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Abstract

Most educators, parents, and students seem to agree that computers and information technology should play an increasingly important role in education. As schools continue to add hardware and software, there has been concern about equity. One fear has been that students in rural schools may be at a disadvantage compared to students in urban or suburban school districts. A major problem in interpreting the small, existing body of research comparing the use of information technology in urban and rural schools is the variety of ways that the term rural is defined by researchers. This study developed two matrices (Appendix A and B) and used them to categorize rural districts as either frontier (extremely isolated) or other rural and compared computing resources. The study determined that frontier schools have a higher quantity and quality of information technology resources per student and per classroom while rural schools tend to have faster and higher quality Internet connections.

Introduction

Over the last 25 years, information technologies in general and small computers in particular have been integrated into every sphere of modern living. As we go about our daily lives, these technologies surround us wherever we go (Smaldino, et al. 2005)[1]. The rapid proliferation of computers has also taken place in education (Parsad and Jones 2005)[2]. While there continues to be skepticism on the part of some (e.g., Cuban 2001)[3], most educators, parents, and students seem to agree that computers and information technology should continue to play an increasingly important role in education at all levels (Roblyer 2004)[4].

Bringing Technology Into Education

While schools continue to increase the pace with which they are acquiring computer hardware, software, and peripherals, few would argue that information technology has revolutionized teaching or learning, or even that educational technology has come close to fulfilling its potential (Hawkes, et al. 2002[5]; Ivers 2002[6]; Norton and Sprague 2001[7]). Many reasons have been advanced as explanations for the difficulties encountered in effectively integrating technology into education. Some reports have suggested that educators lack the skills and knowledge to effectively integrate such technology into their instruction, and call for better teacher preparation programs and more and better staff development opportunities for practicing K-12 educators, (CEO Forum on Education and Technology 1999[8]; Fishman et al. 2000[9]; Yaghi 1997[10]; Yildirim 2000[11]; Yildirim and Kiraz 1999[12]). Other reports have focused on the amount and quality of hardware and software in schools, and the difficulties schools have in obtaining and maintaining such software. However, the most recent of these reports show that schools have made a great deal of progress in obtaining up-to-date equipment. For example, Parsad and Jones (2005)[13] point out that "In 2003, the ratio of students to instructional computers with Internet access in public schools was 4.4 to 1, a decrease from the 12.1 to 1 ratio in 1998, when it was first measured" (p. 7).

Concerns About Digital Equity

However, such statistics are averages, and there is an increasing body of research showing that digital inequality exists among various populations in the U.S. and that this disparity can lead to lowered student achievement (Cattagni et al. 2001[14]; Cooper 2002[15]; and Lauman 2000[16]). One source of concern about possible digital inequality has been that students in rural schools may be at a disadvantage compared to students in urban or suburban school districts.

Technology and Rural Education

There are good reasons to investigate the status of information technology in rural schools. After all, rural households are less likely to have computers and Internet service than are urban households (United States Department of Commerce et al. 2000)[17]. Furthermore, rural communities are less likely to have qualified support staff within their local labor pools. Then too, acquiring technology is often more challenging for rural schools than it is for their urban counterparts (Katsinas & Moeck 2002[18]; Silvis 2000[19]; Staihr and Sheaff 2001[20]; Vidoni 2002[21]). This is true because rural schools tend to have less philanthropic resources at their disposal and depend greatly on government support for their resources (Schwartzbeck 2003)[22]. When governments cut educational spending, rural schools tend to fare worse than urban schools from these cut-backs with the most remote schools faring worst of all (Bolinger 1999[23]; Katsinas and Moeck 2002[24]; Schwartzbeck 2003[25]; Silvis 2000[26]; Staihr and Sheaff 2001[27]; VanSciver

1994[28]). Furthermore, electricity and telephone connections, integral ingredients for connection to the Internet, are still not available or affordable to some people living in rural communities. This is particularly true of those living on Native American reservations where 12% of households lack electricity and 61% lack telephone service (Solomon et al. 2003)[29].

There is also concern that rural districts may be at a disadvantage compared to urban or suburban districts in terms of their ability to maintain and facilitate information technology in schools, since many rural areas lack a skilled local labor pool and the budget necessary to hire and retain such workers. Then too, rural schools may have difficulty providing high-quality inservice education aimed at preparing teachers to use and integrate available technologies. While schools everywhere struggle to cope with such problems, they are often particularly acute in rural schools (Hawkes et al. 2002)[30].

In view of these special difficulties in rural areas, it is surprising that some preliminary research has shown that rural school districts are better equipped than their urban counterparts in terms of quality and quantity of technology (Cattagni et al. 2001[31]; Smerdon et al. 2000[32]). However, these studies also reveal that rural children lag behind their urban or suburban counterparts in terms of home access to information technology. Home access is considered important since research indicates that students who use computers at home generally come to school already comfortable with computers and do not need to learn basic skills before they can begin reaping the benefits of information technology in education (Lauman 2000)[33].

Frontier and Rural Areas

A major problem in interpreting the small, existing body of research comparing the use of information technology in urban and rural schools is the large variety of ways that the term rural is defined by researchers. Unfortunately, there are almost as many ways to define rural as there are rural education studies. For example, three different agencies within the United States government offer three different definitions (Beale 2002[34]; Miller 2003[35]; Yax 2002[36]). Beale codes, developed by the U.S. Department of Agriculture’s Economic Research Service, classify rural counties by their proximity to metropolitan areas (Beale 2002)[37]. The U.S. Bureau of Census developed locale codes, also known as Johnson codes, that are based on a community’s proximity to a metropolitan area and its population density (Miller 2003)[38]. The National Center for Education Statistics developed the simplest of the three classification systems. Their scheme makes use of metro status codes, where physical location of the district superintendent’s office determines the district’s rating (Yax 2002)[39].

Most problematic of all, most existing studies group all rural school districts together by defining rural as all areas that are not urban or suburban. Such a definition gives no consideration to the differences within and between rural educational contexts and settings (Frontier Education Center 2002a[40]; Sherwood 2001[41]). This is a problem because there may be very real and highly relevant differences in the way information technology is treated in rural school districts that are extremely remote or isolated, compared to those that are also rural but that are not nearly so far removed from more populous areas.

One promising way to highlight differences within rural areas is to categorize rural areas as either frontier or other rural. The Frontier Education Center (FEC) was founded in 1997 to address the medical needs of people living in the most remote areas in the United States. One of the first tasks FEC performed was to create this dichotomous classification system for rural areas. The system differentiates between areas that are simply rural and those that are frontier by establishing a scoring matrix. Variables on the matrix include population density, distance from services and markets, and travel time to services and markets (Frontier Education Center 2002b)[42]. FEC then used the matrix to classify each county in the U.S. as either frontier or non-frontier.

As already mentioned, very little research has focused directly on the state of information technology in rural school districts, and none of the studies that do exist have differentiated between frontier and other rural communities or schools. In fact, the most comprehensive study addressing rural education (Stern 1994) makes very little mention of information technology. However, the report suggests that schools in isolated communities can greatly enhance education through information technology, especially if those schools are in very remote areas that lack adequate educational resources.

Purpose of the Study

The present study investigated information technology resource differences in rural areas. A system was devised to classify schools as either frontier (highly remote) or other rural. (In the interest of brevity, the other rural classification will be referred to simply as rural for the rest of this paper.) The study sought answers to the following questions:

- Is there a difference between rural and frontier Nevada schools in the availability of computers?
- Is there a difference between rural and frontier Nevada schools in the quality of information technology hardware, software, and other, related hardware?
- Is there a difference between rural and frontier Nevada schools' availability and quality of Internet access?

Method

Instrument

In 2003, the Nevada Department of Education finished compiling the Nevada Online Technology Information Survey (NOTIS). NOTIS investigates the technology infrastructure, planning, budget, professional development, technical support, and hardware inventories in all Nevada schools. NOTIS data were used in the present study to address the research questions.

The Nevada Department of Education gathered NOTIS data by requiring all Nevada public schools to complete an on-line survey during the Fall, 2002 semester. A copy of the full survey may be obtained by contacting the senior author of this article.

Participants

In 2003, there were 17 school districts in Nevada consisting of 520 schools. With only one exception, Nevada's school districts are separated by county lines. The number of schools in each district varies from 3 to 273. Table 1 lists the 17 Nevada school districts and the number of schools in each district. Letters have been substituted for the actual names of districts.

Table 1: Nevada School Districts and Number of Schools in Each District

DISTRICT	
A	12
B	9
C	273
D	15
E	25
F	3
G	3
H	13
I	6
J	9
K	17
L	5

M	18
N	4
O	4
P	95
Q	9
TOTAL	520

Source: Nevada Department of Education (2003)

Although NOTIS contains data on all Nevada schools, not all Nevada schools were used for this study because some schools are neither rural nor frontier, but urban. Therefore, NOTIS data on urban schools were not used in this study. Thus, a measure for identifying and eliminating urban schools was needed, as well as a method for further categorizing rural schools as either frontier or rural.

Procedure

First, NOTIS data was obtained from the Nevada Department of Education. Second, the data were screened to determine which Nevada schools are urban and which Nevada schools are rural (including both frontier and rural categorizations). Third, urban schools were eliminated and the data were screened a second time to determine which rural Nevada schools are only rural and which are frontier.

The first step was to eliminate urban schools. This was done by identifying those schools that were either rural or frontier and eliminating the others. To do that, all schools in Nevada counties not designated frontier by the Frontier Education Center (Frontier Education Center 2002c)[43] had to be examined to determine whether they were urban or rural. (By definition, no schools in counties designated frontier by FEC could be urban by any definition, and would have to be classified for this study as either frontier or rural.) Nevada counties A, C, D, and P are not designated frontier by FEC, and thus may contain urban schools. A scoring matrix was designed (see Appendix A) that allocates points to schools depending on the population of the town in which the school is located and the driving distance from that town to a major metropolitan area. The points vary and schools must meet minimum requirements within both the population and driving distance criteria in order to be considered rural. For this study, schools located in towns with populations exceeding 2,500 or within 29 miles of a major metropolitan area were designated urban even if they met the matrix requirements for rural designation. This population number was selected because 2,500 is consistent with two of the U.S. Federal Government's definitions of rural (Beale 2002[44]; Miller 2003[45]). The cutoff of 29 miles was selected because it is consistent with FEC's definition of rural (Frontier Education Center 2002b)[46].

Once urban schools were eliminated, the next step was to determine which of the remaining schools were frontier and which were rural. A second scoring matrix (see Appendix B) was created modeled after FEC's frontier scoring matrix. The scoring matrix contains data on three variables: (a) the population of the town in which the school is located, (b) driving distance from the school to the district office, and (c) driving distance from the school to the closest hospital. Although it has been argued that population density is the best gauge of an area's remoteness (Frontier Education Center 2002b)[47], information on Nevada population density is not available for some of its most remote areas. Therefore, absolute population figures for each town were used instead of population density. The driving distance from the school to the district office was included in the matrix because this is consistent with the National Center for Education Statistics' Metro Status Codes. The driving distance to the closest hospital was included and the cutoff distance of 29 miles was established because these criteria are consistent with FEC's definition of frontier.

Population figures were determined by using census data provided by the U.S. Census Bureau (United States Bureau of the Census 2000)[48]. Where Census Bureau information was not available due to remoteness of the area, the Rand McNally 2003 Commercial Atlas[49] population figures were used, since this publication provides populations of remote areas that the Census Bureau does not provide.

Driving distances between points were obtained by entering addresses into the driving direction feature of MapQuest (http://www.mapquest.com), a Web site that offers mapping services over the World Wide Web. Addresses entered were the school's address and the address of the desired destination, either the nearest hospital or the school district office. MapQuest produces a map that pinpoints locations entered, and provides the shortest and quickest route between two locations including estimated driving time and distances in miles. MapQuest updates its databases regularly with data obtained from seven different data vendors (Mapquest 2003)[50].

Only hospitals accredited by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) were used for this study. Twenty-six such hospitals are located in Nevada, and because some communities in Nevada are closer to hospitals in other states than to hospitals in Nevada, four, accredited out-of-state hospitals were used (one each in California, Utah, Oregon, and Idaho) (Joint Commission on Accreditation of Healthcare Organizations 2003)[51]. JCAHO is an independent, not-for-profit organization that accredits only those U.S. hospitals that adhere to their set of standards. Established in 1951, JCAHO is regarded as the premier accrediting agency in the healthcare industry.

Once frontier and rural Nevada schools were identified, it was necessary to enter this grouping variable into the NOTIS data set for analysis. Since these data include the entire population of schools in Nevada, it was not appropriate to use inferential statistics. Therefore, only descriptive statistics were used to analyze the data.

Results

Results will be addressed directly as they apply to the research questions of this study.

- **Is there a difference between rural and frontier Nevada schools in the availability of computers?**

To answer this question, NOTIS data were analyzed to determine, for each rural and frontier school, the mean number of students per computer, mean number of instructional computers per classroom, and mean number of students per instructional classroom computer. The data showed that on average, there are approximately twice as many computers per frontier student (.66:1) as there are computers per rural student (.33:1). This means the student/computer ratios are 1.51 frontier students for each computer and 3.03 rural students for each computer. Additionally, the mean number of instructional computers per classroom is 3.54 instructional computers per frontier classroom compared to 2.61 instructional computers per rural classroom. Furthermore, there are approximately twice as many instructional classroom computers per frontier student (.35:1) than there are per rural student (.17:1). This means the student/computer ratios are 2.86 frontier students for every instructional classroom computer and approximately 5.89 rural students for every instructional classroom computer. Table 2 presents these results.

These data indicate that frontier schools have more information technology hardware available than do rural schools.

Table 2
Computers per Student, Instructional Computers per Classroom, and Instructional Classroom Computers per Student in Rural and Frontier Districts

	Computer/Student*				**Instructional Computer/Classroom****				**Instructional Classroom Computer/Student*****			
Local	***n***	***M***	***SD***	***Mdn***	***n***	***M***	***SD***	***Mdn***	***n***	***M***	***SD***	***Mdn***
Frontier	40	.66	.50	.55	40	3.54	3.29	2.67	39	.35	.23	.30
Rural	83	.33	.22	.26	86	2.61	2.18	1.81	83	.17	.15	.13
Total	123	.44	.37	.33	126	2.91	2.61	2.00	122	.23	.20	.16

* 4 missing rural cases
** 1 missing rural case
*** 5 missing rural and frontier cases

- **Is there a difference between rural and frontier Nevada schools in the quality of information technology hardware, software, and other, related hardware?**

To answer this question, NOTIS data were analyzed to determine mean number of desktop and laptop computers per student that operate with both up-to-date and out-of-date operating systems and mean number of televisions, scanners, laser printers, digital cameras, and graphic calculators per student. Table 3 presents data relevant to this question. Inspection of this table shows students in frontier schools (M = .18, SD = .28) are twice as likely to have access to a Windows XP-compatible desktop computer than are students in rural schools (M = .09, SD = .18). The table also shows that frontier and rural Nevada students have similar access to Macintosh computers.

Table 3

Non-Macintosh OS X, Macintosh OS X, Non-Windows XP, and Windows XP Compatible Desktop and Laptop Computers Per
Frontier and Rural Student

	Frontier				Rural*				Total			
	n	***M***	***SD***	***Mdn***	***n***	***M***	***SD***	***Mdn***	***n***	***M***	***SD***	***Mdn***
<u>Macintosh</u>												
Earlier than 8.0	40	.03	.07	.00	84	.01	.05	.00	124	.02	.06	.00
System 8	40	.01	.05	.00	85	.02	.04	.00	125	.02	.04	.00
System 9	40	.01	.04	.00	85	.02	.04	.00	125	.02	.04	.00
System X	40	.01	.04	.00	84	.02	.10	.00	124	.01	.08	. 00
<u>PC</u>												
DOS	40	.00	.01	.00	85	.00	.02	.00	125	.00	.02	.00
Windows 95	40	.16	.23	.03	83	.07	.10	.02	123	.10	.16	.02
Windows 98	40	.22	.22	.15	83	.13	.19	.07	123	.16	.20	.08

Windows ME	40	.00	.00	.00	84	.00	.01	.00	124	.00	.01	.00
Windows NT	40	.00	.00	.00	85	.00	.00	.00	125	.00	.00	.00
Windows 2000	40	.08	.00	.00	83	.02	.08	.00	123	.04	.19	.00
Windows XP	40	.05	.20	.00	85	.03	.07	.00	125	.03	.13	.00
Linux	40	.00	.00	.00	85	.00	.00	.00	125	.00	.00	.00

*Some variables are missing rural cases

Furthermore, students in frontier schools (M = .08, SD = .27) are eight times as likely to have access to a Windows XP-compatible laptop computer as student in rural schools (M = .01, SD = .08). However, students in frontier schools (M = .24, SD = .26) are also twice as likely to have access to non-Windows XP-compatible desktop computers as students in rural schools (M = .13, SD = .12). Table 4 illustrates that while frontier students are more likely to have access to computers running current operating systems than rural students, frontier students are also more likely to have access to computers running outdated operating systems than rural students.

Table 4

Computers Running Various Operating Systems Per Frontier and Rural Student

	Frontier				Rural*				Total			
	n	*M*	*SD*	*Mdn*	*n*	*M*	*SD*	*Mdn*	*n*	*M*	*SD*	*Mdn*
Desktop												
Non-OS X	40	.04	.09	.00	84	.04	.07	.00	124	.04	.07	.00
OS X	40	.02	.06	.00	85	.02	.05	.00	125	.02	.05	.00
Non-XP	40	.24	.26	.12	83	.13	.12	.11	123	.16	.18	.11
XP	40	.18	.28	.07	84	.09	.18	.01	124	.12	.22	.01
Laptop												

Non-OS X	40	.00	.00	.00	85	.00	.00	.00	125	.00	.00	.00
OS X	40	.00	.01	.00	84	.01	.09	.00	124	.01	.08	.00
Non-XP	40	.01	.02	.00	85	.00	.01	.00	125	.00	.01	.00
XP	40	.08	.27	.00	84	.01	.08	.00	124	.03	.17	.00

*Some variables are missing rural cases

For instance, there is a mean of .05 (SD = .20) PCs running Windows XP per frontier student and .03 (SD =.07) PCs running Windows XP per rural student. On the other hand, there is a mean of .16 (SD =.23) PCs running Windows 95 per frontier student and .07 (SD =. 10) per rural student. Thus, while frontier students have access to more modern computers, both rural and frontier students have less access to modern computers than they do to outdated computers. Additionally, NOTIS data showed that compared to rural students, there are almost

twice as many televisions (frontier - M =.09, SD=.06; rural - M = .05, SD = .04) and laser printers per frontier student (frontier - M = .07, SD = .09; rural - M = .03, SD = .05) and three times as many scanners (frontier - M = .03, SD = .04; rural - M = .01, SD = .01), digital cameras (frontier - M = .03, SD = .04; rural - M = .01, SD = .01), and graphic calculators (frontier - M = .06, SD = .13; rural - M = .02, SD = .06) per student.

- **Is there a difference between rural and frontier Nevada schools' availability and quality of Internet access?**

To answer this question, NOTIS data were examined to determine the number of frontier and rural classrooms with Internet access per total classrooms; and percentages of frontier and rural classrooms, lab, libraries, and medical centers with access via Wide Area Network (WAN) and access via dial-up. The data reveal little difference between frontier and rural schools in Internet access ratios (23:25 vs. 24:25 respectively). However, differences are found when comparing the type of connections present in frontier and rural classrooms (See Table 5). For instance, rural classrooms (83%) are more likely to be connected through a Wide Area Network (WAN) than are frontier classrooms (61%) while frontier classrooms (26%) are more likely than rural classrooms (2%) to access the Internet through a dial-up connection.

Table 5

Ratios of Rural and Frontier Classrooms with Internet Access, Classrooms with WAN Access, and Classrooms with Dial-up Access Per Total Number of Classrooms for Every School

Local	Internet Access*				WAN Access*				Dial-up Access **			
	n	***M***	***SD***	***Mdn***	***n***	***M***	***SD***	***Mdn***	***n***	***M***	***SD***	***Mdn***
Frontier	40	.92	.29	1.00	40	.61	.48	.97	40	.26	.42	.00
Rural	83	.97	.13	1.00	83	.83	.36	1.00	86	.02	.15	.00
Total	123	.95	.15	1.00	123	.76	.41	1.00	126	.10	.29	.00

* 4 missing rural cases
** 1 missing rural case

Analyses comparing Internet access between frontier and rural schools' labs, libraries, and media centers yielded similar results. While almost all frontier and rural labs, libraries, and media centers are connected to the Internet (96% vs. 95% respectively), the type of connection varies. Frontier labs, libraries, and media centers (74%) are less likely to be connected to the Internet through a WAN than are their rural counterparts (86%). Furthermore, frontier labs, libraries, and media centers (17%) are more likely to be connected to the Internet through a dial-up connection than are their rural counterparts (0%).

Thus, the data show that frontier and rural schools do not vary by much in terms of access to the Internet. However, the type of connection is superior for rural schools. Specifically, frontier schools are much more likely to have dial-up connections while rural schools are more likely to have connections through a WAN.

Conclusions

This finding was derived from results indicating that frontier schools have approximately twice as many instructional computers per student as rural schools. Additionally, frontier schools have twice as many desktop computers and eight times as many laptop computers that are Windows XP compatible per student compared to rural schools. Frontier and rural student access to Macintosh computers is similar in the two groups.

Why frontier schools seem to be better equipped than rural schools is a matter for speculation, and it is impossible to know the cause of this finding without conducting further research. A report conducted by the National Center for Education Statistics (Smerdon et al., 2000)[52] states that students at small schools (those with enrollment less than 300) are more likely to have computers in the classroom than large schools. Since the mean Nevada frontier school enrollment is 98.20 (SD = 128.39) and the mean Nevada rural school enrollment is 401.92 (SD = 272.13), it is possible that a school's location (e.g. rural or frontier) has less of an impact on the quality and quantity of its computers than does the size of its student body. Future research should explore this possibility. Nonetheless, this finding is important because rural schools appear to be more poorly equipped than frontier schools in terms of information technology. Perhaps policy makers and voters in more isolated, frontier areas see technology as a viable way to reduce the disadvantage of extreme isolation, while those in less isolated but still rural areas believe that their closer proximity to urban areas reduces the need for extreme compensatory measures. Another possibility is that parents and other citizens in more isolated, frontier areas are themselves more reliant on technology to reduce isolation than are parents and citizens of less isolated areas. Consequently, they may be more likely to support or even demand more technology in their schools. Whether this trend would be found in other states remains to be seen.

Furthermore, it would be interesting to see how Nevada urban schools compare to Nevada rural and frontier schools in terms of quality and quantity of information technology resources. The literature suggests that rural schools are generally better equipped than urban schools. Perhaps urban schools are the poorest equipped of all schools. Such information has obvious implications for policy-makers.

Another interesting finding is that Nevada students at both frontier and rural schools have more access to outdated equipment than they do to modern equipment. This is a problem since a report released by the National Center for Education Statistics (Smerdon et al., 2000)[53], suggests that one of the greatest barriers to beneficial information technology use in schools is outdated, incompatible, or unreliable computers.

Then too, it should be noted that while students at frontier schools have more access to modern equipment, they also have more access to outdated equipment than do students at rural schools. Therefore, to say that frontier schools have higher quality information technology resources than rural schools is a statement that should be explained further. Perhaps it would be more accurate to say that frontier schools have both higher quality and lower quality information technology resources than do rural schools. Little is known about the effects of student use of outdated equipment on learning and this, too, is an area that requires further investigation.

Responses to NOTIS indicate that although a high percentage of both frontier and rural schools are connected to the Internet, rural schools tend to have faster and higher quality connections than do frontier schools. Analysis of the data on Internet access of frontier and rural schools' computer labs, libraries and media centers reveal similar results.

Previous research on rural and remote schools' Internet access indicates a higher rate of access in rural schools than urban schools (Cattagni et al., 2001[54]; United States Department of Commerce, 2002[55]). However, these reports do not investigate the quality of these connections as this study does. Therefore, it is impossible to relate this finding to previous research. Research investigating utility service in remote areas indicates that electricity and telephone service is often not available or affordable to residents of such communities (Solomon et al., 2003)[56]. All Nevada schools have electricity and telephone service. However, results revealed by Solomon (2003)[57] indicate that remote communities have more difficulty than highly populated communities obtaining high quality utility services. It is quite possible that the same trend exists with respect to Internet service, as is indicted by this study.

This finding is limited by the lack of research investigating the quality of Internet connections at schools - rural, remote, or otherwise. Therefore, more research is needed to determine if these results are unique to Nevada. Furthermore, little research investigates how the speed of Internet access affects student achievement. It is possible that quality of Internet connection has little effect on learning and therefore, it may be neither cost effective nor necessary to try to improve the speed of schools' Internet access. However, anyone who has ever waited several minutes for a Web page to load would probably dispute the notion that the speed of Internet access has no effect on the Web user's experience. More research is needed to clarify this.

Results of this study and others like it could be useful to many professionals interested in information technology in education. One of the most dramatic findings of this study is the degree to which information technology resources vary from school to school within both frontier and rural categories within the same state. Administrators might find such results useful in lobbying for information technology funding equity. Researchers who specialize in rural education might also be interested.

This study adds to a small body of research that investigates rural education in the United States. Of the existing research on rural education, only a small part looks at differences between varying rural communities and there are no studies that investigate information technology differences between very remote and isolated frontier schools and rural schools that are not so remote. The matrices developed for this study to objectively differentiate frontier and rural schools may be of particular interest to such researchers.

Results of this study stimulate many additional questions that could be investigated. For instance, it is possible that school enrollment figures have a stronger influence on school information technology resources than school location. Additionally, there may be interactions between school location and enrollment that affects school information technology resources.

Furthermore, investigation of specific differences within frontier and rural schools and communities might produce interesting results. Just as it is unrealistic to assume all urban communities are the same, it is unrealistic to assume all frontier and rural communities are alike. For instance, there may be information technology differences between frontier schools that scored high and frontier schools that scored low on the Frontier Scoring Matrix. The same might be true for rural schools.

Student achievement test scores could also be used as an additional dependent variable in future research. It would be interesting to know if number and quality of information technology resources are related to achievement test scores and whether or not any relationships found are similar in rural, frontier, and urban schools. Furthermore, some of the dependent variables of this study could become independent variables in future studies to determine their affect, if any, on student achievement test scores. For instance, researchers could ask if there is a relationship between the type of Internet access available at schools in urban, rural, or frontier areas and student achievement test scores.

Another factor for future research is related to teacher and administrator characteristics and preferences. The present study did not investigate this variable. Future research might investigate the extent to which differences in technology across types of districts are a function of teacher and administrator variables. Perhaps those schools with a high level of technology access are those in which teachers and administrators are highly supportive of technology or are highly proficient in their use. Such research would have important implications for inservice education. Results from such studies may strengthen the argument for promoting sound technology integration in schools.

APPENDIX A: RURAL SCORING MATRIX FOR SCHOOLS LOCATED IN NON-FRONTIER, NEVADA DISTRICTS

Total Possible Points 100
Minimum Points Necessary for Rural Designation = 51

POPULATION OF TOWN IN WHICH SCHOOL IS LOCATED	**POINTS**
0-1250	50
1251-2500	40
>2500	0
TOTAL POPULATION	
Driving distance in miles to towns in which school is located to closest metropolitan area (Carson City, Las Vegas, Reno)	**POINTS**
>90	50
60-89	40
30-59	30
<30	0
NOTE: Distance is determined through use of the driving direction feature available at http://www.mapquest.com	
TOTAL METROPOLITAN DISTANCE	
TOTAL POINTS BOTH CATEGORIES	

APPENDIX B: FRONTIER SCORING MATRIX

Total Possible Points 105
Minimum Points Necessary for Frontier Designation = 55

POPULATION OF TOWN IN WHICH SCHOOL IS LOCATED	**POINTS**
1-250	45
251-500	30
501-750	20
751-1000	10
>1000	0
TOTAL POINTS POPULATION	
DRIVING DISTANCE IN MILES FROM SCHOOL TO **DISTRICT OFFICES**	POINTS
>90	30
60-89	20
30-59	10
<30	0
NOTE: Distance is determined through use of the driving direction feature available at http://www.mapquest.com	
TOTAL POINTS DISTRICT OFFICE DISTANCE	
DRIVING DISTANCE IN MILES FROM SCHOOL TO **CLOSEST HOSPITAL**	POINTS
>90	30
60-89	20
30-59	10
<30	0
NOTE: Distance is determined through use of the driving direction feature available at http://www.mapquest.com	
TOTAL POINTS HOSPITAL DISTANCE	
TOTAL POINTS ALL CATEGORIES	

End Notes: Kim Vidoni and Cleborne D. Maddux, "Small and Smaller: A Comparison of Information Technology in Rural and Frontier Nevada Schools," *Online Journal of Rural Research & Policy* (2008.1).

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