Chapter 1
Strategies to Increase Technology Acceptance

Gary Lee Ackerman
Rivendell Academy, USA

ABSTRACT

Despite efforts by school leaders, teachers, technologists, and researchers; much teaching is unchanged since the arrival of information and computer technology (ICT). The same devices that are deeply embedded in everyday life are still marginalized in many classrooms. Technology acceptance is a framework that has contributed to the development of ICT and ICT-based practices in many fields other than education. Three strategies for supporting ICT in schools that focus on increasing technology acceptance are described from the participants' perspective. The experiences are discussed from several perspectives to both understand technology acceptance as a framework for planning in education and to identify some unanswered questions about technology acceptance that are relevant to education populations.

INTRODUCTION

Within two decades of the invention of the first electronic digital computer, information and computer technology (ICT) arrived in schools. Its arrival marked a structural deepening (Arthur, 2009) of schools as it added to the existing systems for teaching and learning. Since the late 1970's computers, software, and network devices have been installed in schools only to be replaced with more sophisticated devices within a few years. In the 21st century, schools in the United States have low student to computer ratios, the computers access the Internet via broadband connections, and wireless networks are available so mobile devices owned by the school and owned by individuals are connected as well (Snyder & Dillow, 2013).

Early in the history of electronic educational technology, it was established that availability is not sufficient for it to be an effective tool for curriculum and instruction (Cuban, 1986). Teachers' competence using the systems, their understanding of its role in the classroom, and their confidence in the reliability of the systems are all factors that influence the degree to which they include it in their teaching plans (Sandholtz, Ringstaff, & Dwyer, 1997; Schofield, 1995). Professional organizations have responded by developing expectations for students (NETS Project & Brooks-Young, 2007) and educators (International Society for Technology in Education, 2008), and educational technology continues to focus much research (Hsu, Ho, Tsai, Hwang, Chu, Wang, & Chen, 2012; Hwang, Chu, Yin, & Ogata, 2015;

DOI: 10.4018/978-1-5225-0965-3.ch001

Lee, Waxman, Wu, Michko, & Lin, 2013). Political and educational leaders, including those who are responsible for implementing Common Core State Standards (National Governors Association Center for Best Practices, & Council of Chief State School Officers, 2010), recognize the role of ICT in teaching and school as well (Watters, 2014).

In the environment of rapidly evolving infrastructure and similarly evolving need to support professional learning, school leaders have implemented multi-dimensional systems to support technology in schools. Technicians and system administrators ensure ICT is secure, updated, and remains functional; training is offered to ensure faculty and staff can operate new devices and software, and teachers are provided with professional development opportunities to help them integrate ICT into curriculum and instruction. In many jurisdictions, school leaders are required to create long-term technology plans, and educators must demonstrate competence with ICT to obtain and maintain teaching licenses. All of these factors necessitate comprehensive technology support systems in all schools.

Despite the efforts of local leaders to provide reliable ICT systems and the efforts of professional organizations and education researchers to inform technology decision makers in schools, there is evidence that much teaching resembles that which occurred prior to the arrival of the ICT (Hew & Brush, 2007; Ladbrook & Parr, 2015; Lee et. al., 2013). The slow progress in modifying curriculum and instruction to reflect the emerging ICT-rich world has been a theme in the educators' professional literature for decades. In 1994, Papert suggested a teacher from 100 years earlier would find classrooms familiar. A decade after the World Wide Web was invented; Pflaum (2005) and Seiter (2005) found the Internet was available in schools, but it was largely distracting students. Pearson and Somekh (2006) suggested most ICT-based teaching was designed to increase the efficiency of direct instruction rather than to engage students in alternative learning activities. Lee et. al. (2013) concluded that the greatest effect of ICT on cognitive outcomes occurred when learners are engaged in creative and collaborative activities rather direct instruction, but direct instruction is still the dominant ICT-based pedagogy. In the same decades that ICT changed how we conduct our economic, political, and social lives (Benkler, 2006), schooling appears to be little changed because of it.

In reviewing the literature regarding ICT systems, one will frequently encounter technology acceptance model (TAM) (Davis, 1989) as a framework that focuses the research. In proposing TAM, Davis observed that information and computer technology "offers the potential for substantially improving white collar performance," but that "gains are often obstructed by users' unwillingness to accept and use available systems" (Davis 1989, p. 319). In defining TAM, Davis sought to identify those factors that increase the likelihood that users make the choice to use technology. When it was first elucidated, TAM posited perceived ease of use and perceived usefulness are positively associated with the intention to use technology. In the years since, more sophisticated models of technology acceptance have been elucidated; and through these models, technology acceptance continues to focus much research and guides designers of devices, interfaces, and ICT-rich practices.

In this chapter, the author describes technology acceptance, specifically the unified theory of acceptance and use of technology (UTAUT) (Venkatesh, Morris, Davis & Davis, 2003), as a framework to design the ICT support systems that are necessary in 21st century schools. First, technology acceptance is presented as a model to explain and predict observations in ICT-rich organizations. Second, several practices that appear to have increased technology acceptance in K-8 populations are presented and described through the experiences of the participants. Finally, several themes that appear to emerge from this exploratory research are identified and explained.

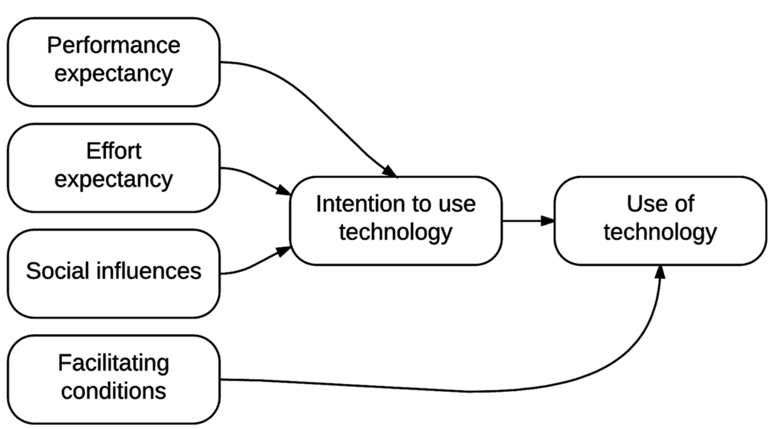
UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY

Perceived ease of use and perceived usefulness are factors that are consistently supported by TAM-based research, and these constructs continue to be refined as well. In 2000, Venkatesh and Davis deconstructed perceived usefulness into job relevance, quality of output, and results demonstrability. This suggests the ICT one believes will improve efficiency or efficacy is more likely to be used. Venkatesh and Davis also found social influences affect technology acceptance; users demonstrate greater acceptance of technologies that are used in social groups with which the user identifies. Hsu and Chang (2013) proposed perceived convenience as a factor positively associated with acceptance of online learning. Other factors including experience (Lee & Kim, 2009) and perceived value (Turel, Serenko, & Bontis, 2007) have been identified as factors that influence technology acceptance by moderating perceived usefulness.

Scholars recognize the use of technology as a human behavior that is affected by the perceptions of the individual; different individuals may perceive different ease of use and different usefulness in same technology. This complicates the work of scholars who seek to understand the phenomena and it complicates the work of designers who create ICT systems to accomplish strategic and logistic goals of organizations. Further complicating the application of TAM are the observations that other aspects of personality including self-efficacy (Wang & Wang, 2009), cognitive style (Pitcuch & Lee, 2006), attitude towards computers (Teo, 2007) and motivation (Schaik, 2011) appear to influence the intention to use technology. Because these moderating effects are ambiguous, many researchers use TAM in conjunction with other models when designing research methodology and proposing hypotheses (Atif, Richards, Busch, & Bilgin, 2015).

In 2003, many models were being used to predict and explain technology use, so researchers consolidated eight theories, including TAM, into the unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003). According to UTUAT, performance expectancy, effort expectancy, and social influences are positively associated with the intention to use technology and facilitating conditions are positively associated with the behavior of using technology (see figure 1). Further, four factors (gender, age, experience, voluntariness of use) are indirectly associated with the intention to use technology.

Figure 1. Unified theory of acceptance and use of technology
Adapted from Venkatesh et al., (2003).



Performance expectancy is grounded in job fit, relative advantage, and quality of outcomes. When technology use is either voluntary or compulsory, individuals show greater acceptance when it is associated with greater effectiveness in accomplishing desired or necessary tasks. Effort expectancy is grounded in users' perceptions of ease of use, so greater ease results in greater effort expectancy. Social influences include both the social norms of a group with which the user identifies as well as the beliefs of individuals who are valued by the user. Facilitating conditions include those aspects of "the technological and/or organizational environment that are designed to remove barriers to use" (Venkatesh et al., 2003, p. 453), and those typically include availability of trained technicians, sufficient numbers of devices, adequate budgets, and similar structures. In summary, individuals tend to use ICT they believe is easy to use, will help them perform important tasks, that others expect them to use, and that are well supported. In addition, leaders can reasonably predict that steps taken to increase technology acceptance will increase the use of technology within an organization.

Especially within populations of educators, several conditions complicate how the factors associated with increased technology acceptance are understood and experienced, so clear definition of the constructs is difficult. Consider, for example, educational outcomes and performance expectancy. Those mathematics educators who believe learning is measured by students' performance on tests of computation are likely to perceive skill building software to increase performance expectancy. Those mathematics educators who believe learning is demonstrated through performance on authentic tasks (Herrington, Oliver, & Reeves, 2014) and problem solving are likely to perceive the same software with lower performance expectancy. Consider, also, social influences. An educator may find conflict between the social influences of his or her social peers who encourage and expect technology use and the influences of experienced colleagues who minimize its importance in teaching.

Compared to the number and range of problems that have been studied using technology acceptance in business and industry, technology acceptance has been less used by educational researchers. Increasingly, however, technology acceptance is used to "establish scientific knowledge about how to get the best out of educational technology" (Davis, 2011, vii). Teo (2011) further observed that much time is used to plan and prepare to integrate technology; so clear frameworks are needed to guide this work, and technology acceptance provides the necessary framework. Efforts to use technology acceptance in education include validating instruments for measuring technology acceptance in relevant populations (Ackerman, 2012; Teo & Noyes, 2008). The following sections illustrate how UTAUT (Venkatesh et al., 2003) has been used to design support systems in schools.

STRATEGIES FOR INCREASING TECHNOLOGY ACCEPTANCE

Technology support is the result of purposeful planning by school leaders. The strategies described in this section emerged from exploratory research investigating the experiences of educators who engaged in that planning. In each case, a school leader articulated the desire to expand and enhance how technology affected teaching and learning; he or she wanted ICT to be used for a greater number of learning activities or wanted the ICT to improve the learning environment. Once a particular problem was isolated and defined, the school leaders either invited the author or accepted the author's offer to identify strategies to solve the problem that were framed in terms of technology acceptance. Defining the details of how each strategy was to be instantiated was assigned to a group of professionals within the community. Once the school leader deemed the strategy was sufficiently developed and that it addressed factors associated with technology acceptance, it was formally introduced to the faculty and staff that would experience it. During the introduction, UTAUT (Venkatesh et al., 2003) was introduced and the leader articulated which factors he or she intended to influence through the new procedures or system.

The qualitative data reported in this chapter originated in documents created during each planning process including memoranda, email, and other communications, records of meetings, journals kept by participants, and training materials. In the initial data set, there were records of 10 projects that were designed and implemented in seven different schools. Of the 10 projects, three had been implemented in more than one school, and those three projects became the focus of this study. The documents available from those three projects were read by two researchers and selectively coded (Strauss & Corbin, 1990) for effort expectancy, performance expectancy, social influences, and facilitating condition. The data in the original documents were supplemented by telephone interviews conducted with each participant whose ideas were used in this chapter. During the interview the participants were asked to reflect on the project and to provide insight gained in the time since the project was originally undertaken.

The schools in which these strategies were implemented are all public schools located in rural areas in the New England states in the northeastern United States. The grade configurations varied, and most of the initiatives extended across multiple buildings to include educators responsible for kindergarten through grade 12. The strategies were part of on-going strategic planning practices in the schools and several were coincidently the focus of instructional design projects of interns working in the schools or action research projects for educators who were completing master's degrees.

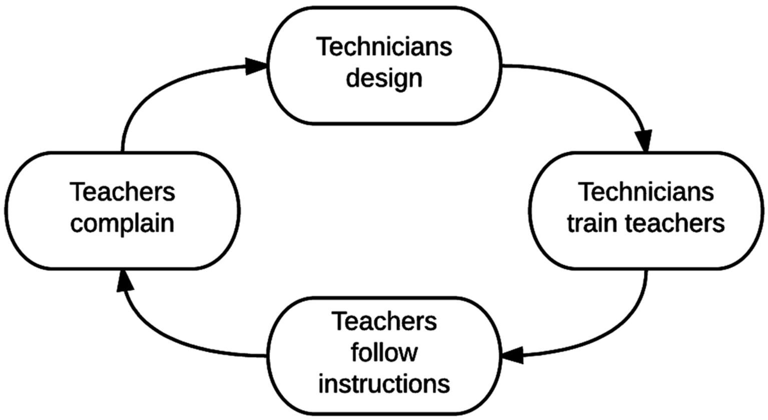
Planning Cycle

To ensure systems used for teaching and learning remain highly functional, technicians configure ICT so that users are restricted in which resources they can access and what changes they can make to the devices. In organizations that comprise adult users who have very specific data and resource needs and reasonably well-developed keyboarding and language skills, security and other policies that ensure high functionality pose little obstacle to technology acceptance. In educationally relevant populations, the same practices that protect the functionality of ICT used by information workers who are adults can interfere with technology acceptance.

Gerry, the principal at a secondary school, along with the other school administrators on the leadership team recognized there were inconsistencies between the ICT needs identified by teachers and those identified by the technology coordinator for the school. Gerry observed, "We have a skilled network administrator, but our teachers are not always sure exactly what they need, then the network administrator makes things way too difficult, but when we try to fix it we seem to not agree about what needs to be done." In an effort to resolve this and increase technology acceptance, especially through improving the effort and performance expectancies, Gerry and his colleagues developed the technology planning cycle summarized in figure 2. As Gerry summarized it, "We want things to be simple and to do what we want without having to fight with it."

The technology planning cycle begins with technicians designing systems to meet the need as they understand it. The extant technology, budget and other resources, and the skills and experience of the technicians are all important determinants in how the system is designed. Once the system is implemented, the technicians explain how it is to be used to the teachers, students, and other users. All users have an obligation to understand and follow the procedures, so the system is used in the manner it was designed. If teachers and students find the design is suboptimal, they describe how the system is interfering with

Figure 2. Technology planning cycle



effort expectancy or performance expectancy. Technicians then redesign the system to reflect the changes that teachers indicate are necessary.

After debating the appropriate entry point into the cycle, Gerry's team decided to have a formal presentation from the network administrator about the existing system, so they entered the cycle by understanding how the technicians had designed the system. At the same meeting where the design was explained, the leadership team explained to the network administrator the planning cycle they were implementing, along with the expectation that changes would increase students' and teachers' effort expectancy and performance expectancy. When teachers returned to school a few weeks later, the planning cycle was explained to them. Specifically, they were told to express technology problems in terms of effort and performance expectancies.

The first situation in which the planning cycle was used began when a mathematics teacher reported that her students could not access the student information system, thus the online grade book, from the laptops distributed as part of the one-to-one initiative in the school. Gerry asked the network administrator to investigate the problem, but he immediately told Gerry, "I want to make sure students don't 'hack' their grades, so [the SIS] cannot be accessed through the wireless network assigned to students. Teachers' laptops are on the administrative network which can access [the SIS]." After confirming with teachers they were unaware of this limitation, Gerry directed the technology coordinator distribute a memo that clarified, "students can check their grades from home, or they can use a teacher's laptop to check grades from school." When the memo was shared, the second step of the planning cycle had been completed; the network administrator had designed the system with the limits he felt were necessary, and he had informed users how to operate it.

After one month of using the "connect from home" or "check grades on a teacher's laptop" solutions, the faculty reported several difficulties to Gerry. The list included, "excessive time to rotate all students through checking grades on our laptops during class" and "students who most need information about their grades are least likely to have access to the Internet from home." When Gerry asked a group of students about checking their grades, they all agreed with the student who said, "I don't bother, but I would if I could do it quickly from my laptop at school." Gerry concluded the current configuration needed to be changed.

In the memo he sent to the network administrator directing the network be changed to allow students to access the SIS, Gerry noted, “I understand your concerns about this change, but the current configuration makes the system so difficult to use that it is not useful to students.” He also referred to the rationale used to justify the investment in the SIS several years earlier, “easy access to grades should improve students’ performance.” The network administrator did change the configuration so that the SIS was available to users from all of the networks in the school, including the one reserved for students’ laptops.

A review of the system logs indicated students did access the SIS more often after the system was reconfigured. No data were collected regarding changes in students’ performance, and the increased number students accessing the SIS can also be attributed to renewed commitment among the teachers to dedicate time in class for students to access the SIS in a concerted effort to reduce the number of missing assignments that were adversely affecting their grades.

Another example of how the technology planning cycle affected a reconfiguration of an ICT system to increase effort expectancy comes from the experiences of Donna’s students. Donna is a teacher of the primary grades who has the reputation using diverse and differentiated methods. Her students are frequently in the computer room available to her students, and she rotates students through activities that required the computer and others that do not. Specific to computers, Donna indicated, “I want my students to be able to get on the computer and working quickly and independently when that is their starting spot.” To accomplish that goal, Donna convinced the technology coordinator to add a generic user with which all students could log on using only three keys. Donna explained, “Even my [students] who can’t read yet are be able to get on the computers with no help.”

One July, a server was updated, and the generic user name was removed from the network. The technicians who completed the upgrade had left written directions for creating new students accounts at the school, but the pages had been lost as the school year started. When Donna and her students first arrived in the computer room, they were unable to log on with the generic user name, and she was unaware of the new procedure. Once she obtained the directions, Donna attempted to lead her students through the new log on procedure, which necessitated most students to key more than 20 characters. She was unsuccessful, however, and she noted to the principal, “Many of my students are just learning to read, and they are unfamiliar with the keyboard, so long usernames and complex passwords prevent them from quickly logging on without help.”

The principal was reluctant to direct the technology personnel to make changes to the system, “After all,” she said, “I am a teacher at heart, and if the tech guy tells me it needs to be this way, I don’t know any different.” After Donna continued to complain that her students could not access the computers with the new usernames and passwords, the principal decided to be present in the computer room when Donna’s students were next scheduled to be there. After she observed students’ struggles to log on, the principal convened a meeting of the technology coordinator along with the teachers, and after some negotiation, the group decided on a scheme whereby students could more easily (and independently) log on to the systems, but each used unique credentials.

After more than one year of framing technology infrastructure and configuration support needs in terms of technology acceptance, Gerry observed, “When we talked about technology at faculty meetings, I used to hear endless griping about how stuff was never fixed. The technicians stuck to their plans and were reluctant to modify things. Of course [teachers] were not articulate about what they wanted or needed.” He contrasted that with the meetings after introducing technology acceptance, *Now, we have a target that everyone understands. If teachers or students tell me something is hard or complicated, we know what needs to be changed and we know things are not fixed until they are easy to use. Teachers also know the standard for purchases or upgrades. They need to explain how new tools will be useful in their courses.*

Gerry also indicated that school leaders where playing a more active role in managing technology decisions, "The administrative team is very talented, but none of us are technology experts, so we had little choice but to accept what the tech people said." Gerry described how the cycle supports his decision-making, "With this model, I know who to listen to at any point, and I can ask questions that help me understand where in the cycle the breakdown is happening, so I know what steps to take."

In the cases of both Gerry and Donna, UTAUT (Venkatesh et al., 2003) provided a method for evaluating the ICT systems. Significantly, in both cases the educators appear to have been empowered by the variables identified as relevant in UTAUT. Donna observed, "Teachers may not know how to set up networks, but we do know if they work for us, and easy and useful are things we can see and talk about." The constructs of effort expectancy and performance expectancy created a meaningful vocabulary with which educators could explain how functioning ICT was dysfunctional from their perspective.

Reflexive Curriculum Design

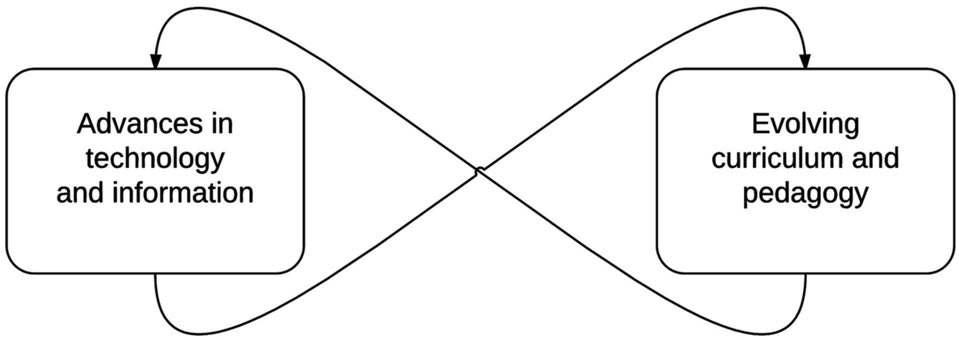
The term reflexive was first used to describe the interactions between social scientists and their subjects. It was reasoned that the presence of scientists affected the subjects' behavior thus the observations made by the researcher. In recent decades, reflexivity has been used to describe the influences between technology, people, and their pattern of information use and social interaction (de Vanjany, 2008). New hardware and software make new patterns of information use and interaction possible, and as the technologies are used, the new patterns contribute to further research and development, which leads to new technologies.

In an initiative begun by Linda, the curriculum director for a school district comprising several schools, a group of K-8 teachers developed a process they called "reflexive curriculum design" (see figure 3). In the email inviting teachers to participate, Linda stated the purpose was to "update the lessons and units for new standards so that new technology is essential." She further explained her rationale, "We have a good foundation of technology skill, and I did not want to loose that as we changed the focus of professional development to the new standards." By specifying, "The lessons we develop will depend on a previously unused technology to accomplish something previously not taught," Linda identified improving the performance expectancy of the ICT as a goal of the work. Dave, Chris, and Jason are three educators who participated in this reflexive curriculum design project.

Dave works as a librarian in two school buildings; between the two schools, he serves the students in all grades K-12 in the town where the schools are located. With a renewed focus in the curriculum on non-fiction texts, he was adding non-fiction to his collections and he was asked to support research projects for students in several grades as part of the reflexive curriculum design initiative.

Dave observed, "Keeping track of references can be a real pain, and we all know students are do not do a good job citing their sources. I see it all the way through high school." When designing a research project for fifth and sixth grade students, he recommended introducing students to an online tool for creating bibliographic references. While the system they selected did not explicitly restrict access to users as young as these students, Dave and his colleagues developed a plan whereby the library assistant would collect and manage the references for all students. When students were ready to compile their

Figure 3. Reflexive curriculum design



references for their paper, they arranged to work with the library assistant to move the items from the online database to the individual's paper.

Reflecting on the first experience using online bibliography tools with students, Dave observed, "Every student had a complete reference section in his or her paper, which has never happened before! Our procedure was a little slow, because everyone went through [my assistant's] account, but it worked out." Dave also noticed a much different attitude among the students compared to other research projects,

Previously, the students were encouraged by teachers to be sure they wrote down the information regarding their sources first, and we saw students taking time with those details rather than reading and taking notes on the articles. With the online system, students would read and take notes, then have [my assistant] put it in the database. They focused on the ideas, not the citation. They also saw getting their references from the database and into their papers as a sign they were done, so they were motivated to take that last step.

Since that first experience, Dave has continued to work with that cohort of students. He described how the students immediately asked about the site they had used in middle school and began creating their own online bibliographies and compiling references when they were given research assignments early in their high school careers.

As part of the reflexive curriculum design project, Chris added several experiments designed specifically to extend and reinforce concepts taught in mathematics curriculum to his middle school science classroom. In one experiment, students record performance on seemingly silly tasks (for example the "cotton-ball shot put"). Students plotted performance on the tasks versus individuals' height to explore correlation as part of the data analysis that was the focus of the lesson. Chris decided to have students plot the graphs using a spreadsheet, and he distributed a spreadsheet template with a scatter plot already inserted and configured to show the regression line (called the "best-fit line" by Chris and his students) on the plot. As students transcribed the data from their notebooks to the spreadsheet, the points were plotted and the regression line updated to reflect the new points.

Students were asked to pay particular attention to the line as the data were plotted, and they shared what Chris perceived to be very sophisticated observations. For example, one student noted, "When the first few points were added, it moved a lot, but it hardly changed at all with the last few points." Chris commented on the data analysis demonstrated by his students, *Seeing the best-fit line grow as they added data seemed to make it stick with kids. I haven't taught best-fit line in years, because, they never really got the idea when they would just draw the line with a ruler on a paper graph. I noticed they even played a little to see if they could change the slope. This would not be possible without the spreadsheet.*

Jason teaches fourth grade in a small rural school, and for several years his students completed a study of the local community. "It has become a feature of our spring open house," said Jason, "but we were starting to run out of ideas for making it interesting." When new computers arrived in his school and they were far better than the computers his students had access to previously, Jason explored Google Earth. For the "our town" project that year, Jason helped students create virtual tours of the town.

Jason also incorporated mathematics lessons into the study and used to the tools in Google Earth for this purpose. "Students chose different properties, including farms and the state-owned forests in town, and mapped them. We ended up with interesting shapes to measure and compare." Jason invited Linda to be in the classroom when his students were preparing to share their work for the open house. In her notes made during that visit, Linda observed, "students checking definitions in the textbook." Linda further explained that observation, "I was struck by the independence and enthusiasm with which students were checking their work. They cared enough to be sure it was correct and they checked their steps by looking in the book rather than checking with the teacher."

To complete the reflexive relationship between the curriculum that was designed and the technology that was available, Linda convened a meeting of the teachers who participated in the curriculum development and the technology planning committee for the district. Chris described how he had to delay his graphing activity because he needed access to laptops with a full spreadsheet application installed to use the regression line feature. Increasing the number of computers with the full spreadsheet available in Chris' school is an example of the reflexive effects that the new curriculum exerted on the ICT in the schools that resulted from the discussion about the technology capacity necessary to fully implement the activities designed during the reflexive curriculum project.

Curriculum Repository

Pam is a sixth grade teacher who has taken a leadership role in her district's curriculum evaluation and redesign efforts in recent years. "We discovered that sharing ideas was the key to our success," she explained. Because her district comprises schools that are separated by more than 10 miles, "working together during the day was not going to be possible, and professional development days were scheduled with other initiatives. We needed to find more time to work together, but the usual options were not possible." Pam and her fellow teachers brainstormed with the author to develop a curriculum repository; it was designed to be an online space for educators to upload, download, revise, and reload instructional materials; exchange tips and strategies for using the materials, share ideas for organizing discussions, and otherwise provide support to peers and colleagues. The repository was built using the learning management system (LMS) maintained primarily for the high school students and their teachers in the district.

The repository was designed to resemble the open educational resource communities in which several student teachers associated with the faculty had participated, "We were guided by the four-R's when we planned the repository," explained Pam. She was referencing reuse, revise, remix, redistribute, the four principles used by advocates of open educational materials (Hilton, 2010) to describe what users of the resources are allowed to do with materials created by others.

As a leader in the curriculum repository project, Pam was a frequent user of the site and a contributor. Pam, observed, “I know to look for certain things from certain teachers. Carol always posts good skill-building sites, and Stephanie has great discussion questions, but Amy always seems ahead, has tried the activities with kids, and has good tips.” She attributes the value of the repository to her confidence the materials will be appropriate for her curriculum goals. Comparing the resources on the local curriculum repository to those on an open education community open to all, Pam commented, “Our site is much more specific. If I get something from OER, it takes time to find it and edit it, but the stuff on our site is exactly what I need.” In this character, the curriculum repository appeared to provide greater job fit, thus greater performance expectancy than the other open education sites used by Pam.

The curriculum repository appears to have exerted social influences, and the social influences appear to have originated from the teachers. “When we have district curriculum meetings, we go right to the repository, and we all know it better than the administrators. It is a grassroots kind of thing.” She further commented on the efforts of teachers to build the system. “When the new special educator was hired, we made sure she could log on and we helped her add to resources to it before she did anything else.”

Pam also described how using the repository improved her own technology skills. “They had been trying to get me to use the LMS with my students, but it always seemed to be more work than it was worth.” After using the site to post and access curriculum materials and also participate in both synchronous and asynchronous discussions, Pam began using the LMS with her students, “I am pretty tech-savvy, but until I got really good at using it, I did not use it with students. Once I could get stuff into my [virtual classrooms] with a couple of clicks, I started posting everything there.”

Pam’s enthusiastic participation in the curriculum repository suggests she has accepted it, and her acceptance appears to have been affected by multiple factors: She perceived the resources to be useful, as she expanded her use of the LMS after she found it easier to use, and she expected her colleagues to participate as well. Not all of the teachers in Pam’s school district reacted with similar acceptance, however. The principal at Pam’s school participated in several meetings at which district administrators discussed the curriculum repository. She noted, “We identified three groups of teachers: Those who were active contributors uploading and downloading and discussing frequently, those who just downloaded, and finally, those who uploaded once, then never logged on again.” The leadership team discovered the groups were not evenly distributed. The contributors tended to work in the same buildings, and the one-time-up loaders tended to work together in other buildings, and the downloaders where scattered throughout.

DISCUSSION

The three strategies described in this chapter illustrate the several dimensions of a comprehensive system to provide technology support in schools; the planning cycle addressed infrastructure support, reflexive curriculum design addressed student activities, and the curriculum repository addressed educators’ professional learning. In the case, school and technology leaders, along with teachers and other educators, were able to use UTAUT (Venkatesh et al., 2003) as a framework for designing technology support practices. Because these were created to address local problems, they were informally evaluated based on the needs and questions of local leaders and practitioners, and all data were collected in a manner that accommodated local circumstances. For multiple reasons, the credibility, transferability, dependability, and confirmability (Hoepfl, 1997) of the qualitative data cannot be assessed. This is not interpreted a limitation of the research, however, as the intent was to explore the influence of technology acceptance on practical planning decisions and designs and and to identify emerging research problems.

Planning for Wicked Problems

In 1973, Rittel and Webber, scholars of design theory and city planning, differentiated wicked problems and tame problems. While both types of problems can be complicated and morally challenging, tame problems are those that can be easily isolated and solved and there is consensus regarding solutions. Wicked problems, on the other hand, are hard to define; result from uncertain causes; and lack consensus regarding definition, cause, or resolution. Mechanical systems that are designed for a particular purpose and that can be tested before they are deployed are examples of solutions to tame problems solved with objectively evaluated solutions. Wicked problems include a social element and solutions are not implemented until humans experience them. Cultural, perceptual, and motivational factors make clear definition and completeness of a solution impossible to know with certainty, and the quality of the solution can only be subjectively evaluated.

Buchanon (1992) suggested the wicked nature of problems arise "because design has no special subject matter of its own apart from what the designer conceives it to be" (p. 98). In these circumstances, Buchanan suggested designers identify relevant guidelines for solving similar problems that have been defined by scholars, but then translate those guidelines into hypotheses and systems that meet the local circumstances. In each of the strategies, we see how the general principles of technology acceptance were instantiated to reflect local needs and resources and solutions were designed and implemented accordingly.

Problems of ICT support in schools appear to be affected by unusual circumstances. First, the design and development of ICT projects typically begin as a technology problem (Richey & Klein, 2014), which can be approached as a tame problem and solutions are engineered to provide functioning ICT. In the cases of Gerry and Donna, however, it can be observed that technologists designed operational ICT, but they failed to recognize the needs of school populations, so solutions deemed satisfactory by technologists were unsatisfactory to teachers and students. This appears to suggest technology management in schools must be an iterative process. Through successive design iterations the guidelines of technology acceptance are reassessed in light of the changed ICT, the capabilities and perceptions of the users, and the goals to be accomplished. Those who solve wicked problems often impose stopping rules so that solutions do no consume excessive resources, but school ICT appears to be a planning problem that necessitates perpetual attention.

When analyzing the process of designing systems for ICT-based teaching and learning, Tracey (2015) found successful teams participate in iterative processes that are marked with collaboration and decisive leadership. In the process she described, "collaboration with prototyping resolved questions regarding the feasibility of existing ideas in the design" (p. 106), but the prototype only came into existence through leaders directing next steps. Gerry experienced this while he was trying to convince the network administrator to make the SIS available to students. The network administrator believed that opening the SIS to students posed a serious security risk to the data, so he was reluctant to make the changes that were requested. As a school administrator, Gerry was in a position with sufficient authority that he directed the network administrator to make the changes.

While the technology planning cycle is only weakly developed, it appears consistent with the design of solutions to wicked problems. In combination with locally relevant definitions for effort expectancy and performance expectancy, the planning cycle appears to provides an heuristic with which the generalizations contained in UTAUT (Venkatesh et al., 2003) can be applied to the design of a technology support system that improved the degree to which ICT serves students' needs.

Indirect Factors Leading to Technology Acceptance

When first elucidated, UTAUT (Venkatesh et al., 2003) posited four factors were indirectly associated with technology acceptance: gender, age, level of experience, and voluntariness of use. The school leaders who participated in these projects suggested those factors are not useful in predicting or explaining technology use among K-12 faculty, and they are not useful in helping them develop support systems to increase technology acceptance. Over time, professional educators have become experienced users regardless of age or gender, and voluntariness of use is a complicated factor as well. School leaders recognize that compliance can motivate initial use of technology, but individuals who do not internalize the rationale for using technology are unlikely to continue or expand its role in the classroom. Linda, the curriculum coordinator who initiated the reflexive curriculum design project, made a statement that seemed to resonate with others, "Every teacher needs to know what technology can do and when it is the best option, and this requires they understand it deeply. Through professional learning, we want to make teachers want to use technology." This motivated Linda's effort to focus on reflexive curriculum development.

Linda appears to be describing a factor that resembles cognitive engagement, and it may be relevant to technology acceptance in educational populations. Blumenfeld, Kempler, and Krajik (2006) suggested cognitively engaging environments are those in which a learner both values the activities and ideas, especially by relating the activities to those that are related to his or her experience, and feels competent to complete the tasks. We can reasonably expect cognitively engaging technology would also be accepted, as value and relevance are similar to performance expectancy and competence is similar to effort expectancy. Autonomy is another factors related to cognitive engagement, but it does not appear to be accounted for in technology acceptance.

Blumenfeld, Kempler, and Krajik (2006) define autonomy to include the "perception of a sense of agency" (p. 477), which arises from awareness and understanding of problems and solutions, as well as capacity and authority to implement solutions. The teachers who argued for opening access to the SIS in Gerry's school exerted agency when they identified a change that was necessary and advocated for the change. The educators who were active in both the reflexive curriculum design and curriculum repository projects were also exerting agency as they were expected to implement the lessons in their classrooms. Given the observations of Huang (2007) and Stefaniak (2015) that autonomy and agency are associated with active learning, it is reasonable to conclude that teachers who are learning "know what technology can do and when it is the best option," which is Linda's stated goal for her teachers will find autonomous professional learning most effective when they are developing useful technology in light of new curriculum expectations.

The relationship between teachers, technology, and autonomy in the classroom appears to be little studied. Compared to users of ICT for other purposes, users of ICT in educational settings do appear to require greater autonomy (Hu, Clark, & Ma, 2003; Teo, 2011), as educators generally are more independent users of ICT and use a greater variety of applications and data sources than information workers in other fields, and they are more likely than other business users to test new applications and data sources for usefulness. There is evidence that teachers may exert limited autonomy with regards to regarding instructional practices (Range, Pijanowski, Duncan, Scherz, & Hvidston, 2014), however. There appears to need to further define, elucidate, and investigate the role of autonomy as a facilitating condition or as a moderating factor on performance expectancy.

Understanding and Measuring the Factors

Practitioners are increasingly approaching their work from the perspective of researchers (McKenny & Reeves, 2014; Richey & Klein, 2007) and they are applying more formal approaches to school planning than they did previously. School leaders are approaching school planning with purposeful actions, as they use theory to predict and explain observations, and they gather data to support decisions. As a planning model, UTAUT (Venkatesh et al., 2003) provides a framework to focus planning and design and interpret data collection. Technology acceptance incorporates several factors, but how these factors are instantiated in schools and how different stakeholders understand them is constantly changing. This necessitates educators continuously refine definitions and measurements of factors related to technology acceptance. Specifically, the situations reviewed in this chapter indicate effort expectancy and performance expectancy are dynamic factors within communities.

Consider steps taken to prevent the intentional or accidental disruption of ICT systems. Technicians and network administrators deploy a wide range of hardware and software protections, and they also establish barriers to prevent unauthorized access to systems and to prevent unauthorized changes to systems. While technicians perceive these as steps to provide stable and secure systems and to improve the effort expectancy of managing the systems (and these are necessary characteristics of functional systems), some steps deemed reasonable and necessary by technicians may make the systems unusable for instructional purposes. Conflicts that can arise from these differences are exacerbated if educators do not have permission to make (or even recommend) changes to ICT configurations.

Bereiter (2002) suggested the most effective professional organizations focus planning around conceptual artifacts, which are clearly understood definitions of the goals of the organization. In education, it is not unusual for definitions to be broadened to facilitate compromise; this does threaten the quality of decisions by weakening conceptual artifacts, however. By clearly defining effort expectancy and performance expectancy as observable actions when teachers and students are using ICT, these factors will become conceptual artifacts and changes to ICT be evaluated by observing users after the changes have been made. When fully developed, conceptual artifacts can be used to create both formal and informal instruments for assessing relevant factors in a more objective manner than is possible when assessment and evaluation is based exclusively on the subjective measures typically available to designers of solutions to wicked problems.

Perceived usefulness is a factor that is especially prone to change as curriculum expectations change within any jurisdiction. Because schools are political organizations, they react to changes in leadership in school buildings, central offices, as well as political changes at the local, state, regional, and national levels. Combined with the many subject areas in which curriculum has been defined, the work of evaluating perceived usefulness must be conducted in the same iterative manner that effort expectancy is improved and refined with the planning cycle. Curriculum design that follows the reflexive process initiated by Linda will be further complicated by the outside influences as teachers or technicians discover new ICT devices and new software and those are integrated into the curriculum. The changes that influence perceptions of usefulness within educational populations are likely to change quickly for individual and groups as well, so systems that cannot adapt to circumstances in days or weeks rather than months or years will be regarded as less useful by educators.

CONCLUSION

Many stakeholders are concerned with the degree to which technology benefits teachers as they design learning activities to facilitate development of the learning embedded in the Common Core State Standards (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). Technology acceptance is a concept that has contributed to understanding of and design of ICT and ICT-based practices in many organizations, and it has provided a framework for educational technology research. In this chapter, several instances in which it was used to design diverse ICT support systems for K-8 educators were described. The unified theory of acceptance and use of technology (Venkatesh et al., 2003) appears to explain and predict the results of decisions and actions intended to improve the function of ICT in schools. As the model is refined and scholars further elucidate how the factors are realized in educational populations, it will be more accurate and valuable tool for school and technology leaders.

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