.05	.90	-.09
Free and reduced lunch rate	-1.21	2.35	-.04
Per pupil expenditure	.000	.001	.01

Note. $R^2 = .52$
*$p < .05$
** $p < .01$

integration measured in terms of the sophistication of student technology use. Providing these supports to rural teachers is likely to improve their ability to integrate technology into instruction as well as their willingness to do so.

At the same time, we still see considerable room for research that goes beyond describing the landscape of technology use in rural elementary schools. Research based on observations of and interaction with students, for example, would provide a richer understanding of what sophisticated technology use actually entails. Furthermore, additional research of this sort might illustrate how sophisticated technology use actually functions to promote meaningful learning. Although research describing such dynamics does exist (e.g., Boxie & Maring, 2002; Brucklacher & Gimbert, 1999), we found only a few studies (e.g., Haskin, 1999; Squire, Barnett, & MaKinster, 2003) reporting on technology integration that were explicitly attentive to the rural context. By contrast, we have observed in some earlier work (Howley & Howley, 1995; Howley et al., 2010) that certain technological applications actually distance rural students from their local communities by teaching them that meaning resides outside of rural places and, in fact, can be found primarily in cities and suburbs. Our perspective then and now, however, suggests that teachers in rural schools certainly have the power to increase student use of sophisticated technologies as a way to improve their learning without requiring them to abandon care for and commitment to local places and community priorities.

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APPENDIX A

Technology Integration Scales

Scale	Alpha Reliability	Items
perceived adequacy of technology	.83	• How would you describe the number of computers that are *always available* for students to use in your classroom (or a classroom where you typically teach)? • Including computers both within and outside of your classroom, how would you describe the *overall number of computers that are available* for your students while under your instruction? • How would you describe the *computer software* available for your students to use at your school? • How would you describe the *computer hardware* for your students to use at your school? • How would you describe the *speed* of the Internet connection that is available to students at your school? • How would you describe the *reliability* of the Internet connection that is available to students? • How would you describe the computer resources that your school makes available to you for purposes of *teaching preparation*? • How would you describe the computer resources that your school makes available to you *for providing instruction to students*?
perceived preparation for using technology	.82	• How *skilled* do you feel as though you are with using a computer? • How well prepared do you feel you are to use a computer for teaching-related needs?
perceived support for the use of computer- and internet-based technologies	n/a	• How would you describe the extent to which administrators in your school (e.g. the school principal) are supportive of students' use of computers at school?
attitudes toward instructional technology	.87	• Research has shown that elementary school teachers have a wide range of attitudes about the importance of computers in elementary school education. How important do you believe *student use of computers at school* is to your students' education? • Similarly, and in terms of *the Internet* in particular, how important do you believe *student use of the Internet at school* is to your students' education? • On a scale of 0-10 (with 0 being 'no contribution' and 10 being a 'major contribution'), in your opinion how much has your students' *use of computers at school* this year contributed to their education? • On a scale of 0-10 (with 0 being 'no contribution' and 10 being a 'major contribution'), in your opinion how much has your students' *use of the Internet* at school this year contributed to their education?

Appendix A (continued)

sophistication of technology use	.80	• Generally speaking, how would you describe the level of sophistication of your students' activities with computers while under your instruction?
		• Research shows that frequency of computer use by elementary school students varies considerably, with some students using computers every day and others never using computers at all. Over this past school year, which statement best describes how often your students have used computers at school while under your instruction?
		• Using your best estimate, how *skilled* would you say your students are with using computers?
		• Again use your best estimate, how *motivated* would you say your students are when it comes to using computers?
		• Please indicate approximately how often your students have used computers for each of the following during this school year.
		  ○ Writing (essays, etc.)
		  ○ Typing Practice/Keyboarding
		  ○ Reference CD-ROMs
		  ○ Instructional Games
		  ○ Internet-based Learning Module
		  ○ Acquire info from Internet/Web
		  ○ Remedial Work
		  ○ Activities for Advanced Students
		  ○ Drawing/Graphics
		  ○ Video Production
		  ○ Presentation (e.g. PowerPoint)