Using ubiquitous technology to support teacher performance

Abstract: This article illustrates a Ubiquitous Performance Support System for Teachers (UPSST) the authors developed to support the performance of high school teachers and its formative evaluation results. Twelve Taiwanese teachers participated in the formative evaluation, and they filled out questionnaires after testing the UPSST. To triangulate data, the authors also interviewed eight participants. Although participants generally showed positive attitudes toward the UPSST, the responses of the participants indicated the complexity of implementing a technology innovation in an educational setting. Explanations of the participants' concerns and suggestions for future studies are provided.

1. Introduction

The concepts of EPSSs focus on providing task performers with necessary support and learning opportunities within working contexts so they can improve their performance and learn relevant knowledge and skills while performing tasks (Barker, van Schaik, & Famakinwa, 2007; Cagiltay, 2006). Researchers have recommended integrating EPSS concepts into educational settings to enhance teaching and learning (e.g., Chiero, 1996; Peng, Chuang, & Hwang, 2007; van Schaik, Pearson, Barker, 2002). Meanwhile, the characteristics of mobile technology such as ubiquity, smaller sizes, and comparatively cheaper prices, and the widespread use of wireless networks has encouraged researchers to further investigate the potential of integrating mobile technology with EPSS applications (Barker et al., 2007; McManus & Rossett, 2006; Peng et al., 2007).

In Taiwan, each class is assigned a homeroom teacher who usually teaches the class a subject and, in addition, is paid more for taking care of the class. Often, the homeroom teachers are busy handling classroom management and administration work. Kuo (2003) surveyed 789 Taiwanese junior high school homeroom teachers and found that on average the teachers spent 70% of their time in school interacting with students and 14% of the time with colleagues. However, the time spent with colleagues was not necessarily for sharing teaching and administration experiences, and schools seldom offered opportunities for professional development in classroom management. Hence, we assume that a well-designed EPSS could reduce homeroom teachers' workloads, and we developed a Ubiquitous Performance Support System for Teachers (UPSST) with ubiquitous technology to assist the performance of high school homeroom teachers. Twelve homeroom teachers participated in testing the developed system. Their opinions on the UPSST and its application were documented.

2. Theoretical framework

2.1 Electronic Performance Support Systems

Society nowadays emphasizes the importance of lifelong learning and, in fact, most adults acquire their knowledge and skills mainly from their work after leaving school （Brown, 1996）. By undertaking authentic tasks, learners can achieve deeper understanding of their work, and the learned knowledge and skills can be better transferred to future working contexts (Brown, Collins, & Duguid, 1989). Therefore, how to help adults to effectively learn relevant knowledge and skills during task execution has become an important issue, and the concept of Performance Support Systems (PSS) has been raised. The purpose of PSSs is to improve task performance by providing performers with just-in-time support and information, meaning that the intervention is triggered whenever the user needs it. With the improvement of computer technology, Electronic Performance Support Systems (EPSSs) have been developed to assist workers to make their jobs more productive and efficient (Barker et al., 2007; Cagiltay, 2006).

Researchers have noticed the potential of EPSSs for improving teaching and learning in school contexts. With the scaffolding provided by EPSSs, learners gradually develop the expertise of certain areas (Barker et al., 2007; Wild, 2000). Moreover, EPSSs can combine various technologies and resources to improve teacher performance. Well-designed EPSSs can play different roles such as librarians, advisors, and instructors to provide users with instant, relevant, and useful information and advice, and all kinds of built-in tools can reduce teachers' work loads and information loads, and facilitate teacher effectiveness (Chiero, 1996).

Meanwhile, ubiquitous (or mobile) technology and its applications have become a prosperous and global research agenda because of the rapid growth in wireless sensor networks. The innovative technology can detect

incidents in contexts and give users instant responses, information or support (Huang, 2006). Hence, research on how ubiquitous technology such as laptop computers and handheld computers can influence the design and implementation of EPSSs and on how to generate more effective work-support models and applications deserves further investigation (McManus & Rossett, 2006).

2.2 Using ubiquitous technology in educational settings

Due to the features of handheld computers such as portability, adaptability, flexibility, intuitiveness, and comparatively cheaper prices, ubiquitous/mobile learning which integrates handheld computers with wireless networks in teaching and learning has become one of the leading topics in educational research (Chen, Kao, & Sheu, 2003; Pownell & Bailey, 2002; Roschelle, 2003; Sharples, 2000; Sharples, Corlett, & Westmancott, 2002). Chan et al. (2006) argued that one-to-one handheld computers will be an indispensable tool for many students in ten years time, and that many countries can directly cross the digital divide via such technology because of the much lower cost. They envision more chances of collaboration on research projects related to mobile technology among worldwide researchers, and the formation of global research communities in this area.

Regarding the benefits of using ubiquitous/mobile technology in school teaching and learning, research results indicate that most teachers possess positive attitudes toward this kind of technology use in education. For instance, SRI International implemented a project called Palm Education Pioneers from January, 2001 to August, 2002 in more than one hundred K-12 schools to investigate how teachers and students used hand held computers in various school contexts. Over 90% of the teachers held positive attitudes toward using handheld computers in K-12 classrooms, and they reported positive influences of using handheld computers on student learning, such as more time spent by students in learning with technology, higher learning motivation, more communication and collaboration among peers, etc. Furthermore, the handheld computers' features of portability and accessibility allowed the students to own a personal learning tool, and the teachers confirmed that the computers made instruction and classroom management more effective (Crawford & Vahey, 2001; Vahey & Crawford, 2002).

However, it seems that there is limited research on a systematically-designed EPSS with ubiquitous technology to provide homeroom teachers with just-in-time, necessary, informative, and flexible support (Chuang, 2007). In their article, Peng et al. (2007) illustrated a scenario about how ubiquitous technology could be used as the platform of an EPSS for supporting homeroom teachers in school contexts. In her Masters thesis, Chuang (2007) created an interface prototype of a mobile performance support system for junior high school homeroom teachers. However, according to the 4D-stage process of EPSS design and development (define, design, develop, and deliver) proposed by Brown (1996), Chuang's study only completed certain parts of the first two stages without creating a deliverable system and without collecting data of field implementation.

3. The UPSST implementation model

Figure 1 presents the UPSST implementation model we proposed. The UPSST consists of three system modules, that is, the Data Exchange Group, the UPSS Service Group and the User Interface Group. The Data Exchange Group is the module for maintaining the consistency of data in the databases of the UPSST and the official administrative systems. The data collected or modified by the teachers need to be uploaded via this module to ensure the security of the official database. The UPSS Service Group consists of the most frequently used functions for the daily work of high school homeroom teachers, that is, "calendar", "student records", "conduct-record management" and "academic-record management". The User Interface Group provides flexible interfaces and operation functions to assist the teachers in accessing and updating data via PDA's or Personal computers, that is, the UPSST will display the same data with different presentation styles (e.g., brief or detailed information, low or high resolution) based on the devices used by the teachers.

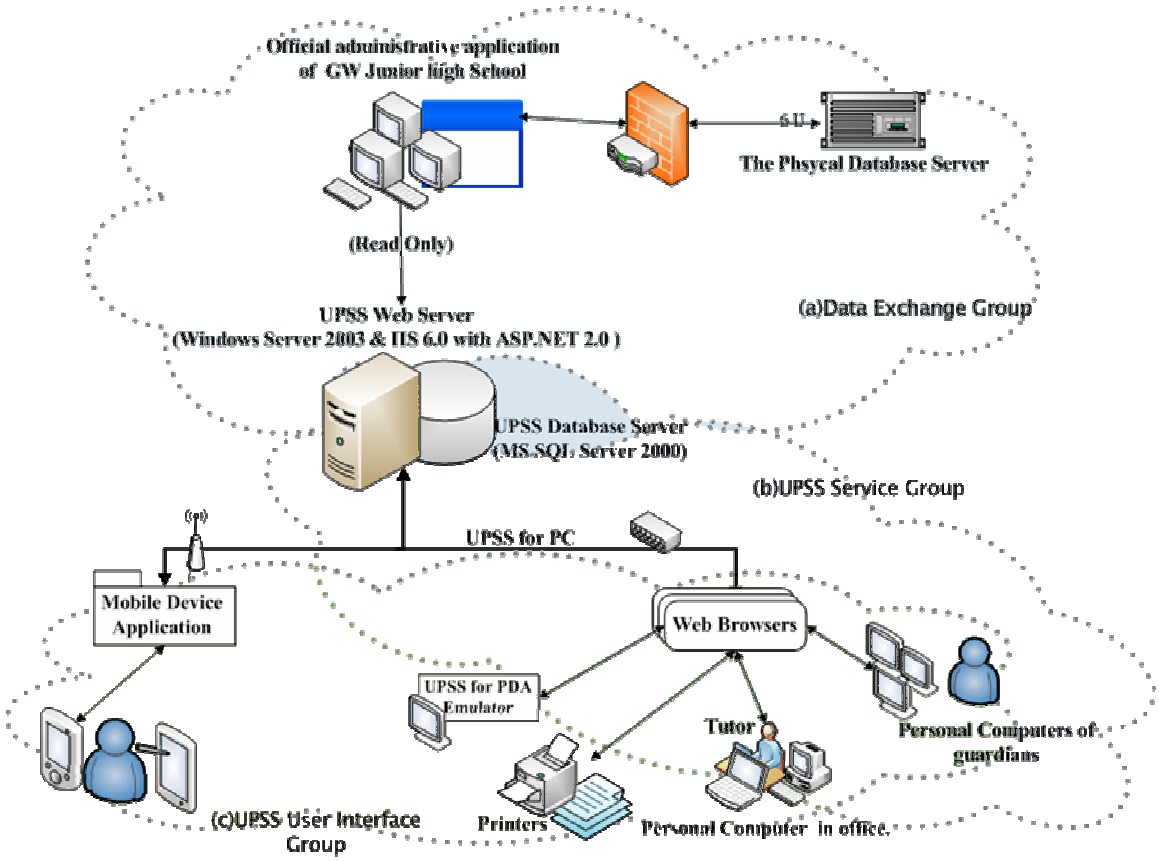

Figure 1. UPSST implementation model

Connecting to the existing administration automation system, the UPSST server automatically retrieves information and records scattered around different offices. For instance, the academic affairs office manages all students' academic records, the student affairs office helps homeroom teachers with issues related to student behavior, and the counseling office provides all kinds of counseling services. Homeroom teachers can use PDAs with the developed UPSST system to receive reminders or information they need for performing tasks. They can also update records stored in the server or send requests to obtain necessary information via their PDAs. With PDAs and the UPSST, homeroom teachers have easy access to the assistance and information they need for effectively communicating with parents, students and colleagues. In addition, they can easily update existing records, append new records, or write down personal reflections regarding how to better tackle student behavior and improve student performance. The teachers can also print out relevant information in formats consistent with the school's official forms.

To prevent some important data in the administrative system from being modified by unauthorized persons, the physical database server of the administrative system is protected by a firewall, and a read-only copy that is refreshed periodically is accessed by the UPSST. An asynchronous strategy is also adopted by the UPSST for updating the data collected by the teachers.

4. Results of the formative evaluation on the UPSST

After completing the beta version of the UPSST, we invited twelve homeroom teachers to test it. The twelve teachers filled out questionnaires including close- and open-ended questions after the trial, and we interviewed eight of them to allow us to further understand their opinions of the functions and interface design of the UPSST and its utilization in school. Although the twelve teachers mostly reported the usefulness of receiving and managing information via the UPSST, not all participants considered the UPSST as an effective solution to communicating with parents and to reducing their workloads.

In the questionnaires, the teachers confirmed the benefits of the UPSST such as its ubiquity, convenience, readiness, timeliness, and richness in inquiring, recording, and managing information. They envisioned benefits including easier grasp of students' behavior and academic performance, more effective communication with parents, efficient use and management of electronic data, and substantial support for novice homeroom teachers. However, some responses reminded us of the difficulty of introducing an innovative technology into school settings, especially when existing practices work well. Three teachers reported that the administration automation system, phones, and paper and pencil were good and fast enough for them to manage student data and communicate with parents. The concerns expressed by the twelve teachers about the implementation of UPSST focused on the time and effort needed to learn how to operate a PDA and the UPSST, the availability of necessary equipment and technical support, the stability of the wireless network and server, and the compatibility of the UPSST with the current system. Although nine out of the twelve questionnaire respondents expressed their willingness to try the UPSST in their schools, without stable and compatible equipment and support, the benefits of the UPSST could not persuade the teachers to replace their familiar ways of performing homeroom teachers' duties with the functions provided in the UPSST.

Moreover, based on the questionnaire responses, we found that while recognizing the overall usability of the UPSST interface design, not all participants could intuitively navigate the system. The following open-ended questions and interviews provided useful information to further improve the interface design. However, we found that some of their less positive responses might result from their unfamiliarity with operating a PDA. Six out of the eight interviewees mentioned a potential obstacle to implementing the UPSST could be teachers' resistance to operating an unfamiliar system, and the constraints of PDAs such as small screens and inconvenient data entry were mentioned as discouraging factors for teachers to adopt the UPSST in their daily work. Six respondents suggested we add functions which were already provided in the UPSST, which may have been due to the too brief introduction and trial. Therefore, to conduct the usability evaluation of the PDA user interface, we should allow evaluators sufficient time to be familiar with PDA operation and the tested system.

5. Discussion and conclusion

Generally, the twelve participants confirmed many advantages of utilizing the UPSST in assisting homeroom teachers' work, and they mostly showed positive attitudes toward the functions and interface design of the UPSST. However, not all participants agreed on the necessity of every function of the UPSST. Since the development of EPSSs emphasizes the importance of fulfilling specific user needs and taking contexts into accounts, we tailored the UPSST design to suit the target users' needs, their school settings, and their working contexts. It is not an easy task to maintain the balance between making the UPSST design meet the needs of specific users and contexts and allowing other prospective users enough flexibility to alter the functions and interface of the UPSST to fit their needs. The limitations of mobile computing devices such as small screen sizes and inconvenient input and output methods (Heath et al., 2005; Shin, Norris, & Soloway, 2007) make our design even more challenging.

The responses of the twelve participants also reminded us of the complexity of implementing a technology innovation in an educational setting. They expressed concerns about the time and effort needed to become familiar with the PDA and UPSST operation, the shortage of necessary equipment, technical support, and stable network connectivity and, most importantly, the compatibility of the UPSST with their current practices and systems. From the experience of conducting formative evaluation, we found the necessity of giving participants enough time to digest the introduction to the UPSST, to raise questions, and to be familiar with PDA operation. Because most participants were not familiar with the devices, they could not totally attend to the functions and interface design to focus on the evaluation task.

Regarding future studies, we plan to undertake intensive field trials in the target users' school, and to keep revising the UPSST, and we will continue collecting data to investigate how integrating ubiquitous technology into school settings differs from other forms of technology integration in education, and what factors influence the effectiveness of such integration. How teachers change their adoption of ubiquitous technology at different stages, and how their beliefs and practices transform can be important research issues, and these studies can provide researchers and practitioners with insights into how to disseminate ubiquitous technology in meaningful ways.

6. References

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