Examining teachers' decisions to adopt new technology

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Abstract

This study examined teachers' beliefs about technology adoption as a reasoned, deliberate, intentional decision-making process, as reflected in Ajzen's (1985) Theory of Planned Behavior. Qualitative and quantitative data were collected from teachers in four schools located in the southeastern region of the United States. Overall results indicated that technology adoption decisions were influenced by teachers' individual attitudes towards technology adoption, which were formed from specific underlying personal beliefs about the consequences of adoption. External support from key persons and contextual resources (e.g., funding) were insignificant factors affecting teachers' technology adoption decisions. From these results, we recommend that school administrators work closely with teachers to address their beliefs and concerns about technology adoption and provide an influential level of personal support and resources. We also offer recommendations for educational software designers for developing future technology resources for teachers.

Keywords

Teachers' beliefs, Technology adoption, In-service teachers, Educational technology

> "Design should make use of the natural properties of people and of the world: it should exploit natural relationships and natural constraints." (Norman, 2002, p. 188)

Introduction

In his seminal work, *The Design of Everyday Things*, Don Norman (2002) urged readers to adopt a human-centered design perspective. This viewpoint is a "philosophy based on the needs and interests of the user, with an emphasis on making products usable and understandable" (p. 188). As teacher educators we are firm believers in this design approach. When developing effective and appropriate educational technologies it is critical for developers to anticipate and address teachers' technology needs. Comprehensive technology adoption and integration can be an overwhelming task for most public schools and teachers. The "Field of Dreams" syndrome ('build it and they will come") is too often applied in educational settings without success. In 1999, 99% of all public school teachers reported having computers available in their schools and 84% of those teachers had access in their actual classrooms (U.S. Department of Education, 2000). As of 2002, 92% of the public schools now have Internet access in the classroom, computer labs and media centers (U.S. Department of Education, 2003).

However, only a third of these teachers reported being "well prepared" or "very well prepared" to use computers for classroom instruction (U. S. Department of Education, 2000). The critical variable in this adoption process and subsequent integration is the teacher. Teachers must be convinced of the feasibility of using a particular technology before adoption and integration occur (Office of Technology Assessment, 1995, p. 71).

Existing studies on teachers' technology beliefs

Though funding, equipment, lack of time, and knowledge are known obstacles to successful technology integration (Hardy, 1998; Lam, 2000; Simonsen & Dick, 1997), a critical component in meeting teachers' technology needs is responding to teachers' beliefs toward technologies. In fact, teachers' beliefs are essential in considering how a teacher teaches, thinks, and learns (Richardson, 1996). Hope (1997) wrote, "Teachers basically had to contend with two factors [with technology adoption]: (a) the psychological effect of change and (b) learning to use microcomputer technology." (p. 158). Understanding teachers' beliefs toward technology plays an essential role in successful technology adoption.

Previous studies employed a variety of methods and perspectives to assess in-service teachers' technology beliefs. These methods included: Likert-scale questionnaires (e.g., Ross, Hogaboam-Gray, & Hannay, 1999); case study methodology (e.g., Ertmer, Gopalakrishnan, & Ross, 2001); Concerns-based Adoption model (e.g., Germann & Sasse, 1997; Hope, 1997); in-depth interviews (e.g., Simonsen & Dick, 1997), as well other methods. Several of these technology studies reported that teachers who received laptop computers increased their technology confidence and skills and were more likely to remain in teaching (Falba, Grove, Anderson, & Putney, 2001). Germann and Sasse (1997) found that teachers who participated in a two-year technology integration program improved their technology self-efficacy and their interest in learning more about how technology could impact the curriculum. Ross, Hogaboam-Gray, and Hannay (1999) reported that access to technologies increased teachers' "opportunities for successful teaching experiences, thereby contributing to greater confidence in their instructional ability" (p. 87). In addition, they also noted, "teachers who interpret their interactions with computers as indicative of high ability grow in self-confidence, regardless of their experience" (p. 93). Research reveals also that before teachers use technology for instruction they must be personally convinced of its benefits and must see the utility of using a particular technology (Lam, 2000).

Before technology is used in the classroom teachers focus attention on their students. They want to know what impact it will have on students' learning outcomes (e.g., Higgins & Moseley, 2001). Teachers use technology because it motivates students and offers a different mode of presentation. Instead of using computers for drill and practice, more confident teachers use technology as an instructional tool to enhance students' learning (Lam, 2000). Successful technology adoption in teachers' classrooms is dependent upon school administrators providing an individualized, differentiated process of training and implementation (Gray, 2001). Glenn (1997) commented, "often districts rely upon a 'one size fits all' approach that meets the needs of only a few participants" (p. 126). Teachers must see how technology fits within their localized classroom setting (Stein, Smith, & Silver, 1999).

Teachers' technology beliefs are influenced by their teaching philosophy. Resistance to adopting new technologies stem from teachers' existing teaching beliefs (Norton, McRobbie, & Cooper, 2000). For technology adoption to be successful teachers must be willing to change their role in the classroom (Hardy, 1998). When technology is used as a tool, the teacher becomes a facilitator and students take on a proactive role in learning. Niederhauser and Stoddart (2001) noted a "consistent relationship between teachers' perspectives about the instructional uses of computers and the types of software they used with their students" (p. 27). Often, this change of teaching philosophy and methods focuses on learner-centered teaching and constructivist teaching practices (e.g., Rakes, Flowers, Casey, & Santana, 1999). In fact, Ertmer, Gopalakrishnan, and Ross (2001) found that exemplary technology-using teachers exhibit more constructivist teaching practices. Successful integration of technology into teaching depends on transforming teachers' belief and philosophy concurrently (Windschitl & Sahl, 2002).

Technology adoption as intentional behavior

In this study we sought to examine technology adoption through the systematic application of a comprehensive, causal social-cognitive model of human behavior, developed nearly three decades ago. Introduced in 1975 by Fishbein and Ajzen, the theory of reasoned action (TRA) offered a theoretical perspective that human behavior is intentional and that an individual's stated intention to engage in a behavior is the most immediate predictor of

that behavior. Behavioral intention was posited to mediate the effects of two social cognitive variables, attitude toward the behavior and subjective norm. Attitude toward a behavior reflects an individual's personal disposition toward engaging in the behavior and represents the individual's assessment of the personal beliefs regarding the target behavior's effectiveness in producing favorable and unfavorable outcomes, each outcome weighted by a personal evaluation of the outcome. The normative component, subjective norm, represents a person's perception of whether significant others support engaging in the behavior weighted by the person's motivation to comply with the perceived wish of the significant others. Underlying the TRA model is the assumption that the behavior of interest is volitional, completely under the individual's control.

In 1985, Ajzen extended the TRA to allow for prediction of behavioral intention and thus behavior in situations in which an individual has incomplete control. A third, construct was introduced independent of attitude and subject norm, perceived behavioral control, and the resultant model was called the theory of planned behavior (TPB). Perceived behavioral control reflects the belief that an individual holds about the availability of resources and opportunities (factors that further or hinder performance of the behavior). In combination, attitude toward the behavior (AB), subjective norm (SN), and perceived behavioral control (PBC) contribute differentially to the formation of behavioral intention (BI), which is assumed to be the antecedent of behavior (B), as summarized in the following equation:

$$B \sim BI = w_1AB + w_2SN + w_3PBC$$

Salient beliefs form the indirect, underlying cognitive basis of the personal (AB), normative (SN), and control (PBC) antecedents of behavioral intention. The foundation of personal attitude (AB) lies in the salient personal beliefs (b_i) held by an individual about the outcomes of engaging in a behavior, each belief weighted by the extent to which the person values the outcome (e_i). Likewise, the foundation of subjective norm resides in the salient normative beliefs (behavioral expectations of salient referents, nb_j), each weighted by an individual's motivation to comply (mc_j) with the salient referent. In turn, each control belief (the likelihood that each control factor will be present, c_k) is weighted by the power of the control (perception of the extent to which the control impedes or facilitates behavior performance, p_k) to form the indirect measure of perceived behavioral control. The relative contribution of each of the salient personal, normative, and control beliefs to the formation of AB, SN, and PBC, respectively, is described by the expectancy-value theory. According to this theory the value of an attribute (viz., an outcome, referent, or control) is weighted by expectancy that the attribute is associated with performing a behavior (viz., outcome evaluation, motivation to comply, or control power). Links between direct and indirect, belief-based measures of attitude toward the behavior (AB), subjective norm (SN), and perceived behavioral control (PBC) are described respectively as follows and also illustrated in Figure 1:

$$AB = \Sigma_i b_i\, e_i \qquad SN = \Sigma_j (nb)_j (mc)_j \qquad PBC = \Sigma_k c_k p_k$$

We chose to view teachers as reflective, rational practitioners whose technology adoption decisions result from thoughtfully considering the consequences, social support, and resources available to them. The Theory of Planned Behavior offered a useful framework for viewing technology adoption as a change in teachers' everyday instructional behaviors in the practical, real-world context of classrooms and schools today.

Goal of study

Our study sought to identify and examine teachers' beliefs regarding their decision to adopt new technology into their classrooms using Ajzen's (1985) Theory of Planned Behavior (TPB). We originally focused our efforts on a high school and then expanded our study to include three additional K-12 schools located in the southeastern region of the United States. These schools included an elementary school, middle school and a private school (K-8).

Methods

Pre-assessment survey

We initially examined the current technology beliefs of six teachers in the high school. To select these teachers, we applied Patton's (2002) purposeful sampling procedures guided by results of a pre-assessment survey. This survey revealed faculty's technology skills and beliefs toward technology use at this high school. We selected a heterogeneous, representative group of teachers from the faculty. To achieve this representation, we selected

teachers based upon the following five factors, namely, content area, technology experience, gender, student technology usage and opinion about the school's technology utilization (See Table 1).

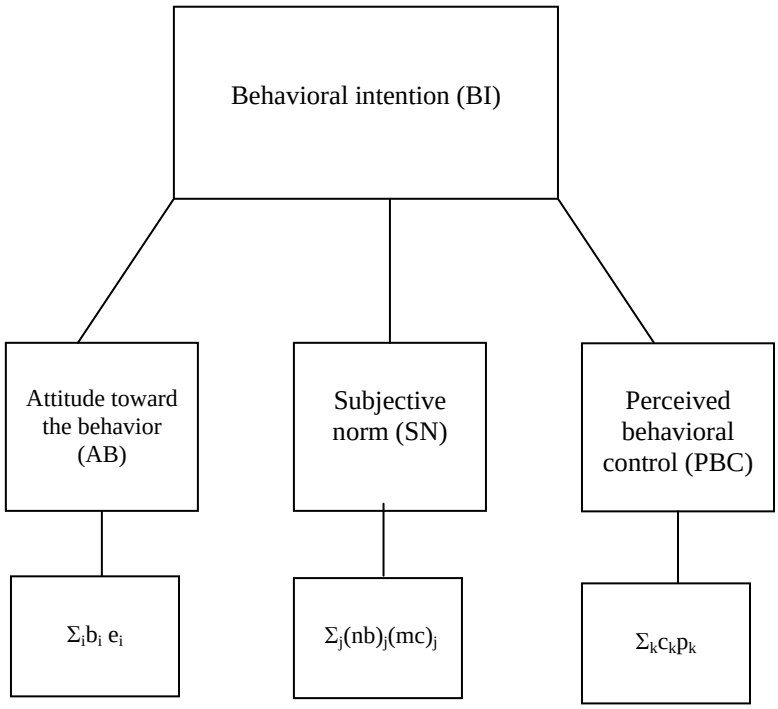

Figure 1: Causal relations among Theory of Planned Behavior variables

Table 1. Selected teachers' pre-assessment responses

Teacher	Gender	Technology skills	How often do your students use technology in your classroom?	Is technology effectively utilized at your school?
Business Education	Female	E-mail; Internet; PowerPoint; computer graphics	Daily	Undecided
English	Female	E-mail; Internet	Monthly	Undecided
Exceptional Children	Male	Basic computer operations	Monthly	Disagree
Math	Female	Internet; PowerPoint; computer graphics	Daily	Undecided
Science	Male	Basic computer operations	Weekly	Disagree
Social Studies	Male	E-mail; Internet	Weekly	Disagree

Open-ended questionnaires and semi-structured interviews

The six teachers representing the social studies, math, science, English, business and special education departments participated in the interviews. We interviewed teachers regarding their beliefs about adopting technology in their classroom. To prompt a discussion of this topic, the teachers answered an open-ended questionnaire, constructed according to the guidelines originally proposed by Ajzen and Fishbein (1980) and described in Crawley and Koballa (1994). Our targeted behavior was "adopting at least one new technology into a lesson by the end of the next school year." Questionnaire items were written to elicit teachers' personal, normative, and control beliefs about technology adoption. After completing this written open-ended questionnaire, each teacher participated in a semi-structured interview. The purpose of this interview was to further explore teachers' answers and gain additional insights. Results from these questionnaires and interviews were transcribed. We use an adaptation of the constant comparison technique (Lincoln & Guba, 1985) to

examine the open-ended questionnaire and semi-structured interview data collected in this study. We examined and grouped belief statements according to the three TPB constructs and identified the beliefs believed to be salient to teachers' decision to adopt new technology. Salient beliefs were those that accounted for 75% of the beliefs provided by teachers who completed the open-ended questionnaire.

Closed-ended questionnaire

Salient beliefs were used to develop a closed-ended questionnaire. Teachers indicated their perceptions of the relative influence on behavior (technology adoption) of the personal, normative, and control constructs. The closed-questionnaire provided data from participating teachers regarding the direct and indirect influences of AB, SN, and PBC on their behavioral intention (BI), i.e., their motivation to adopt new technology. Additional information regarding questionnaire construction, data collection and analysis, and model testing can be found elsewhere (see Ajzen, 1985; Ajzen, 2002; Ajzen & Fishbein, 1980; Crawley & Koballa, 1994; Fishbein & Ajzen, 1975, for details). When we had identified which TPB constructs (AB, SN, and PBC) influenced teachers' behavior intention (BI), we then examined the correlations between direct and indirect measures of the constructs (i.e., $\Sigma_i b_i\, e_i$, $\Sigma_j (nb)_j (mc)_j$, & $\Sigma_k c_k p_k$, respectively) for significance, which then enabled us to specify the personal, normative, and control beliefs that influenced teachers' intentions to adopt new technology. These closed-ended questionnaires originally were distributed to the entire faculty (37 teachers) at the high school. Thirty questionnaires were completed and returned, for an 81% return rate. A total of seventy-eight questionnaires were distributed to teachers in an elementary school, a middle school and a private school. Sixty-seven of these questionnaires were completed and returned, for an 86% return rate.

Results

In the following sections, we describe results from the open-ended questionnaires, semi-structured interviews, and closed-end questionnaires. For the open-ended questionnaires and the semi-structured interviews, we organized the results according to the TPB components.

Personal component

Almost all of the teachers who participated in the semi-structured interviews noted that the sole beneficiaries of adopting new technology in their classroom would be their students. Our respondents identified five salient beliefs representative of their perceptions about the consequences, favorable and unfavorable, of adopting a new technology. These beliefs included:

- • Preparing students for their future careers
- • Exposing students to a variety of new technologies
- • Holding students' interest
- • Enabling students to gain additional skills
- • Making students too dependent on technology

The Social Studies teacher described why it was important to provide technology skills to students. He stated:

> I think the more you introduce these things to high school students—even if it's not in depth but so that they feel comfortable, they can get on the computer, they can start up Netscape, they can check their e-mail, even something as simple as that—might be something that somewhere on down the line somebody says well to do this job we will need you to check in and to check this to see if you have any messages once or twice a day and [they will] ask a student do you know how to work e-mail and they can say yes. That would put them ahead of somebody who has to say no.

He also observed high school graduates working in an employment office who did not "know what in the world they're doing" with the employment office computers. He realized that "some of our students are going to be in there looking for jobs sometimes quite often" and they will need to know how to run basic computer operations. These teachers feel obligated to teach their students how to use technology that might need in their future careers.

In addition to preparing students for the future, adopting a new technology would hold students' interest in their respective classrooms. The Social Studies teacher developed computer games that emulated *Jeopardy* and

Wheel of Fortune. His students played these games to help them review specific social studies concepts and prepare for exams. The Social Studies teacher "could see a great deal of retention even though they thought [students] were just playing a game."

Although all of the interview participants agreed that adopting a new technology would hold students' interest in their respective classrooms, there appeared to be an implicit tension with this assertion. This inconsistency points to a conflict in teachers' willingness to adopt a new technology. In discussing the potential advantage of adopting a new technology, the Exceptional Children's teacher commented, "For the most part, the kids use the computers [for recreational purposes] and they do some e-mail kind of things, and they do searches of their areas of interest, which might be good." He admitted that he found "that computers can be very distracting and sometimes they'll [his students] rush through their work to get to use the computer." The Business teacher also observed that her students always would want to try a new technology as opposed to using an existing one. She noted that "they feel like, or they seem to, that their attitude is well we have done this before why do I have to do the same thing again."

There appeared to be a belief among the selected teachers that students prefer to focus on the technology rather than the content of a lesson. This is exemplified with the Science teacher's short answer response to the question, "what are the advantages to adopting a new technology…." He wrote: "technology engages students, *but* [emphasis added]…only for 'ten minutes.'" During the follow-up interview, he explained his response. He commented:

> It's sort of like that it's something new, boom, and then zoom, okay so it is somewhere else. You know it is like if you get them started on something, it's like then they've got to keep having more and more and more you know. It just seems like that it just doesn't hold their interest very long you know.

In addition to students' expectation for new technology, students also expected teachers to use technology to entertain them. The Social Studies teacher explained this expectation. He remarked:

> I've been teaching long enough to know that you can be swinging in through the windows crashing like James Bond or something like that and ten minutes later the kids will talk about how boring your class is. In five minutes after you're done with that presentation they would have-you know, then they're back to actually having to do class work and suddenly they're bored again. The class is just horrible and we never do anything fun in here.

According to the Social Sciences teacher, this *entertainment* expectation is due to the advent of video games. Students expect to be entertained and if they are not, "they [students] tend to put the blame on the teacher because they're not dancing in front of the classroom or something." Apparently, these teachers equate adopting and using new technologies with increasing students' skills and maintaining their students' interest, but at the same time, adopting a new technology appears to be a superficial solution to helping students learn. The Social Studies teacher observed:

> They [students] do pay attention more to it [technology]. In terms of actually learning how to use the technology if it's just new and exciting, I don't think they really learn the technology that well. I think the more they use the technology themselves then they have to be responsible for presenting some kind of educational material, I think that kind of takes away from the novelty of it a little bit, and I think that gets them a little bit more able to get the point of it rather than the we get to play computers today.

Another negative aspect of adopting a new technology is that students become too dependent on it. Both the Math and Science teachers stated that students' use of technology has become mechanical and they no longer are able to think. The Science teacher defended this assertion:

> My heartburn is kids can't do anything without technology. They can't add. I found out that if I say what is a 1000 divided by 10. They can't do it. They have to get out a calculator and take a thousand and divide it by ten. They can't move decimal points, and I've got Physics kids who can't do math problems without a calculator. They have no idea how to do it. It is just that they do not have to think anymore, and it is very aggravating.

The Math teacher concurred by stating, "I'm finding a lot of kids who don't know the multiplication, because they have had the calculator all along." Apparently, there is a "dark side" to adopting a new technology.

Though a majority of teachers may have a positive attitude towards adopting a new technology, technology usage may be equated with *entertaining* students as opposed to *educating* students.

Normative component

Five salient referents or key individuals related to teachers' decision to adopt a new technology was identified. These included the following individuals: school administrators; principals; parents; employers; and students. Another common response among the interview respondents was all-inclusive. When asked about the groups or people who would approve of their adopting a new technology, several respondents responded, "Everyone". Conversely, when asked about the groups or people who would disapprove of adopting a new technology, a majority of the respondents commented, "No one". The English teacher replied that there is *no one* who would disapprove of using technology. The Social Studies teacher noted:

> If you talk to somebody in administration, county office whoever, you say I'm going to be including more technology in my classroom this year [and they say,] 'oh, great fantastic.' I can't picture anybody telling me that they think it's wrong to teach [using new] technology in a classroom.

The Science teacher concurred by stating: "I don't think anybody would really have any heartache about using new technology."

While "everyone" would approve of a teacher adopting a new technology and "no one" would disapprove, this social support has not been explicitly communicated to teachers by any specific individual(s). For example, the English teacher remarked "no one ever said anything to me personally about the use of technology. It is an indirect expectation or assumption to use it, as we have access to it here." The Exceptional Children's teacher speculated on the administration's intentions. He commented:

> With the administration, I think the concern is more of management. If it had demonstrated effect on managing the classes, I think they would be approving it. I really don't have it clear in my mind to what extend technological prowess is involved in this next year plan.

When asked about whether the school administration supported technology integration, the Science teacher answered:

> You know they're into the technology. The kids have to take a computer class, competency test to pass, have to do this to pass you know so you know they want you to do all this extra stuff but [administrators] give you no money to do it.

The Math teacher stated that "we are encouraged as teachers to take technology courses" but she also noted that it is difficult to obtain additional funding. These teachers perceive that they should adopt new technologies, but there is not a consistent, overt message that directed this activity.

Contextual component

Teachers who participated in the interviews identified five salient contextual referents including: training; time; money; standardized testing; and homogeneous grouping of students. The Social Studies teacher noted that "to expect students who have had no computers in their classroom and a couple in the library that they have access to, to expect them to come in here and be able to use all this new technology is kind of unreasonable." It also would be unreasonable for teachers, who previously had little or no technology equipment in their classroom to expect them to teach without any training. The English teacher lacked knowledge on how to use new technologies and cited "lack of knowledge" as the biggest impediment to adopting new technologies. However, Business Education and Social Studies teachers acknowledged that they took the initiative and taught themselves specific technology skills (e.g., FrontPage). The Math teacher commented "schools have a disadvantage in the area of money for our training in the use of technology." Schools typically will pay for the equipment, but not for training.

Both standardized testing and homogeneous grouping limit teachers' use of technology in their classroom. Though standardized testing and grouping of students seem unrelated to teachers' ability to adopt a new technology, these practices do limit teachers' ability to teach in their classroom and thus, have an indirect effect

on technology adoption. At the respondents' school, teachers are expected to structure their curriculum according to the end-of-grade or end-of-course exam. Since one-fourth of the students' final grade is based upon results of the statewide exam, teachers are told to emphasize multiple-choice questions in their class. The Social Studies teacher reported:

> [Teachers] have been told to incorporate multiple-choice questions because that's what kids are going to see on the end-of-course test. It doesn't make any difference whether or not it's a better way to teach them that they get better understanding of the subject matter. That's irrelevant. What is relevant with the way things are now is to show it on the test.

The emphasis on multiple-choice questions limits the types of technologies that teachers can adopt. Consequently, they only utilize technologies that facilitate multiple-choice test taking.

The heterogeneous grouping of students also limited the choice of technologies to adopt in the classroom. The Science teacher would prefer homogeneous grouping and fewer students in his classroom. He remarked:

> I have classes with three students it. I have done more things with those classes than I would ever think about doing with a class with thirty people because if I am looking over here, then I have people here doing things, and I have no idea. I had one [student] who picked up a glass beaker and drank its contents. He had no idea what was in it, but he drank it and luckily it was only colored water. Do I cater to this kid down here and this kid and hopefully I can give him something that will keep his mind occupied and then I have got everybody else in the middle. Who do I teach to? It is hard to teach to all of them. If I had a class that was exceptional then, I could teach at one level. If I had a class of regular students whatever they are, I could teach another level.

When asked what he does to remedy this particular situation, he responded:

> I basically have the same activities. I end up expecting less from the lower students. It is very hard. Not only do you have the ones that are low on intelligence but you have the behavioral ones in here too. You are trying to fight keeping them quiet to keep the rest of them in their seats or whatever, and it is just such a large discrepancy between the different stuff and the lower. About a fourth of our kids are on the lower level, but they just mix them all together.

This limitation on teachers' ability to instruct to a particular group of students reduces teachers' choice of available technologies to adopt and utilize in their classroom.

Closed-end questionnaire results

Results of the closed-ended questionnaire analyses are promising. We found that 68% of the respondents adopted at least one technology during the past year and results of the data analyses also reveal that over two-thirds of the teachers held favorable beliefs toward adopting a new technology in the upcoming year. The new technologies included: software applications, online tutorials, web page development, Kurzweil 3000, graphing calculators, and other similar instructional technologies. Overall, respondents were quite likely to adopt a new technology during the next school year (M=1.8; SD=1.245). Teachers' motivation to comply factor (M=1.35; SD=2.984) and the external factor (M=3.96; SD=3.506) were moderate (see descriptive closed-end questionnaire results, direct, and indirect measures of the TPB components in Table 2).

We examined the independent contributions of the three direct measures of the TPB model variables, namely the personal, normative, and contextual components to the
prediction of Behavioral Intention (see Table 3). In the aggregate, the personal component, Attitude toward the Behavior, was the best predictor of teachers' intention to adopt a new technology during the next year (ß=.619; t=6.337; p<.01). Then, we disaggregated the group data so that we might examine these relationships for different teacher subgroups, according to the following characteristics:

- Types of schools (High; Middle; Elementary; and Private)
- Teaching experience (1-5 years; 6-20 years; and 20+ years)
- Number of workshops completed during the past five years (1-2 workshops; 3-5 workshops and 6 or more workshops)
- Adoption of new technology during the previous year.

Examination of the disaggregated data revealed that attitude was the lone predictor of intention to adopt a new technology but only among public high school teachers (ß=.772; t=6.647; p<.01), not teachers in middle or elementary schools. Among private school teachers, the personal (ß=.543; t=2.856; p<.01) and normative (ß=.342; t=2.470; p<.01) components were found to be predictive of their intention to adopt new technologies.

Table 2. Descriptive closed-end questionnaire results

Item	M	SD	Actual range	Possible range
Intention (BI)	1.8	1.245	-2 to 3	-3 to 3
Personal component (AB)	8.01	3.35	-3 to 12	-12 to +12
Personal component indirect measures				
Students – Future careers	5.58	3.24	-6 to 9	-9 to 9
Students – New technologies	5.38	2.96	-6 to 9	-9 to 9
Students' interest	5.48	2.828	0 to 9	-9 to 9
Students – Additional skills	5.6	2.255	0 to 9	-9 to 9
Students – Too dependent	1.16	3.193	-6 to 9	-9 to 9
Normative component (SN)	1.35	2.984	-6 to 6	-6 to 6
Normative component indirect measures				
School administrators	3.25	3.127	-4 to 9	-9 to 9
Principal	3.2	3.602	-9 to 9	-9 to 9
Parents	2.28	2.883	0 to 9	-9 to 9
Employers	2.78	3.303	-9 to 9	-9 to 9
Students	2.39	3.092	-6 to 9	-9 to 9
Contextual component	3.96	3.506	-6 to 9	-9 to 9
Contextual component indirect measures				
Training	4.74	4.459	-9 to 9	-9 to 9
Time	5.56	4.14	-9 to 9	-9 to 9
Less objectives to teach	4.41	4.436	-9 to 9	-9 to 9
Money	6.02	3.396	0 to 9	-9 to 9
Homogeneous	3.61	4.019	-9 to 9	-9 to 9

Table 3. Regression of TPB Model Variables on Intention (BI)

Category	Item	n	Personal (AB)	Normative (SN)	Contextual (PBC)
All teachers		97	ß=.619; t=6.337**	ß=.05; t=0.604	ß=.034; t=0.354
Schools	High	30	ß=.772; t=6.647**	ß=.032; t=0.308	ß=.153; t=1.326
	Middle	20	ß=.478; t=.1.508	ß=.147; t=0.635	ß=.066; t=0.232
	Elementary	33	ß=1.268; t=0.215	ß=.106; t=0.513	ß=-.058; t=-0.250
	Private	14	ß=.543; t=2.856**	ß=.342; t=2.470**	ß=.424; t=2.174
Years teaching	1-5 years	26	ß=.263; t=1.136	ß=.175; t=0.947	ß=.339; t=1.571
	6-20 years	32	ß=.606; t=3.495*	ß=.195; t=1.331	ß=.006; t=0.036
	20+ years	37	ß=.857; t=6.546**	ß=-.122; t=-1.068	ß=-.152; t=-1.161
Workshops	1-2 workshops	24	ß=.352; t=1.477	ß=.16; t=0.826	ß=.185; t=0.776
	3-5 workshops	40	ß=.841; t=7.091**	ß=.114; t=0.954	ß=-.323; t=-2.684**
	6 + workshops	29	ß=.536; t=2.616**	ß=.083; t=0.499	ß=.25; t=1.162
Adopt during past year?	Yes	63	ß=.710; t=5.244**	ß=.055; t=0.518	ß=-2.07; t=-1.556
	No	29	ß=.506; t=3.158**	ß=.075; t=0.484	ß=.306; t=2.023

* Significance at the 0.05 level. ** Significance at the 0.01 level.

Next, we disaggregated the data according to teaching experience. Among experienced teachers (persons with 6-20 years of experience (ß=.606; t=3.495; p<.05) and persons with 20+ years of experience (ß=.857; t=6.546; p<.01), the personal component alone was predictive of teachers' technology adoption intentions. None of the TPB components were predictive of new teachers' (persons with 1-5 years of experience) intentions to adopt new technologies.

We then disaggregated the data according to the number of technology workshops teachers had completed within the past five years and examined the independent contributions of personal, social, and contextual components to the prediction of intention. Among teachers with some technology training (3-5 workshops) (ß=.841; t=7.091; p<.01) and teachers with considerable training (6 or more workshops) (ß=.536; t=2.616; p<.01), attitude toward technology adoption was predictive of their technology intentions, but neither the personal, social, or contextual factors were predictive of the technology intentions of teachers with limited training (1-2 workshops). In addition to the personal component, the contextual (ß=-.323; t=-2.684; p<.01), variable also was found to be predictive of the technology intentions of teachers with some training, but in unanticipated ways. Additional resources and opportunities were predictive of a reduced commitment to technology adoption.

For our final sub-group analysis we disaggregated data into two groups of teachers, individuals who indicated that they had adopted a new technology during the previous school year and those who reported that they had not. Regardless of prior adoption decisions, the personal component was the sole predictor of teachers' intentions to adopt a new technology during the upcoming year [Adopters: ß=.710; t=5.244; p<.01 and Non-adopters: (ß=.506; t=3.158; p<.01)].

Table 4. Correlations between direct measures of model variables and belief-based estimates

Category	**Sub-category**	**n**	**Personal (AB) (Direct/Indirect)**	**Normative (SN) (Direct/Indirect)**	**Contextual (PBC) (Direct/Indirect)**
All teachers		97	r=.641; p<.01	na	na
Schools	High	30	r=.632; p<.01	na	na
	Middle	20	na	na	na
	Elementary	33	na	na	na
	Private	14	r=.736; p<.01	r=.781; p<.01	na
Years teaching	1-5 years	26	na	na	na
	6-20 years	32	r=.632; p<.01	na	na
	20+ years	37	r=.654; p<.01	na	na
Workshops	1-2 workshops	24	na	na	na
	3-5 workshops	40	r=.619; p<.01	na	r=.129; p>.05
	6-11 workshops	29	r=.794; p<.01	na	na
Adopt during past year?	Yes	63	r=.661; p<.01	na	na
	No	29	r=.538; p<.01	na	na

We next examined the antecedent beliefs for sub-groups in which significance was found between one or more model variables (personal, normative, and contextual) and behavioral intention (BI). First, we examined the significance between the direct measure of the model variable and its belief-based estimate, for each subgroup. In each case, the belief-based estimates were found to good estimates of the direct measure (see Table 4). We further analyzed the data using regression analyses to identify the significant salient beliefs that contributed to the direct measure of each key model variable. Specific significant beliefs were identified among the subgroups. Preparing students for their future careers (t=3.157; p<.01) and providing additional skills (t=4.913; p<.01) were determined to be significant predictors of teachers' attitude toward technology adoption as a group. For teachers who had adopted new technology during the past year these same two factors, preparing students for their future careers (t=3.649; p<.01) and providing additional skills (t=3.196; p<.01) also proved to be significant beliefs underlying their technology adoption attitudes. Moreover, preparing students for future careers was a significant salient belief for teachers, who took 3-5 technology workshops during the past five years (t=2.554; p<.05), for teachers, who took 6 or more technology workshops during the past five years (t=- 3.552; p<.01), and for teachers, who did not adopt technology during the past year (t=2.881; p<.01). Holding students' interest

(t=3.208; p<.01) was found to be a significant salient belief for teachers who had taught between 6 and 20 years. Among teachers with more than 20 years of experience, preparing students for their future careers (t=3.12; p<.01) and making students too dependent on technology (t=2.066; p<.05) were identified as salient beliefs underlying their attitude toward technology adoption. More experienced teachers believe that their students become too dependent upon technology and that technology *entertains* more than it teaches, as corroborated by results of our semi-structured interviews.

Discussion

Primary importance of personal component

One of the key outcomes of the closed-end questionnaire results was the primary emphasis of the personal component on teacher's intent to adopt a new technology. Based on our study's results, technology adoption is a personal decision, uninfluenced by other people and the presence of resources or impediments in the local school/district. The normative and contextual components did not have any significant effect on teachers' motivation to adopt new technology. The fact that technology adoption results solely from teachers' conscious reasoning about the personal consequences for doing so may reflect the isolated nature of the teaching context, a situation in which supportive people, resources, and in-classroom training are lacking and thus viewed as inconsequential to the technology adoption decision. Though teachers' decision focuses on the consequences for students (i.e., future careers and students' interest), the student plays a non-significant role as either a social or contextual influence. The exclusive focus on students interest and career needs indicates a necessary change in how teachers perceive technology adoption. They may lack an understanding how technology can assist their careers as teachers. Training and implementation efforts may need to help teachers understand how adopting new technology helps teachers, in addition to their students. By adding this new message, teachers will have another reason for technology adoption and will avoid the conflict about the *entertaining* aspects of technology.

Enhancing the normative component

The insignificant social or normative factor is disconcerting and reflects the "everyone wants teachers to adopt technology" perspective. Teachers lack a specific, clear message and personal support from school administrators about technology adoption. Besides the politically correct and generic "technology is good" message, teachers need to know how technology will affect their roles and how to effectively use technology in their classroom. We question why school administrators and other key school and district personnel are seen as inconsequential in this technology adoption decision. Critical stakeholders (e.g., administrators) affecting teachers' adoption decisions need to clearly communicate their vision of the benefits of and provide implementation support for adopting new technology in teaching. This communiqué should not be an exclusive directive, but a message that supports and enables teachers to collaborate in ways that *directly* benefit teachers, as well as their students.

Implications for educational software designers

Results from our study offer a mixed message for educational software designers. On the one hand, administrators and school media specialist usually purchase software and other related technology. On the other hand, teachers are sole decision-makers regarding technology use in their classrooms. Consequently, educational technology and software designers must train their adoption efforts to two groups, the buyers and the users of technology. Messages to school administrators about technology adoption might differ considerably from the messages presented to teachers about the personal consequence, social support, and needed resources associated with technology adoption. Because of the apparent gap between teachers and school administrators on specific ways to adopt technology, it is quite difficult to ascertain how to directly affect teachers and their technology needs. To remedy this situation, designers must bridge this gap by working with school administrators and teachers to develop specific, coherent technology adoption messages.

Another factor that designers must consider pertains to unique beliefs held by high school teachers about the consequences of technology adoption in their teaching context. Operating in an environment driven by end-of-course tests and concerns about reaching a diverse group of students in their classrooms (i.e., standardized exams and homogeneous grouping of students) high school teachers struggle as to the best use of new technologies. Middle, elementary and private school teachers apparently do not share high school teachers' unique contextual

concerns. It would be prudent for educational software designers to consider the specific contexts and school environments when developing software applications for each group of teachers.

Conclusion, limitations, and future directions

The results from our study provide insight on teachers' beliefs toward technology adoption. These results not only confirm the primary importance of teachers' personal decision-making on whether a new technology is adopted or not, but also indicate an apparent conflict between teachers' technology adoption perspective and that of school administrators. The teachers, who participated in our study, and their corresponding behaviors, limit the generalizability of our results. Future TPB studies that concentrate on a group of teachers from a different geographic region and/or who teach in a different school system may yield an altered set of results. Our study also solely focused on teachers' intention to adopt new technologies. Other factors, such as teachers' confidence and competence in using technology also play a role in this behavior.

Our specific future plans are two-fold. First, we want to collaborate with school administrators to develop specific coherent technology adoption messages and assist in the design of implementation programs for their teachers. We also would like to replicate our study with a different group of teachers, this time examining not only teachers' technology adoption intentions and their personal, social, and contextual beliefs but their teaching philosophy as well and the role that philosophy plays on teachers' technology adoption decisions.

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