Educational Software Use

The 2000 Report

SEIR•TEC at AEL

Educational Software Use: The 2000 Report

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AEL is a catalyst for schools and communities to build lifelong learning systems that harness resources, research, and practical wisdom. AEL serves as the Regional Educational Laboratory for Kentucky, Tennessee, Virginia, and West Virginia. For these same four states, it operates both a Regional Technology in Education Consortium (SEIR◆TEC at AEL) and the Eisenhower Regional Consortium for Mathematics and Science Education. In addition, it serves as the Region IV Comprehensive Center and operates the ERIC Clearinghouse on Rural Education and Small Schools.

AEL operates the Technology Consortium under a subcontract with the SouthEast and Islands Regional Technology in Education Consortium (SEIR◆TEC)—one of six regional technology consortia established by the U.S. Department of Education to accelerate school reform initiatives through the integration of advanced technologies into the instructional process. SEIR◆TEC at AEL provides technology-related assistance through awareness presentations, policy development and planning, staff development, and evaluation.

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Introduction

A 1999 report on educational software use in Kentucky, Tennessee, Virginia, and West Virginia (McGraw, Blair, & Ross, 1999) noted the old adage "You can lead a horse to water, but you can't make it drink." The saying underscored a disturbing finding: despite access to computers, 83.6% of teachers responding to a survey *never* used software in the classroom. This statistic prompted a follow-up survey in 2000 to determine whether progress had been made.

This report presents the findings of a SEIR◆TEC at AEL follow-up survey and puts a slightly different spin on the adage: "You can lead a horse to water, but if you can get it to float on its back, you've really done something." The first survey demonstrated that merely leading teachers *to* the technology is not enough. Barriers exist between technology access and technology use, and this report focuses on *why* teachers do not use software—the first step toward ensuring the effective use of classroom technology.

Lessons from Past Research

In the previous study (McGraw et al., 1999), SEIR◆TEC at AEL questioned teachers in its region—Kentucky, Tennessee, Virginia, and West Virginia—regarding their use of software: How often do you use software in the classroom? What type of software do you use? Alarmingly, 83.6% responded they *never* use software in their teaching. This finding is more disturbing considering the amount of money spent and the numerous programs implemented across the region to support technology integration. Against the backdrop of these funding efforts and innovative programs, the follow-up survey concentrated on why so few of the respondents use software in their teaching.

The four states have initiated technology programs intended to capitalize on technology-assisted instruction; however, each state has focused on a different approach. In the 1990-91 school year, West Virginia instituted the Basic Skills/Computer Education (BS/CE) program, a long-term initiative to incorporate curriculum software and course management software. Kindergarten classes selected software developed by two approved vendors to address state standards in reading, language arts, and mathematics. One grade per year has been added to the program. Results of a longitudinal study (Mann, Shakeshaft, Becker, & Kottkamp, 1999) have been positive, with the program contributing to 11% of the variance in improved standardized test scores. While these findings are encouraging, the relationship between a similar approach, integrated learning systems (ILS), and academic achievement is not conclusive. In Indiana, students using an ILS also showed significant gains; however, when compared to a control group of students that had not used the ILS, the advantages were negated: "The results of the data analysis indicated that there was not a significant difference in the pattern of gain between the test scores of ILS user schools and paired ILS nonuser schools" (Estep, McInerney, Vockell, & Kosmoski, 1999-2000, p. 15). Programs in the other states in the region are more diverse and do not represent such a unified effort.

Additional surveys support the authors' previous finding of low software use throughout the region. *Education Week's* most current nationwide survey, "Technology Counts '99," reports similar software usage frequencies among teachers in the region. The percentage of fourth-grade students in the region whose language arts teachers use computer software for instruction either every day or at least once or twice a week is lowest in Kentucky (22%), followed by Virginia (30%) and Tennessee (37%). Forty percent of West Virginia respondents reported software use once or twice a week, with 34% indicating fourth-grade

teachers use software every day. This high usage frequency in comparison to the other three states is due most likely to the BS/CE Program. Usage rates in the same curriculum areas in the eighth grade are much lower throughout the region, with states reporting the following percentage of use either once or twice a week or every day: Kentucky (12%), Tennessee (16%), Virginia (6%), and West Virginia (11%). The disparity of use in West Virginia between fourth-grade and eighth-grade teachers is most likely due to the fact that the BS/CE Program was one year away from implementation in the eighth grade at the time of the survey (Edwards, 1999).

A survey of district technology coordinators (DTCs) from 27 states reported similar low software use. Of these 27 state DTCs, participants from Kentucky and West Virginia reported low use of simulation software when teaching science. On a scale from 1 to 5 on which 1 is "Not at All" and 5 is "Very Much," only 9.6% (Kentucky) and 18.9% (West Virginia) of the DTCs responded with a 4 or 5. The overall response from all 27 states was 11.4%. The DTCs reported that desktop publishing software was used most frequently to teach writing, with the following responses of 4 or 5: 39.2% for Kentucky, 34.1% for West Virginia, and 28.9% overall (Solomon, 1999). Extrapolating from the Apple Classroom of Tomorrow™ (ACOT™) studies (Dwyer, Ringstaff, & Sandholtz, 1991), a dependence upon applications to teach writing—which also can be found in more traditional classrooms that do not depend upon technology—and low use of simulation or curriculum software suggest a low level of technology integration in these two states.

An extensive review of technology initiatives (Lemke, Quinn, Zucker, & Cahill, 1998) noted low levels of technology integration in Virginia as well. This analysis reflects a rather poor return on investments by Virginia and the other three states. Between 1994 and 1998, Virginia invested $200 million dollars of public funds in its Six-Year Educational Technology Plan. A report assessing the impact of funds and programs initiated during the first four years of the plan indicated low frequency of use or low level of technology integration by teachers. One finding showed that students and educators had gained expertise in basic computer skills but had not integrated technology effectively to improve student learning. Other findings indicated that technology use had focused on skill development rather than content standards and that inadequate quantity and/or quality of equipment and software are significant problems.

Potential Barriers

While access to technology and the need for training and support are key issues facing educators, SEIR◆TEC at AEL's follow-up survey sought to explore the possible barriers related specifically to software in an effort to explain the high number of respondents indicating *never* using software in their classrooms.

Dockstader (1999) summarizes technology integration as organizing the goals of the curriculum and technology into a "harmonious whole." This implies that curriculum should drive technology decisions and that technology integration requires more than simply increasing access (Meyer, Steuck, Miller, Pesthy, & Redman,1999; Miller & Olson, 1995; Panel on Educational Technology, 1997; Coley, Cradler, & Engel, 1997). Additional key factors that promote effective integration include professional development, an environment that supports collaboration and communication among peers, the support of school leaders, and teacher confidence (Bouie, 1998; Consortium for School Networking, 1999; Groves, Jarnigan, & Eller, 1998; Kozma & Schank, 1998; Panel on Educational Technology, 1997; Schoeny, Heaton, & Washington, 1999; Ross, Hogaboam-Gray, & Hannay, 1999). The SEIR◆TEC at AEL follow-up survey investigates software use in relation to curriculum and training with the goals of better understanding (1) the tools necessary for technology use, (2) the implications of curriculum standards upon software use, and (3) teacher preparedness for use.

Peggy Ertmer (1999) suggests that barriers to technology integration fall within two general categories. First-order barriers are extrinsic and include lack of access to computers and software, lack of time, and inadequate technical and administrative support. Second-order barriers, on the other hand, are more intrinsic to teachers and include beliefs about teaching, beliefs about technology, established classroom practices, and resistance to change. Second-order barriers are just as important as teachers' access to equipment (Ertmer, Addison, Lane, Ross, & Woods, 1999).

Lack of training. The factor cited most often as a barrier to technology integration is training, or professional development (Charp, 1997; Fisher & Dove, 1999; Rogers, 1999). Current models of training frequently are limited in time and scope; teachers need extended training—possibly with follow-up sessions—to address integration strategies (Coley et al., 1997; Fulton, 1996; Panel on Educational Technology, 1997; Rockman, 1998). Jamie McKenzie (2000) suggests the solution does not lie in providing more hours of software instruction but in targeting the focus on curriculum opportunities, teaching strategies, and an understanding of adult learner preferences. William Jaber and Mike Moore

(1999) found that teachers are strapped for time already without the burden of technology training or additional planning needed for effective technology integration; yet, teachers are expected to be experts in instructional technologies. This is an unrealistic expectation because, in general, it takes 10 years to become an expert, during which one needs to practice deliberately for four hours each day (14,600 hours) and be tutored by the best experts in the field (Ericsson & Lehmann, 1996, as cited in Schacter & Fagnano, 1999). Making the challenge more overwhelming is the rapid evolution of digital tools and media (McCullough, 1996). Certainly, these realities warrant more effective models of professional development and teacher support. The SEIR◆TEC at AEL follow-up survey intended to ascertain current levels of training in the region and whether a lack of training can be a barrier to software use. The survey made distinctions between general training in technology and training in specific software applications.

Lack of appropriate software. The lack or limited availability of software—especially that designed to support the curricula teachers must cover—makes it difficult to justify putting even a reasonably affordable computer on every desk (Graham, 1997; Rogers, 1999). The importance of quality educational software cannot be understated. P. Dublin, H. Pressman, and E. J. Woldman claim that "diversity among students (racial, socioeconomic, cultural, learning styles, academic achievement, gender, disabilities) is uniquely accommodated by top-notch software" (as cited in Eastman & Hollingsworth, 1998, p. 272). It is unlikely, however, that software publishers will keep pace with the demand for quality educational software. For example, more than 184,000 copies of the popular game Diablo II were sold on a single day in July 2000 (National Public Radio, 2000b). Unlike software games, where popular titles can top $100 million in sales, educational software is far less profitable, resulting in limited availability of appropriate titles (Teacher's pet, 1994). Software selection, then, becomes an increasingly important skill for teachers to learn. Teachers must know their system requirements, instructional goals, and software expectations to make informed decisions (Rader, 1997).

Appropriations for software. Problems posed by software appropriation often are ignored in favor of questions about hardware purchases. Yet, the approval, selection, and purchase of software constitute a significant portion of technology expenditures and should be tied to hardware decisions. Ideally, hardware decisions should be based on software choices, and software deci-

sions, in turn, should be guided by curricular goals. Hardware that cannot run required software is useless. West Virginia tackled this decision head-on in 1990 with the implementation of its BS/CE Program (Mann et al., 1999). The state selected two vendors to develop courseware and allowed schools to choose one or the other.

Methods of software acquisition are less structured in other states. In observing the integration of computers into two preschool classrooms at a child development laboratory at the University of Tennessee, Melissa Groves, Michelle Jarnigan, and Kendra Eller (1998) reported that software often appeared by "trial and error." Teachers at the laboratory rarely discussed how to use the software and had little opportunity to review software outside their teaching duties. These two methods represent extremes for selecting software in the region; the SEIR◆TEC at AEL follow-up survey sought to fill in some of the answers.

Encouraging Signs

Software use at school does not necessarily reflect a teacher's entire exposure to technology. Computer use is definitely growing. A recent poll indicated that 81% of respondents under age 60 have used a computer either at home or at work (National Public Radio, 2000a). The rise in ownership of home computers has increased the access of students and teachers to technology (Robertson, Calder, Fung, Jones, & O'Shea, 1997). A 1997 survey of educators, computer coordinators, and school librarians by Educational Market Research (as cited in Charp, 1997) indicated that 72.2% of the respondents used the Internet at school and/or home. Even school administrators, a population whose technology adoption levels usually fall much lower than classroom teachers (Caverly, Peterson & Mandeville, 1997), indicated increased computer use. In a recent survey (Benson, Peltier, & Matranga, 1999), 80.6% of the respondents reported using word processing at least weekly, and 78% indicated owning a computer at home. Susan Eastman and Helen Hollingsworth (1998) suggest "that those teachers who have most successfully utilized computers in the classroom usually have equivalent technology in their homes. But even if they have the hardware, many teachers lack the software for their curricula as well as the time to develop original presentations for their classes" (p. 259). The SEIR◆TEC at AEL follow-up survey investigated linkages between home use and school use.

Sample

Sample

The SEIR◆TEC at AEL follow-up survey involved respondents from the previous survey, as reported in *Educational Software Use: Results from a 1999 Survey*. They represent a random sample of K-12 public school teachers in Kentucky, Tennessee, Virginia, and West Virginia. A cover letter indicating the follow-up nature of this survey, a color-coded survey, and incentive form were mailed to each respondent from the previous survey. Color coding permitted the investigators to track the anonymous returns by state.

Survey Instrument

Survey Instrument

Researchers developed a brief survey instrument consisting of 14 multiple-choice questions designed to encourage the participation of busy classroom teachers. Questions were intended to provide insight into teachers' beliefs about the importance of software use in teaching and learning, barriers to software use in the classroom, software selection practices, beliefs regarding the alignment of software and instructional goals, beliefs about the relationship of software use and performance on standardized tests, professional development experiences related to technology integration, and patterns of software use. The survey also included questions related to teaching experience, grade level, and content area.

Findings

Survey results indicate that educators in the four-state region view software as important to their daily teaching and students' learning. Of the teachers responding, 81.6% (total of very important, important, and somewhat important in Figure 1) said software is important to daily teaching; 26.4% said it is very important. When asked how important software is to student learning, 84% (total of very important, important, and somewhat important in Figure 3) responded that it is important, with 23.2% saying it is very important. Closer examination of the data reveals that views on the importance of software in teaching and learning are comparable among the four states, with no remarkable differences. Figures 1, 2, 3, and 4 provide data for the region and each of the four states.

Barriers. This information seems to counter data from the initial survey, in which 83.6% said they never used software in their teaching. Why is software viewed so importantly but used so sparingly? The answer might be in the barriers. The two most mentioned barriers across the four-state region were lack

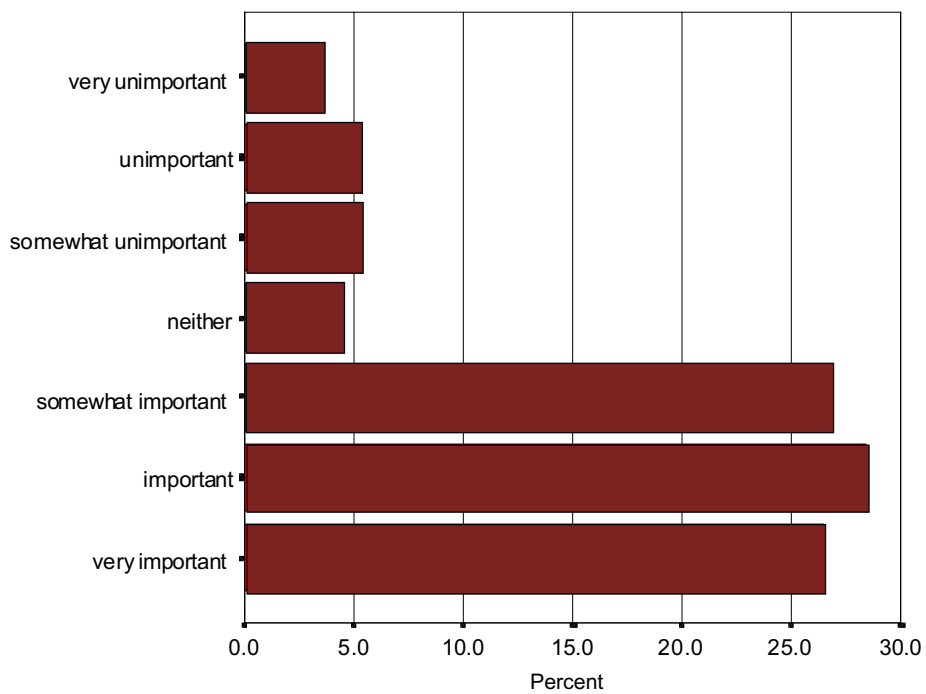

Figure 1. Importance of software to daily teaching as rated by teachers from across the region

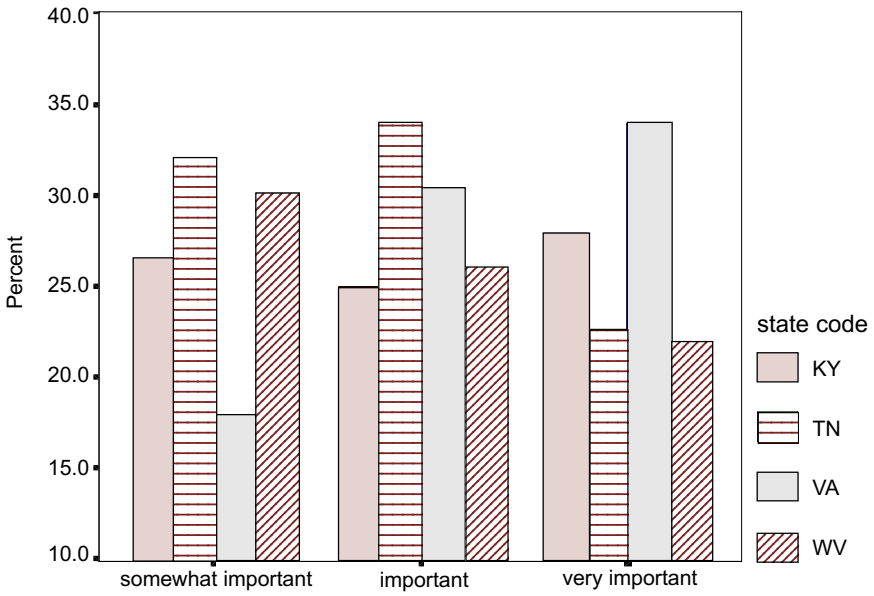

Figure 2. Importance of software to daily teaching as rated by teachers within the four states

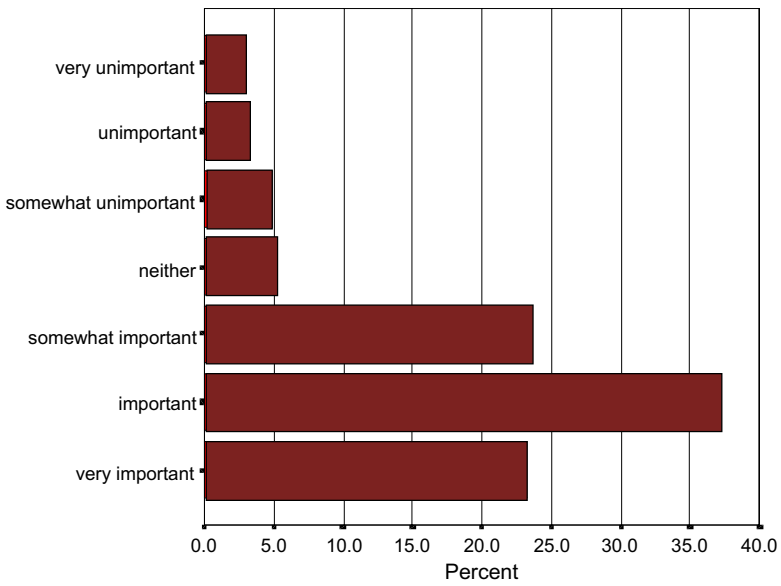

Figure 3. Importance of software to students' learning as rated by teachers from across the region

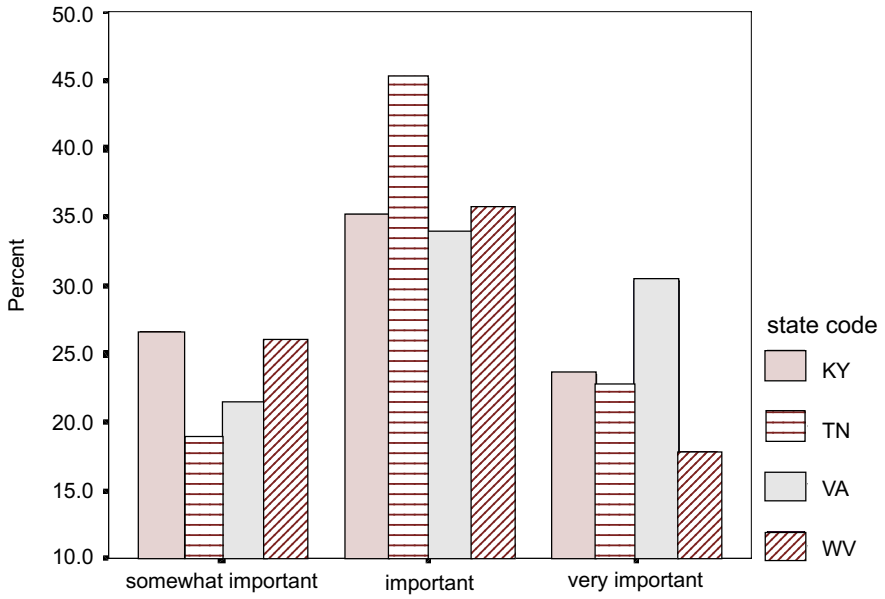

Figure 4. Importance of software to students' learning as rated by teachers within the four states

of time to integrate software into daily practice (24.8%) and lack of computers or equipment needed to use the software (24.4%). Other barriers included lack of money to purchase appropriate software (15.9%), and lack of money to purchase appropriate computers or equipment (11.9%).

Figure 5 shows the four most common barriers by state. The most mentioned barrier in Kentucky and West Virginia was lack of computers or equipment needed to use the software, followed by lack of time to integrate software into daily practice. The leading barrier noted in Tennessee was lack of time to integrate software into daily practice, followed by lack of computers or equipment needed to use the software. Educators in Virginia mentioned these two problems most often, giving them equal emphasis.

Educators in all four states mentioned lack of money to purchase appropriate software as the third most encountered barrier. They identified lack of money to purchase appropriate computers or equipment as the fourth most encountered barrier.

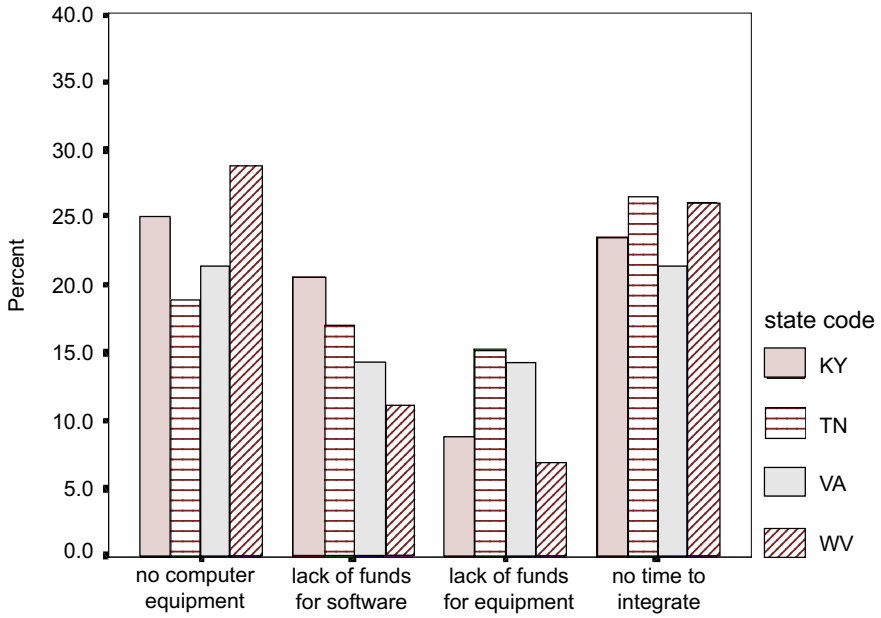

Figure 5. Top four barriers faced by teachers across the four states in using software in teaching

Software selection. The survey indicates the majority of respondents (57.8%) are responsible for selecting their own classroom software. Among the four states, positive answers to this question ranged from 77.4% in Tennessee, to 60.3% in Kentucky, to 50% in Virginia, to 47.2% in West Virginia. Respondents across the four states also identified school committees (16.1%) and central office staff (10.8%) as responsible for selecting software.

Figure 6 provides the three most mentioned responses regionally for software selection. Across all four states, the majority of software decisions are made at the building level, by either teachers or school committees. Eighty-five percent of Kentucky and Tennessee respondents said software decisions are made at the building level. Just over 25% of Virginia and West Virginia respondents placed software selection at the building level, and around 25% from these two states said this responsibility is handled by central office staff.

Educators who said they are responsible for selecting their own software were asked how they make their decisions. Regionwide, 35.2% of the teachers read about software before recommending its purchase, 26.1% said they try software before purchasing it, 18.3% usually hear about software first from a colleague, and 9.9% initially see it displayed at a conference. Figures 7 and 8 display complete results for the region and for each state.

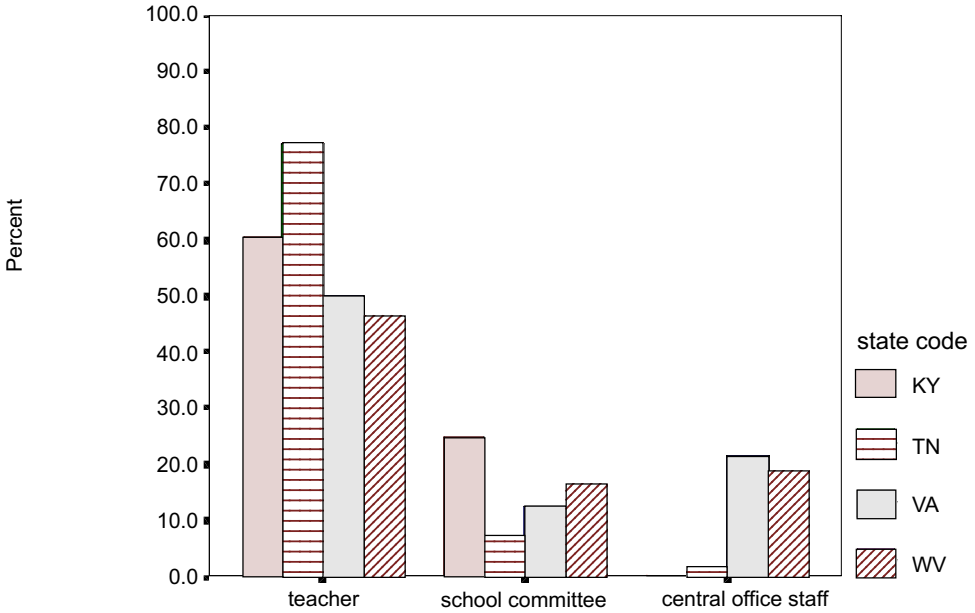

Figure 6. Top three choices of how educational software is selected within the four states

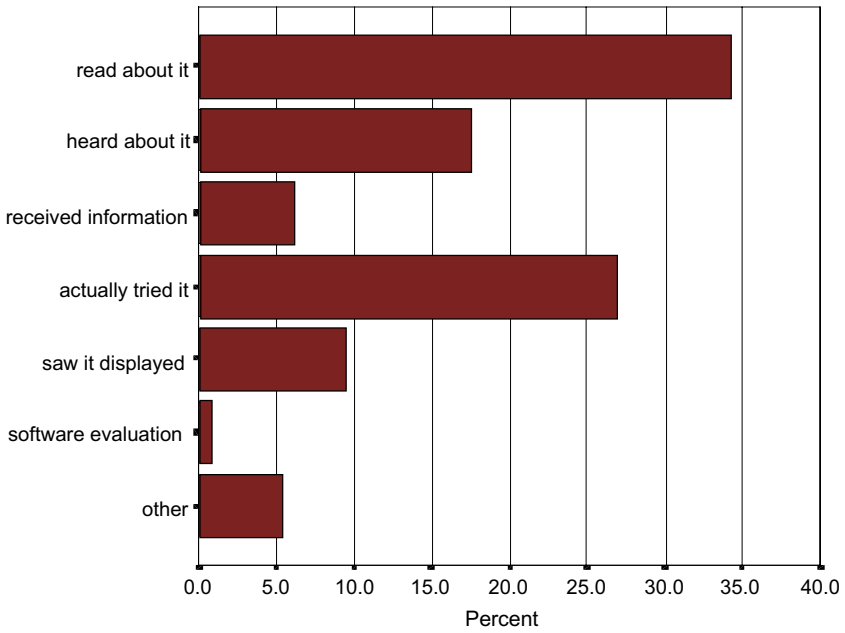

Figure 7. Methods used when selecting software for classrooms across the region

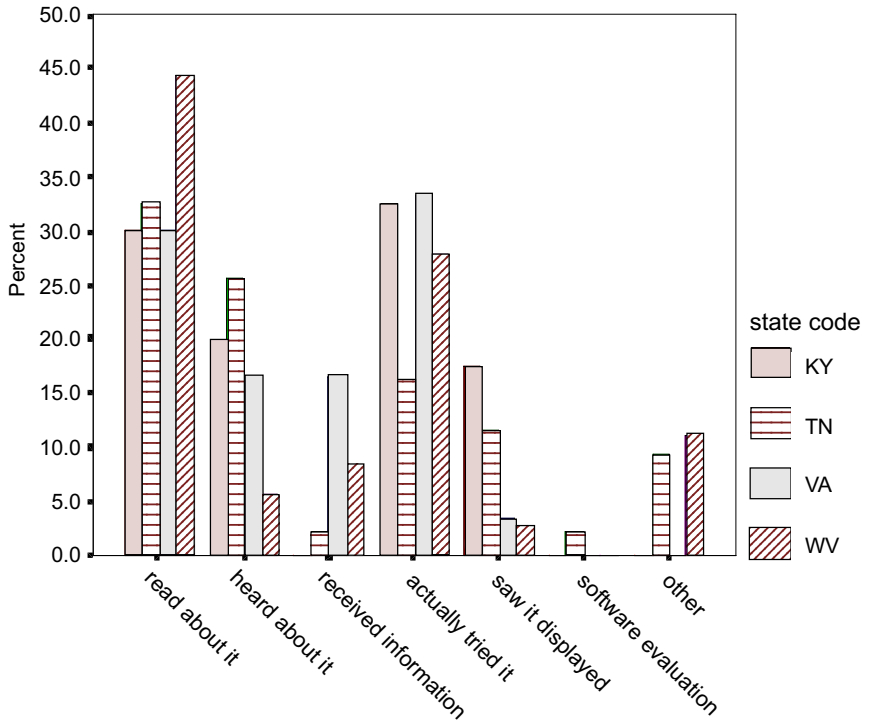

Figure 8. Methods used when selecting software for classrooms within the four states

Alignment with instructional goals. Educators were asked how the available software aligns with instructional goals. Regionally, 53% said the available software aligns well (see Figure 9); however, 30.5% were undecided. The results are similar across the four states. Figure 10 provides complete results.

Training. Across the region, 22.1% of respondents reported receiving no training related to technology integration, and 32.1% indicated receiving less than five hours per year. Of the remaining respondents, 18.1% had received between 5 and 10 hours the previous year, and 11.6% had received more than 25 hours. Figure 11 provides complete results, and Figure 12 takes a closer look at training in the region.

Educators were also asked about training over the past year related specifically to software use. Of the respondents, 30.2% had received no training on this topic, 33.9% had received less than five hours, and 21% had received between 5 and 10 hours. Figure 13 provides complete results, and Figure 14 examines the topic more closely.

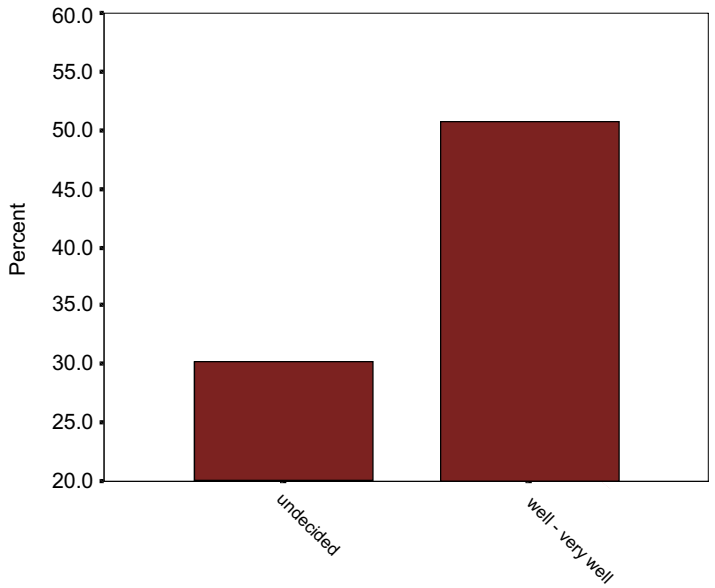

Figure 9. Percentage of teachers across the region describing alignment of software to instructional goals

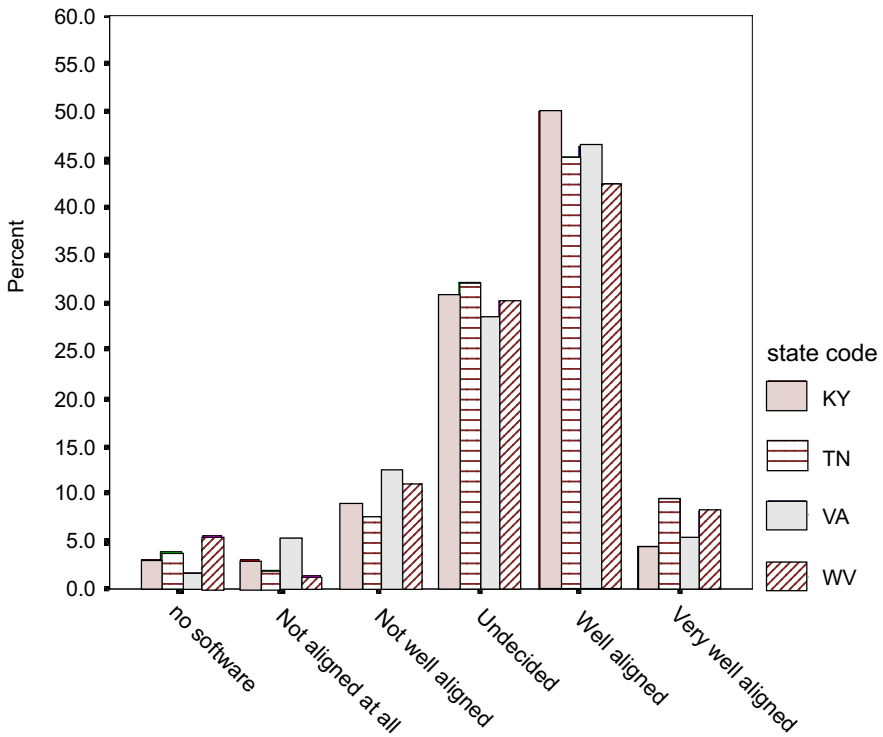

Figure 10. Percentage of teachers within the four states describing alignment of software to instructional goals

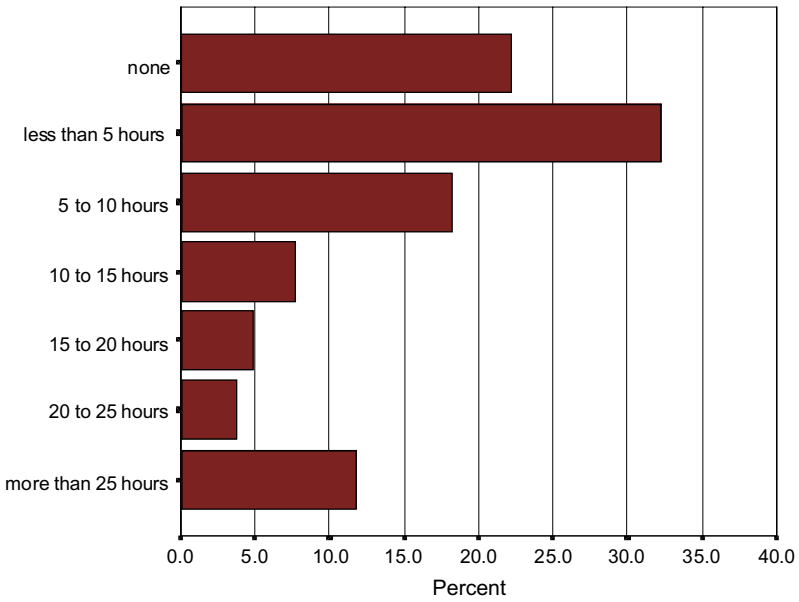

Figure 11. Percentage of training related to **technology integration** received across the region

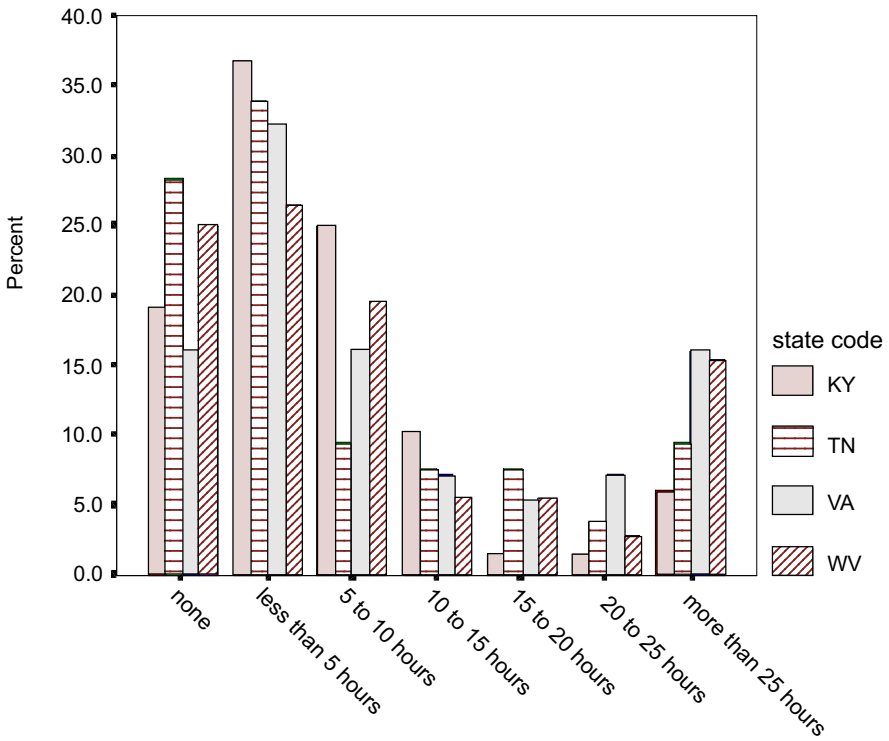

Figure 12. Percentage of training related to **technology integration** received within the four states

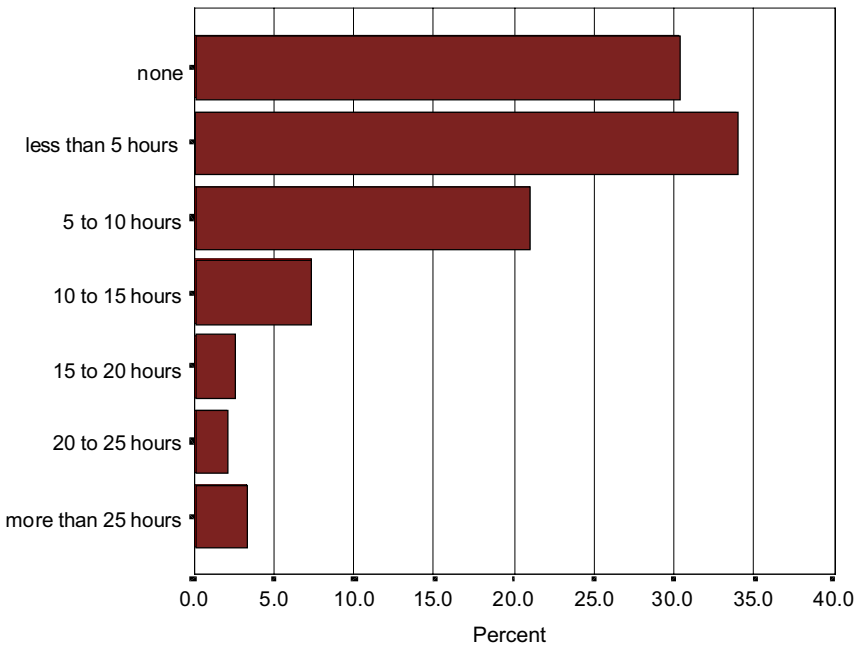

Figure 13. Percentage of training related **specifically to software use** received across the region

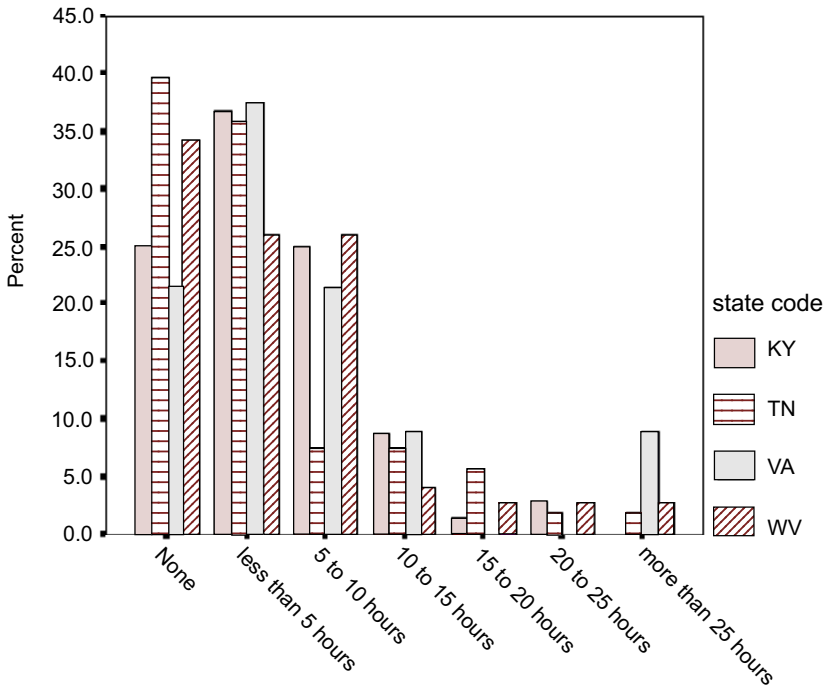

Figure 14. Percentage of training related **specifically to software use** received within the four states

Frequency of use. Of those who use software, nearly 50% said they spend less than five hours per week using software in their classrooms. Close to three-fourths (72.2%) reported spending 10 hours or less each week using software in their teaching; 8% said they do not have software available. **Figure** 15 provides complete results for this item.

The results are similar when broken down by state. The majority of teachers in Virginia and West Virginia reported using software in teaching less than five hours per week; 46.3% in Kentucky and 39.6% in Tennessee also reported less than five hours per week. Combined with data for those who use software less than 10 hours per week, the percentages increase to more than 75% for Tennessee and West Virginia and more than 67% for Kentucky and Virginia. Kentucky teachers, more than others, said they do not have software available; Virginia teachers responded most positively to this question. Because they have more software available, more teachers from Virginia said they use

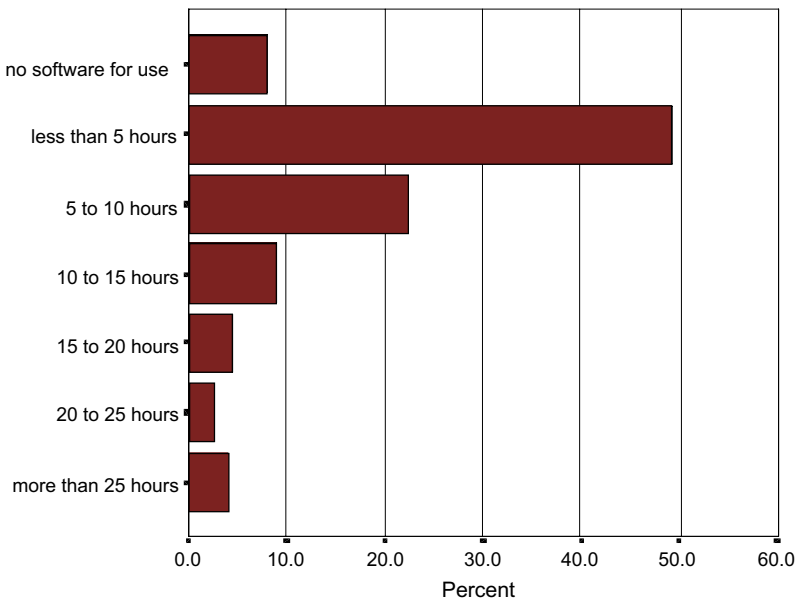

Figure 15. Percentage of time teachers spend each week using software in teaching across the region

software more than 25 hours per week. Figure 16 provides complete results for this item.

Software use at home. Regionally, 34.5% use some type of software at home less than 5 hours per week, and 28.9% reported between 5 and 10 hours of home use; 11.6% do not have any software at home. The majority reported using software at home less than 10 hours each week. West Virginia respondents had the least access to home software. Virginia teachers had the most access and were more likely than respondents from the other states to use home software more than 25 hours per week. Figures 17 and 18 provide complete results for this item along the various response options.

Effect on student achievement. Most respondents (53.9%) believed students would score higher on state-mandated tests if software were used in teaching. Just more than 10% disagreed, and 35.6% were undecided. Responses to this question were similar across the four states.

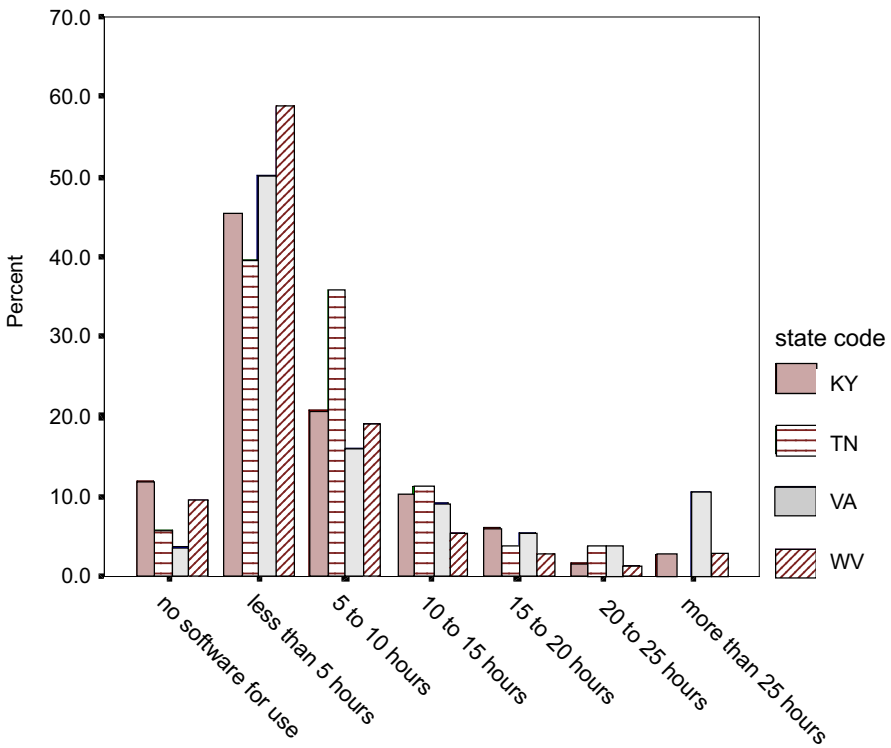

Figure 16. Percentage of time teachers spend each week using software in teaching within the four states

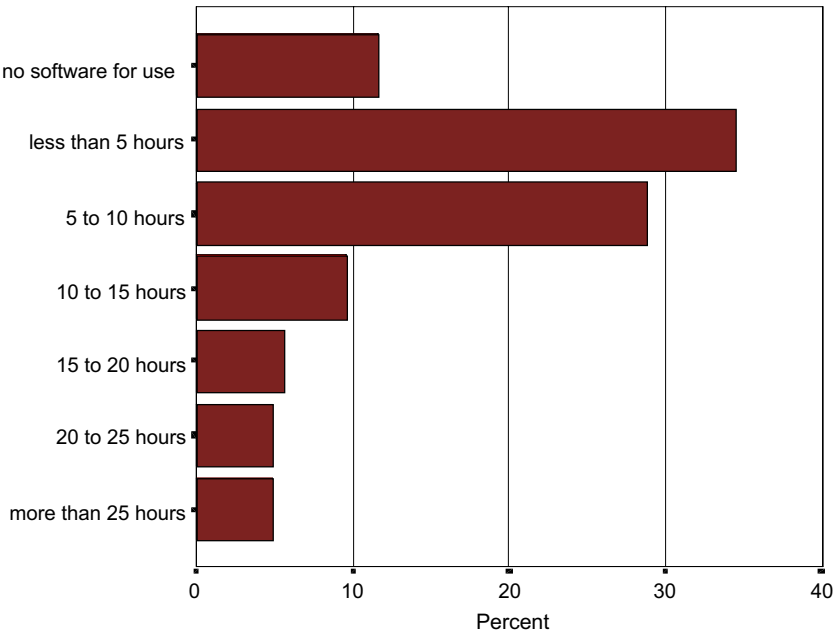

Figure 17. Percentage of time teachers spend each week using software at home across the region

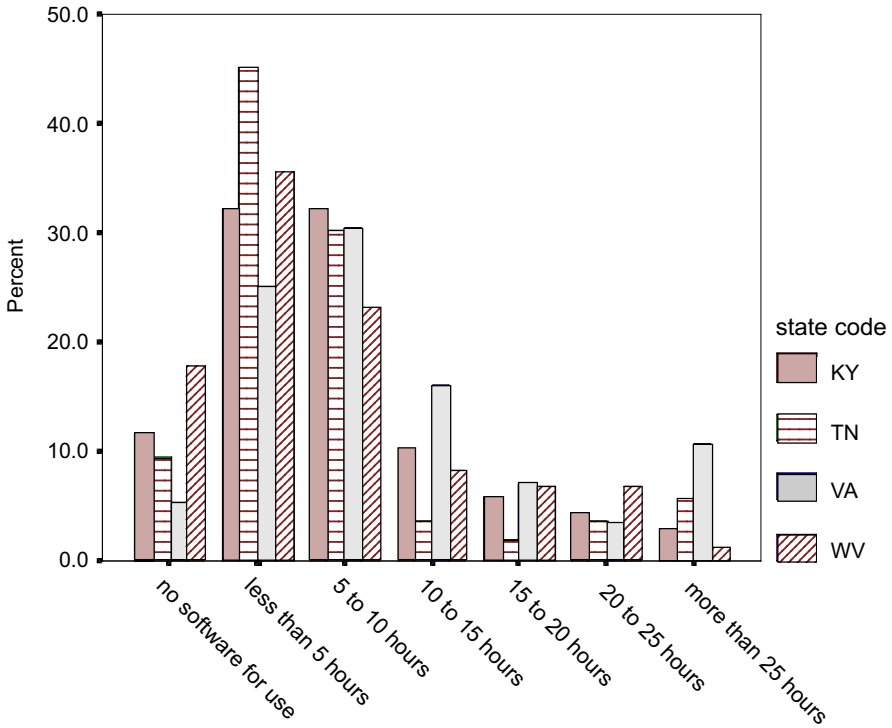

Figure 18. Percentage of time teachers spend each week using software at home within the four states

Implications for Action

The results of this study offer encouragement about the progress teachers in Kentucky, Tennessee, Virginia, and West Virginia have made regarding educational software use. It is reassuring that more than 80% of educators surveyed in the region view software as an important element of their teaching (81.6%) and student learning (84%). Richard Coley, John Cradler, and Penelope Engel (1997) suggest that integrating technology into schools is much more a human issue than a technological one, lending support to the idea that positive change will occur as teachers strive to integrate technology into their daily practice.

It also is important to note that barriers to technology integration may be less formidable than previously believed. For example, the problems of inadequate time, equipment, and money are easier to observe and address than barriers that stem from teachers' deeply held beliefs about teaching, learning, and technology.

While many of the findings are encouraging, some areas of concern have emerged. The majority of educators responding to this survey (57.8%) are responsible for selecting software for their classrooms. Of these, 35.2% indicated they most often recommend software for purchase based on material they have read about the software. This is somewhat alarming because well-designed and persuasive marketing materials can easily skew an individual's decisions. Particularly disturbing is that 73.9% of respondents never try software prior to purchasing it. Since respondents indicated lack of money to purchase software as a major barrier, this finding suggests that scarce resources are not being used effectively.

Given these statistics, it is imperative that educators acquire the knowledge and skills to evaluate and determine the appropriateness of educational software in the curricula and their classrooms. These findings should prompt school and district leaders, as well as state and federal education agencies, to consider ways to provide unbiased research-based information regarding educational software. The California Instructional Technology Clearinghouse and Evalutech are examples of how some states have addressed this issue.

A surprising finding is that 53% of the respondents indicated that the available software aligns well or very well with instructional goals. Further research is warranted to determine why 30.5% of the respondents are undecided about this issue. Each of the four states reported similar results, a somewhat perplexing finding given that West Virginia's Basic Skills/Computer Education program has focused on curriculum alignment.

Implications for Action

More than half of the respondents (53.9%) believe students would score higher on state-mandated tests if software were used in teaching, while another 35.6% were undecided. With the region's emphasis on addressing high academic standards, it is noteworthy that only a slim majority of teachers see a correlation between software use and achievement on state-mandated tests. This might explain why nearly half (49.6%) of the respondents said they spend less than five hours per week using software in their classrooms.

At the very least, additional professional development focused on software evaluation is needed. Training related to technology integration appears to be inadequate across the region, as 22.1% of the respondents had received no training over the last year and another 32.1% had received less than five hours. In regard to training related specifically to software use, 30.2% reported none, and 33.9% had received less than five hours.

These findings support the suggestion that teachers need better skills to select and use appropriate software in their teaching. It also serves to remind software developers and publishers that relevant, high-quality, standards-based software must be available for educators.

There are more than 8.6 million instructional computers located in classrooms across the nation (Anderson & Ronnkvist, 1999). This enormous financial investment in educational technology, along with the national movement toward greater accountability in public education, exerts tremendous pressure on educators to produce results. As the momentum of accountability builds and technology expenditures increase, educators will be expected to demonstrate more frequently how they use technology to improve student achievement. Linking software use to student achievement demands effective technology integration, which, in turn, requires highly confident teachers who are skilled in effective pedagogy, hardware and software use and support, classroom management, and content knowledge. As D. Shade (1999) suggests, "The most critical decision a teacher can make is that of software selection. After all, a computer is little more than plastic and electronic circuitry until software is loaded" (p. 276).

References

Anderson, R.E. & Ronnkvist, A. (1999, June). *The presence of computers in America's schools. Teaching, learning and computing. Report No. 2*. Irvine, CA. University of California, Center for Research on Information Technology and Organization.

Benson, P., Peltier, G. L., & Matranga, M. (1999) Moving school administrators into the computer age. *Education, 120* (2), 326.

Bouie, E. L., Jr. (1998). Creating an information rich environment. *T.H.E. Journal, 26* (2), 78-79.

Caverly, D. C., Peterson, C. L., & Mandeville, T. F. (1997). A generational model for professional development: Training teachers to use computers. *Educational Leadership, 55* (3), 56-59.

Charp, S. (1997). Changing teaching strategies through technology. *T.H.E. Journal, 24* (10), 6.

Coley, R. J., Cradler, J. & Engel, P. K. (1997). Computers and classrooms: The status of technology in U.S. schools. Princeton, NJ: Educational Testing Service. Available: http://www.ets.org/research/pic/compclass.html

Consortium for School Networking. (1999). *Taking TCO to the classroom: A school administrator's guide to planning for the total cost of new technology*. Washington, DC: Author. Available: http://www.cosn.org/tco/

Dockstader, J. (1999). Teachers of the 21st century know the what, why, and how of technology integration. *T.H.E. Journal, 26* (6), 73.

Dwyer, D. C., Ringstaff, C., & Sandholtz, J. H. (1991). Changes in teachers' beliefs and practices in technology-rich classrooms. *Educational Leadership, 48* (8), 45-52.

Eastman, S. & Hollingsworth, H. (1998). Implications of home technology for school decision-making. *Journal of Educational Technology Systems, 26* (3), 255-280.

Edwards, V. B. (Ed.). (1999). Technology counts '99: State-by-state data. *Education Week, 19* (4). Also available at http://www.edweek.org/sreports/tc99/

Ertmer, P. (1999). Addressing first- and second-order barriers to change: Strategies for technology integration. *Educational Technology Research and Development, 47* (4), 47-61.

Ertmer, P., Addison, P., Lane, M., Ross, E., & Woods, D. (1999, Fall). Examining teachers' beliefs about the role of technology in the elementary classroom. *Journal of Research on Computing in Education, 32* (1), 54-72.

Estep, S., McInerney, W., Vockell, E. & Kosmoski, G. (1999-2000). An investigation of the relationship between integrated learning systems and academic achievement. *Journal of Educational Technology Systems, 28* (1), 5-19.

Fisher, S. & Dove, M. K. (1999). Muffled voices: Teachers' concerns regarding

References

technological change. *Proceedings of SITE 99: Society for Information Technology & Teacher Education International Conference, San Antonio, TX*. ERIC Document Reproduction Service No. ED 432 281.

Fulton, K. (1996). Moving from boxes and wires to 21st century teaching. *T.H.E. Journal, 24* (4), 76-79.

Graham, David R. (1997, Spring). The classroom computer revolution that hasn't happened—yet! Some reflections on computers. *Education Canada, 37* (1),10-14, 52.

Groves, Melissa, Jarnigan, Michele, & Eller, Kendra. (1998). "But how do we use it?" Discovering hidden barriers and unanticipated successes in integrating computers in a preschool curriculum. *Proceedings of the Families, Technology, and Education Conference, Chicago, IL (October 30-November 1, 1997)*. ERIC Document No. ED 424 998.

Jaber, W., & Moore, D. M. (1999). A survey of factors which influence teachers' use of computer-based technology. *International Journal of Instructional Media, 26* (3), 253-266.

Kozma, R. & Schank, P. (1998). Connecting with the 21st century: Technology in support of educational reform. In C. Dede (Ed.) *Learning with Technology: 1998 ASCD Yearbook*. Alexandria, VA: Association for Supervision and Curriculum Development. ERIC Document Reproduction Service No. ED 416 857.

Lemke, C., Quinn, B., Zucker, A., & Cahill, S. (1998, December 31). *An analysis of the status of education technology availability and usage in the public schools of Virginia*. Report to the Commonwealth of Virginia. http://www-test.pen.k12.va.us/VDOE/Technology/vastudy/ (October 23, 1999).

Mann, D., Shakeshaft, C., Becker, J., & Kottkamp, R. (1999, March 10). *West Virginia story: Achievement gains from a statewide comprehensive instructional technology program*. http://www.mff.org/publications/publications.taf?page=155

McCullough, M. (1996). *Abstracting Craft: The Practiced Digital Hand*. Cambridge: MIT Press.

McGraw, T., Blair, B., & Ross, J. D. (1999). *Educational software use: Results of a 1999 regional survey*. Charleston, WV: AEL, Inc. Also available at http://www.ael.org/rtec/surintro.htm

McKenzie, J. (2000, March). Beyond technology. Electronic School. http://www.electronic.school.com

Meyer, T. N., Steuck, K., Miller, T. M., Pesthy, C., & Redmon, D. (1999). Lessons learned from the trenches: Implementing technology in public schools. *Proceedings of SITE 99: Society for Information Technology & Teacher Education International Conference, San Antonio, TX*. ERIC Document Reproduction Service No. ED 432 252.

References

Miller, L. & Olson, J. (1995). How computers live in schools. *Educational Leadership, 53* (2), 74-77.

National Public Radio. (2000a). Survey shows widespread enthusiasm for high technology. http://www.npr.org/programs/specials/poll/technology (September 5, 2000).

National Public Radio. (2000b). Diablo II. [Real Audio] http://search.npr.org/cf/cmn/cmnpd01fm.cfm?PrgDate=10/11/2000&PrgID=3 (October 11, 2000).

Panel on Educational Technology. (1997, March). *Report to the President on the use of technology to strengthen K-12 education in the United States.* http://www.whitehouse.gov/WH/EOP/OSTP/NSTC/PCAST/k-12ed.html (October 13, 1999).

Rader, J. (1997). Preparing teachers for educational software purchases. *Kappa Delta Pi Record, 34* (1), 20-21.

Robertson, S., Calder, J., Fung, P., Jones, A., & O'Shea, T. (1997). The use and effectiveness of palmtop computers in education. *British Journal of Educational Technology, 28* (3), 177-89.

Rockman, S. (1998). Leader's guide to education technology. Edvancenet. http://www.edvancenet.org/ax/metacontent_fs.html?res*guide.

Rogers, P. L. (1999). *Barriers to adopting emerging technologies in education.* Richmond, VA: Virginia Commonwealth University. ERIC Document Reproduction Service No. ED 429 556.

Ross, J. A., Hogaboam-Gray, A., & Hannay, L. (1999). Predictors of teachers' confidence in their ability to implement computer-based instruction. *Journal of Educational Computing Research, 21* (1), 75-97.

Schacter, J. & Fagnano,C. (1999). *Journal of Educational Computing Research, 20 (4)* 329-343.

Schoeny, Z., Heaton, L., & Washington, L. (1999). Perceptions and educational technology needs of school administrators. *Proceedings of SITE 99: Society for Information Technology & Teacher Education International Conference, San Antonio, TX*. ERIC Document Reproduction Service No. ED 432 224.

Shade, D. (1999). Software evaluation. *Information Technology in Childhood Education, 51* (6), 276-280.

Solomon, Lewis. (1999, October 19). *Survey of technology in the schools.* Milken Family Foundation. http://www.mff.org/publications/publications.taf?page=277 (October 31,1999)

Teacher's pet. (1994, December 10). *The Economist*, p. 67.

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