Self-Efficacy Beliefs as an Indicator of Teachers' Preparedness for Teaching with Technology

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Abstract: The focus on information technology in education has shifted towards curriculum integration. Consequently teacher education programs need to prepare graduates for teaching with IT. Graduates should possess both skills in the use of IT and belief in their capacity to integrate IT into teaching. Decisions about course design might be informed by a measure that is directly influenced by course changes and also indicates likely long term outcomes for teacher behavior. Self-efficacy beliefs can provide such a measure especially in the context of preparing teachers to teach with technology.

Introduction

Beginning in 1984, Queensland State governments introduced a series of funding initiatives to promote the use of information technology in schools. Early initiatives promoted the provision of equipment to support courses that would prepare students with the skills for participation in an increasingly technological workplace. Initial funding to establish laboratories for teaching computer literacy was followed by special purpose grants for Business Education Centers and Electronic Learning Centers in specialist subjects such as Art and Music. The first general funding provision for computers in primary schools came about ten years after the first secondary program, with the goal of increasing access to computers in the final two years of primary school. In many respects this represented a continuation of the focus on workforce preparation by developing basic skills before entry into secondary school.

More recently the emphasis of Queensland government initiatives in relation to information and communication technology (ICT) in education has shifted focus. Funding is still being provided for purchase of equipment but the new focus for its use is on integration into the curriculum. In the words of current Queensland policy, information technology should be applied "to effective learning and teaching in all key learning areas, P-12" (Education Queensland, 1998b).

The implications for schools and teachers are considerable. A requirement for students to develop work related computer skills could be accommodated through separate classes taught by specialist computing teachers. Other teachers were under no obligation to develop or apply knowledge and skills in the use of ICT. However, the new expectations effectively require that every teacher should integrate technology into his or her particular curriculum. The associated changes in teacher knowledge and skills will need to be addressed through professional development for the existing teaching workforce and through initial teacher education programs for future teachers.

Teacher education institutions, employer groups and governments are seeking to address these issues using strategies such as technology standards for teacher education programs (DfEE, 1998; NCATE, 1992). In Queensland, the most recent policy initiative included competencies that are to be achieved by all teachers in the state education system within the three year span of the program (Education Queensland, 1998a). Although there is, as yet, no stated requirement for graduating teachers to meet these standards prior to employment it seems likely that employers of teachers will soon expect that applicants are not less capable than current employees in respect of ICT. Thus the requirements mandated for serving teachers are likely to represent a de facto requirement for graduates and hence a baseline consideration for course planning in teacher education.

Preparing Teachers to Integrate Technology

Teacher education faculties have grappled for years with the challenge of preparing teachers to integrate technology using a variety of different approaches. Brownell (1997) reviewed published research about technology in teacher education which appeared between 1990 and 1995. She concluded that there seemed to be consensus that technology is important and that teacher educators need to serve as role models. However, there was little hard evidence to guide the development of effective programs and she called for more evaluative research on technology in teacher education programs.

One of the difficulties facing developers of teacher education programs is that, although the true measure of their success is in the work which will be done by teachers some years in the future, decisions about the design of courses must be made in the present. Some components of the knowledge and skills required for teaching with technology can be assessed with reasonable confidence. These include technical skills such as the operation of hardware or software and knowledge of relevant curriculum and policy documents.

Many teacher education courses have been graduating beginning teachers with these capabilities for several years. However, research suggests that this does not translate into more or better integration of ICT into teaching. Oliver (1993) found that beginning teachers who had formal training in the use of computers as a personal tool did not differ in their use of computers for teaching from their peers who had not had the training. It is at least arguable that there are factors other than technical knowledge and skill which contribute to teachers' success at technology integration in their teaching.

If teacher education programs are to be effective at increasing teachers' capability for integrating technology, then decisions about the structure and content of those courses need to be based upon an understanding of the factors which contribute to successful technology integration. An appreciation of those factors should permit their development to be traced and the design of courses to be adjusted to achieve the desired outcomes.

It may also be possible to identify one or more measures which are directly influenced by experiences in teacher education and which, in turn, predict success at technology integration either directly or through their influence on other factors. Such measures would be especially helpful in the design and evaluation of teacher education programs where one of the challenges is to make decisions which are implemented immediately while accepting that the ultimate effects of those decisions may not become apparent until some years after graduation.

This paper argues that teachers' beliefs are a significant factor in their success at integrating technology, that self-efficacy beliefs are an important, and measurable, component of the beliefs that influence technology integration and that particular instructional strategies might be effective for increasing self-efficacy beliefs relevant to technology integration.

The Importance of Teachers' Beliefs

Teaching frequently involves solving ill-structured problems which are characterized by a large amount of information, open constraints and the absence of a single correct solution (Voss & Post, 1988). Nespor (1987) argued that the ill-structured nature of many of the problems encountered by teachers resulted in teachers' beliefs playing a major role in defining tasks and selecting strategies because, unlike other forms of knowledge, beliefs can be flexibly applied to new problems. He suggested that, rather than reflective and systematic study in the course of teacher education, it seemed "likely that some crucial experience or some particularly influential teacher produces a richly-detailed episodic memory which later serves the student as an inspiration and a template for his or her own teaching practices" (p. 320). Pajares (1992) found that there was a "strong relationship between teachers' educational beliefs and their planning, instructional decisions, and classroom practices" (p. 326) and that "educational beliefs of preservice teachers play a pivotal role in their acquisition and interpretation of knowledge and subsequent teaching behavior" (p. 328). Indeed, it seems that "beliefs are far more influential than knowledge in determining how individuals organize and define tasks and problems and are stronger predictors of behavior" (Pajares, 1992, p 311).

Decisions made by teachers about the use of computers in their classrooms are likely to be influenced by multiple factors including the accessibility of hardware and relevant software, the nature of the curriculum, personal capabilities and constraints such as time. However, there is substantial evidence to suggest that, teachers' beliefs in their capacity to work effectively with technology are a significant factor in determining patterns of classroom computer use. Honey and Moeller (1990) interviewed 20 elementary and secondary school teachers and found that teachers with student-centered pedagogical beliefs were successful at integrating technology except in cases where anxiety about computers prevented them from appropriating the technology. In contrast, teachers with more traditional beliefs faced much greater change in their practices in order to integrate

technology. A case study approach to the use of computers by four special education teachers found that for the most part they adapted computers to meet their overall goals and fit their routines with their beliefs and attitudes strongly influencing how the computers were used (MacArthur & Malouf, 1991). Marcinkiewicz (1994) found that of a number of personal variables, self-competence (belief in ability to use a computer for teaching) and innovativeness (willingness to change) were most closely related to computer use among 170 elementary teachers. Studies of computer use during teaching practicum (Albion, 1996; Downes, 1993) have found that, despite possessing positive dispositions towards computer use, pre-service teachers lacked confidence in their capacity to teach successfully with computers.

Defining and Measuring Self-Efficacy Beliefs

The construct of educational beliefs is broad and for research purposes has been refined into more specific sub-constructs (Pajares, 1992). Examples include beliefs about confidence to affect students' performance (teacher efficacy), about the nature of knowledge (epistemological beliefs), about perceptions of self (self-concept) and about confidence to perform specific tasks (self-efficacy). The latter is of particular interest because of the role it is proposed to play in determining behavior.

According to Bandura (1997), who first described the construct, "perceived self-efficacy refers to beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (p. 3), and such beliefs are the most central mechanism of personal agency. As proposed by Bandura, self-efficacy is specific to a particular set of behaviors and comprises two components, efficacy expectations and outcome expectations which respectively relate to belief in personal capacity to effect a behavior and belief that the behavior will result in a particular outcome. As a consequence, instruments for the determination of self-efficacy typically include two scales to measure these two components.

Bandura's claims about the importance of self-efficacy beliefs in explaining behavior have been supported by research in a variety of contexts, including general health behaviors, treatment of phobias, self-regulation of pain, academic performance and career development (Bandura, 1986). Perceived self-efficacy with respect to computers has been found to be an important factor in decisions about using them (Hill, Smith, & Mann, 1987) and increased performance with computer related tasks was found to be significantly related to higher levels of computer self-efficacy (Harrison, Rainer, Hochwarter, & Thompson, 1997). An instrument including several sub-scales for self-efficacy in relation to particular aspects of computer use has been developed and validated with students studying business, nursing and education (Kinzie, Delcourt, & Powers, 1994). A recent study confirmed the reliability of the instrument and found that the most significant predictor of self-efficacy for computer use among teacher education students was frequency of computer use (Albion, in press).

Gibson and Dembo (1984) developed an instrument to measure teachers' sense of efficacy for teaching. Subsequent studies have linked this construct to patterns of classroom behavior known to yield achievement gains (Dembo & Gibson, 1985) and have shown it to be positively related to change in individual teacher practice (Smylie, 1988), ratings of lesson presentation, classroom management and questioning (Saklofske, Michayluk, & Randhawa, 1988) and teacher success in implementing innovative programs (Stein & Wang, 1988).

A more specific Science Teaching Efficacy Beliefs Instrument (STEBI) developed by Riggs and Enochs (1990) has been used to investigate the impact of variations in course design on elementary science teachers (Watters & Ginns, 1997). The STEBI was used by Enochs et al. (1993) as the basis for development of a Microcomputer Utilization in Teaching Efficacy Beliefs Instrument (MUTEBI) which was used in the evaluation of a staff development program designed to encourage microcomputer use in science teaching [Borchers, 1992 #210]. That study demonstrated that when teachers' self-efficacy beliefs in their ability to use computers were increased through appropriate professional development they were more likely to incorporate computers into their teaching strategies.

Although there do not appear to be any other studies which specifically link self-efficacy with computer use in teaching, several studies (Albion, 1996; Downes, 1993; Handler, 1993; Summers, 1990) have identified lack of confidence for teaching with computers as a factor influencing the levels of use of computers by student and beginning teachers. Marcinkiewicz (1994) also reported that teachers' use of computers for teaching was related to their belief in their ability to do so.

Taken together, the studies referenced above point towards teachers' beliefs and, in particular, self-efficacy beliefs, being useful indicators of likely success at technology integration. Certainly they provide

sufficient reason to undertake further investigations in this area and to consider what approaches to teacher education and professional development might be effective in increasing self-efficacy for teaching with technology.

Influencing Self-Efficacy Beliefs

According to Bandura (1986) self-efficacy beliefs develop in response to four sources of information. The most powerful influence on self-efficacy is "enactive experience" in which self-efficacy for a behavior is increased by successfully performing the behavior. The second most powerful influence is "vicarious experience" in which other similar people are seen to perform a behavior successfully. A third source of influence is verbal persuasion, which, if realistic, can encourage efforts that are more likely to increase efficacy through success. Finally, self-efficacy beliefs can be affected by physiological and affective states such as stress.

From the standpoint of self-efficacy theory, the ideal method for developing teachers' self-efficacy for computer use would be to provide them with training and support to work successfully with computers in their classrooms. The study conducted by Borchers et al. (1992) demonstrated that a professional development program which included several workshops over an extended period and on-site support for participants could be effective for increasing both self-efficacy and computer use.

In the context of a teacher education program, enactive experience and resultant increases in self-efficacy might be achieved through successful experiences with the use of computers during field experience. In practice, variations in the experience and expectations of cooperating teachers and in the availability of equipment make it impossible to ensure that all students will experience the success that builds self-efficacy beliefs. Vicarious experience through direct observation of experienced teachers engaging in appropriate behavior poses similar logistical difficulties and verbal persuasion has limited application unless students have opportunity to perform the appropriate behaviors.

These logistical problems might be overcome by developing multimedia materials to make examples of effective classroom use of technology available to a wider group than could participate in direct observation. Whether delivered by web (Bronack & Kilbane, 1998) or on CD-ROM (Kurth & Thompson, 1998), such materials find theoretical support in a rich literature base on case methods in teacher education (Carter & Unklesbay, 1989; Merseth & Lacey, 1993; Shulman, 1986). Viewed from a self-efficacy perspective, the mechanism of the case method corresponds most closely to vicarious experience in which self-efficacy is increased through consideration of examples of successful performance by others. The inclusion of multimedia elements in the presentation of a case adds layers of detail that are not possible with a purely text description.

Self-efficacy theory suggests that real experience is more effective than vicarious experience for increasing self-efficacy beliefs. Thus it seems reasonable to suppose that multimedia case designs which encourage increased involvement of the user in the case should be more effective at increasing self-efficacy beliefs.

Problem-based learning (PBL) is one approach to instructional design that appears to warrant investigation for this purpose (Albion & Gibson, 1998a). When students succeed in creating solutions to the authentic problems of practice which are the focus of a PBL sequence their experience should include more of the characteristics of enactive experience and thus be more powerful than vicarious experience as a source of self-efficacy beliefs. Interactive multimedia materials using a PBL design have been developed (Albion & Gibson, 1998b; Albion & Gibson, 1998c) and will be evaluated for their effects on teacher education students' self-efficacy beliefs for teaching with technology.

Conclusion

As community expectations for integration of information technology into the daily practices of teaching grow, it will become increasingly important that all teachers are adequately prepared for this dimension of their professional practice. Research suggests that teachers' self-efficacy beliefs about using technology for teaching are directly related to their practice. Measurement of self-efficacy using appropriate instruments may provide a useful indicator of the effects of teacher education initiatives intended to better prepare graduates for technology use. Moreover, self-efficacy theory may offer insights into the development of materials with more powerful instructional designs.

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