Educational Technology International
2009, Vol. 10, No. 2, 1-27

Teachers' Needs and Implications to Design of an Electronic Performance Support System(EPSS)

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Technology use can dramatically enhance teachers' performance in teaching and administrative tasks. An Electronic Performance Support System (EPSS) is a versatile tool that could provide just-in-time and on-the-job training when teachers need it. In order to design an effective EPSS for teachers, it is critical to identify their needs. This study used interviews to identify teachers' needs for technology by asking them about their workloads, the difficulty and time demands of tasks, and useful technologies. The implications of the findings for the design of an EPSS are discussed, including the necessity of an adaptive design of the EPSS.

Keywords : teacher education, teacher performance, Electronic Performance Support System, EPSS, adaptive design

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Introduction

Today, teachers' work environments are rapidly changing. Technology, especially the Internet, is penetrating and transforming the current school system. Improving teachers' job performance is becoming an essential part of educational reform efforts (Cochran-Smith & Fries, 2005; Fullan, Bertani, & Quinn, 2004; Lieberman, 2000; Darling-Hammond & McLaughlin, 1995; Quatroche, Watkins, & Bolinger, 2004). However, there are many factors that hinder teachers' job performance: lack of skills and knowledge on the part of teachers, lack of support from administrators, crowded classrooms, unmotivated students, inefficient administrations, burdensome paper work, insufficient infrastructure, and so on.

Technology tools are one factor that can improve teachers' performance. There are at least two ways to support teachers in using technology to perform tasks. One is to provide training opportunities for learning the technology. Another is to provide performance support tools to help teachers perform certain tasks. The proponents of training approaches might argue that, in order to use technology in work places, teachers need to know first of all the kinds of supports that technology tools can provide and how to use them. Especially after computer technology has been installed, additional training is regarded as an important factor for its successful implementation (Vockell, Jancich, & Sweeney, 1994). Many teachers and administrators tend to perceive that "not enough training" is a significant obstacle to using technology (Baylor & Ritchie, 2002; Chiero, 1997; Cuban, 2001), and training is regarded as a way to facilitate teachers' effective use of technology.

But some researchers doubt that the training approach is an effective as well as cost-efficient way to improve teachers' job performance (Darling-Hammond, 1994; Griffin, 1999; McAninch, 1993; Lieberman, 2000; Wang & Reeves, 2003). Training is an event planned to enable an individual to learn new knowledge and skills prior to the expected use of the knowledge. However, the knowledge and skills acquired

from a training session or workshop are typically not easily applied to real teaching situations. According to Raybould (1995), "85-90% of a person's job knowledge is learned on the job, and only 10-15% is learned in formal training events" (p. 8). In addition, teachers tend to learn over time with reflective practice (Leahy & Corcoran, 1996). Since a teacher's job situation is dynamic, it is important to provide learning opportunities close to the job situation.

Teacher educators frequently indicate the need to incorporate training into work environments (e.g, Griffin, 1999). The notion of on-the-job training, on-the-job support, or just-in-time training introduced the necessity of electronic performance support systems (EPSSs) (Gery, 1991, 1995). EPSSs are one way to provide on-the-job training at the time of need. An EPSS is an electronic infrastructure "that captures, stores and distributes individual and corporate knowledge assets throughout an organization, to enable individuals to achieve required levels of performance in the fastest possible time and with a minimum of support from other people." (Raybould, 1995, p.11). The basic assumption of EPSSs is that knowledge and skills are best learned "just in time" on the job while the learner is being supported by an "expert" of some kind. The goal of an EPSS is to enable efficient, effective performance by people with limited external support or training (Cagiltay, 2006; Gery, 1995; Gustafson, 2000; Nguyen, 2005; Raybould, 1995).

To design an EPSS that supports teachers' performance needs, we must know what teachers' needs are. In this paper, we define teachers' technology needs as what teachers want to and hope to have in order to support their daily practice using technology. Teachers perform many duties and responsibilities related to the delivery of instruction and classroom management. Orey, Moore, and Hardy (1997) conducted a performance assessment to analyze the work environment of teachers in order to design an EPSS. Based on their close observation of teachers' performance, they created 8 categories: communication, classroom management, instruction, grades, mentoring, special assignments, in-service/professional development, and social activity. Later, they added three categories: Work at home,

in-school suspension, and moving around the building (Moore, Orey, & Hardy, 2000, p.36). Table 1 shows the amount of time spent on categories related to job performance.

Table 1. Average amount of time on teachers' major work

Category	Time (min')
Instruction	223.8
Special Assignment	77.1
Grades	73.5
Communication	56.4
Classroom Management	19.5

(Moore, Orey, & Hardy, 2000)

Teachers spent an average of 31.6 minutes per day preparing resources and 49.4 minutes per day planning lessons. They spent 73.5 minutes per day on grading, which includes testing, assessing, recording, and reporting. Based on the results of the study, Orey et al. (1997) argue that an EPSS can be built that will improve a teacher's ability to perform the myriad tasks of a teacher that need to be done on a daily basis. Even though the study shows the teachers' performance needs in terms of time devoted to various tasks, it did not consider other factors influencing teachers' needs, such as the difficulty of the tasks and the teachers' technology competence. To build an effective EPSS, it is important to identify all relevant factors that affect teachers' needs and to prioritize those needs.

Consequently, this study is intended to identify the full range of teachers' needs regarding their job performance improvement and to identify the factors that affect those needs. Eventually, this study will provide insight into building an effective EPSS for teachers. Since some of the teachers' needs vary from person to person, school to school, and district to district, it is important to distinguish needs that are

common and those that vary across these dimensions. Also, it is important to identify design guidelines for building a generic EPSS with the ability to meet the needs common to all teachers and the flexibility to meet the specific needs of certain types of teachers.

The goal of this study is to develop a deeper understanding of teachers' job performance needs that can be supported by technology tools and to identify implications for designing an EPSS for teachers. This study was designed to answer the question, "What are teachers' needs and what are the implications of those needs for designing an EPSS?" More specific research questions include:

- What tasks do teachers perceive as time-consuming or difficult?
- What kinds of help do teachers want when they use technologies?
- What kinds of type in technology needs among teachers exist?
- What are the implications of these needs to the design of EPSS?

Methodology

This study is exploratory in nature and is not guided by hypotheses, since we do not have sufficient understanding of the phenomena under study. In an exploratory study, the researchers are open to new findings and themes or patterns that emerge during the study. The researchers have teaching experiences as K-12 teachers and have studied instructional technology for many years. Personally, we are familiar with teachers' needs and how technology can help teachers' job performance.

In this study, we conducted semi-structured interviews and observations if possible. The purpose of the interviews was to gather qualitative data on teachers' needs. For the interview, we selected a school district of a small city in a mid-western state to recruit interviewees. We asked a technology coordinator in the school district and principals in each school to recommend possible interviewees. Based on their recommendation, we contacted the teachers individually. A total of

nine teachers out of thirteen teachers we contacted agreed to participate in the interviews. Due to their busy schedule, the four teachers declined our invitation to participate in the interview. One teacher came from an elementary school, four teachers from a middle school, one from a private school, and three from a high school. Six teachers were female, and three were male. All teachers were experienced and the range of that experience was from 4 to over 20 years. Middle and high school teachers taught music, social studies, English, technology, mathematics, and science. Here are their profiles (we used pseudonyms for confidentiality).

1. Diana: A 5th grade elementary school teacher with 10 years teaching experience. Her classroom contains three computers (Pentium 2's, very slow, with an Internet connection) at the classroom but she usually use computers in the lab in order to give students more opportunities. She earned her Master's degree in an Instructional Technology program and is working on her doctorate degree. Her teaching practices tend to lean towards integrating technology wherever she can.

2. Bill: A middle school music teacher with four years teaching experience. His music classroom was well equipped: containing computers, synthesizers, and numerous musical instruments. Various kinds of music software were used to learn, compose, and play music. He designed and developed technology-enhanced music lessons. He presented the results of the lessons in a teacher conference. He is a very positive technology user. He was interested in using the Internet and curious to know how to design better web pages.

3. Pamela: A middle school social studies teacher who had been teaching for 27 years. One computer, a printer, a TV hooked to the computer, and an overhead projector were in her classroom. She used the computer mainly for presentations. She wanted to show graphics materials from two CDs that accompanied the textbook. She obtained help from the librarians to find relevant information on the Internet for her class.

4. Eric: A social studies teacher in a private school who had been teaching for nine years. Before his teaching job, he served in the army and the government, and he had traveled all over the world. He taught social studies and religion to 6th through –9th graders. His classroom had two computers, a TV hooked to a computer, and an overhead projector. He used the Internet for his class and for updating his knowledge. He asked students to use the Internet for their research.

5. Jamie: A middle school English/Literature teacher who had been teaching for 20 years. One computer, a printer, a TV hooked to a computer, and an overhead projector were in her classroom. She rarely used the computer for her class. When she did use it, it was for presentations or making worksheets. She used to use grade-book software.

6. Mary: Technology coordinator and technology teacher in a middle school who had been teaching for over 20 years. She directed technology use in the school and provided technical help for teachers. When we visited her, she was teaching how to make fancy letters using MS Word. Each student had their own computer on their own desk and was doing computer work.

7. Laura: A high school mathematics teacher with eight years teaching experience. Before she entered teaching, she had been a corporate trainer. Two computers (one for her, the other for her students), a printer, and an overhead projector were in her classroom. When we visited her, she was searching for geometric figures on the Internet. She had many materials from the Internet in her computer. She often used email to communicate with the parents of her students. She had a positive attitude toward technology use in the classroom.

8. Barbara: A high school Math teacher with 11 years teaching experience. There were one computer for her and five other computers for students. She used WebQuest to facilitate students' inquiry-based learning activities and have participated in an Inquiry Learning Forum (http://ilf.crlt.indiana.edu), a web-based professional development site, since 2001. She has been teaching teach technology courses in a community college.

9. Michael: A high school Math teacher with 16 years teaching experience. In his classroom, there was one computer for students and one computer for the teacher networked to Internet. He uses computers for developing algebra tests, sending email, keeping grade and attendance records, and to participate in a lesson study group activities with other math pre-service, in-service teachers, and university faculty members. He actively adopted Texas Instrument Calculators in his class and utilized software that can be operated in the calculators.

Among the interviewees, Diana, Barbara and Michael tended to consider themselves as constructivists who attempted to use constructivist instructional methods- inquiry-based approach, performance assessment, project based activities etc.- in their daily teaching. Interviews were held in each teacher's classroom in a semi-structured manner for about 40 – 70 minutes. Each interview was audio taped with the permission of the teacher. The interviews were designed to identify the teachers' workloads, the tasks they performed (including task difficulty and time demands), detailed information about the teachers' needs, barriers to using technology, and technologies they found useful. During the interviews, we observed the teachers' classrooms, teaching materials, grade-books, and computers to get insights about the teachers' work environments. We also asked the teachers how they used technology in the classroom.

The data in the audiotapes were transcribed and analyzed using the content analysis method. Content analysis is one of the classical analysis procedures that is used to analyze various forms of textual data, such as interview data (Frick, 1998; Schwant, 1997). The data were categorized into several areas: time-consuming tasks, tasks for which assistance was needed, kinds of technology that teachers wanted to use, and teachers' attitudes toward technology use. Each data entry was codified, listed under one of the categories above, and compared with other entries. During the data analysis process, we paid attention to emerging themes and patterns from the data as recommended by Lincoln and Guba (1985). For example, we found a close relationship between teachers' attitudes toward technology use and

technology knowledge level. We used the term "technology acknowledgement/use pattern" to describe the different patterns of using technology emerged among teachers. After prioritizing the different categories of teachers tasks above, we suggested tentative guidelines fordesigners to consider when they design an EPSS tasks in terms of three parameters - teaching experience, technology competence, and grade level.

To ensure "trustworthiness," triangulation were pursued through the use of multiple data collection methods and sources (Denzin & Lincoln, 2000; Lincoln & Guba, 1985; Merriam, 1988). Member-checking were also used; this involves submitting transcripts of interviews and observations by email to the participants for their review, to ensure accuracy.

Findings

During the interviews and observations, we identified the workloads and working environments of teachers, their technology uses in the classroom, their computer environments, and their materials. All teachers interviewed were extremely busy. With a five-minute break, they had to finish the previous class and prepare for the next class. The elementary school teacher laid stress on the point that "everyday is typically a very busy day and there's no break so it's constantly go, go, go from the moment we get [in the classroom]." All middle school teachers who were interviewed had one planning period (45 minutes) and six classes per day. They taught 30 classes per week, and this was similar for the other participants in private schools and high schools. The teachers we interviewed indicated that lack of time was both a barrier to learning new technology and a motivator to use technology (Hargreaves, 1994).

Perceived time consuming tasks and difficult tasks

Most time-consuming tasks

Every teacher we interviewed said that grading was the most time-consuming task. During a semester, the elementary school teacher had one grading period and secondary school teachers also had 3 grading periods. Diana, the elementary school teacher, reporting her teaching as a constructivist approach, used an electronic grade book like most teachers interviewed, but she also helped her students to create their portfolios every quarter. This involved her, at the end of every unit or chapter, sending home a grade report, including a special note to the parents explaining what it was the class just finished working on. In her case, a significant portion of time in grading is taken by "communicating with parents."

After grading, lesson planning and information seeking were indicated as the most time consuming tasks. Michael said developing mathematics worksheets aligning with different students' levels took a great deal of his time. Pamela, a social studies teacher, said that she spent lots of time on "just planning three different classes" and "looking for materials and resources in the public library, newspapers, magazines, something like that."

The next most time consuming task was organizing papers and documents in order that they can be retrieved easily. Barbara, a high school mathematics teacher said that she had been filing things down but have not figured ways to organize resources she collected in a manner to easy to access. She considered putting everything online as a way of solving the issue.

Difficult tasks: Urgent need for technology support and Internet use in the classroom.

When the teachers were asked the question, 'What's a difficult task for which you would want some assistance from an expert?,' they mentioned the following: technology support; making and using web pages; technology use in the classroom;

gaining up-to-date information, teaching materials, and resources; and developing teaching/learning materials for different learning styles and levels of students.

Among difficult tasks, the need for technology support was considered the most urgent. Since many teachers are not knowledgeable about hardware and software, they easily 'panicked' when a problem occurs. They seek help from the technology coordinator or colleagues. However, getting help right when a problem occurs can be quite difficult. When we interviewed Mary, a technology coordinator, a teacher interrupted the interview and said, "My printer is not working. Would you help me? I am in class now." She was in a hurry and eager to fix the problem immediately. Mary went with the teacher and found that the solution to the problem was simple: the toner just needed to be changed. Mary said:

"[Teachers] really want somebody available in this school all day. For example, the teachers in the middle of typing a paper—maybe it is a test for tomorrow—they want immediate help. … help with the hardware and software. They cannot wait. They get panicked when one of the 36 computers in the computer lab is not working properly."

Technology knowledge and practical use in the classroom were considered a priority. Teachers had difficulty figuring out how to use the Internet in their classrooms. Mary introduced her related literature to teachers who were trying to post a lesson on the Holocaust to the Internet. Since the teachers had limited knowledge and skills, they wanted continuous support from Mary. Eric, a social studies teacher, also wanted to learn how to use the Internet in his classroom. Since one of his most time-consuming tasks was to help students make up for classes they had missed, he wanted to use the Internet as a communications tool. He said, "I'd like to learn how to put together my own stuff into a web page so that students can connect to the web page to see what the homework is, for example, when they are sick."

Both Diana and Michael raised the most difficult task that they have as a teacher was creating instruction that meets the different learning styles and ability levels. In

Diana's class there were five children that were inclusion "meaning they are identified as special needs" and had about four students who were identified as gifted and talented with IQ's of 140. She said, "So for me here I am say teaching the American Revolution. How do I make that understandable who can barely read at a second grade level and challenging for the student who is at a 12th grade level. So I would definitely say designing curriculum that meets the different needs of the students."

Needed technologies for job performance

During the interviews, the teachers indicated the technologies they used or needed: software, such as a word processor, presentation software, test generator, courseware(math software and simulation software), graphics software, grade-book software, and communication tools, such as e-mail and the web; hardware, such as a graphic organizer, a LCD projector, synthesizer, and computer. The web, e-mail, and presentation programs are popular. The web was regarded not only as a good instructional tool, but also as information resource. Eric talked about his experience using the web as an instructional tool.

"It was a lesson about the hurricane. At that time, a hurricane was approaching South Carolina. I connected to the web and showed students how the hurricane kept moving toward the north. Since my parents lived there, I called my parents and asked how things were going. My kids are listening to the call, at the same time they keep watching the computer screen. Isn't it cool?"

E-mail was widely used, more for personal than professional reasons. In the personal use, communication was done mainly with family and friends. In the professional use, teachers used e-mail to communicate with a very limited number of parents (one to four). For example, Laura said she used it for organizing a field trip with one parent. Teachers indicated that e-mail was convenient and it saved time.

Whether teachers used lecture as a main instructional method or a project based approach, they found that a presentation program was helpful. Several interviewees indicated that they used a screen projector to present Internet resources or CD ROM materials accompanying the textbook. Laura's explanation showed how she used various technologies for her class.

"I know how to find information on the Internet. I want to be able to get pictures that represent things in geometry. Get the picture [from the Internet] and present it and have kids get the idea."

For successful implementation of her idea, she needs a computer connected to the Internet, a LCD projector, and a presentation program along with technology knowledge.

Differences in teachers' technology use in their jobs

We found a wide spectrum of teachers' attitudes regarding technology use in their jobs, and their attitudes seemed to affect their use of technology. A majority of teachers had positive attitudes toward technology use in their teaching and other tasks. Some were enthusiastic, others more cautious, and another even negative. Bill, Laura, Mary, Barbara, Diana, and Michael were very positive about using technology. They wanted to introduce more technology into their teaching and work. Conversely, Eric, a social studies teacher, admitted the potential of technology in his teaching and work but cautioned that dependence on the computer could be dangerous. Regarding the use of grade-book software, for example, he said, "I don't trust computer software. I keep a grade book, then record it in the [computer] grade book. I want a backup system."

The use of grade-book software illustrates these various attitudes. Most teachers used various kinds of grade-book software. Bill, Laura, Mary, Barbara, Diana, and Michael had a positive attitude. As already indicated, Eric was very cautious. Jamie, an English teacher, complained that her grade-book software was not working now,

so she had to rely on a printed grade book that she had to make by herself. So it had become more painful for her to manage the grade book than ever. In her case, technology use resulted in wasted time and made the workload heavier. Pamela, a social studies teacher in a middle school, did not use grade-book software. When we observed her paper grade book, there were lots of evaluation items such as seatwork, quizzes, and participation as well as written assignments. During the class, she seemed to evaluate students' performance and attitudes continuously. She did not want to use grade-book software. She said, "Grade book? I don't use a [computer] grade book, but most teachers use it." [The researcher asked why.] "Why? Because I don't have a computer at home. So it takes too much time to put all the information in here." To her, technology did not help ease her workload.

Implications for the Design of EPSS

Teachers' main job performance needs

Based on the interview, the teachers' needs are identified as follows: technology support/management, technology use in classroom, technology knowledge, assessment and grading, making test items, unit planning, lesson planning, up-to-date information, content knowledge, instructional methods, administrative work, behavior management, consultation with students/parents, making classroom materials, and participation in teachers' network. Each item was cross-checked and ranked in terms of time consumption, difficulty level, and areas needing assistance.

For example, "technology support/management" was not a "time-consuming" activity, but teachers definitely needed it. In contrast, while grading and assessment were not so much an area needing assistance, they took a lot of time. Therefore, both items should be considered important when a designer builds a performance support system for teachers. In this way, we ranked each need. Based on this

analysis, we found some needs such as technology support/management, assessment and grading, and up-to-date information were ranked highly, followed by technology use in the classroom and technology knowledge need. Unit planning, lesson planning, and administrative task needs were ranked moderately important. Making test items, instructional methods, content knowledge, and behavior management needs followed.

Earlier we reviewed the performance assessment conducted by Orey et al. (1997), which indicated that the following areas should be assisted with technology tools: planning, creation of materials, grading, communication, and behavior management. Their results are generally consistent with ours, except that "creation of materials" did not appear in our study.

These findings have a great implication on the development an EPSS for teachers. To develop an EPSS for teachers, however, it is not enough to identify generic teachers' needs. While the findings of generic needs may help designers to develop a generic EPSS for teachers, the findings may not be helpful in developing a more customized design of an EPSS for teachers. Since teachers needs vary in many ways, it is important to identify what factors affect teachers' performance needs. By doing so, we can articulate design guidelines to develop an EPSS for teachers, referring to those factors. The next session discusses the factors we identified during the study.

Technology acknowledgement-use patterns and implications to build EPSS

Technology acknowledgement/use patterns(TAUP)

It might be reasonable to assume that elementary and secondary teachers would have their own unique needs as well as generic needs. In this study, we identified the variables that might be affected by the teacher's grade level: lesson planning, use of technology, content accuracy, useful software, work place culture, and software quality. Elementary teachers were more concerned with effective use of technology

and software quality than were secondary teachers. They were less concerned with lesson planning, content accuracy, and graphics software than were secondary teachers. Based on these findings, providing lesson plan tools might be more beneficial to secondary teachers than to elementary teachers. Elementary teachers might be happier using a guide or advice system about the effective use of technology in the classroom.

Novice teachers were concerned about what rules and procedures they would use for classroom management. They needed more help with behavior management than did the experienced teachers. Effective behavior management was a high priority for the novice teachers. They also spent more time on planning a lesson than did the experienced teachers. So, novice teachers might need more information or expert systems about behavior management and lesson planning in the EPSSs.

Technology-competency level seemed to play an important role in influencing needs. During the research process, we identified that the technology-competency level did not merely mean technical ability or knowledge of how to use technology. More importantly, skills, knowledge, and attitude all together determined one's technology-competency level. Based on the interview data, we developed one emerging category, i.e., patterns in technology use and attitude among teachers. The patterns seemed to be determined not only by technology knowledge and skills but also by attitude toward technology, such as how to help other teachers use technology in their classrooms.

Generally speaking, people's existing attitudes toward technology can influence their acceptance and performance, such as the style of technology implementation and outcomes related to implementation (Baylor & Ritchie, 2002; Klein & Knupfer, 1993). As Moore (1998) indicates, there are three interdependent variables when teachers use technology: attitudes, usage, and performance. These variables affect each other. The attitudes toward technology affect teachers' usage and performance. Also, teachers' performance can change an attitude or motivation for using the

technology. For example, if teachers realize that tasks are easier and require less time to perform with a computer, they might develop more positive attitudes, and the positive attitudes can motivate them to adopt other technology tools (Moore, 1998).

With this conceptual tool and the data we gathered, we identified four patterns. The patterns are the hesitant/curious, pre-active, active, and proactive patterns which mirror, to a certain degree, Rogers' adopter categories on the basis of innovativeness (1995): laggards, late majority, early majority, early adopters, and innovators. Table 2 shows these features in more detail. These patterns are a conceptual tool to help identify teacher' technology needs, and they are not a development process through which teachers go. The patterns are not entirely distinct from each other; they often overlap.

Here are some examples of the four patterns from our interviews and observations that are accompanied with the comparison with characteristics and values of Roger's adopter categories.

Hesitant/Curious: Jamie, an English teacher, felt uncomfortable using technology. She seldom used technology in her classroom. Even though she admitted the necessity of technology use in her classroom, she was not convinced that she could learn the new technology at her age.

This pattern exhibits the main characteristics and values of Rogers' laggards (traditional). Their decision making process of innovation take a relatively longer time than that of teachers' in other categories. It will be legitimate for laggards to be hesitant or resistant to innovation. Teachers in this category will be extremely cautious and would maintain the attitude of "wait and see" until the use of technology in their teaching is highly accepted in their schools/school districts.

Table 2. Technology Acknowledgement-Use Patterns

Pattern	Attitude	Usage	Performance
Hesitant/ Curious	- Curious or negative attitude - Not comfortable with technology - Uncertain about the necessity of technology	- Hesitant to use technology - Use only when mandated and only with the help of other teachers	- Stick to traditional teaching methods - Not helpful for students to use technology
Pre-active	- Somewhat comfortable with technology - Admits the necessity of technology	- Does not often use technology - Limited knowledge of technology - Focuses on personal use	- Mainly use traditional teaching methods - Unclear or uncertain about effective use of technology
Active	- Comfortable with technology - Positive attitude - Limited to personal use	- Often uses technology - Knowledgeable of technology - More focus on individual-purpose when using technology	- Some innovative use of technology in the classroom - Limited use of technology in his/her own classroom
Proactive	- Comfortable with technology - Positive attitude - Shows effort in diffusing technological knowledge to other teachers	- Frequent use of technology - Knowledgeable of technology - More focus on collaborative use of technology	- Innovative use of technology in the classroom - Collaborative use of technology with other teachers

Pre-active: Pamela, a social studies teacher, had dual attitudes toward technology. She used technology in her classroom and admitted the necessity of technology integration into the classroom. However, her use of technology was limited. She mainly used presentation software, but seldom used the Internet as an inquiry tool for her class. She said that she had no computer at home and no time to learn the computer.

The main characteristics and values of Rogers' late majority (skeptical) are close to those of this pattern. People fitting in this category will be skeptical and cautious of an innovation until it is widely accepted by their organization. Teachers in these categories would be motivated to adopt technology when peer pressure when most of their colleagues utilize technology (Rogers, 1995).

Active: Eric, a social studies teacher in a private school, knew how to integrate technology into the curriculum. He used the Internet to show the flood in North Carolina. But his attitude toward technology was very cautious. Even though he thought technology could make a big difference and to some degree used it in an effective way, he was neither a major technology supporter nor interested in encouraging his colleagues to use technology.

The attitude of a certain level of acceptance with caution is well captured in "deliberate willingness," one of the key characteristics of Rogers' early majority group (1995, p. 265). They will try out the new idea or the innovation, but they may mull it over for a while before they fully adopt it. While teachers in this category are bridge teachers between Pro-Active and Pre-Active and Hesitant/Curious, they rarely hold a position of opinion leaders in the use of technology (Rogers, 1995).

Pro-active: Laura, Mary, Bill, Barbara, Diana, and Michael were very positive in using technology. They wanted to learn new technology and tried to use it in their classes. They were eager to share their findings and beliefs with other teachers. Also, they were competent with various technology tools. They used technology to improve their teaching. They believed that students were happy with the technology use in the class and that other teachers need to join them.

Teachers in this pattern show characteristics of Rogers' both innovators and early adopters. According to Rogers (1995), innovators have a strong interest in new ideas and technical knowledge and skills. They are "venturesome" (Rogers, 1995, p. 264) and tolerant to uncertainty in the adoption process. Early adopters

serve as a "role model" for others in the system (Rogers, 1995, p. 264). Teachers in this category conduct various experiments to find ways of integrating technology to improve their teaching and are very active in sharing their practice with colleagues.

Since these patterns are brought into authors' minds during the data analysis, further study might be needed to verify these patterns. Also, confirmative research might be needed to verify factors affecting teachers' needs which were identified in this study.

Adaptive EPSS design

Since teachers may have different needs according to their grade level, teaching experience, and technology-competency level, a designer might need to build an adaptive EPSS, considering the specific needs of teachers. Here, we are not arguing that every need can be addressed and supported by technology. Some are more effectively supported by traditional, non-technology approaches such as training workshops, job aids, mentoring, updating technology knowledge, instructional methods, skills in behavioral management, etc. Others might be best met by using technology tools such as managing technology tools, grading, making test items, lesson planning, communication with students and parents, etc. Actually, even in tasks supported by traditional methods, there is often a way to use technology to perform the specific tasks better. However, the focus of this research is more on informing designers of types of needs that teachers might have and helping them develop a customized EPSS rather than analyzing cost-effectiveness of using technology in performing teachers' tasks. There might need to be additional cost-effective analysis to identify what needs can be best met by technology tools.

The need for a customized EPSS design is well addressed by many researchers (Cagiltay, 2003; Gustafson, 2000; Moore, Orey, & Hardy, 2000; Moore & Orey, 2001). Moore, Orey, and Hardy (2000) developed prototypes based on their observation of teachers' job performance. The prototypes were presented to

teachers to get their feedback, which resulted in *Teacher Tools*. *Teacher Tools* consists of seven different modules: Communication, Lesson Planning, Calendar, Classroom Management, World Wide Web, Grades, and It's My First Time. Since their data came from observation of eight middle school teachers, they did not consider other factors such as grade level, teaching experience, and technology competency level. However, this study provides complementary findings by identifying many factors that might influence teachers' needs.

In the following table, we suggest some tentative guidelines for designers to consider when they design an EPSS. It shows the focused areas for the EPSS design based on three conditions (teaching experience, technology competence, and grade level).

Needless to say, when designing an EPSS for teachers, a designer needs to identify what needs can be met by an EPSS and what needs can not. If the needs can be supported by an EPSS, a designer needs to consider the three conditions in order to identify the priority of performance needs and design a system appropriate for each set of conditions. Based on the matrix, the designer can determine the design principles and main components of the EPSS. For example, if the main users are elementary, novice, and tech-savvy teachers, the design might look like this: The EPSS should focus more on an expert system for lesson planning, effective use of technology in the classroom, classroom management tools, and a database system on information management, and less on technology training software.

There are three cautions that should be heeded when designing an adaptive EPSS. First, designers do not need to develop every tool we found in this study. Since many tools have already been developed, designers may simply indicate which available tools are most appropriate for what conditions. For example, since diverse kinds of grading software are already available, designers may provide an EPSS that compares them and suggests an appropriate one for their needs.

Table 3. Matrix of User Conditions and Focused Areas for EPSSs Design

Grade level	Technology Competency	Teaching Experience	Focused Areas for EPSSs Design
Elementary	Pre-active	Novice	- technology use in the classroom - grade & assessment - administrative works - behavior management - lesson planning - technology knowledge support
Elementary	Active/ Proactive	Novice	- technology use in the classroom - grade & assessment - administrative works - behavior management - lesson planning- advanced technology needs
Elementary	Pre-active	Expert	- technology use in the classroom - more emphasis on grade & assessment - administrative works - less emphasis on behavior management - technology knowledge support
Elementary	Active/ Proactive	Expert	- technology use in the classroom - grade & assessment - administrative works- advanced technology needs
Secondary	Pre-active	Novice	- information management- planning- technology use in the classroom- technology knowledge- classroom management
Secondary	Active/ Proactive	Novice	- information management- planning- technology use in the classroom- advanced technology needs- classroom management
Secondary	Pre-active	Expert	- information management- planning- technology use in the classroom- technology knowledge- less emphasis on behavior management- grade & assessment
Secondary	Active/ Proactive	Expert	- information management- planning- technology use in the classroom- advanced technology needs- less emphasis on behavior management- grade & assessment

Second, designers also need to consider the conditions particular to each school, district, and state as well as the general conditions identified in this study when they develop an adaptive EPSS. Each school, district, and state has its own curriculum standards, unique policy of technology use, different technology tools, etc. Therefore, when designing an adaptive EPSS, designers need to identify the particular conditions of the school, district, and state, and determine what components should be introduced into the EPSS based on them.

Third, it is important to note that "technology use in the classroom" was the area that was commonly identified as a key area across the different grade level, technology competency, and teaching experiences. Teachers from all different teaching and technology backgrounds tend to look for ways to improve their instruction using technology. The designers need to incorporate components to support such as technology training sessions and best practices of technology use in the classroom that accommodate teachers' different technology competencies. This adaptive learning environment will help a teacher use the EPSS components effectively in relation to his or her level of expertise.

Some of limitations of this study are as follows: First, some factors were not considered. Teachers' cognitive styles and subject-matter effects on teachers' performance needs were not analyzed. Future research could investigate how these factors affect teachers' needs. Secondary, this study only focused on teachers' job performance needs. The study findings need to be verified with actual implementation of EPSS designs. Long-term, detailed case studies might be needed to provide principles and guidelines for the design and development of an adaptive EPSS for teachers.

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Received: July 15, 2009 / Peer review completed: August 30, 2009 / Accepted: October 10, 2009