Differential barriers to educational technology faced by urban and rural schools.

AnnMaria De Mars

The Julia Group

Research on rural education has found significant differences in preferences, resources and access compared to rural communities. Lowrie and Jorgensen (2012) reported that rural teachers valued electronic delivery of mathematics education in that it facilitated updates of curriculum materials, an especial value in remote communities that were hundreds of miles from the nearest specialized bookstore. Changes made to assignments or explanations were immediately available online, eliminating the cost and delay in providing supplemental materials to correct students' misunderstandings or as an alternate method of instruction. Not all electronic media was equally valued. Both teachers and parents were turned off by the "drill-and-practice" methods in much of technology, which encouraged students to guess rather than reason out answers. Teachers also express a preference for assessments similar to those used in high stakes testing (Lowrie & Jorgensen, 2012). In urban areas, commercial test preparation centers are an option for practice in test-taking skills. In rural communities, online is usually the only option for students to gain standardized test experience.

Regardless of their preferences, rural educators may be prevented from accessing educational technology. Due to high costs of installing fiber optic connections in rural areas, urban residents are three times more likely to have high-speed broadband access (Wheeler, 2014). Hunt-Barron et al. (2015) reported a variety of barriers in Internet access across rural school districts, with some teachers citing unreliable Internet connections that resulted in often being disconnected from the Internet while using computers. Sites blocked by district policy

were a barrier to technology for 17% of the rural teachers surveyed, consistent with our results that this is a barrier for a minority of rural personnel. Richardson and McLeod (2011) in a sample of nine rural schools found an unmet need for technology specialists as an impediment to using educational technology.

Rural schools **differ** from their urban counterparts in broadband access, professional development needs, curriculum and institutional barriers. National Center for Education Statistics (2013) reports portray rural America as well-supported with educational technology; 100% have instructional computers with Internet access. At the national level, "cloud-based solutions" are being advocated. However, Internet access is far from equal. The chair of the Federal Communications Commission noted that 41% of rural schools "couldn't get a high-speed connection if they tried" (Wheeler, 2014). Broadband access, defined as download speeds of 25 megabits per second, is only available to 45% of rural Americans versus 92% of urban Americans. Rural teachers find unreliability of access in bandwidth to be a major problem (Lowrie & Jorgensen, 2012).

Rural districts have more problems recruiting and retaining teachers and more personnel teaching out of their specialty area, particularly in mathematics and science. Teachers in rural schools have greater difficulty accessing professional development than their urban counterparts, due to both lack of qualified substitute teachers and greater cost and time away from school to travel to training. Information technology is of uneven benefit to rural communities. It does provide the ability to share experiences and knowledge with other professionals, at the same time, the bandwidth, software or hardware limitations of some schools is a barrier to easily accessing resources (Beswick & Jones, 2011).

The present study is the result of a pilot study funded by a U.S. Department of Agriculture

Small Business Innovation Research grant aimed at providing an optimal educational technology solution for rural schools. During the pilot testing in two rural school districts, five urban schools, from two districts, approached The Julia Group during the grant period and volunteered to be part of the initial testing at their own expense. We took advantage of this opportunity to compare implementation at urban and rural schools. This serendipitous event provided valuable data. None of the rural schools identified installation as an issue, either, teachers had their own administrator password, or an on-site information technology specialist is available to install software. To follow up this unexpectedly large discrepancy between districts, a larger sample size was collected to test the hypothesis that rural districts would have greater hardware barriers to implementation of educational technology while urban schools experience equal or greater barriers due to district policies.

Method

Sample

A sample of 17 schools participated, 8 rural schools and 9 urban schools. The rural schools were from one district in California, one district in Missouri and three districts in North Dakota. Rural schools were located in towns ranging from less than 200 in population to 9,100. Urban schools came from two districts in California, both with over 100,000 students.

Volunteers were recruited through our mailing lists of educator contacts and posting on our company website and Facebook page. Data were collected during the 2015 fall semester from schools that had volunteered to be part of a pilot test of educational adventure games designed to teach mathematics, social studies and English/ language arts (ELA). To participate, a member of the school staff was required to commit to having desktop games installed on school computers and online game accessed from school laptop, desktop or tablet computers. Schools were

provided USB drives for two games that required a desktop install, a link to downloads for the same games, links to login and play two, additional, on-line games and a link for an achievement test of mathematics and ELA standards taught in the games. As an incentive to participate, schools received the games free for two years, the pilot testing period and the following school year. All respondents who worked at schools serving students in grades 5-8 and replied by the deadline were included in the sample.

Data Collection

Semi-structured interviews were conducted in person or by telephone within one month of receiving the software with the designated contact person for each site. Contacts were asked whether the games had been installed, and if yes, whether students were using the games and for feedback on game usability and design. Respondents were also asked to describe any barriers to getting the software installed and accessible to students. Whether or not they used a flash drive for installation, school contacts were asked to download the software and report the amount of time required. Schools that were not using the games at the one-month follow-up were contacted again after two months, and, if still not using the games, contacted a third time for a three-month follow-up.

Validation of responses was conducted by cross-referencing reports of installation with the student database records of game usage. There was a 100% match; all schools reporting the game installed had active student records in the game log file, and there were no student records prior to reports of installation.

Data Analysis

Data analysis was conducted using SAS/STAT statistical analysis software, version 14.1 (A cross-tabulation of install issues (yes or no) by rural district (yes or no) was created with

PROC FREQ. Given that all cells had expected counts less than 5, a Fisher's Exact Test was used to test for statistical significance.

Results

Cross-tabulation of district type (urban versus rural) by whether the school experienced problems with installation is shown in Table 1. The probability under a two-sided null hypothesis of no relationship = .0034. It can be seen below that the experiences at urban and rural schools were diametrically opposite. While nearly 90% of urban schools

Table 1

District Type by Installation Issue

	Installation Issues		
District	**No**	**Yes**	**Total**
Urban			
• **Frequency**	1	8	9
• **Row Percent**	11.11	88.89	
Rural			
• **Frequency**	7	1	8
• **Row Percent**	87.50	12.50	
Total	8	9	17
	47.06	52.94	100.00

reported an issue with installation, nearly 90% of rural schools did not report installation as a

barrier. At two rural schools, the software was installed the day it was received, and at seven of the eight schools, it had been installed within two weeks of receipt. At only one school was policy a barrier to installation; software was approved for installation on an annual basis and the teacher was required to wait until the approval date for the new software to be approved and installed. At the time of publication, the approval date had not yet arrived!

At urban schools, in contrast, the median wait time from receipt of software to installation was three months. Median is used instead of mean because five months into the academic year, four of the schools still have not been able to get the games installed. The director of one after-school program that wanted to use the games decided it was easier for his program to go out and buy their own computers than to get through all of the layers of district approval to use the school computer labs. Installation is planned as soon as the program's computers arrive.

Qualitative data from the interview transcripts supported equally distinct experiences. Table 2 below gives typical examples of the contrasting statements between urban and rural schools.

Table 2

Participants' Descriptions of Installation Issues, by School Type

School type	**Installation Experience**
Rural	"It took me, like, two minutes to get approval. I called the IT guy and he came over and installed it."
Rural	"Well, we're a very small school you know. I wear many hats and one of them is the IT administrator at our school, so I just installed them myself."
Urban	"I needed to get it approved by the math coach, and she was all on board. Then

	I got it approved at the building level. We had new administration this year so it took them a few weeks to get around to it, and then they were all for it. Then it got sent to the district level. Since your games had already been approved by the district, that was just a rubber stamp but it took a few weeks until it got back to us, then we had all of the approvals so we needed to get it installed but the person who had the administrator password had been laid off. Fortunately, I had his phone number and I got it from him. Then, we just needed to find someone who had the spare time to put the game on all of the computers. All told, it took us about three months, which was sad because that was a whole semester lost that the kids could have been playing the games. "
Urban	"The computers were donated from a local company and no one at our school had the administrator password. We called the company and the person who knew the password was no longer there. "

With regard to download time, the urban schools had a substantial advantage over the rural ones. Since four urban schools did not yet gain access to the computers, and one school contact did not download the game, data were only available for four urban schools, two from each of two districts. There was very little variance in download time reported. For the two files of size 500MB and 700MB, staff reported that download times were "about five minutes", "2-5 minutes", "3-5 minutes" or "under 5 minutes".

Of the 7 rural schools where the game was installed, the picture was very different. Several schools flatly told us we were "crazy" but allowed us access to a school computer to time the download. The median download time required was 45 minutes. Four schools required

approximately 45 minutes, one required 55 minutes, and one school in a remote community, download required 240 minutes, as the Internet connection dropped repeatedly. The seventh school contact reported simply “a really long time”.

Conclusion

Solving the access problem is a multi-faceted issue. While urban schools have access to the information superhighway, rural schools have access to their own hardware. In accessing an educational adventure game, desktop-based solution proved effective for nearly all of the rural schools in this sample, while a cloud-based solution, requiring no installation but high-speed bandwidth seemed optimal for most urban schools.

The current sample was limited both in size and geographic distribution. Further study is required with larger and more representative sample sizes. A multi-method design, such as the present study, in which teachers are not merely surveyed but rather are required to attempt implementation, is strongly recommended in research on barriers to implementation. None of the school contacts that experienced barriers in installation had predicted the extent of delay in implementation. On the other hand, while teachers were generally poor predictors of barriers, they were very accurate reporters, with complete agreement between teacher reports of software installation and electronic records of school usage.

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