The Application of Technology Acceptance to Educational Design

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Paper delivered at

New England Education Research Annual Conference,

April 28, 2016 in Portsmouth, New Hampshire, USA

Abstract

Despite a long history of computers in schools, many educators continue to struggle with the problem of creating effective technology-rich learning environments. In this exploratory research, documents collected as several K-12 schools designed systems to support technology-rich education are analyzed. School and technology leaders in each school followed educational design research, an iterative method of planning, to implement interventions intended to increase factors associated with technology acceptance. An emerging research agenda is described.

Keywords: technology acceptance, educational design research, teacher education

The Application of Technology Acceptance to Educational Design

Soon after personal computers appeared in the consumer market, both professional educators and computer hobbyists began to advocate for installing the devices in schools. As desktop computers were more affordable and easier to manage than mainframe computers, this marked the beginning of the "computer revolution" in schools. Almost immediately, computer-rich education began to focus the attention of educators and educational researchers (Sandholtz, Ringstaff, & Dwyer, 1997; Schofield, 1995); since then, libraries full of literature, billions of dollars, and entire careers have been dedicated to understanding and designing effective technology-rich education.

Despite the considerable efforts of these professionals, many educators find that curriculum and instruction continues as it did before personal computers arrived in schools (Chai, Koh, Lim, & Tsai, 2014; Lee, Waxman, Wu, Michko, & Lin, 2013).). There are many reasonable explanations for this observation, and these explanations are supported by ample evidence. This paper addresses one explanation that is well summarized by Gerry, a principal who will be introduced in following sections. He noted with obvious exasperation, "You go to conferences and read the stuff for school leaders, and there is so much contradictory advice, I don't know what to do. I wish someone would cut to the chase, and tell us what works."

The exploratory research described in this paper investigates several situations in which unified theory of acceptance and use of technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003) was used to design technology support systems in K-12 settings. The development of the support systems followed educational design research (McKenney & Reeves, 2012; Richey & Klein, 2007). Several strategies that were implemented on multiple schools are described through qualitative data, and an emerging research agenda is summarized.

Introduction

School leaders engage in continuous strategic planning. They identify goals for improving school functions, create systems intended to affect the desired improvements, and gather data to evaluate success in reaching those goals. The projects described in this paper approached this work in a very specific manner. First, school leaders identified problems in ICT-based teaching and learning they intended to improve. Second, they engaged groups in educational design research to increase factors positively associated with technology acceptance. Finally, they assessed the degree to which the problems were solved.

Educational Design Research

Education is both a field of study and a technology. Whereas researchers identify unanswered questions, design methods to gather data, and analyze those data to answer the questions; practitioners design curriculum and instructional interventions to meet the needs of humans. While these processes are largely separate, there are clear connections between them. Many researchers seek to answer questions relevant to practitioners and many practitioners seek to ground their work in the discoveries of researchers. Educational design research (McKenney & Reeves, 2012; Richey & Klein, 2007) is an iterative process of analysis and exploration, design and construction, and evaluation and understanding through which practitioners become active consumers of the research as they design and evaluate educational systems (see figure 1).

The intent of educational design research is to develop interventions that are deeply informed by theory, and then to reflect on those interventions to develop new theory. McKenny and Reeves observed the approach includes using scientific understandings to "shape the design of a solution to a real problem," and that it is used to "validate, refine, or refute hypotheses and conjectures embodied in the design" (2012, p. 13). In the situations described in this paper,

school leaders sought to design strategies that were based in theory, thus they could predict and explain the results of the interventions with greater accuracy than with other approaches to planning.

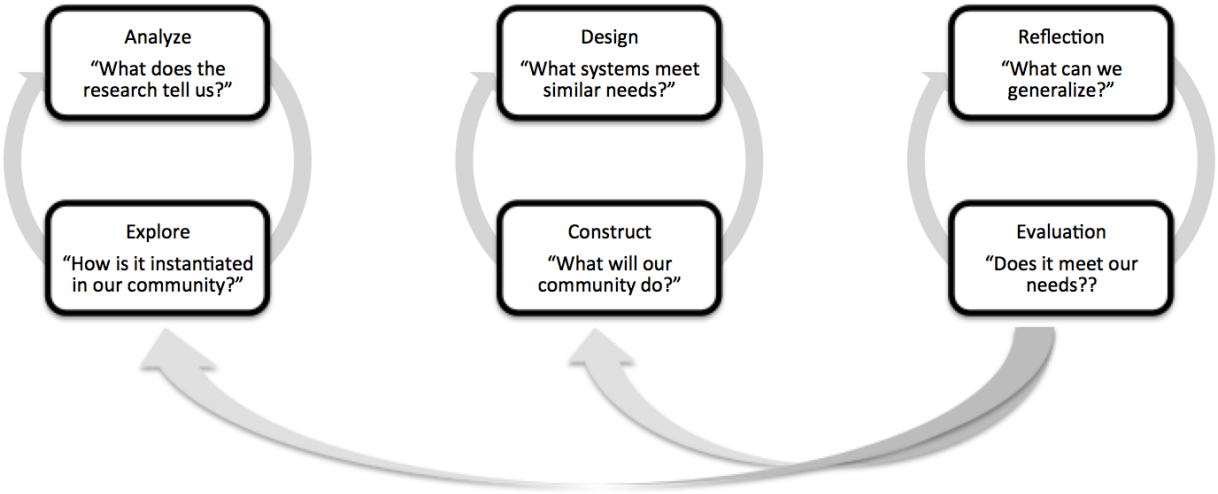

Figure 1: Educational design research adapted from McKenny & Reeves (2012).

Technology Acceptance

In first elucidating technology acceptance model (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). Since then, scholars and designers have used various definitions of technology acceptance to overcome users' unwillingness to use technology. While technology acceptance has largely been applied to fields other than K-12 education, scholars are increasingly using technology acceptance to frame study in educationally relevant populations (Teo, 2011).

In 2003, the unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003) incorporated eight models of explaining the intention to and behavior of using technology into a single theory; it has become widely used when studying technology

acceptance. According to UTAUT (see figure 2), four factors: a) effort expectancy (grounded in ease of use), b) performance expectancy (grounded in perceived usefulness), c) social influences, and d) facilitating conditions are positively associated with the intention to use technology.

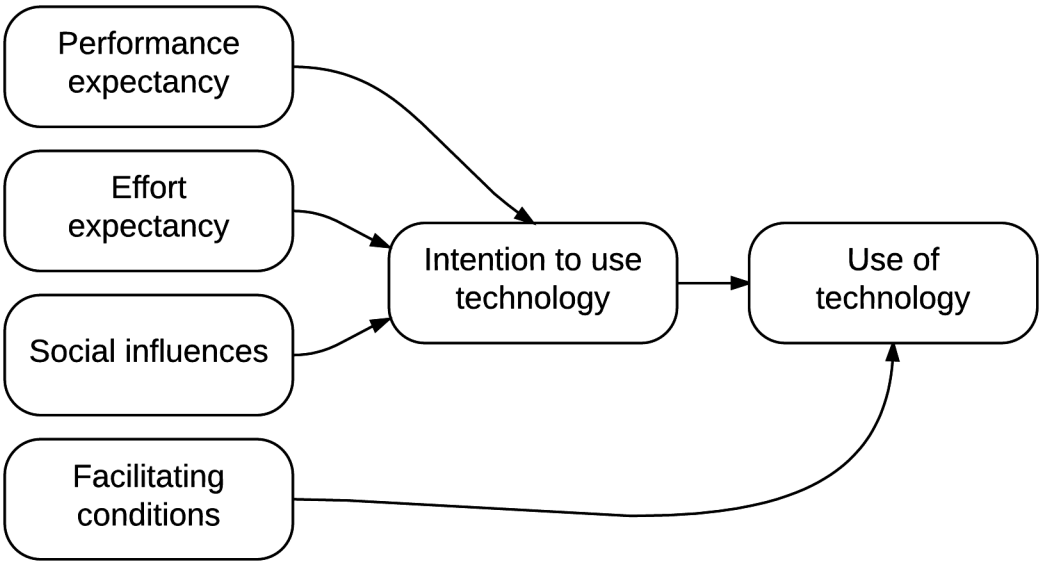

Figure 2. Unified theory of acceptance and use of technology adapted from (Venkatesh et. al., 2003).

This paper describes interventions designed following the iterative processes of educational design research. In each case, the school leader sought to improve the efficiency or performance of ICT in teaching and learning by affecting one or more of the factors associated with increased technology acceptance.

Data

The data analyzed for this study come from documents; including emails, memoranda, meeting agendas and minutes, training materials, research journals, and similar planning and implementation materials collected from 12 projects undertaken by schools in rural New England. The schools varied in enrollment but the projects affected teachers and students in all

grades from kindergarten through grade 12. Each project was undertaken as part of the typical strategic planning activities of school leader and the faculty. The author was involved in identifying and clarifying the problem with the school leaders and framing the work as addressing technology acceptance to the groups of professionals designing the interventions.

The documents collected during the design and implementation of the projects were read and coded (Auerbach & Silverstein, 2003) for emergent themes by three researchers. Illness prevented one researcher from completing the data analysis, so inter rater reliability cannot be evaluated.

Results

Three designs constructed to increase technology acceptance were judged to have met the school leaders' goals of improving access to and use of technology in multiple schools represented in the data. Those designs include one focused primarily on improving infrastructure, on focused on improving curriculum, and a third focusing on teachers' professional learning.

Technology Planning Cycle

Technicians are employed to keep the ICT systems functioning, and systems are in place for reporting malfunctioning computers. Gerry is the principal in a secondary school, and he observed inconsistent communication between technicians and educators. He 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." In response, the technology committee in the school had implemented a help system whereby problems were communicated to the technicians, and the status of repairs was reported.

The leadership team on which Gerry serves observed that the help system was not effective. The leadership team reported, “Repairs are being made, but there is still not communication about what our technology can and should do.” In an example of the iterative processes that characterize education design research, Gerry charged the technology committee with, “reanalyzing the ‘help’ system so it can address ‘what should it do?’ not just ‘what needs to be fixed?’” In this work, the technology committee was revisiting the exploration and analysis of the problem to more clearly understand the problem in their community.

Within a month, the technology committee presented a new technology planning cycle (see figure 3) to the leadership team. The rationale for formally articulating what appeared to be a common sense approach to the work included the observation, “we want to be able to identify where in the process communication has broken down.” After it was presented to the leadership team and the technicians, the specification that “complaints be expressed in terms of effort

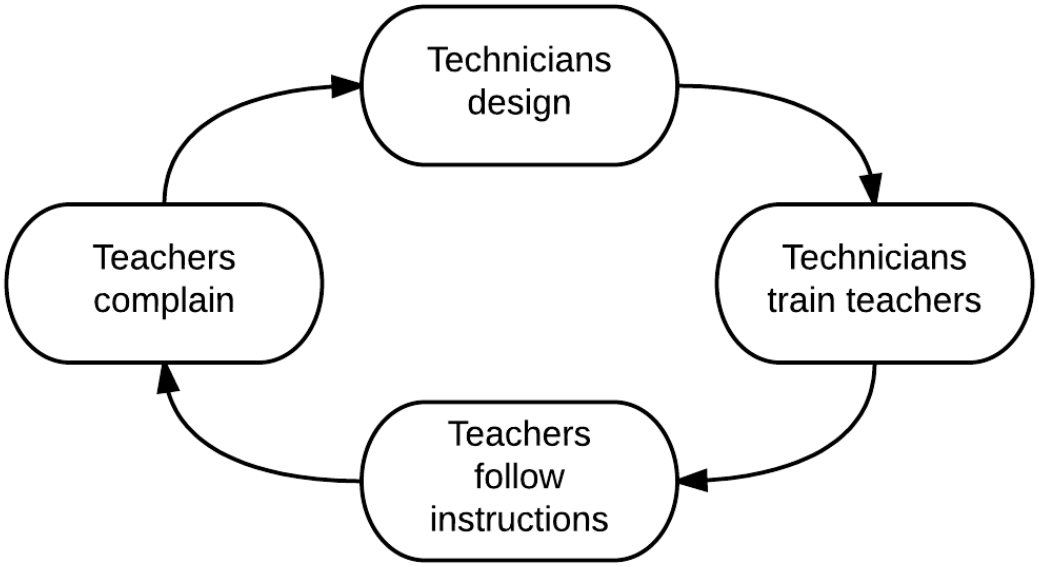

Figure 3. Technology planning cycle.

expectancy and performance expectancy" was added to the guidelines for the technology planning cycle over the objections of the technicians. The leadership team directed these specifications, as they believed strongly that "our computers must work for students and teachers."

Within a few weeks of the beginning of school when the technology planning cycle was introduced, teachers in Gerry's school observed that students were unable to access the student information system (SIS), thus the online grade book, from computers assigned to students as part of the one-to-one initiative. When asked to investigate the problem, the technology coordinator immediately indicated he had blocked those computers from accessing the SIS at school in an attempt to minimize the threat from "students hacking their grades."

The technology coordinator recommended students use teachers' laptops to check grades in school or students check their grades from home. After implementation the technology coordinator's solution for one month, both the teachers and principal concluded the system was negatively impacting both effort expectancy and performance expectancy. In the memo to the technology coordinator directing him to change the configuration of the network, the principal indicated, "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, and this is contrary to the plan we implemented in August."

Donna, a teacher of primary grades, used a less explicit version of the technology planning cycle to resolve a problem that was interfering with her students' ability to use computers independently. Her students had used the same credentials, which required only three keys, to log on to computers for several years. When a new server was installed one summer, those credentials were removed which necessitated students to use unique usernames and create

sophisticated passwords. Donna commented to the principal, “We knew the account students used was not secure, but they could start working without help. With the new accounts, some need to type 20 characters to log on and it is too much for young students.”

Donna’s 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, we need to follow that.” Donna continued to advocate for changes to the system, and both shared her understanding of technology acceptance and the relevant factors with the principal and invited to the principal to the computer room when here students next visited. After observing the difficulties Donna’s students were having, the principal convened a meeting of the technology coordinator along with the teachers because, “the new passwords are too hard for our students, so it is an obstacle to their use of the computers for educational purposes.”

In both Gerry school and in Donna class, we see the iterative processes of educational design research. As designs proved inadequate, practitioners revisited the problem and drew from deeper knowledge of the literature to refine subsequent interventions until they were deemed adequate.

Reflexive Curriculum Design

Reflexivity is a term that was originally used to describe the effects of social science researchers on the situations they were studying; the presence of the researcher affects the behavior of subjects and the observations researchers seek to make. More recently, the term has been used to describe the influence of ICT on how people use information and how they interact with each other (de Vanjany, 2008). The reflexive relationships between technology and the nature of information tasks and the patterns of information use are extending to curriculum and

instruction, and teachers increasingly perceive roots of the performance expectancy in terms of ICT-mediated lessons (see figure 4).

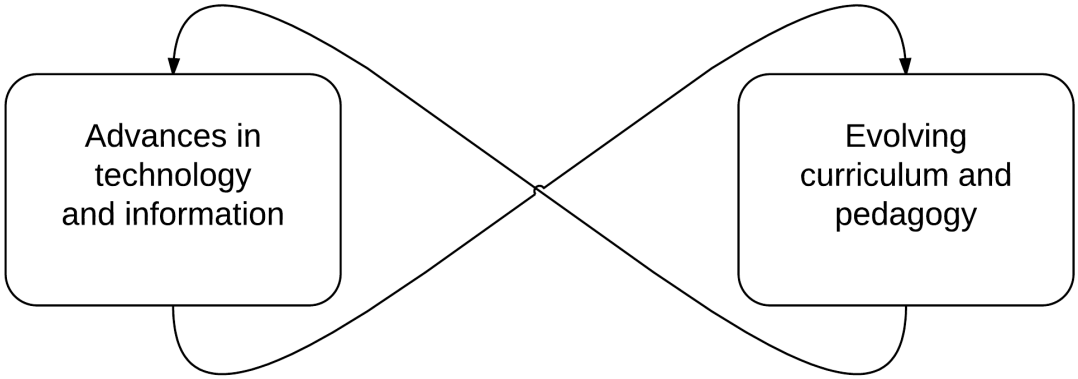

Figure 4. Reflexive influences of technology and pedagogy.

Linda is a curriculum coordinator who works with the faculty in a supervisory union that comprises several schools including both elementary and high schools. She was refocusing professional development efforts to create curriculum that reflect newly released standards. In an effort to continue previously completed professional development focusing on teachers' competency as technology users, she invited teachers to participate in a reflexive curriculum design project to "update the lessons and units for new standards so that new technology is essential." 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. Scott participated in a reflexive curriculum project at a different school; his specific goal was to "build an online course, so that students can take [my elective course] as an independent study, because our kids do not have much flexibility in their schedules."

Both the teachers who participated in Linda's project and Scott found the problems they were trying to solve were unchanging; all had very specific instructional goals they wanted to achieve. By reflexively changing tasks to leverage technology and specifying technology that was well-suited to particular tasks, these teachers created lessons they perceived to be very effective. A middle school math teacher had planned a graphing activity using Google Applications for Education, but realized Excel provided was easier to use for him and that he was more confident using that application. Scott experimented with the options for focusing interaction among his students, and explained, "I started out thinking to just put everything on a discussion board, but then I learned that blogs are better for some questions and wikis good for others."

While minor changes were made as teachers iteratively designed and constructed reflexively designed curriculum materials, the decisions that seemed to generate the most far-reaching changes appeared to arise as the teachers evaluated their work. Linda encouraged them to follow a protocol to provide feedback on what technology was essential for the lessons. Linda reflected, "Our schools make their own technology decisions, and we wanted to be sure we completed [the educational design research] steps of reflection and evaluation so we could help transfer the materials from one school to another."

The technology coordinator who supported the infrastructure in the schools served by Linda indicated, "The feedback they gave was key. It told me what I needed to take care of before recommending a teacher start of the projects, and it gave me a direction to go when recommending upgrades and purchases." Linda found the technology-based lessons developed during the project helpful as well as she could "talk with [the technology coordinator] about

things that we shared knowledge of… he would talk about things that I didn't understand, and I think I did the same to him."

Curriculum Repository

A curriculum repository is an online space, usually a virtual classroom within the learning management system (LMS) that is maintained by the school, which contains a growing collection of open educational resources maintained by a local community of educators. Two curriculum repositories were represented in the data, but permission to use data in this paper could not be obtained from participants at one of the schools; while the data were from both were coded, all evidence is drawn from a participant whose permission was secured.

In each case, the curriculum repository was designed as a space where the iterative processes of educational design research were continuously used to refine and refocus efforts to improve the effectiveness of technology-rich education. Pam, a sixth grade teacher who contributes to a curriculum repository initiative in her district, summarized the embedded nature of the factors associated with UTAUT and the curriculum repository. "At first, we tried to be real specific. When we posted stuff, we would label it 'ease of use,' or 'useful for whatever,' but that got old quickly, so we just used it… posting, sharing. We just did it."

For Pam and her colleagues, the iterative processes of designing and creating curriculum materials were truly collaborative. She observed,

> "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. But the best part is when the things have been used a few times and so there are comments under the original posting with even more tips. At first, we were also slow to edit things others had posted, but now there are two or three versions of most activities.

This contributed to the social influences that were associated with participation in the curriculum repository; she described these influences as organic and emerging from the teachers. "When we

have district curriculum meetings, and we need an example, we go right to the repository. There is no leader, we know it better than the curriculum coordinator, and it is a grassroots kind of thing." These effects are further illustrated by the fact that she created a step-by-step guide to using the repository and those were demonstrated as part of the on-boarding procedures for new faculty.

Pam also observed her use of the curriculum repository for her professional learning affected her effort expectancy related to the LMS. "I am tech-savvy, but I never got into online teaching with my kids. It just seemed too much work." In this she identified effort expectancy as an impediment. "The more I posted, the more it made sense. Once I found I could include something from the repository in my class in with a couple of clicks, I used [the LMS] more and more."

In Pam's experience, we see the experience of participating in a curriculum repository positively influenced the effort expectancy of the LMS; it positively influenced her performance expectancy as she found materials that supported her teaching goals in an efficient manner. Further, she perceive it as a positive aspect of her work and sought to engage others through it, thus demonstrating its role as a venue for increased social influence.

Discussion

The primary purpose of the work described in this paper was to develop interventions for local school communities, and the documents that were analyzed were created as part of the design and implementation of specific projects. Because the completeness of the data cannot be assured, the analysis was exploratory; the observations discussed in this section appear to be supported by the data, but further investigation into each is necessary.

This work was undertaken to determine if educational design research and technology acceptance could provide a framework for creating effective interventions. In the cases investigated here, technology acceptance appears to be a general planning heuristic that can focus the analysis and exploration phase of educational research design as well as the design and construction of interventions. In the examples of Gerry's and Donna's situations, the planning cycle focused on improving factors associated with technology acceptance resulted in ICT systems that were more used for relevant purposes than they were previously. In Gerry's case, the planning cycle was more formally adopted and was used as part of on-going technology support. In Donna's school, the technology acceptance was used in that particular case, but had not been used in a systematic manner. Buchanon (1992) concluded that local planners who follow general planning heuristics could best solve wicked problems for local populations, and that the specific interventions depend on many local factors.

One reason that technology acceptance and educational design research seems to facilitate the implementation of effective interventions appears to be the confidence educators have in recommending technology decisions. After more than one year of framing technology infrastructure and configuration support needs in terms of technology acceptance, Gerry observed,

> "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 getting new stuff. 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.”

This research also suggests there are several problems that deserve further investigation. First, within educational communities, there are likely to be multiple and conflicting understandings of technology acceptance; the nature of these differences as well as measuring them in educational populations deserves study. While Donna did not perceive the new and more sophisticated log on procedures necessitated by the new server to interfere with her use of computers, she perceived the same change to be problematic for her students. This suggests individual teachers appear to have different constructs for themselves and for their students. Also, individual teachers’ perceptions of effort expectancy and performance expectancy vary with the context; teachers may describe high acceptance for productivity tools for management purposes, but low acceptance when the same tools are used for instruction. Further, some teachers identified conflict between their personal social influences and their professional social influences; veteran colleagues who minimized the importance of technology in instruction made them reluctant to adopt tools they would otherwise. Finally, understanding of effort expectancy and performance expectancy appear to vary between professional who interact with students and those who maintain technology infrastructure.

Bereiter (2002) suggested the most effective professional organizations focus planning around conceptual artifacts, which are clearly understood definitions of the goals and strategies 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.

In the original definition of UTAUT (Venkatesh et. al., 2003), four factors (gender, age, experience, and voluntariness of use) were found to be indirectly associated with the use of technology. The school leaders how participated in the initiatives described in this paper found those to be of minimal usefulness in predicting technology use by teachers in their schools. Linda, the curriculum coordinator who led a reflexive curriculum design effort, observed, "We want all teachers to understand when technology is the best choice and to have the skill and confidence in the system to use it." This is an opinion that appeared to resonate with the other school leaders in the study. Linda appears to be describing autonomy as a factor that is indirectly associated with technology use by her teachers.

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 when technology 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 than users of computers n other organizations (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.

Leadership also appears to be either a moderating factor or a facilitating condition with particular resonance in K-12. As has been described, technology acceptance allows educators to observe the effects of malfunctioning or misconfigured technology. Both Gerry and Donna's principal made leadership decisions based on observations interpreted in light of technology acceptance.

The curriculum repository created by Pam and her colleagues was the focus of discussions at meetings attended by Pam's principal as well. She indicated, "We noticed more participation in particular schools in [the district]. It seemed to be better where there was a strong teacher who led others, and at one school, the principal appeared not to care, so teachers didn't

participate." UTAUT (Venkatesh et. al., 2003) does posit social influences arise from both peers and leaders, but leadership appears to be a particularly strong factor in schools (Fullan, 2002).

Conclusion

Educational design research appears to provide an effective approach to effective and responsive technology support systems when technology acceptance is used as a theory to guide the design of interventions. This exploratory research documented several initiatives in which educators perceived elements of ICT in their school improved through the implementation of interventions designed in this manner.

Technology acceptance was originally elucidated in populations other than K-12 education. It appears that there are uncertainties about how the construct is instantiated in educationally relevant populations. How context affects the factors related to technology acceptance seems to be an emerging problem, as do other factors such as autonomy and leadership.

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