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Student Teachers' Intentions and Actions on Integrating Technology into Their Classrooms during Student Teaching: A Singapore Study

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Abstract

The purpose of the study is to explore student teachers' intentions and actions in technology integration in their classrooms. A postgraduate teacher education cohort of 118 Singapore student teachers participated in the study. The results suggested that student teachers in Singapore showed positive intentions to integrate technology to facilitate student-centered learning in their future teaching. However, they reported that they were more likely to use technology as a supporting and instructional tool during their student teaching rather than using technology to promote student-centered learning. Qualitative findings from 10 purposefully selected participants showed consistency with the quantitative results. The results of the study helped to better exemplify the student teachers' intentions and their actions in integrating technology into their classrooms. (Keywords: preservice teacher education, technology integration, teaching practice, information and communication technology)

INTRODUCTION

Technology integration has come a long way since the 1990s. Many previous studies have discussed the values and the positive and the negative effects of technology in education (Cuban, Kirkpatrick, & Peck, 2001; Kay, 2006; Russell, Bebell, O'Dwyer, & O'Connor, 2003). The literature of educational technology is gradually changing and showing some encouraging improvements. Schools and classroom infrastructures improved from the average student-to-computer ratio of 12:1 in 1998 to 5.4:1 in 2001 in the United States (Kay & Knaack, 2005). Although debates on the advantages and disadvantages of technology integration in learning continue, researchers tend to agree that it is important to integrate technology into the preservice teacher education curriculum (Anderson & Maninger, 2007; Wright & Wilson, 2005–2006) because the value of integrating technology has always been to promote students' critical thinking, collaboration, and problem-solving skills (Jonassen, Peck, & Wilson, 1999). As a result, preparing teachers who are capable and comfortable with applying a broad spectrum of advanced technologies to meet the learning needs of their students is on the agenda of educational reform initiatives worldwide (U.S. Department of Education, 2008; Singapore Ministry of Education, 2006). Student teachers are expected to understand the potential of technologies, have opportunities to apply them, be supported in their explorations, and have time to experiment with technologies in teacher education programs. In addition, the

perceptions, attitudes, knowledge, and skills of student teachers are critical to the integration of technology into teaching (Kay & Knaack, 2005).

The purpose of this study is to examine the intentions and actions of student teachers in integrating technology into their teaching in Singapore. The researchers administered surveys three times to collect information throughout their preservice teacher education program—before taking a standalone "ICT for Engaged Learning" technology course, after completing the course, and after their 10-week student teaching at elementary schools. In addition, the study also aimed to investigate the changes in their intentions and actions and explore if the student teachers were able to translate their intentions to use technology effectively into actions during their 10-week student teaching. The aim and research questions of the study are detailed in the methodology section.

Student Teachers' Beliefs, Attitudes, Intentions, and Actions

Student teachers' beliefs and attitudes towards technology integration in the classrooms have been widely researched and published (Ertmer, 1999; Pajares, 1992; Richardson, 2003; Swain, 2006). Ertmer (1999) suggested that both the first-order barriers to change, which were related to teachers' more effective use of technology, and the second-order barriers to change, which were related to teachers' intrinsic beliefs and practices, have to be addressed for teachers to integrate technology to promote student-centered learning. Pajares (1992) discussed that student teachers' educational beliefs and self-efficacy greatly influenced their subsequent instructional decisions and classroom practices. Teachers' belief system about teaching and learning may have an effect on meaningful technology integration. Richardson (2003) discussed that student teachers held "deep-seated beliefs" about teaching and learning that were developed from their experiences as students. These beliefs have a strong influence on their future teaching styles and preferences. Swain (2006) examined student teachers' self-assessment of integrating technology and found that they lacked the readiness to change their underlying beliefs of how educational technologies can enhance the teaching and learning process. Learning to teach is to bring about cognitive change in student teachers to enable them to be more specific in their knowledge of student learning and the context (Hollingsworth, 1989). We teach the way we were taught (Lortie, 1975). Therefore, teacher educators play an important role in facilitating student teachers to critically reflect on their own beliefs and shape their beliefs for future teaching during the teacher education program.

In addition to beliefs, teachers' attitudes are also strongly related to, and can be used as, predictors of behaviors. Studies have discussed different ways of providing technology-related knowledge and skills to student teachers to try to change their attitudes toward technology integration. Some examples are using standalone technology skills–based courses (Abbott & Faris, 2000) and integrating technology into different courses in the teacher education program (Albee, 2003). These studies suggested that providing educational technology courses to student teachers improved their technology skills and knowledge and in turn improved their attitudes and self-efficacy in integrating technology in the future. However, many of these studies concluded at the improvement of beliefs

and attitudes without further investigating the intentions and actions of the student teachers in integrating technology into their teaching.

Preparing Student Teachers for Technology Integration

A review of studies on student teachers' learning to teach with information technology indicates a trend of moving from taking on-campus technology courses to extending learning into field-based technology practices. Technology courses have successfully shown advantages in developing the student teachers' basic knowledge and skills in a manageable way, and in changing the student teachers' attitudes toward information technology and perceived self-efficacy when using technology (Albion & Ertmer, 2002; Ertmer, 2005; Persichitte, Caffarella, & Tharp, 1999). However, short-term exposure to technology does not prepare student teachers with the necessary skills and knowledge for integrating technology into classroom instruction effectively (Moursund & Bielefeldt, 1999). Brown and Warschauser (2006) further concluded that these skills-based technology courses provided the skills and knowledge that are separated from the overall teacher education curricula as well as the classroom setting. To facilitate student teachers' positive attitudes in integrating technology in their teaching, they need to be exposed to technology being used in a pedagogically sound manner throughout their teacher education program (Bai & Ertmer, 2008).

The actual experience of teaching itself can be a powerful influence on a teacher's learning (Zeichner & Tabachnick, 1985). Stuhlmann (1998) argued that the reinforcement and practice in technology over time had an enormous impact on student teachers' abilities to transfer their technology-related knowledge and skills to other educational situations. Mullen (2001) suggested that student teachers' technology field practices should be seriously considered to relate the learning of technology integration with teaching. Additional studies also showed that when preparing the student teachers to teach with technology, they should be contextually and socially situated in the school-based learning environment rather than taught in isolated course work in universities for better transfer of knowledge and skills (Hooper & Rieber 1995; McIntyre & Tlusty, 1995). Therefore, one way to improve student teachers' technology preparation is to go beyond the standalone courses offered in university classrooms. Teacher education programs should be providing opportunities for student teachers to practice the integration of technology in their student teaching during field experience (Bullock, 2004; Dexter & Riedel, 2003).

Although many suggested what should be done in the student teachers' field experience, there are limited studies that tracked the changes of student teachers' attitudes, beliefs, and practices in technology integration from the beginning of coursework till the end of field experience. Brown and Warschauer (2006) investigated student teachers' perceptions of technology during coursework and field placement. Their findings suggested that there was a lack of exposure to technology integration during field experience. However, they did not investigate if the student teachers had used technology during field experience.

Integrating ICT into Student Teacher Preparation in Singapore

The development of Singapore's first and second Masterplan for Information and Communication Technology (ICT) in Education showed that integrating technology into Primary and Secondary education (grades 1–12) was one of the main educational priorities in the education system. The first Masterplan was launched in 1997 (Singapore Ministry of Education, 2004). It focused on:

- Curriculum and assessment: Include assessments that will measure abilities in applying information, thinking, and communication
- Learning resources: Acquire and develop a wide range of education software to meet curriculum needs; facilitate use of relevant online resources
- Human resource development: Provide training to every teacher in core skills in teaching with and using ICT meaningfully
- Physical and technological infrastructure: Provide access to ICT, schoolwide network; provide teacher-computer ratio and student-computer ratio of 2:1, respectively

Although the first Masterplan for ICT in Education emphasized more on the infrastructure, resources, and teacher training, the second Masterplan in 2002 was geared toward changing the culture of the classroom and school to support and motivate thinking and independent learning among young students (Singapore Ministry of Education, 2006). Some of the intended outcomes for Masterplan 2 are for:

- Students to use ICT effectively for active learning
- Connections between curriculum, instruction, and assessment to be enhanced using ICT
- Integration of ICT in curriculum and assessment to be enhanced
- Teachers to conduct active research in the use of ICT in education

To achieve these intended outcomes, the roles of the teachers are changed from that of the main knowledge provider to that of a facilitator in learning. In addition, students are to become engaged in constructing their own learning. Finally, technologies are being integrated into the students' learning process as supportive tools rather than being used mainly by teachers as presentation tools.

The preservice teacher education programs provide foundational knowledge and skills and inspire student teachers to be innovative leaders in schools (Wong, Chong, Choy, Wong, & Goh, 2008). As the sole preservice teacher education provider in Singapore, the National Institute of Education (NIE) plays an integral role in preparing the student teachers for all Singapore schools. More than 2000 student teachers are admitted into five preservice teacher education programs in NIE annually. These programs are postgraduate diploma in education (primary), postgraduate diploma in education (secondary), diploma in education, bachelor of science (education), and bachelor of arts (education). If the student teachers are able to adopt the pedagogical use of ICT learned in

NIE in their 10-week student teaching and their beginning years of teaching, it is more likely that they will bring new ideas and practices into their classrooms and the schools. In the long run, they may become the change agents in their schools, helping to alter the school culture in the effective use of ICT.

THEORETICAL FRAMEWORK

The theoretical framework of this study is based on the constructivist learning theory, which articulates that learning to teach is to bring the sorts of changes in knowledge or understanding, skills, and beliefs that may occur through teacher education (Brophy, 1991; Hollingsworth, 1989). Constructivism maintains that individuals create or construct their own new understanding or knowledge through the interaction of what they already know and believe with the new ideas, events, and activities with which they come in contact (Cannella & Reiff, 1994; Lerman, 1989). The applications of constructivist learning theory in the use of ICT in the classroom reveal a shift from using ICT as "instructional tools" that support the teachers' teaching to using ICT as "cognitive tools," "mindtools," and "cognitive partners" to promote meaningful learning that is active, constructive, intentional, authentic, and cooperative (Jonassen, Peck, & Wilson, 1999).

Constructivist views lead to the notion that student teachers need to construct their own meanings of teaching and learning. This study aims to find out how the student teachers construct their own intentions and actions in technology integration. Based on their existing attitudes and beliefs in technology integration in teaching and learning that was developed before the preservice teacher education program, this study investigates their changes in intentions and actions of technology integration after they learn about ICT from the technology course and after their 10-week student teaching.

Research on teacher education and teacher learning with ICT guided this study. A large number of previous research studies focused on teachers' attitudes towards using technology in the classrooms (Ertmer, 1999; Pajares, 1992; Richardson, 2003; Swain, 2006). Rather than just looking at attitudes and beliefs, this study focused on the student teachers' intentions and actions. Intention was defined as an individual's self-prediction of the likelihood to perform a certain action in social psychology (Ajzen & Fishbein, 1980; Davis & Warshaw, 1992). They further explained that intentions could be a measure of the likelihood that an individual will engage in a given behavior in the future. In this study, the student teachers' intentions are defined as their thoughts about integrating technology in their future classrooms when they were enrolled in the technology course during their teacher preparation program. On the other hand, for the purpose of this study, the student teachers' actions are defined as their actual practice in integrating technology during their 10-week student teaching for the purpose of this study.

METHODOLOGY

The purpose of this study is to investigate the student teachers' change in intentions and actions in technology integration during the preservice teacher

education program. This study began by examining the intentions of student teachers in integrating technology in their future teaching before and after they took a standalone technology course. After that, their intentions were compared with their actual actions in integrating technology during their 10-week student teaching. The results of the study were used to show how the student teachers translated their intentions constructed during the preservice teacher education technology course into actions in integrating technology in their student teaching.

The research questions are:

- What are the intentions of student teachers in integrating technology before they took and after they completed the technology course?
- What are their actual actions in integrating technology into their teaching during the 10-week student teaching?
- What are the changes in their intentions and actions? Are the student teachers able to translate their intentions of integrating technology into actual actions?

Quantitative data collection was used as the main method to collect information to answer these research questions. Survey instruments were administered at three different stages of the preservice teacher education program. The three stages were before the technology course, after the technology course, and at the end of student teaching. The researchers invited the 308 student teachers enrolled in the one-year postgraduate diploma in education (PGDE) (Primary) (i.e., elementary, grades 1–6) initial teacher preparation program to participate in this study. At the end of data collection, 118 student teachers had completed all three surveys. The overall return rate of the surveys was about 38%. The researchers coded the surveys collected by using the student teachers' National Registration Identity Card (NRIC) number during the data collection process to match the survey response for each individual across the three data collection stages. Completed surveys that could not be matched across all three stages were eliminated from the study. In addition to the survey results, the researchers included some representative qualitative data from structured interviews and lesson observations in the data analysis and results sections to further substantiate their research findings.

Similar to many preservice teacher education programs, all NIE student teachers are required to complete a course that is related to technology integration. In the one-year PGDE (Primary) program, student teachers complete this course during their first semester. The course is titled "ICT for Engaged Learning." This course is different from many skill-based standalone technology courses that have been mentioned in previous studies (Abbott & Faris, 2000; Albee, 2003; Kay, 2006). The main objective of this course was to introduce the pedagogy in integrating technology into classrooms, which was more aligned to the suggestions from more recent studies, in which technology courses should be showing student teachers the meaningful ways to integrate technology into teaching and learning (Lambert, Gong, & Cuper, 2008). The student teachers were expected to have basic knowledge and skills in using technology. If they

did not, they were encouraged to attend workshops that were specially designed to help them learn these technology-related knowledge and skills. These workshops were considered as extra training for those who needed help.

In this technology course, student teachers learned about different ways that technology can help to enhance their primary school students' learning experiences, promote small group and cooperative learning, and allow students to construct their own knowledge. At the end of the course, student teachers worked in pairs to design and develop a student-centered learning package. In this package, they were expected to design problems and activities in an authentic learning context. The purpose of the final project was to let the student teachers think through the process of integrating technology into student-centered learning activities, with the hope that they will be able to adapt and apply their packages in their teaching. At the beginning and at the end of the course, the student teachers completed the surveys, which asked them about their intentions of integrating technology into their future teaching.

After completing all the required course work, the last component was a 10-week student teaching in this one-year PGDE (Primary) program. During this period, they taught at a designated primary school for 10 weeks under the supervision of cooperating teachers at schools and one university supervisor. On average, the student teachers taught 20–24 thirty-minute lessons per week. The number of subjects they taught depended on the curriculum studies areas they were reading at NIE. In general, student teachers taught two to three subjects, such as English language, mathematics, science, and social studies. The cooperating teachers and the university supervisors completed a total of 10 formal lesson observations. At the end of the student teaching/teaching practicum, the researchers administered the survey again to ask the student teachers to reflect on their actions in technology integration during their student teaching. Upon the completion of the three data collections, we used statistical analyses to compare the student teachers' intentions with their actions.

We designed the survey instrument, as we were unable to find an existing instrument to measure what we wanted to assess. We used literature on the analysis and organization of teachers' use of ICT and the constructivist learning theory to guide the development of the survey instrument.

McNabb, Valdez, Nowakowski, and Hawkes (1999) categorized teachers' use of information technology into the following four main areas:

- Basic uses of technology: operating basic computer hardware and software programs
- Instructional use of technology: using technology to design and develop instructional materials and resources to support different kinds of instructional strategies
- Administrative use of technology: using technology to manage information related to teaching and monitor students' performance
- Professional development uses of technology: using technology to access online resources, communicate with colleagues, and promote collaborations

Table 1: Selected Items in Each Factor from the Post–Student Teaching Survey

Factor and Examples of Items (Total Number of Items in Each Factor)	Loadings	Cronbach Alpha
Factor 1: Use of ICT as supporting tools (7)		0.80
I used ICT to prepare lesson plans, handouts, assignments, and examinations for students.	0.72	
I used ICT to record grade, attendance, and other administrative records.	0.49	
I use ICT to communicate and collaborate with other teachers for professional matters.	0.50	
Factor 2: Use of ICT in student-centered learning (14)		0.93
I used ICT as an alternative way to assess students' learning.	0.61	
I spent less time lecturing to allow my students time to conduct online research in class.	0.69	
I encouraged my students to work collaboratively by using ICT.	0.76	
Factor 3: Being a facilitator in class (4)		0.82
Using ICT helped me to reflect on my own teaching in a more systemic manner.	0.72	
Using ICT helped me to become a facilitator in class.	0.68	
Using ICT changed my role from knowledge authority to a fellow learner with my students.	0.58	
Factor 4: Confidence in leading the integration of ICT in school (6)		0.83
I was confident in evaluating website contents for teaching.	0.68	
I was confident to teach my peers how to integrate ICT into classroom practice.	0.87	
I was confident to teach my teaching colleagues how to integrate ICT into classroom practice.	0.86	
Factor 5: Support from school and peers (5)		0.89
I got the support of my peers in integrating ICT into my classroom.	0.84	
I got the support of my cooperating teachers in integrating ICT into my classroom.	0.88	
I got the support of my university supervisor in integrating ICT into my classroom.	0.79	
Overall Cronbach alpha for 36 items		0.89
Items eliminated (2)		
As a student teacher, I am very satisfied with the way ICT is being used in my teacher preparation classes.		
All this new technology is basically another fad in a long chain of innovations that will make little impact on my classroom or students.		

Thus, we used these four main areas of teachers' use of information technology as the basis to develop the statements in the survey instrument. The researchers crafted items in the areas of basic, administrative, and professional development uses of technology according to the definitions of the categories. Within the area of "instructional use of technology," studies showed that the notion of constructivist learning shifted the use of ICT from instructional tools that assist conventional teaching to cognitive tools that support students to construct their own knowledge through meaningful learning (Jonassen, Peck, & Wilson, 1999). As a result, for this area, we developed the statements of the survey to cover both the use of ICT as instructional tools to assist conventional teaching and as cognitive tools to promote student-centered learning.

The survey instrument consisted of 38 items on a 5-point Likert scale (strongly disagree: 1, somewhat disagree: 2, neutral: 3, somewhat agree: 4, and strongly agree: 5). The pre– and post–technology course surveys focused on the student teachers' intentions to integrate technology in their classrooms in the future. Here are some sample statements in the survey:

- I will use ICT to implement problem-based learning in my classroom.
- I will spend less time lecturing to let my students conduct online research in class.
- I need the support of my school/cooperating teachers to integrate ICT in my classroom.

The post–student teaching survey asked the student teachers to evaluate their actual actions during their student teaching. As a result, most of the wording of the survey remained the same, with only minor revisions. Here are some sample statements from the post–student teaching survey:

- I used ICT to implement problem-based learning in my classroom.
- I spent less time lecturing to let my students conduct online research in class.
- I find that the support from my school/cooperating teachers is important to help me integrate ICT in my classroom.

In addition to the quantitative data collection, the researchers collected some qualitative information from selected student teachers from the cohort through in-depth interviews and observation of at least one of their lessons during their student teaching. We purposefully selected 10 focus participants on a voluntary basis, based on their self-reported confidence level from their pre–technology course survey. The pre–technology course survey asked student teachers to indicate if they would be interested in sharing more information with the research team about their intentions and actions to integrate technology into their student teaching. Those who were interested were asked to leave their e-mail addresses at the end of the survey. The researchers then sent invitation e-mails and additional information related to the qualitative data collection, such as potential interviews and lesson observations, to all student teachers who indicated

Table 2: Student Teachers' Intentions and Actions in Integrating Technology into Their Teaching

Factor	Precourse Intentions	Postcourse Intentions	Post–Student Teaching Actions	*F*	*p*-value
1. Use of ICT as supporting tools	4.15	4.18	4.06	2.81	.06
2. Use of ICT for student-centered learning	3.81	3.86	2.98	80.43**	<.01
3. Being a facilitator	3.93	4.01	3.51	22.19**	<.01
4. Confidence in leadership in ICT	3.55	3.84	3.64	12.06**	<.01
5. Support from schools and peers	4.08	3.99	3.46	26.47**	<.01

*** significant at p < 0.01 level*

their interest. For those who expressed that they would like to participate in the study after reading about the research, we asked them to reply to the invitations. The research team reviewed the list of respondents and checked their self-reported confidence levels toward integrating technology results from the pre–technology course survey. We purposefully selected 10 focus participants with different confidence levels from the respondents. Three out of the 10 focus participants reported a high level of confidence in planning to integrate ICT to promote student-centered learning, four of them reported a medium level, and the rest indicated a low level of confidence.

We conducted one-on-one semi-structured interviews with all of them after the technology course and a second round of interviews after their student teaching. We also conducted lesson observations during their student teaching. At the end of data collection, we were able to observe seven participants with a total of 13 completed lesson observations. On the other hand, we were unable to observe three of the participants during the 10-week student teaching due to various issues such as participants' readiness, preferences, and scheduling.

DATA ANALYSIS AND RESULTS

The researchers conducted factor analysis using the SPSS statistical analysis software at the end of the data collection process. The analysis with Varimax rotation revealed five factors that carried eigenvalues higher than 1.2 from the 38-item survey. These factors were reviewed and labeled as:

- Factor 1: Use of ICT as supporting tools
- Factor 2: Use of ICT in student-centered learning
- Factor 3: Being a facilitator in class
- Factor 4: Confidence in leading the integration of ICT in school
- Factor 5: Support from school and peers

Each factor comprised 4–14 items. Some examples of the items in each factor and their loadings are provided in Table 1 (page 182). Two out of the 38 items did not fit into any of the five factors, as their loadings were low. Hence, they were eliminated from the data set.

The average age of the participants was 27.8 years. As all the student teachers are required to complete their undergraduate degrees before their PGDE teacher preparation program, the youngest participants were 22 years old. These participants had most likely joined the teacher education programs directly after they obtained their university undergraduate degrees. There were also student teachers who were working full time in other careers prior to joining the program. Thus, the oldest participant in the study was 43 years old. A majority of the participants was under the age of 30. The age group from 22 to 26 comprised 50% of the total participants, and another 30% were between 27 and 31 years of age. Only two participants were above 40 years of age. There were more female (76%) than male (24%) participants.

The researchers conducted a pilot test one semester earlier with another cohort of student teachers before the full-scale data collection for the present study to verify the validity and the reliability of the survey instrument. Based on the results of the pilot test, we eliminated and revised some items in the survey. Cronbach alpha from the pilot test was 0.89, showing that the instrument is fairly reliable. Thus, the full-scale data collection proceeded using the survey.

The researchers employed one-way analysis of variance (ANOVA) on repeated measures to find out if there were significant differences between the student teachers' intentions and actions in technology integration at the three different data collection points. The ANOVA results showed that there were significant differences in the student teachers' intentions and actions in the integration of ICT across the three stages in four out of the five factors (see Table 2). There was no significant difference found in Factor 1: Use of ICT as supporting tools (4.15; 4.18; 4.06). There were significant differences in the other four factors. In Factor 2: Use of ICT in student-centered learning, the average mean in the pre–technology course increased slightly from 3.81 to 3.86 after the course in their intentions, and dropped to 2.98 in their actions after the student teaching. This similar pattern was also observed in Factor 3: Being a facilitator in class and Factor 4: Confidence in leading the integration of ICT in school. The averages increased slightly after the technology course, with a substantial decrease after the student teaching. In Factor 3, the average increased from 3.93 to 4.01 after the technology course, then decreased to 3.51 at the last data collection. In Factor 4: Confidence in leading the integration of ICT in school, the average score increased from 3.55 to 3.84 after the technology course but dipped to 3.64 at the end of the student teaching. However, in Factor 5: Support from school and peers, the average decreased after the technology course, from 4.08 to 3.99, and decreased further to 3.46 at the end of the student teaching (see Table 2).

The researchers ran further pairwise comparisons to compare the differences of the means between pre– and post–technology course, and between post–technology course and post–student teaching. The comparisons before and

Table 3: Pairwise Comparisons of Means before and after Technology Course

Factor	Precourse Intentions	Postcourse Intentions	*t*	*p*-value
1. Use of ICT as supporting tools	4.15	4.18	0.34	0.56
2. Use of ICT for student-centered learning	3.81	3.86	67.01**	<.01
3. Being a facilitator	3.93	4.01	9.37**	<.01
4. Confidence in leadership in ICT	3.55	3.84	9.83**	<.01
5. Support from schools and peers	4.08	3.99	30.80**	<.01

** *significant at p < 0.01 level*

after the technology course focused on their changes in intentions, whereas the comparisons after the technology course and student teaching focused on the translation of their intentions to actions. When comparing the means of their intentions in the pre– and post–technology course surveys, four of the five factors showed significant differences (see Table 3). Upon completion of the technology course, student teachers perceived that they were more confident in Factor 2: Using ICT in student-centered learning, Factor 3: Being a facilitator, and Factor 4: Taking on a leadership role in ICT at schools. There was also a significant decrease in Factor 5: Support from school and peers, from 4.08 to 3.99, which showed that the student teachers perceived themselves as needing less support from their schools and peers in using ICT after they completed the course. The only factor that did not show any significant differences was Factor 1: Use of ICT as supporting tools.

When comparing their actual actions in using technology during student teaching with their intentions from the post–technology course survey, the means decreased significantly in all five factors. The biggest decrease was shown in Factor 2: Use of ICT for student-centered learning, from 3.86 to 2.98 (see Table 4). The smallest drop was found in Factor 1: Use of ICT as supporting tools, from 4.18 to 4.06. Therefore, the transition of student teachers' intentions of using ICT in classrooms after the technology course to their actions in classrooms significantly decreased (see Table 4). Even though they perceived themselves as confident in integrating ICT in the classroom, many of them were unable to put their intentions into actions in the student teaching. Further discussion of the results will be provided in the conclusion.

The final survey asked five additional questions to find out their experiences in using technology during their student teaching. The student teachers showed that they had positive attitudes in using technology in teaching. On a 5-point Likert scale, they tended to agree that using technology helped their students to learn more effectively (3.97), integrating technology helped them to gain the students' attention in class (4.13), and they would like to use more technology in their future teaching (4.09). When asked if integrating technology made classroom management and time management more challenging, their

Table 4: Pairwise Comparisons of Means after Technology Course and after Student Teaching

	Postcourse Intentions	Post–Student Teaching Actions	*t*	*p*-value
1. Use of ICT as supporting tools	4.18	4.06	5.41*	.02
2. Use of ICT for student-centered learning	3.86	2.98	135.72**	<.01
3. Being a facilitator	4.01	3.51	42.29**	<.01
4. Confidence in leadership in ICT	3.84	3.64	10.89**	<.01
5. Support from schools and peers	3.99	3.46	35.26**	<.01

** significant at p < 0.05 level; ** significant at p < 0.01 level*

responses ranged from neutral (3.0) to agree (4.0). The averages for integrating technology made classroom management and time management challenging were 3.47 and 3.67, respectively. On average, they perceived that the greatest challenge in using ICT during student teaching was the availability of facilities (4.19) and the smoothness in the use of technology in the classrooms (4.13). The results showed that even though some student teachers experienced some challenges in facilities and classroom and time management, they were able to see the advantages in using technology. Therefore, they would like to use more technology in the future.

Although this paper focused primarily on sharing the results from the quantitative data of the study, the authors would like to highlight some representative qualitative data from the interviews and lesson observations to substantiate the results ascertained from the surveys. We adopted the constant comparative method of data analysis (Glaser & Strauss, 1967) to make sense of the meaning by triangulating investigators, methods, and data (Lincoln & Guba,1985).The results from the qualitative data collection revealed consistency with the survey results.

During the post–student teaching interview, student teachers could explain in detail how they would integrate technology in their classrooms. However, they felt that they were unable to use technology in their teaching because technology was not readily available in the classrooms. Although most schools had at least one computer in the classroom, many found that plug-ins were not updated, Internet speed was slow, and the technology sometimes just did not cooperate. Some of them expressed that they chose not to use technology because they did not feel confident in managing students in computer laboratory settings. Some also explained that it was difficult to integrate technology in teaching when they had to complete teaching a certain portion of the curriculum in a limited time. These reasons may have caused the statistically significant drop in means in all five factors between the end of their technology course and the end of their student teaching.

Lesson observations of the seven selected student teachers showed that five out of the seven participants were using technology as instructional tools to

convey information and gain attention. One student teacher who was not confident in using technology felt that he could teach better without using technology because he saw it as an additional challenge in the classroom. At the beginning of the student teaching, he shared that:

> I am not familiar with using a lot of software. It takes time to use the basic functions. When PowerPoint was used for teaching, I have some personal concerns and reservations. For example, I saw some student teachers spend a tremendous amount of time to develop fancy presentations. However, the content of the presentation was not as good as I expected. I felt that the PowerPoint looked very nice, but I did not learn much from the presentation. I have a concern whether PowerPoint or other ICT tools are too artificial. I have used ICT to meet students' wants during my previous teaching [before teacher education]. If they want something that you cannot offer, they may have a feeling of resentment. That's why I used it.

However, his fourth grade students in Chinese language expected and repeatedly requested for him to use technology during his lessons. As a result, he tried integrating technology into one of his lessons and coped with it as best as he could. He asked his peers for support by asking for copies of PowerPoint slides that his peers have developed. Based on those PowerPoint slides, he spent more than two hours modifying the lesson that he taught. Going through this self-learning process helped him develop confidence in using technology as an instructional tool, and he planned to continue to use technology in his future teaching. He said:

> I spent so much time and hard work and I finally figured out how to do it [use PowerPoint in class].… Although I will not say that I am good in using technology, I think I will continue to learn and use PowerPoint in my Chinese language class because I can see the differences in my students.

On the other hand, another student teacher used technology in his student teaching to conduct collaborative problem-based learning. He found classroom management challenging in the beginning. However, the students got used to that mode of learning as it became a regular activity in class. He said:

> The instruction [for small group activities] has to be very clear to the students because it is pretty hard for them [second grade students] to really work together, especially with ICT, which they are not familiar with.… Before I start to do anything with technology or anything new, I need to brief them first. I need to provide them with examples. Yeah. And the main thing that is very important is that the ICT product cannot fail. They were much better after we conducted the [problem-based] activity for a number of times. They were able to follow the instructions and stayed on task.

The interviews and lesson observations indicated that the other eight student teachers in the selected group did not use technology to promote collaborative learning in their lessons. They chose to use technology as an instructional tool to support their teaching by mainly using PowerPoint and gain their students' attention by showing images or videos from the Internet as tuning-in activities.

CONCLUSIONS AND IMPLICATIONS

The purpose of this study was to investigate the change, if any, in student teachers' intentions and actions in integrating technology into their teaching. The change in their intentions toward technology integration after the technology course was expected to become more positive as they gained more pedagogical knowledge about how to integrate technology in their future teaching from the course. The results of this study showed that the student teachers' intentions to use ICT for student-centered learning increased from 3.81 to 3.86, their intentions to be a facilitator in class increased from 3.93 to 4.01, and their confidence level in playing a leadership role in integrating ICT in schools increased from 3.55 to 3.84. All of these results showed that their intentions to integrate technology in their teaching increased significantly.

It was also not surprising to some extent that student teachers were unable to translate their positive intentions toward technology integration into actions during their student teaching because they were new to the profession and unfamiliar with the school environment. The results of this study showed that their actual practice decreased significantly when compared to their intentions after the technology course. Previous studies have discussed that inexperienced teachers are overwhelmed by issues such as lack of subject matter knowledge (Parkinson & Rea, 1999), nonteaching duties, classroom management, and diverse student needs (Grudnoff & Tuck, 2003). These could be some of the reasons why integrating technology does not appear to be one of their priorities in the beginning days of teaching. Although the new generation of student teachers showed that most of them have the competency and confidence to integrate technology into their teaching, the results from our study showed that they experienced difficulties in incorporating their technology competencies in their teaching. According to the survey results, student teachers reported that the availability of technology resources in the classroom had a bigger impact than their personal proficiency in technology integration. When facilities, hardware, software, and plug-ins were not readily available, they tended to shy away from the idea of integrating technology in their lessons. The results provided a different insight from previous studies related to the internal and external barriers of teachers in integrating technology.

Ertmer (1999) suggested that barriers of technology integration exist both internally and externally to teachers themselves. First-order, or external barriers, such as lack of access to computers and administrative support, are more easily recognized and relatively easier to address. Internal barriers such as teachers' beliefs in technology integration in teaching and preferred teaching methods may require major change in teachers' beliefs to be removed. Building on the study, we see that there were changes in the intentions of student teachers in

our current study. Throughout the teacher education program, the participants' intentions of integrating technology in their classrooms remained positive. They also showed confidence in their technology skills and felt that integrating technology would enhance their students' learning experiences. In other words, these student teachers did not perceive that they had internal barriers. They did not resist the use of technology because they were confident in using technology and were able to see some of the benefits of technology integration. In addition, a major part of the external barrier has been removed in Singapore because almost all classrooms are equipped with at least one computer and all schools have multiple computer laboratories. However, the external barriers in this study were generally more related to minor technical challenges, such as software availability, plug-in problems, and Internet connection speed.

The student teachers seemed unable to plan and prevent potential minor technical problems or glitches that they could encounter when they used technology in their teaching. The results from the post–student teaching survey suggested that student teachers may not have sufficient pedagogical skills and knowledge in planning to integrate technology in their lessons. Teacher educators should try to design and demonstrate models that would facilitate the student teachers to be better prepared when they integrate technology in their teaching. Student teachers need to learn how to plan and integrate technology into their lessons seamlessly, anticipate potential technical problems that may be related to the use of technology, manage time and/or the classroom, conduct basic troubleshooting in class, set effective rules and routines for students during technology-integrated learning experiences, and prepare alternative plans if technology does not cooperate during the lesson. These are some differences between planning a lesson without technology and planning a technology-enhanced learning experience.

The Technological Pedagogical Content Knowledge (TPACK) model shows the need for teachers to have technological knowledge, pedagogical knowledge, and content knowledge to integrate technology successfully and meaningfully into their teaching (Hofer & Swan, 2008/2009; Mishra & Koehler, 2006). If the student teachers are not aware of these technology-related pedagogical knowledge and differences, it will be difficult for them to integrate technology into their teaching even if most of the external and internal barriers were removed. Teacher educators also need to do their part in modeling the planning process of technology-enhanced lessons and demonstrating alternative solutions in teacher preparation programs.

Qualitative results showed interesting findings about the student teachers' use of technology. The student teachers shared that using technology helped to capture students' attention effectively. As a result, they perceived that their integration of technology was successful. Most of their ideas about technology integration remained superficial. The value of technology lay in its capability to promote student-centered learning and to enhance students' higher-order thinking, collaborative learning, and problem-solving skills (Jonassen, Peck, & Wilson, 1999). In their discussions of the Cognitive and Technology Group at Vanderbilt's (CTGV) evolving work on Anchored Instruction, Pellegrino and

Brophy (2008) also illustrated that effective learning environments are knowledge centered and learner centered. Meaningful technology integration should facilitate learning with understanding. Teachers should be able to monitor the students' learning process and further build on their existing knowledge with the use of technology. However, the student teachers in our study tended to view technology as instructional and supporting tools for the teachers. They intended to use technology as supporting tools and were able to translate their intention to promote student-centered learning into action during student teaching. Their intentions to use technology as supporting tools remained high throughout their teacher education program (4.15 before the technology course and 4.18 after the course). Their actions did not decrease significantly after the student teaching (4.06). The results implied that teacher education programs need to do more in building up student teachers' awareness of the benefits of integrating technology in student-centered learning approaches and provide the pedagogical knowledge related to student-centered learning and technology integration to the student teachers. As the overall technology confidence and competency of the student teachers are increasing, preparing them to integrate technology in their future teaching should move beyond technology skills. Teacher education programs need to look into promoting the translation of their positive intentions toward technology integration into actions. Therefore, opportunities need to be provided to student teachers to help them acquire, plan, and practice their technological pedagogical knowledge (Mishra & Koehler, 2006). These opportunities may come in the form of microteaching within their course work (Dawson, Pringle, & Adams, 2003) and structuring student teaching in such a way that these future teachers will be expected to plan and implement technology-enhanced student-centered learning activities under the supervision and support of cooperating teachers and university supervisors.

There are three possible implications of the findings obtained from this study. First, it could offer practical suggestions about how to restructure teacher education programs in Singapore with regard to integrating technology in teaching and learning (i.e., the inclusion of microteaching and technology-enhanced student-centered learning activities during student teaching, as mentioned in previous paragraphs). Second, it could contribute to the building of theoretical knowledge among teacher educators. They need to understand how student teachers learn to teach with technology so that they will be able to better facilitate student teachers' development of their technological pedagogical content knowledge. Third, this study indicated graduating student teachers were more likely to use technology as instructional and supporting tools. This would imply that the design of inservice teacher education courses should focus on promoting higher-order technology integration and facilitating student-centered learning. In our teacher education program in Singapore, we continue to review our course. These implications are applicable to teacher education programs that face similar challenges internationally.

As a continuation of this study, we are planning to follow these student teachers into their first year of teaching to explore their actions in technology integration. Future studies can investigate the level of technology integration between

elementary and secondary student teachers. Additionally, teacher educators may be interested in comparing the level of technology integration by student teachers and beginning teachers from different teacher education programs and countries.

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