ICT in Education: A Critical Literature Review and Its Implications

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ABSTRACT

This review summarizes the relevant research on the use of information and communication technology (ICT) in education. Specifically, it reviews studies that have touched upon the merits of ICT integration in schools, barriers or challenges encountered in the use of ICT, factors influencing successful ICT integration, in-service and pre-service teachers' attitudes, perceptions, and confidence in using ICT as well as the importance of school culture in the use of ICT. This review discusses gaps in the literature and the directions that future studies may take to address these gaps.

Keywords: *ICT; Technology Integration; Barriers and Solutions of ICT use; Teachers' attitudes and beliefs on ICT use*

INTRODUCTION

Information and Communication Technology (ICT) includes computers, the Internet, and electronic delivery systems such as radios, televisions, and projectors among others, and is widely used in today's education field. Kent and Facer (2004) indicated that school is an important environment in which students participate in a wide range of computer activities, while the home serves as a complementary site for regular engagement in a narrower set of computer activities. Increasingly, ICT is being applied successfully in instruction, learning, and assessment. ICT is considered a powerful tool for educational change and reform. A number of previous studies have shown that an appropriate use of ICT can raise educational quality and connect learning to real-life situations (Lowther, et al. 2008; Weert and Tatnall 2005). As Weert and Tatnall (2005) have pointed out, learning is an ongoing lifelong activity where learners change their expectations by seeking knowledge, which departs from traditional approaches. As time goes by, they will have to expect and be willing to seek out new sources of knowledge. Skills in using ICT will be an indispensable prerequisite for these learners.

ICT tends to expand access to education. Through ICT, learning can occur any time and anywhere. Online course materials, for example, can be accessible 24 hours a day, seven days a week. Teleconferencing classrooms allow both learner and teacher to interact simultaneously with ease and convenience. Based on ICT, learning and teaching no longer depend exclusively on printed materials. Multiple resources are abundant on the Internet, and knowledge can be acquired through video clips, audio sounds, visual presentation and so on. Current research has indicated that ICT assists in transforming a teaching environment into a learner-centered one (Castro Sánchez and Alemán 2011). Since learners are actively involved in the learning processes in ICT classrooms, they are authorized by the teacher to make decisions, plans, and so forth (Lu, Hou and Huang 2010). ICT therefore provides both learners and instructors with more educational affordances and possibilities. More specific benefits of using ICT in education are described below.

BENEFITS OF USING ICT IN EDUCATION

The merits of ICT in education have been extolled in the literature. The use of ICT has been found to:

Assist students in accessing digital information efficiently and effectively

As Brush, Glazewski and Hew (2008) have stated, ICT is used as a tool for students to discover learning topics, solve problems, and provide solutions to the problems in the learning process. ICT makes knowledge acquisition more accessible, and concepts in learning areas are understood while engaging students in the application of ICT.

Support student-centered and self-directed learning

Students are now more frequently engaged in the meaningful use of computers (Castro Sánchez and Alemán 2011). They build new knowledge through accessing, selecting, organizing, and interpreting information and data. Based on learning through ICT, students are more capable of using information and data from various sources, and critically assessing the quality of the learning materials.

Produce a creative learning environment

ICT develops students' new understanding in their areas of learning (Chai, Koh and Tsai 2010). ICT provides more creative solutions to different types of learning inquiries. For example, in a reading class, e-books are commonly used in reading aloud activities. Learners can access all types of texts from beginning to advanced levels with ease through computers, laptops, personal digital assistants (PDAs), or iPads. More specifically, these e-books may come with some reading applications, which offer a reading-aloud interface, relevant vocabulary-building activities, games related to reading skills and vocabulary acquisition, and more. Therefore, ICT involves purpose-designed applications that provide innovative ways to meet a variety of learning needs.

Promote collaborative learning in a distance-learning environment

Koc (2005) mentioned that using ICT enables students to communicate, share, and work collaboratively anywhere, any time. For instance, a teleconferencing classroom could invite students around the world to gather together simultaneously for a topic discussion. They may have the opportunity to analyze problems and explore ideas as well as to develop concepts. They may further evaluate ICT learning solutions. Students not only acquire knowledge together, but also share diverse learning experiences from one another in order to express themselves and reflect on their learning.

Offer more opportunities to develop critical (higher-order) thinking skills

Based on a constructive learning approach, ICT helps students focus on higher-level concepts rather than less meaningful tasks (Levin and Wadmany 2006). McMahon's study (2009) showed that there were statistically significant correlations between studying with ICT and the acquisition of critical thinking skills. A longer exposure in the ICT environment can foster students' higher critical thinking skills. Thus, schools are strongly advised to integrate technology across all of the learning areas and among all learning levels. Where this is done, students are able to apply technology to the attainment of higher levels of cognition within specific learning contexts.

Improve teaching and learning quality

As Lowther et al. (2008) have stated that there are three important characteristics are needed to develop good quality teaching and learning with ICT: autonomy, capability, and creativity. Autonomy means that students take control of their learning through their use of ICT. In this way, they become more capable of working by themselves and with others. Teachers can also authorize students to complete certain tasks with peers or in groups. Through collaborative learning with ICT, the students have more opportunity to build the new knowledge onto their background knowledge, and become more confident to take risks and learn from their mistakes. Further, Serhan (2009) concluded that ICT fosters autonomy by allowing educators to create their own material, thus providing more control over course content than is possible in a traditional classroom setting. With regard to capability, once students are more confident in learning processes, they can develop the capability to apply and transfer knowledge while using new technology with efficiency and effectiveness. For example, in an ESL listening and speaking class, students may be asked to practice their pronunciation using an online audio dictionary. They are required not only to listen to the native pronunciation from the dictionary, but also to learn the definitions and examples of a new vocabulary item. They then have to make a recording of their own pronunciation and provide examples of how this new word is used in context. Before completing this task, they have to know which browser to use in order to search a suitable online audio dictionary. They will have to browse several online dictionaries, and select the one that best meets their learning needs. In addition, finding good software to record their voice is another prerequisite for these learners. Therefore, the whole learning process enriches students' learning skills and broadens their knowledge beyond what they already know. By using ICT, students' creativity can be optimized. They may discover new multimedia tools and create materials in the styles readily available to them through games (Gee 2007, 2011), CDs, and television. With a combination of students' autonomy, capability, and creativity, the use of ICT can improve both teaching and learning quality.

Support teaching by facilitating access to course content

Watts-Taffe et al. (2003) found that teachers can act as catalysts for the integration of technology through ICT. If the encouragement, equipment, and necessary technological support are available from institutes for the teachers, developing an ICT class will be easier for them. The main responsibilities of these teachers will be changing their course format, creating and explaining the new assignments, and arranging for the computer lab through their technology-learning specialists or assistants.

In sum, as Reid (2002) has indicated, ICT offers students more time to explore beyond the mechanics of course content allowing them to better understand concepts. The use of ICT also changes the teaching and learning relationship. Based on the findings of Reid's study, teachers reported that the relationship between teacher and learner is sometimes reversed with regards to information technology. This relationship boosts students' confidence when they are able to help teachers with technical issues in the classroom. Therefore, ICT changes the traditional teacher-centered approach, and requires teachers to be more creative in customizing and adapting their own material.

While ICT is changing teaching and learning for the better in several ways, the existing literature has also identified some barriers. In the following sections, these barriers are classified into four categories based on the perspectives of students, teachers, administrators, and ICT infrastructure. A variety of strategies for addressing these barriers is also discussed.

BARRIERS AND SOLUTIONS: STUDENT PERSPECTIVE

Although the advantages of using ICT in the classroom have been demonstrated in previous research, barriers or challenges associated with its use still exist. Frederick, Schweizer and Lowe (2006) showed that student mobility, special needs, and anxiety over standardized test results are the main challenges associated with ICT use. These challenges can be solved by providing more authentic group- and problem-based learning activities, and adequate learning support (Whelan 2008). Whelan (2008) also identified more barriers from the student perspective, including: subpar technical skills that reduce access to ICT in classroom; an insufficient number of academic advisors and lack of timely feedback from instructors; and reduced interaction with peers and instructors. Therefore, the author recommends the following strategies to facilitate the learning process: more induction, orientation, and training for students; an increased emphasis on the importance of instructor access and effective administration; and the expansion of podcasting and online conferencing tools. In general, capacity building, curriculum development, infrastructure, policy, and government support are required in order to lower student barriers and improve the effectiveness of ICT use in the classroom. In addition, Castro Sánchez and Alemán (2011) encourage students to acquire specific technical skills to facilitate learning in ICT environments.

BARRIERS AND SOLUTIONS: TEACHER PERSPECTIVE

Barriers to effective technology integration from a teacher perspective include:
• Low teacher expectations and a lack of clear goals for ICT use in schools (Al-Bataineh et al. 2008);
• A lack of teacher collaboration and pedagogical support, as well as a lack of experience among cooperating teachers (Ertmer and Otternbreit-Leftwich 2010);
• Insufficient time to master new software or integrate ICT during a class period (Almekhlafi and Almeqdadi 2010);
• Insufficient skills for managing teaching materials (Frederick, Schweizer and Lowe 2006);
• Low software competence and habitual ways of conceptualizing what and how students should learn (Goktas, Yildirim and Yildirim 2009);
• Limited knowledge and experience of ICT in teaching contexts (Honan 2008);
• A lack of specific knowledge about technology and how to combine it with the existing pedagogical content knowledge to support student learning (Hutchison and Reinking 2011);
• Excessive focus on teaching technical or operational skills rather than course content (Lim 2007);
• Pressure to improve scores on national examinations (Liu and Szabo 2009);
• A lack of recognition and encouragement of the timely and effective use of ICT (Tezci 2011a);
• A lack of in-service training on the use of ICT (Yildirim 2007);
• Technical problems in the classroom (Yildirim 2007);
• Classroom management with large class sizes (Tezci 2011a);
• A lack of motivation, and technical and financial support (Liu and Szabo 2009);
• Uncertainty about the possible benefits of using ICT in the classroom (Yildirim 2007); and
• Lack of specific and definite ideas about how integrating technology into instruction will improve student learning (Al-Bataineh et al. 2008).

Several strategies for dealing with these challenges have been suggested. Schools are encouraged to:
• Provide professional development activities related to technology to update teachers' skills and knowledge, and offer technical support when needed (Al-Bataineh et al. 2008);

- Support partnerships that help teachers share effective technology practices and experiences (Ertmer and Otternbreit-Leftwich 2010);
- Provide workshops that allow teachers to reflect upon effective strategies for technology integration into instruction and unveil issues that are central to understanding the process of technology integration into instruction (Almekhlafi and Almeqdadi 2010);
- Offer opportunities to virtually observe teachers who use technology (Frederick, Schweizer and Lowe 2006);
- Augment curricula with technology-enhanced materials (Goktas, Yildirim and Yildirim 2009);
- Provide enough freedom for teachers in selecting and covering curriculum materials (Honan 2008);
- Provide effective, timely, and continuous training to improve ICT skills and manage a technology-rich classroom (Hutchison and Reinking 2011);
- Encourage positive attitudes about the significance of integrating ICT into instruction (Lim, 2007); and
- Provide adequate technical support (Liu and Szabo 2009; Tezci 2011a; Yildirim 2007).

Technology should be used for more than just support of traditional teaching methods (Tezci, 2011a). According to Tezci (2011a), teachers should learn not only how to use technology to enhance traditional teaching or increase productivity, but also should learn from a student-centered perspective how ICT can be integrated into classroom activities in order to promote student learning. This means that teachers need to use ICT in more creative and productive ways in order to create more engaging and rewarding activities and more effective lessons (Birch and Irvine 2009; Honan 2008). Hence, Castro Sánchez and Alemán (2011) suggested that teachers keep an open mind about ICT integration in classroom. It is imperative that teachers learn new teaching strategies to adapt to the new instruments when teaching with technology.

However, Yildirim (2007) found that teachers use ICT more frequently for the preparation of handouts and tests than to promote critical thinking. Similarly, Palak and Walls (2009) found that teachers mainly use technology to support their existing teaching approaches and rarely to foster student-centered learning. According to the authors, one possible explanation is a lack of models for how to use technology to facilitate learning, and limitations related to contextual factors such as class size and student ability. Further, Brush, Glazewski and Hew (2008) found that pre-service teacher preparation does not provide sufficient ICT knowledge to support technology-based instruction, nor does it successfully demonstrate appropriate methods for integrating technology within a curriculum. More training should be provided in pre-service teachers' curricula, and ICT skills must be applied in the classroom in order to integrate effective technology strategies (Supon and Ruffini 2009). To help teachers cope with these difficulties, Chen (2008) suggested that rather than only providing education theories, ICT researchers should also document examples of how teachers accomplish meaningful and effective technology integration to meet their pedagogical goals and needs.

BARRIERS AND SOLUTIONS: ADMINISTRATIVE AND ICT INFRASTRUCTURE PERSPECTIVE

In addition to the challenges faced by both students and teachers in the use of ICT, other obstacles also exist in terms of an administrative and ICT infrastructures. Such barriers include:
- School inspectors focus more on the quantity of course content and student test scores than on ICT usage (Yildirim 2007);
- A lack of appropriate administrative support for the effective use of ICT (Lim 2007);

- Administrative mandates to improve examination results, which shifts the focus away from using ICT to engage students in higher-order thinking activities (Goktas, Yildirim and Yildirim 2009);
- A lack of appropriate course content and instructional programs (Yildirim 2007); and
- A lack of appropriate hardware, software, and materials (Yildirim 2007).

To address these barriers, Yildirim (2007) suggested that schools need to provide appropriate access to technology. Furthermore, schools and related institutional systems need to employ new policies to involve teachers in the decision-making and planning processes regarding ICT in their classrooms. Lim (2007) conducted a qualitative study examining effective and ineffective ICT integration in schools in order to provide tangible solutions. The results showed that the availability of ICT tools, the establishment of disciplinary and educational principles and procedures, as well as the division of labor among teachers, teaching assistants and students are crucial elements to establishing a well-managed ICT-integrated class. By emphasizing these elements, a learning process that is more likely to engage students in higher-order thinking can be facilitated.

Ertmer and Otternbreit-Leftwich (2010) reviewed the existing literature on the necessary elements to enable pre-service and in-service teachers to apply ICT as a meaningful pedagogical tool. They recommended that schools provide teachers with solid evidence supporting the positive impact of technology-based and student-centered instruction on student learning and achievement on standardized tests. For instance, schools can provide opportunities for pre-service teachers to observe a variety of examples and models, which they can then apply with real learners. Schools need to help pre-service teachers understand difficulties they may face when they begin to use ICT in their classrooms, and present effective strategies for addressing them. In sum, school leaders should ensure that teachers understand that the ultimate objective of technology integration is to advance the teaching and learning process, not replace it. Developing a pedagogical model requires a strong link between theory and application in order to help teachers overcome the obstacles faced in technology integration (Keengwe and Onchwari 2009). Thus, Staples, Pugach and Himes (2005) stated that good planning for technology integration requires a special understanding of specific hardware and software related to the curriculum. Staff development and teacher training are also indispensable to supporting the curriculum with technology integration.

FACTORS INFLUENCING THE USE OF ICT

Factors influencing the use of ICT can be divided into external factors and internal factors. The two types of factors are related to each other and to ICT usage level (Tezci 2011a). A variety of external factors have been identified that influence the progression or effectiveness of technology integration in schools. These include technology availability, accessibility of ICT equipment, time to plan for instruction, technical and administrative support, school curriculum, school climate and culture, faculty teaching load and management routine, and pressure to prepare students for national entrance exams (Al-Ruz and Khasawneh 2011; Lin, Wang and Lin 2012; Tezci 2011a). Among these external factors, the most common are lack of access to computers and software, insufficient time for course planning, and inadequate technical and administrative support (Chen, 2008). Al-Ruz and Khasawneh (2011) found that some external factors were positively associated with technology integration, including availability of technology ($r = 0.39$, $p < 0.01$) and support from technicians, teachers, and principals ($r = 0.44$, $p < 0.01$). Thus, technology availability and overall support are important to technology integration. The higher the support structure and technology availability, the higher the technology integration efforts are made by teachers.

Several internal factors also influence technology integration outcomes (Sang et al. 2011). Internal factors related to teachers include: understanding of ICT use; beliefs, which may conflict with the application of ICT; attitudes toward technology integration; perceptions, including intention or motivation to use ICT; self-confidence and knowledge; technology skills; readiness to use ICT; and technology self-efficacy (Al-Ruz and Khasawneh 2011; Chen 2008; Lin, Wang and Lin 2012; Sang et al. 2011; Tezci 2011a). Chen (2008) discovered two common issues associated with internal factors. First, teachers may implement policies based on limited or improper theoretical interpretations and comprehension of ICT use. Second, teachers may be under pressure to cover all content and be unwilling or hesitant to let students spend more time exploring content on their own with technology due to their other conflicting beliefs. These issues imply that teacher beliefs may not resonate in their practices. A school culture emphasizing competition and a high stakes assessment system can discourage teachers from integrating technology into their classrooms. Thus, teacher beliefs influence ICT use in the classroom (Chen 2008).

More specifically, Teo et al. (2008) investigated a quantitative study examining the possible relationship between Singaporean pre-service teachers' beliefs about teaching and technology use. Constructivist teaching beliefs were significantly and positively correlated with both constructivist ($r = 0.59$, $p < 0.01$) and traditional ($r = 0.50$, $p < 0.01$) technology use. On the contrary, traditional teaching beliefs were significantly and negatively correlated with constructivist technology use. The outcome of the study implies that Singaporean pre-service teachers are not adequately prepared to facilitate student construction of knowledge. Even though technology can foster interactive, self-directed learning and higher order thinking, technology integration is not the most effective way to improve learning. Through a combination of constructivist learning and technology, learners will be assisted in an active learning process and encouraged to organize information by making internal cognitive connections. ICT, therefore, will not in itself prove effective in the classroom without teachers who possess knowledge of both the technology and how to use it to meet educational goals (Koc 2005).

TEACHER ATTITUDES, PERCEPTIONS, AND CONFIDENCE IN ICT USE

As established in the literature, internal variables greatly influence how teachers integrate technology in the classroom. But which variable has the strongest impact on ICT use and how internal variables are influenced by ICT preparation programs are discussed below.

Palak and Walls (2009) conducted a mixed study to investigate whether teachers who frequently integrate technology and work at technology-rich schools shift their beliefs and practices toward a student-centered paradigm. The results showed that their practices did not change; neither student-centered nor teacher-centered beliefs are powerful predictors of practices. However, teachers' attitudes toward technology significantly predict teacher and student technology use, as well as the use of a variety of instructional strategies ($p < 0.05$). Sang et al. (2010) focused on the impact of Chinese student teachers' gender, constructivist teaching beliefs, teaching self-efficacy, computer self-efficacy, and computer attitudes on their prospective ICT use. The findings confirmed the results of the study by Palak and Walls (2009) that the strongest predictor of future ICT use were teachers' attitudes toward it.

In addition to the influence of teacher attitudes, Sang et al. (2010) further indicated that pre-service teachers with highly constructivist teaching beliefs have stronger intentions to integrate technology into their future teaching practices. Furthermore, more confident pre-service teachers were more capable of and interested in using computers in real classrooms. Thus, although teachers' attitudes towards ICT use were found to be the strongest predictor of technology

integration, the impact of their beliefs and confidence in using ICT should not be disregarded either.

Internal variables can partially explain the success of technology integration in the classroom. However, the influence of these variables may change after participation in technology preparation courses or programs. Abbott and Faris (2000) examined pre-service teachers' attitudes toward the use of computers before and after a semester-long technology literacy course. The results showed that positive attitudes toward computers increased after the course because of the instructional approaches, meaningful assignments requiring technology, and supportive faculty. Thus, the authors claimed that teacher education programs should teach pre-service teachers not only how to use hardware and software, but also how to incorporate computers into their teaching strategies and activities. The authors also noted that small groups and collaborative learning are the most appropriate when introducing new hardware and software because more advanced and experienced teachers can assist those who need more technology learning support.

Another similar study was conducted by Doering, Hughes and Huffman (2003), who analyzed pre-service teachers' perspectives regarding ICT in their future classrooms before and after participation in a teacher preparation program. Prior to taking the preparation courses, teachers were doubtful about the utility of ICT in the classroom, implying that they would closely examine and consider technology integration, rather than blindly incorporate it into their teaching practices. After completing the courses, their doubt had transformed into more positive sentiments. The teachers had a better understanding about ICT use in the classroom. Although the teachers confronted other issues such as technology availability, accessibility, professional support, and classroom management, their perceptions about technology's role had changed. They were more likely to believe that technology can assist in learning and to recognize its importance.

Serhan (2009) and Chai, Koh and Tsai (2010) also investigated pre-service teachers' beliefs about the use of computer technology and the effectiveness of ICT courses. The results of both studies indicate that after participating in courses, pre-service teachers recognized the importance of technology integration into their curricula and believed that ICT use would enhance student learning. They felt that such courses prepared them to apply ICT in the future, and their abilities to select, evaluate, and use a variety of technological resources improved. More specifically, Chai, Koh and Tsai (2010) found that ICT courses with direct instruction on the use of technological tools through the technology enhanced lesson (TEL) approach helped teachers learn how to use technologies as supporting tools in order to enhance their teaching and student learning. Consequently, the pre-service teachers viewed the preparation course favorably.

It is worth exploring how the ICT preparation courses or programs change teachers' intentions and actions. Choy, Wong and Gao (2009) conducted a mixed study to examine the intentions of pre-service teachers before and after a technology preparation course. Their intentions were then compared with their actions related to technology integration during their teaching. Confirming previous results from Doering, Hughes and Huffman (2003), the findings showed that their intentions became significantly more positive ($p < .05$) as a result of increased pedagogical knowledge. Nevertheless, these teachers were not able to translate the positive intentions into actual teaching, largely due to unfamiliar school environments. Based on these results, Choy, Wong and Gao (2009) concluded that teacher education programs need to increase awareness of the benefits of integrating technology into student-centered learning approaches, and provide pedagogical knowledge related to student-centered learning as well as technology integration strategies.

Beyond the impact of preparation courses on teacher perceptions and attitudes, Vannatta and Beyerbach (2000) reported increased proficiency in technology applications and instructional

methods. They found a significant increase ($p < 0.01$) in technology integration for both pre-service and in-service teachers after participation in a preparation course. After the course, teachers were able to incorporate a constructivist view of technology integration into their instruction in order to engage students in meaningful learning. Qualitatively, the pre-service teachers reported great benefits from the use of technology in the classroom after the course. The study concluded that simply teaching basic ICT skills is inadequate if teachers are to constructively integrate technology constructively into their instruction. More emphasis should be placed on advanced skills in teacher education programs in order to provide teachers with authentic opportunities to experience and develop lessons that integrate technology in a meaningful context. The findings also encourage collaborative learning in technology-related assignments.

THE IMPORTANCE OF SCHOOL CULTURE ON ICT USE

School culture encompasses the vision, plans, norms and values that are shared by school members (Maslowski 2001). Focusing on the importance of school culture for ICT integration, Pelgrum and Law (2009) indicated that effective ICT integration depends on the perceptions and vision of school leaders rather than teachers' ICT skills. School culture has a mediating role that influences teachers' actions, beliefs, and attitudes (Chai, Hong and Teo 2009). Therefore, in addition to the external and internal variables mentioned previously, school culture also plays an important role in successful technology integration (Tezci 2011b).

In order to explore teacher perceptions of school culture related to the level of ICT usage, Tezci (2011b) examined Turkish teacher perceptions from both the technical and motivational perspectives. The results showed that their perceptions from both perspectives were not positive, because the majority did not believe that they would receive adequate technical and motivational support from their school. However, as the school culture became more positive, the teachers' ICT usage level increased. Ward and Parr (2010) stated that teachers need to feel confident in their ability to facilitate student learning with technology in order to integrate technology into their classrooms. To achieve this goal, more professional development is required with a focus on increasing teachers' skills so that they are able to overcome apprehensions associated with using technology. Further, new teaching approaches and technical support should be offered by schools to allow them to retain control while facilitating learning with computers. Overall, implementing effective teaching with technology integration requires changes in teachers' knowledge, beliefs, and school culture (Ertmer and Otternbreit-Leftwich 2010).

SYNOPSIS OF PREVIOUS RESEARCH ON ICT USE IN EDUCATION AND POSSIBLE DIRECTIONS FOR FUTURE RESEARCH

ICT integration in education has its merits. Its use not only changes the traditional ways of teaching, but also requires teachers to be more creative in adapting and customizing their own teaching materials and strategies (Reid 2002). Among all the teaching methods and strategies, collaborative learning, problem-based learning, and the constructivist approach are the most widely used teaching strategies to deal with the challenges of ICT use (Abbott and Faris 2000; Whelan 2008). This corresponds with the suggestion of Palak and Walls (2009), as well as Tezci (2011a), that technology integration will not have the desired effect without student-centered classroom practices. Therefore, ICT integration in education cannot be implemented in isolation. When it is applied in combination with diverse teaching methods and approaches, especially constructivist practices, learning outcomes may be more successful. On this basis, future researchers are recommended to undertake studies related to the benefits and challenges of a combination of ICT and other student-centered approaches such as collaborative learning across

all learning areas. The findings may provide more tangible suggestions for the use of ICT by teachers and scholars. In addition, schools should also provide some well-structured learning support while integrating technology in their curriculum and instruction (Whelan 2008). Schools are also highly recommended to offer their teachers workshops or training courses to improve their ICT skills and prepare them to encounter possible challenges while integrating technology in order to improve teachers' professional development on ICT use (Staples, Pugach and Himes 2005).

Previous research has indicated that both external and internal factors influence ICT use in education (Al-Ruz and Khasawneh 2011; Lin, Wang and Lin 2012; Sang et al. 2011; Tezci 2011a). Among the external factors, the most common are access to computers and software, insufficient time for course planning, and inadequate technical and administrative support (Al-Ruz and Khasawneh 2011). Among the internal factors, teachers' attitude, confidence, and belief in ICT use are commonly cited in the existing literature (Al-Ruz and Khasawneh 2011; Chen 2008; Lin, Wang and Lin 2012; Sang et al. 2011; Tezci 2011a). The research appears to have identified all possible external and internal factors influencing ICT use (Al-Ruz and Khasawneh 2011; Lin, Wang and Lin 2012; Sang et al. 2011; Tezci 2011a); however, there has been meager research into the possible relationships between external and internal variables, and how these relationships differ according to the variables involved in ICT integration. Examining these relationships could not only help teachers, students, and administrators understand the challenges of ICT use better, it could also assist them in uncovering other solutions to overcome the existing barriers based on the relationships among different variables.

More specifically, Chen (2008) has shown that there is no resonance between teachers' beliefs and their actual practice while integrating technology in the classroom. While most of the previous studies focused more on the influence of teachers' attitudes and beliefs on actual practice (Chai, Koh and Tsai 2010; Palak and Walls 2009; Sang et al. 2010; Serhan 2009), it has been rare for any study to investigate the reciprocal relationship between teachers' attitudes and beliefs and their practice. Another area to explore could be whether the relationship differs between pre-service teachers and in-service teachers. What are their views about their beliefs and their actual practice of ICT integration? Comparative studies would be particularly applicable in examining this perspective. Additionally, few previous studies have examined the challenges or barriers to ICT integration from students, teachers, and administrative perspectives with involvement of specific teaching strategies and activities. This is also an area worth further investigation in future research.

A review of the existing literature makes it apparent that ICT integration is mediational and entails an evolving process, not a final product. To achieve successful integration of technology requires an effort from three sides: teachers, students, and school administrators. This critical review discusses the current situations, barriers to, and solutions for ICT integration in the classroom. Further, the possible gaps in the existing literature are shown above in order to provide lucid directions for future research into ICT use.

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