Research Article

Teachers Bridging the Digital Divide in Rural Schools with 1:1 Computing

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This article shares the findings of a mixed-method study about the implementation of 1:1 computing in a small rural Florida school district. Researchers used multiple regression analyses to examine whether Davis' (1989) Technology Acceptance Model helped explain teachers' adoption of 1:1. The results indicated that the rural teachers' perceived ease of use and perceived usefulness of 1:1 were significant predictors of both whole class and individualized instructions with 1:1. The qualitative phase of the study explored the ways in which the teachers integrated 1:1 into their instructional practices and what factors motivated them to do so. The analysis showed that the teachers used 1:1 largely to foster digital literacy and collaboration as well as to conduct student assessment. Reasons why the teachers integrated 1:1 into instruction, included increasing student engagement, personalizing learning, and facilitating teacher productivity.

For decades, rural education advocates have argued that rural students represent a forgotten minority (Azano & Stewart, 2015). Teachers in rural school districts have unique challenges, including a high concentration of low socioeconomic status (SES) students living in small and often geographically isolated communities (Azano & Stewart, 2015). Decreased funding and a "digital divide" that exists between rural schools and their suburban and urban counterparts have made it difficult for many rural districts to implement new instructional technologies (Sundeen & Sundeen, 2013). According to a report published by the Pew Research Center, 85% of suburban residents, 85% of urban residents, and 75% of rural residents have access to the Internet (Perrin & Duggan, 2016). Given this disparity in Internet access, children living in rural communities may have fewer opportunities to use digital devices than their urban and suburban counterparts. These shortcomings in technology access may also be exasperated by the lower overall SES of rural school contexts (Dolan, 2016). A study by Hohlfeld, Ritzhaupt, Dawson, and Wilson (2017) found that students in low SES schools used computers significantly more often for drill and practice and for free time. Conversely, the researchers noted that higher SES schools more frequently had students use technology for the development of higher-order thinking skills and analyses (Hohlfeld et al., 2017). These challenges translate into an even greater gap between those who possess the latest technologies and digital literacy skills, and those who do not.

To address these issues of equity and access, some schools equip each student with a laptop, notebook, or tablet computer for use at school, and in some cases, at-home use (Topper & Lancaster, 2013). A key objective of one-to-one (1:1) computing programs is to increase educational and social equity by providing technology-based instruction to students who may lack access to these tools (Lei & Zhao, 2008). According to Islam and Grönlund (2016) 1:1 computing in schools is expanding globally,

> 1:1 programs in education are becoming popular worldwide for three main reasons—easy availability and affordable information and communication technologies, increasing demands for adaptation to a networked and shared learning environment that allows access to information from anywhere at any time, and inclusion of ICT in the educational development policy agenda of countries and states. (p. 193)

Creating classrooms that offer 1:1 computing provides teachers with the opportunity to ubiquitously integrate technology into instruction and strengthen the 21st-century digital literacy skills that rural students need to excel in a globally connected world.

The purpose of this study was to examine the adoption and usage of 1:1 computing by teachers in a small, rural school district in Florida. The study utilized Davis' (1989) Technology Acceptance Model (TAM) as a theoretical lens to investigate a newly implemented 1:1 computing initiative. Increasing student access to instructional technology in the classroom has the potential to transform teaching and learning. However, according to Wake (2012), only minimal educational research focuses on rural school contexts and even less focuses specifically on technology use in rural schools. Furthermore, understanding rural teachers' adoption and usage of these technologies in a district that has had the opportunity to implement 1:1 computing can help shed light on the unique educational challenges rural schools face.

The Rural District

Florida has a large rural population that includes 30 rural counties with a population of 713,665 and another 1.1 million people living in the rural areas of Florida's urban counties (Rural Health Information Hub, 2018). The school district that was the setting for this study is in a rural area within the state of Florida and is comprised of a diverse student body. The student population of the district was 47.1% White (n=3,032), 8.1 % Black or African American (n=519), 39.9 % Hispanic/Latino (n=2,568), and 0.9% Asian (n=55) during the 2015–2016 school year (Florida Department of Education, 2015). The local economy is primarily focused on agriculture, and the 2016 average family income was estimated to be $39,587 annually (City-Data.com, 2018). The 2016 U.S. Census estimates that 31.5% of people in this county between the ages of 18 and 24 years of age do not have a high school diploma.

In 2015, a team of information technology personnel, teachers, and administrators teamed up to form a plan to integrate technology into the school district examined in this study. Prior to the technology initiative, some of the classrooms in the district were equipped with four or five computers, and other classrooms only had access to a computer lab. The bandwidth and Internet connections were unreliable, and computers were not up-to-date models, resulting in slow performance and frustration for students. The resulting program was called the Digital Classroom Plan which was comprised of five long-term goals:

1. To implement Florida Standards-based instruction and integrate technology into the curriculum in every classroom.
2. Provide ongoing staff development for implementation and use of technology.
3. Increase access to technology for all students.
4. Implement 1:1 computers across the district.
5. Establish an ongoing process as a means to evaluate the effective implementation of the technology plan.

By the 2016–2017 school year, all middle school and ninth grade high school classes had achieved the goal of 1:1 computer access. The district also piloted 1:1 computing devices in several kindergarten through fifth grade elementary classrooms. Classrooms were equipped with laptops, Chromebooks, iPads, or other types of tablets. In order to help prepare teachers to use 1:1 computing, the district created a summer technology camp dedicated to professional development and the training needed to implement technology in the classroom. The day camp provided teachers with training and with hands-on experience in integrating the technologies that would be available in their classrooms.

Theoretical Framework

The Technology Acceptance Model (TAM) was employed in this study as a theoretical framework to examine teachers' instructional use of 1:1 computing. Under TAM, two variables, perceived usefulness and perceived ease of use, are postulated to influence one's Behavioral Intention (BI) to use a technology, where that BI influences actual system usage

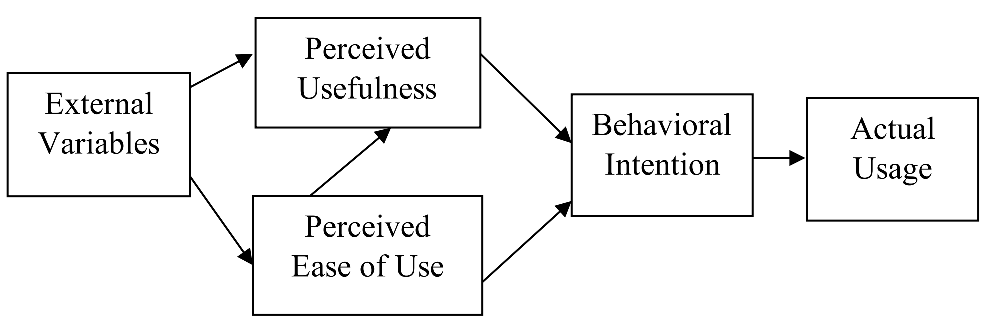

Figure 1
Refined technology acceptance model. Adapted from Davis & Venkatesh (1996).

(Bogazzi, 2007). Davis (1989) defined PU as "the degree to which a person believes that using a particular system would enhance his or her job performance" and PEOU as "the degree to which a person believes that using a particular system would be free of effort" (p. 320). According to Davis, Bogazzi, and Warshaw (1989), external variables may also influence technology usage. Examples of external variables that may influence technology adoption include user support, training, and educational programs (Davis et al., 1989). The TAM model was depicted by Davis and Venkatesh (1996) as shown in Figure 1. The literature on the TAM's use in rural education is sparse, although one study used it to examine technology use in a rural area of Malaysia (Samah, Shaffril, Hassan, & D'Silva, 2011).

Research Questions

The first purpose of this study was to examine whether an adapted Technology Acceptance Model (TAM) helped to predict rural school teachers' adoption of 1:1 computing for classroom instruction. Two forms of instructional usage were examined, whole class, and individualized instruction. Secondly, this study sought to identify factors that motivated the teachers to use 1:1 computing and to describe the ways in which they used the tool. Utilizing an explanatory mixed methods design (Fraenkel, Wallen, and Hyun, 2012) to address them, the following research questions were asked:

1. To what degree does teachers' perceived ease of use of 1:1 computing predict their reported instructional usage of 1:1 computing?
2. To what degree does teachers' perceived usefulness of 1:1 computing predict their reported instructional usage of 1:1 computing?
3. What motivates teachers to use 1:1 computing as an instructional delivery tool?
4. In what ways do teachers use 1:1 computing as an instructional delivery tool?

It is also anticipated that the findings of this study may help policymakers evaluate the effectiveness of the Digital Classroom Plan that was adopted by the district.

Literature Review

Research on Technology in Rural Schools

Research shows all schools face challenges with the implementation of 1:1 computing, but these can be amplified in rural school districts with fewer resources. Key issues rural districts face include replacing aging technology, a need for more computers and related devices, and professional development for teachers to learn how to use the new devices and how to change pedagogy. Technology integration best practices have changed from a school sharing a computer lab, to a configuration that now provides all students with a computer. This increased number of computers leads to the need for a more robust support system. A rural community may have less availability of locally sourced professional development, which is vital to the success of a 1:1 computer initiative. Usinger, Ewing-Taylor, and Thornton (2016) examined grant-funded educational technology projects across a rural western state and reported positive changes in the classrooms but emphasized the need for adequate internet connectivity, quality professional development, and a need for funding to replace and update technology after the life of the grant.

Rural districts have a unique need for quality internet access, computers, and related technologies, which affect both classroom instruction and homework assignments. The homework gap impacts numerous school-age children when accessing instructional materials and prevents these children from developing robust digital literacy skills (Brown, 2018). Azano and Stewart (2015) examined the experiences of pre-service teachers who were student teaching in the Appalachian region of the U.S. Perceived challenges included not being able to assign homework due to lack of parental support and lack of access to technology, as well as other rural specific issues, such as missing school during hunting and harvesting seasons. One pre-service teacher explained that most of his students did not have access to technology at home, which affected his beliefs about homework and assignments he gave to students (Azano & Stewart, 2015).

When students and teachers in rural classrooms can use 1:1 computing, they use them for a wide variety of tasks. Keengwe, Schnellert, and Mills (2012) examined how a 1:1 computing initiative affected student learning in a rural Midwestern U.S. school district during the 2008–2009 school year. Of the 105 students from grades 10 through 12 who participated in the survey, 90.7% said they used their laptops on a daily and weekly basis to search for information, 80.9% to complete homework, 69.8% to organize information, and 67.4% to communicate using e-mail or instant messaging. When looking at faculty perceptions of the 1:1 computing in rural schools, Keengwe et al. (2012) found that 76.9% of faculty reported that student engagement and interest level improved as a result of the integration of 1:1 computing into the learning environment. Also, 69.2% of faculty reported that student motivation was improved with the use of laptops (Keengwe et al., 2012). Walker and Shepard (2011) observed sustained student attentiveness in the classroom as well as an increase in student focus when technology was integrated into lessons. Together, these findings highlight some of the benefits and challenges that the integration of 1:1 computing may have on the instruction of rural students and the potential for technology integration to help create educational equity for rural students.

Considering Pedagogy before Technology

Teachers can be provided with all the latest technology resources, but without a change in teaching philosophy, no real change in the classroom occurs. One of the earliest 1:1 student laptop programs was launched in 1989 in Melbourne, Australia (Newhouse & Rennie, 2001). Mixed results from this initiative indicated that without a change in teacher pedagogy to embrace a student-centered, constructivist classroom environment, little change occurs. If institutional supports are present, 1:1 computing can lead to a pedagogical change. In 2008, the Australian government launched the Digital Education Revolution (DER) initiative with aspirations of bringing sustained and meaningful change in the way teaching and learning were delivered in the country (Mitchell, 2015). As a result, numerous scholars have sought out to examine the impact of 1:1 computing in Australian secondary schools. For instance, Keane and Keane (2017) examined the implementation of a DER funded 1:1 computing program in a Catholic secondary school and in doing so identified four success factors including:

1. stable infrastructure
2. supportive teachers
3. delegated leadership
4. collaborative professional learning

Professional development is one of the most important support factors that can create a change in teaching practices. A large study of 11 Florida, U.S. school districts found numerous changes in teachers' instructional practices with the implementation of 1:1 computing combined with professional development (Dawson, Cavanaugh, & Ritzhaupt, 2008). Findings included teachers making greater use of project-based learning, teachers acting as coach/facilitator, and cooperative/collaborative learning. At the same time, the researchers observed decreases in the teachers' use of traditional independent seatwork, direct instruction, and differentiation. Other notable findings included increases in student attention, interest, and engagement, along with changes in the way computers were used, such as a decrease in teachers' use of computers as a delivery tool and an increase in student use of technology as a learning tool. Corn, Tagsold, and Patel (2011) found that teachers in 1:1 computing initiatives enhanced lesson plans, redefined pedagogical approaches, and increased the use of authentic learning tools and assessments. These findings demonstrated a shift from teacher-centered to student-centered activities (Dawson et al., 2008).

Another large-scale study on 1:1 computing in the U.S. was conducted by the Maine Education Policy Research Institute (MEPRI). The report summarized the impact of a 1:1 computing initiative that provided laptops to all grades 7 and 8 students and their teachers. Concurrently, teachers, and schools were provided with wireless infrastructure, technical assistance, and professional development for integrating laptops into curriculum and instruction (Silvernail, Pinkham, Wintle, Walker, & Bartlett, 2011). The results of the study indicated that the teachers used the laptops in a variety of ways and with different levels of frequency. A large majority of teachers reported frequently using laptops for developing lessons and providing classroom instruction while only a little over half reported using the laptops to provide differentiated instruction. Along a similar lines, three out of five teachers reported using the laptops for summative assessment, while only half of the teachers reported using them for conducting a formative assessment (Silvernail et al., 2011).

When teachers are given the option to use 1:1 computing devices for instructional purposes, there is a substantial variation in frequency and ways that they choose to use the technology with their students (Bebell & Kay, 2010). Research on different factors impacting teachers' technology adoption may help explain some of this variation. Inan and Lowther (2010) examined factors impacting technology integration in 54 K-12 schools taking part in the first year of two Tennessee, U.S. technology initiatives. The results indicated that eight of the variables hypothesized to impact technology integration in the model explained 56.4% of the variance in teachers' integration of technology. In particular, they found that teachers' demographic characteristics (years of teaching and age) may negatively affect their computer proficiency while other variables (teachers' beliefs and readiness, availability of computers, and availability of technical support) positively affected technology integration (Inan & Lowther, 2010). These findings are important because they highlight how alterable characteristics such as teacher technology readiness and technology availability can promote classroom technology integration. As teachers transform instruction, it is impossible to overstate the power of individual teachers in the success or failure of 1:1 computing (Bebell & Kay, 2010).

Individualized and Whole Class Instruction

Many studies show that 1:1 computing can create a learning environment that improves a teacher's ability to engage their students in both whole class and individualized instruction. Individualized and personalized study is an often-overlooked benefit of laptop programs and one that is not easily replicable in other technology-intensive educational environments (Grimes & Warschauer, 2008). Bebell and Kay (2010) found teachers using 1:1 computing over two years reported an increase each year of the frequency in which they adapted an activity to students' individual needs using computers. A 1:1 computing investigation in a rural midwestern high school found the integration of 1:1 increased student engagement and learning, motivation, as well as teachers' ability to work individually with students (Keengwe, Schnellert, & Mills, 2012). The ability of teachers to individualize learning might provide an important tool to improve traditional, at-risk, and high-achieving students' learning experiences.

Whole class use of 1:1 computing is sometimes inferred as it typically is the bulk of instructional time. Bebell and Kay (2010) found teachers using 1:1 computing to present information to their class often used the Internet in lessons and created WebQuests for their students. Whole class instruction was often represented by examples in subject areas and student projects. Corn et al. (2011) described a history teacher who placed all the lesson links on the class web page and discussed them as a whole group and another teacher who helped prepare the whole class with software to improve standardized test scores. These are just a few of the examples of how teachers have used 1:1 computing in classrooms for whole-class instruction.

Methods

Data Collection

The researchers designed a teacher self-report questionnaire to gather data for this study. The self-report survey was the most appropriate means of collecting data regarding teachers' use of 1:1 computing for a large variety of instructional applications within a reasonable amount of time. The survey was administered electronically via an email invitation that included a link to the questionnaire that was created with *SurveyMonkey* software. A pilot survey was administered to three teachers to get feedback and face validity. Their feedback was used to adjust both the survey items and its administration procedure. Information collected on the final version of the 22 item survey included teacher background information (gender, grade level/s taught, subject/s taught, highest degree earned, and 1:1 computing device most used), and the adapted TAM components (perceived ease of use, perceived usefulness, and frequency of use of 1:1 computing). In the final section of the survey, open-ended responses were included to collect qualitative data to address research questions 3 and 4. At the end of the survey, teachers were invited to participate in a voluntary interview. An 11-item teacher interview script was used to collect additional qualitative data about how and why the teachers used 1:1 computing for instruction. Two teachers participated in the in-depth interviews.

Population

The study participants were kindergarten through ninth grade teachers working in a small rural school district in the state of Florida. The district is comprised of five elementary schools, two middle schools, one alternative school, one freshman campus, and one high school. The survey was sent electronically to 131 teachers who met these criteria as reported by the district technology director. Forty-six teachers participated in the survey (response rate = 35%) with two teachers participating in interviews. Data was collected over the spring and summer of 2016.

Research Design

As noted earlier, an explanatory mixed methods approach was taken by this study. This enabled the researchers to examine whether the TAM components influenced the rural teachers' adoption of 1:1 computing through the quantitative phase of the study. By following up with qualitative inquiry, the researchers were able to gain a deeper understanding of the quantitative findings and paint a picture as to how the rural teachers used 1:1 computing for classroom instruction along with what motivated them to use it.

Quantitative Analysis

The data was entered into SPSS software for analysis. Items that were part of a construct were summed to obtain a single score. To handle the issue of missing data, sums of scale variables were calculated by estimating from the mean of variables used in their construction. Descriptive statistics were calculated for all variables and Cronbach's alphas were calculated to provide a measure of reliability for variables constructed from multiple items. Regression analyses were conducted to answer research questions 1 and 2. Teachers' reported whole class instructional usage of 1:1 computing served as the dependent variable in the first set of regressions, and then regressions were run with teacher's reported individualized instructional usage of 1:1 computing as the dependent variable. The independent variable examined in the first model was teacher's reported perceived usefulness of 1:1 computing (PU 1:1). The second model examined the independent variable teacher's perceived ease of use of 1:1 computing (PEOU 1:1).

Qualitative Analysis

Qualitative methods were used to analyze data gathered from interviews and open-ended survey items. Once the data were collected, information from the interview transcripts and open-ended survey items was coded. This data helped answer research questions 3 and 4. A list of a priori codes that related to the research questions posed by this study was utilized as a starting point. However, the researchers adapted the coding system during the coding process to accommodate unexpected findings. In doing so, additional coding categories were developed by reading over all of the data and searching for regularities in the data, and then writing down words and phrases that represented the topics and patterns that were not included in the initial set of codes (Bogdan & Biklen, 2007). The researchers then systematically sorted the data into the final set of coding categories (Bogdan & Biklen, 2007). Finally, the researchers examined the categorized data to identify any overarching themes or thematic findings (Bogdan & Biklen, 2007; Merriam, 1998). A list of the a priori and additional codes are presented in Table 1.

Findings

Quantitative Results

Teacher background information. Thirty-six of the teachers indicated they were female and 10 male. Teachers' reported years of teaching experience ranged from one to 40 years, with an

Table 1
Code List

A Priori Codes	Additional Codes
Whole class instructional use	Online learning
Individualized instructional use	Student assessment
Usefulness	Differentiated instruction
Ease of use	Electronic communications
Professional development	Technology-based projects
Technology experience	Online research
Planning time	Drill and practice
Technical support	Teacher productivity
Frequency of use of 1:1 computing	Student engagement

Table 2
Descriptive Statistics for Teachers' Grade Level Taught of Survey Participants

Subject	*Frequency*
Kindergarten	1
1st grade	0
2nd grade	0
3rd grade	0
4th grade	1
5th grade	3
6th grade	11
7th grade	7
8th grade	9
9th grade	7
Multiple elementary grades	1
Multiple middle school grades	5
Not reported	1
Total respondents	46

(n=20), mathematics (n=10), science (n=13), social studies (n=9), and other subjects (n=7). Thirty-nine of the participants indicated that they held a bachelor's degree, five a master's, one a doctorate, and one an "other" degree. When asked which 1:1 computing device they mostly used, 27 teachers responded laptops, three said tablets, and 16 reported using Chromebooks. The teachers represented seven grade levels ranging from kindergarten through ninth grade, as summarized in Table 2.

Correlation matrix. A matrix of Pearson correlations was produced to examine the correlations among select teacher background variables included in the survey and frequency of usewhole of 1:1 computing for class and individualized instruction. The results of the analysis indicated that teachers' years using a smartphone had a significant positive correlation with the frequency of usage of 1:1 computing for individualized instruction. The correlation matrix is presented in Table 3.

Instructional usage of 1:1 computing. On the survey, teachers were asked, "how frequently do you use 1:1 computing in each of the following ways" in separate items for each whole class and individualized instruction. The items were adapted from Davis' (1989) actual system usage and measured on a 5-point scale with endpoints ranging from "extremely frequently" to "extremely infrequently" (values were 5, 4, 3, 2 and

Table 3
Correlation Matrix of Teacher Background Variables Included in the Survey

Variable	Individualized Instruction	Whole Class Instruction
Years teaching	-.022	-.095
(sig.)	.913	.638
Years using computers	.215	.142
(sig.)	.281	.479
Years using laptop	.263	.123
(sig.)	.185	.540
Years using tablet	.346	.322
(sig.)	.077	.101
Years using smartphone	.518*	.358
(sig.)	.006	.067

* $p<.05$

Table 4
Survey Items Used to Calculate Teachers' Reported Frequency of Use of 1:1 Computing for Instruction

Survey Item	N	Min	Max	Mean	Standard Deviation
Whole Class Instruction					
a. I engage students in English / language arts lessons	5	1.00	4.00	3.200	1.304
b. I engage students in mathematics lessons	4	3.00	4.00	3.500	0.577
c. I engage students in science lessons	12	4.00	5.00	4.333	0.492
d. I engage students in social science / history lessons	9	2.00	5.00	3.668	0.866
e. My students conduct Internet research	38	1.00	5.00	3.658	1.258
f. My students create word processing documents	37	1.00	5.00	3.489	1.407
g. My students create multimedia presentations	35	1.00	5.00	3.000	1.534
h. My students create videos	35	1.00	5.00	2.114	1.301
i. My students use educational programs for drill and practice	38	1.00	5.00	3.605	1.242
j. My students access eBooks (online textbooks)	30	1.00	5.00	3.067	1.413
k. My students access complete digital curriculum materials	35	1.00	5.00	3.029	1.524
l. My students take computer-based assessments	41	1.00	5.00	4.073	1.081
m. My students take distance education courses	10	1.00	5.00	2.300	1.494
Individualized Instruction					
a. I engage students in English / language arts lessons	20	2.00	5.00	4.350	0.933
b. I engage students in mathematics lessons	10	2.00	5.00	3.300	1.059
c. I engage students in science lessons	13	2.00	5.00	4.000	1.080
d. I engage students in social science / history lessons	9	2.00	4.00	3.444	0.882
e. My students conduct Internet research	43	1.00	5.00	3.721	1.241
f. My students create word processing documents	40	1.00	5.00	3.775	1.097
g. My students create multimedia presentations	38	1.00	5.00	3.184	1.333
h. My students create videos	34	1.00	5.00	2.118	1.175
i. My students use educational programs for drill and practice	39	1.00	5.00	3.769	1.158
j. My students access eBooks (online textbooks)	31	1.00	5.00	3.258	1.341
k. My students access complete digital curriculum materials	36	1.00	5.00	2.972	1.502
l. My students take computer-based assessments	46	2.00	5.00	4.239	0.923
m. My students take distance education courses	13	1.00	4.00	1.846	1.068

1respectively). The list of items along with descriptive statistics for each is presented in Table 4.

Single resultant scores for teachers' reported frequency of whole class and individualized instructional use of 1:1 computing were calculated by estimating their sums from the mean of 13 survey items. Items a-d in the previous column were coded missing if the teacher did not report teaching the corresponding subject. Single resultant scores for whole class and individualized instructional usage was calculated by estimating the sum from the mean of the teachers' responses to all 13 teacher survey items. The rationale for doing so was to obtain an overall measure of use of 1:1 for both types of instruction while accounting for the fact that not all classrooms are the same, and the availability of technology resources and appropriateness of resources for use in a given subject or grade level may vary. It should be noted that teachers were able to choose the option "not applicable" on the survey if a given type of instruction did not apply to them and that those responses were coded as missing to minimize the problem of skewing the data in one direction or another if a particular technology was not available for a teacher to use in the classroom. Descriptive statistics and Cronbach's alphas for teachers' reported whole class and individualized instructional use of 1:1 computing are presented in Table 5.

Table 5
Descriptive Statistics for Teachers' Reported Frequency of Use of 1:1 Computing for Whole Class and Individualized Instruction

Variable	N	Min	Max	Mean	Standard Deviation	Cronbach's Alpha
Whole class instruction	45	1.75	5.0	3.286	.858	.799
Individualized instruction	46	2.0	5.0	3.429	.752	.890

Perceived ease of use and usefulness of 1:1 computing. Single resultant scores for teachers' reported PU 1:1 and PEOU 1:1 were calculated by estimating the sum from the mean of six teacher survey items. The survey items and details on the procedure for calculating these variables is described in Appendix A. Descriptive statistics and Cronbach's alphas for PU 1:1 and PEOU 1:1 are presented in Table 6.

Multiple regression analyses. Multiple regression analyses were conducted to address research questions 1 and 2. These analyses indicated that each PEOU 1:1 and PU 1:1 were significant predictors of both forms of instructional usage of 1:1 computing. The explanatory power of each of the models ranged from 8.1% for PU and whole class instruction (adjusted $R^2 = 0.181$, $F (1, 42) = 4.776$, $p < .034$) to as high as 26.4% for PEOU and individualized instruction (adjusted $R^2 = 0.264$, $F (1, 43) = 16.817$, $p < .000$). For the model that looked at PEOU 1:1 and whole class use, the adjusted R^2 was 0.152, indicating that 15.2% of the variability in whole class instructional use of 1:1 computing was explained by the model ($F (1, 42) = 8.705$, $p < .005$). Finally, in the model with PU1:1 and individualized use, the adjusted R^2 was 0.162, indicating that 16.2% of the variability in individualized instructional use of 1:1 computing was explained ($F (1, 43) = 8.340$, $p < .006$. The regression coefficients for each of the regressions are presented in Table 7.

Qualitative Results

What motivated teachers to use 1:1 for instruction? The qualitative findings of this study are organized by research question and theme and are supported by quotes from teacher interviews and open-ended items from the teacher survey. The first qualitative research question asked in this study was, "What motivates teachers to use 1:1 computing as an instructional delivery tool?" In the interviews and the open-ended survey items, teachers provided a range of reasons for using 1:1 computing in their classrooms. Some were very pragmatic, e.g., "fulfills the technology requirement" or "I use the Chromebooks [*sic*] because we have them. I want to utilize what we have that others do not." However, the most common

Table 6
Descriptive Statistics for Teachers' Reported Perceived Ease of Use and Perceived Usefulness of 1:1 Computing

Variable	N	Min	Max	Mean	Standard Deviation	Cronbach's Alpha
PEOU 1:1	45	2.67	5.00	4.274	.59618	.932
PU 1:1	45	2.67	5.00	4.327	.68947	.950

Table 7
Summary of Simple Regression Analyses for Variables Predicting Whole Class and Individualized Instructional Use of 1:1 Computing

Variable	Whole Class Use			Individualized Use		
	B	*SE B*	*β*	*B*	*SE B*	*β*
PEOU 1:1	.595	.202	.005**	.673	.530	.000**
PU 1:1	.395	.320	.034**	.442	.403	.006**

$^{**}p < .01$

reasons centered on increased student engagement, individualized instruction, and teacher productivity.

Increased student engagement. Many of the teachers noted that their students were engaged and enthusiastic about the use of the technology in the classroom. As one survey respondent said, "The students are many times more receptive to the 1:1 presentation than other teaching tools." Others noted that students enjoyed working together on the computers, and several respondents added that access to the technology helped prepare their students for the future. Asked about whether 1:1 computing was worthwhile, the Exceptional Student Education (ESE) Teacher replied, "Yes, absolutely! That is the best way to get them exposed to what they can expect on state testing, social media, email, etc. in the future."

Individualized instruction. Another powerful theme that emerged from the survey and interviews was individualized instruction and how the 1:1 computing setups could contribute to differentiation and personalized learning. For the ESE Teacher, individualization was an important reason to use 1:1 computing. "If the student is fine and only needs to work on vocabulary, I can do that. Groups are huge, and I can't get them all without that help." This may be especially relevant to coaches or others working beyond a single classroom; one survey respondent noted as a teacher of various grade levels and abilities that individualization and differentiation of instruction are vital. However, it can be important in every classroom, as one respondent noted, "Allows students to work at their own pace while I assist those who need help."

Teacher productivity. The next theme that emerged was more about the logistics of teaching, particularly efficiency, convenience, and organization. Several respondents appreciated the reduced need for paper, with one noting, "I love that I am not having to run to the copy room every day." Ease and efficiency of grading and assessment came up repeatedly, including the ability to provide faster feedback. A typical comment was "It frees up time for grading as well as time for students as everything is organized in one convenient place." One teacher, highlighting a logistical benefit, noted, "I don't always choose 1:1 computing - I select it when it's advantageous, ex. grading assessments & syncing grades to gradebook."

In what ways did teachers use 1:1 for instruction? The second qualitative research question in this study was, "In what ways do teachers use 1:1 computing as an instructional delivery tool?" In the interviews and the open-ended survey items, teachers reported numerous examples of both whole class and individualized instructional usage of 1:1 computing. The ways that the teachers used 1:1 computing for both types of instruction revolved around three themes: digital literacy tools, collaboration, and assessment.

Digital literacy tools. Several teachers described various digital literacy tools, including engaging students in Internet research, virtual labs, and deploying instructional materials via a learning management system (LMS). One example of fostering digital literacy with 1:1 computing was described by an Exceptional Student Education (ESE) teacher who taught multiple elementary grade levels. In her interview, she described some of the most useful tools for engaging her class in digital instruction as, "I use ActivInspire, Promethean Board for things like animal research. I use them to teach the students to type in a URL and how to verify validity of websites." This teacher's response is an example of how a teacher can combine the use of multiple forms of instructional technology to teach the fundamental digital skills of Internet research and website evaluation.

A ninth-grade science teacher provided an example of using 1:1 computing as a digital literacy tool. She described a typical lesson as one in which she differentiated instruction for students in need of remediation, as well as for those with Limited English Proficiency (LEP). On the survey, she wrote, "I send out videos, podcasts, enrichment activities, as well as remediation activities. In some cases, notes are given electronically as an accommodation or in another language for my LEP students." Another ninth-grade teacher of social studies fostered digital literacy through the activity of students, "looking up how a [sic] historical events connect to issues today to support rigor and relevance in a lesson."

Collaboration. The qualitative data also showed that the teachers used 1:1 computing to engage students in collaborative assignments such as conducting Internet research and creating technology-based projects. For example, on the survey a middle school research teacher described a typical lesson in which 1:1 computing was used. Specifically, the teacher wrote, "Students complete individualized research online. Students are put into teams to collaborate on their research and create a digital presentation of their work to the class." Another ninth-grade science teacher described a typical 1:1 computing lesson along similar lines. On the survey, she reported that students use 1:1 computing to conduct their own research with the devices and collaborate on Google Docs for projects. In both cases, these teachers incorporated research with the use of digital tools and digital literacy to complete collaborative projects.

During another interview, a kindergarten teacher reported that she favored using 1:1 computing for whole class instruction; she also reported using it for individualized collaborative assignments. On the survey, she wrote, "I find it [1:1 computing] more useful for whole group with my little ones. But I do a lot of partnering with the kids, and they have created Google slides together and presented them to the class." This finding is important because it shows how teachers of very young children can foster collaboration along with digital literacy skills using 1:1 computing devices.

Assessment. Assessment was the last theme that was prevalent in the qualitative analysis of how teachers used 1:1 computing for instruction. The quantitative results showed teachers used assessment tools with 1:1 computing very frequently in both individualized and whole class instruction. Qualitative results showed more details about the type of assessments and how they were used. One teacher reported frequently using computers for formative and summative assessment using a popular online program in Florida called the i-Ready. Another second grade teacher found the computer equally useful for individualizing assessment if remediation is needed after whole class assessment. One third grade teacher particularly liked the computer for assessment because it allowed students to control the pace of the assessment. A third through fifth grade teacher uses computers for formative assessments during lessons that take several days.

Discussion

This study found significant relationships among several of the variables examined as well as qualitative findings that helped explain rural school teachers' adoption of 1:1 computing. Regarding our first research question, "To what degree does teachers' perceived ease of use of 1:1 computing predict their reported instructional usage of 1:1 computing?", the quantitative analysis indicated the variables perceived ease of use and perceived usefulness of 1:1 computing were significant predictors of both individualized and whole class instructional use of 1:1. These findings supported Davis' (1989) theory that perceived ease of use and usefulness influence the actual system usage of a given device. It is important to point out that the descriptive statistics of the variables that made up the 1:1 computing usage constructs varied from one instructional application to another. For example, while the mean teacher-reported frequency of using 1:1 computing for whole class instruction was 3.286, engaging students in science lessons (mean = 4.333) was the form of whole class 1:1 computing with the highest reported frequency of use. The whole class practices that teachers said they used with the least frequency were lessons in which students create videos (mean = 2.114). It was not surprising to find that individualized instruction (mean = 3.429) was used with a slightly higher frequency than whole class since individualization was a factor found to motivate teachers to use 1:1 computing as an instructional delivery tool in the qualitative analysis. The application of individualized instruction the teachers said they used most frequently was for teaching English / Language Arts lessons (mean = 4.350) while the most infrequently used practice was students taking distance education courses (mean = 1.846). These findings are important because the use of distance learning could open new educational opportunities for geographically isolated students (Azano & Stewart, 2015). This could give these students access to courses and individualized learning opportunities that smaller districts might not have the resources to provide. These distance learning resources include courses that are accelerated, remediated, or unavailable in smaller districts. Public funded virtual schools and non-profits such as the Khan Academy might help fill these gaps. Although the quantitative analysis in the current study focused on examining the degree to which the rural teachers' perceived ease of use of 1:1 helped to predict their instructional use of 1:1, future studies could look at the adoption of distance education to expand rural students' educational opportunities.

Another goal of this study was to learn what motivated the rural teachers to use the 1:1 computing for classroom instruction and to describe the ways in which they did so. One of the prominent themes to emerge was the motivation to use 1:1 computing as a way to increase teacher productivity. Although some of the reasons the teachers provided relating to productivity were teacher-centered, such as saving time running to the copy machine, other reasons were student-centered, including freeing up time for students by electronically organizing learning materials in a central location. This was important because it showed that the teachers' motivation to use 1:1 computing extended beyond themselves to include making instruction more productive for their students. As one teacher in our study said, "I choose it [1:1] in order to progress the students to a logical path they will see in human life, the computer/technology age is here and needs to be embraced." A related finding was that teachers use 1:1 computing to personalize instruction for their students. One example was the high school science teacher who described using 1:1 computing to differentiate instruction for special needs and LEP students. This illustrates how 1:1 computing, coupled with an LMS can be used to individualize instruction to meet the unique needs of different types of learners commonly enrolled in rural schools.

The current study also revealed that the rural teachers were motivated to use 1:1 computing because it increased student engagement. These findings were consistent with previous research on technology integration in rural schools, which indicates that implementation of 1:1 computing positively impacts student engagement and attentiveness (Dawson et al., 2008; Keengwe et al., 2012; Walker & Shepard, 2011). Furthermore, Wake (2012) found that the appeal of technology alone motivated rural middle school students to share digital stories that expressed their views on teen life in a small, rural town. Although student engagement with the technology was noted by many respondents in this study, is this a finding that is destined to be ephemeral? As more students become accustomed to 1:1 computing classrooms, will the novelty of the technology, and the engagement boost that comes with it, wear off? For now, these findings support the notion that the implementation of 1:1 computing devices has a positive impact on teaching practices. In order for teachers to adapt to an ever-changing society with technological advances, it is important for them to adopt teaching practices that will continue to motivate and engage students.

Limitations & Future Research

As this study was conducted in a small, rural school district, the sample size was relatively small with only 46 participants. The limited number of teachers meant we had to look at instruction with 1:1 from a macro level. A larger number of participants would allow analysis of smaller subsets, including examining the impacts of things like instructional purpose or whether differences in 1:1 use varied by grade level or subject. Elementary, middle, and high school teachers often come from different educational programs and may have different experiences and views on classroom technology use; the same could be said for teachers in different subject areas. Another limitation was that the data collected reflected teachers' perceptions of the concepts and ideas in the study, rather than actual observed values. For this study resources were limited, but in future research it is hoped that researchers could also observe the teachers in the rural district using 1:1 computing for instruction and compare those results to the self-reported data. Another limitation is that some selection bias was certainly possible in the survey response rate. For one, it is possible that the teachers who responded to the survey and interview invitation were also those who were more avid users of 1:1 computing, so a study that was able to survey an entire rural teaching faculty, or a true random subset of it, would be useful.

An important consideration is the range of professional development opportunities available to the teachers in the rural district. The district in the current study is located within an hour or two drive of a larger urban area that offers a wide range of teacher training and professional development opportunities. Therefore, some teachers may have been able to access training that extended beyond the district. These factors could affect the pool of teachers willing to participate in the study and the experience of teachers implementing new technology. It would be useful to compare these results to a rural context that was significantly more remote.

Conclusion

The results of this study demonstrated that the rural teachers taking part in the 1:1 computing initiative made use of the devices for instruction in a variety of ways, some that are supported by previous studies, and others that suggest more research on the role of technology in rural schools is worthwhile. Digital literacy is a constantly evolving concept that encompasses a broad range of necessary skills in the connected world, everything from reading on a mobile device to gauging the validity of a website or creating and sharing videos (Heitin, 2016). Participant teachers used 1:1 computing as a digital literacy tool to conduct Internet research and collaborate in online projects. These findings are important because possessing digital literacy is an essential 21st century skill, and they are consistent with prior research that indicates 1:1 computing is associated with pedagogical shifts towards more student-centered teaching practices such as project-based instruction and collaborative learning (Dawson et al., 2008).

Using 1:1 computing for assessment was another theme that emerged in this study and was also prominent in prior research (Corn, et al., 2011; Silvernail et al., 2011). However, this study found differentiation and individualization of instruction involving 1:1 to be a prominent theme in the qualitative analysis, whereas prior research found differentiation either decreased (Dawson et al., 2008) or was observed in only about half of the participating teachers (Silvernail et al., 2011). Whether this emphasis on differentiation is enhanced in the rural school context would be worth exploring in future research on instruction with 1:1 computing. Differentiating instruction and assessment can help rural teachers close gaps that have been more challenging to address in rural contexts. As comments by our participants indicated, connected classrooms and related technology are providing tools, training, and student resources that were previously unavailable or difficult to access for teachers in more remote locations.

Adapting to 1:1 classrooms can take time, and it is worth noting that school-wide, or in this case, district-wide 1:1 computing programs extend beyond the early adopters and technophiles that often populate educational technology studies. Bebell and Kay (2010) noted that despite successes "…almost everyone involved also expressed the sentiment that 'even after a couple of years teachers still felt like they were just getting accustomed to teaching in a 1:1 setting'" (p. 21). Overall though, the implementation of 1:1 computing appears to have been well received by the teachers in this study. Taken together, our quantitative and qualitative data suggest that when given the opportunity, teachers in rural schools can find ways to make 1:1 computing classrooms work for them, both instructionally and logistically. Continued research on the implementation of 1:1 computing will help shed light on more of the long-term effects and unique benefits on teaching and learning in the rural school context.

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Appendix A

Table A1

Survey Items Used to Calculate Teachers' Reported Perceived Ease of Use of 1:1

Survey Items Used	Method of Calculation
Please indicate your level of agreement with each of the following statements regarding your 1:1 computing experiences. 1. Learning to operate 1:1 computing would be easy for me 2. I find it easy to get 1:1 computing to do what I want it to do 3. My interaction with 1:1 computing would be clear and understandable 4. I find 1:1 computing to be flexible to interact with 5. It was easy for me to become skillful at using 1:1 computing 6. I find 1:1 computing easy to use Items were measured using a 5 point - scales with endpoints ranging from *extremely likely* to *extremely unlikely* (value of 5, 4, 3, 2 and 1 respectively).	Each participant's points for these items were summed (using the X-1 criteria for inclusion) to obtain a single score.

Table A2

Survey Items Used to Calculate Teachers' Reported Perceived Usefulness of 1:1

Survey Items Used	Method of Calculation
Please indicate your level of agreement with each of the following statements regarding your 1:1 computing experiences. 1. Using 1:1 computing in my job enables me to accomplish tasks more quickly 2. Using 1:1 computing improves my job performance 3. Using 1:1 computing in my job increases my productivity 4. Using 1:1 computing enhances my effectiveness on the job 5. Using 1:1 computing enhances my effectiveness on the job 6. Using 1:1 computing makes it easier to do my job 7. I find 1:1 computing useful in my job These items were measured and coded using the same scale in Table A1 above.	The same summing procedures in Table A1 above.