LEARNING TO CHANGE: FACTORS THAT FACILITATE OR HAMPER THE USE OF ICT IN SCHOOL FROM THE TEACHERS' PERSPECTIVE

Tamar Levin
Department of Curriculum & Instruction
School of Education
Tel Aviv University

Rivka Wadmany
Kiboutzim College & Teachers College of Technology
Israel

Abstract

This paper reports on an exploratory, longitudinal study, which examined six teachers' views on the factors that facilitate or hamper their use of technology in rich technology classrooms in grades 4 to 6. The findings point to two developmental patterns in teachers' views on the factors affecting technology use in the classroom: the first is concerned with the *source of influence* on technology adoption, and focuses mainly on the human factor; the second is concerned with the *nature of the influence* when using technology in the classroom, ranging from technical to cognitive transformation. The three case studies reveal the complexity of the relations between teachers' views concerning the supporters and inhibitors of technology use, and the changes that occur in teachers' views and practices.

Introduction

The integration of information and communication technology (ICT) has become a high priority in schools internationally. New technologies and conceptualizations of learning, together with the individual school's educational vision, policies, and strategy present a new challenge to the traditional use of information technology in schools. Although research findings over the past 20 years provide some evidence as to the positive effects of the use of information and communications technology (ICT) on students' learning (Mumtaz**,** 2000**)**, technological innovations appear to leave education systems largely unchanged (Mann, 2000). ICT implementation proceeds at a slower rate than expected in the educational systems of many countries (Cox et al., 1999; Pelgrum & Anderson, 1999). Teaching with information technologies and incorporating them in schools and classrooms is a highly complex challenge (Mills & Tincher, 2003). It is neither value neutral nor universally understood and depends to a large extent on significant issues relating to teacher professional development, ICT competencies and beliefs (Ertmer, 2005; Jamieson-Proctor et al., 2006).

Although teachers have slowly incorporated ICT in their repertoire, the use of powerful technologies is often limited to sustaining rather than transforming educational practice (Cuban, Kirkpatrick, & Peck, 2001). One serious problem is that many times, ICT applications are poorly attuned to the curriculum (Voogt, 2003), and educational software is generally unrelated to and not integrated with the textbooks many teachers use. Moreover, educators and above all, techno-reformers qualify the belief that technology can fuel innovation in school and schooling and that such innovations are possible. The question of how to include information technologies in the curriculum requires educators to reconsider the goals of education and the nature of interactions between teachers, students, educational and information resources, and curricular goals and materials (Voogt & Pelgrum, 2005). Furthermore, researchers and techno-reformers admit that many questions regarding the effective use of information technologies are still unanswered. It is therefore not surprising that despite the research accumulated over the past three decades we still have to ask what can be done to increase the frequency and improve the quality of the use of technology in schools.

To influence the incorporation of information technology in schools calls for improved insights into teachers' beliefs regarding the use of ICT in their classrooms (Czerniak & Lumpe, 1996). This study addresses that question by investigating what teachers think about the factors that facilitate or hamper the use of technology in their classrooms and by acquiring a fuller understanding of how teachers' views concerning the value of ICT in the classroom develop over the years.

Theoretical Rationale

Numerous research studies provide a long list of factors that can potentially affect the use of technology in schools. These factors include the influence of teacher confidence and expertise, teacher beliefs about the potential of ICT to make a difference in student learning, as well as issues around teacher professional development, school technological infrastructure and technical support, along with the need for leadership (Cowie & Jones, 2005). More specifically, these factors include lack of convenient access to computers, inadequate infrastructure and poor planning for the use of technology (Smerdon et al., 2000). Other relevant factors pertain to information and innovation overload and burnout (Herbig & Kramer, 1994); limited and/or inadequate staff development versus properly planned staff development (Weikart & Marrapodi, 1999); lack of ongoing support, fragmented knowledge, ignorance of school needs, and poor leadership knowledge and support (Hardy, 1998). Also affecting the use of technology in schools is the availability of guidance from specialist mentors and online resources (Sherry et al., 2000); compatibility of technology-related innovation with the school's

philosophy (Latham, 1988), and, finally, the changing nature of technology itself (Cuban, 1999).

According to some researchers, teachers have the most impact on the quality of technology use in schools and therefore. For example, according to Hardy (1998) review of studies on teacher attitudes revealed that teacher confidence affects the use of technology more than variables such as access to equipment, administrative support, and time. Other researchers have noted various important, teacher-related variables that influence the effective adoption or implementation of information technology. For example, whether teachers are positive about technology (Becker, 2000); teachers' beliefs and views on information technologies (Ertmer, 2005; Sandholtz, Ringstaff, & Dwyer, 1997); teachers' willingness to change their classroom role (Hardy, 1998); teacher confidence to incorporate innovation (Parr, 1999) and ability to integrate technology (Kent & McNergney, 1999); and prior experience of using technology as a productivity tool and teachers' motivation and need to improve their computer technology skills and knowledge (Kay, 1993).

If we conceptualize the adoption of technology as a learning process for individuals and organizations (Wilson et al., 2002), then it becomes clear that simply examining isolated factors or variable lists and typologies will not further our understanding of technology use in the school. Moreover, the factors influencing the adoption of technology are often examined separately from one another and from the system in which they interact, whereas classroom technology usage illustrates a combination or network of factors within a particular environment. Zhao and Frank (2003) call this "the ecological system." In other words, a systemic perspective is needed to help us reach a better understanding of why teachers adopt or do not adopt classroom technologies.

Although researchers have suggested numerous system-based conceptual frameworks of constructs that explain ICT use, not many studies have in fact explored the relationship between the factors that promote and detract from the quality of technology use in the classroom. Moreover, although the process of adopting technology is conceived as evolutionary (Zhao & Frank, 2003), and although it is acknowledged that teachers' pedagogical philosophies and practices are not constant but rather affected by their classroom experiences (Levin & Wadmany, 2005), little research have longitudinally examined the introduction of technology. With the exception of the ACOT studies (Sandholtz et al., 1997) and Pierson and McLachlan's (2004) study on prospective teachers, most research has investigated large survey groups of teachers or smaller samples and based their analysis on existing models of change.

The present study addresses this gap in two complementary ways. First, it documents teachers' opinions regarding the factors that supported and hampered

their use of technology in the three consecutive years of experiencing teaching in a technology-rich environment. Secondly, it describes the interrelationship between the various aspects of the teacher's experience with technology: the teachers' views of the factors affecting their use of technology, the changes in their educational beliefs during their classroom experiences, their views on the technology they used, and the constituents of their classroom practices. The interrelationship between these different factors is clearly seen in the three case studies of teachers that are presented.

Methodology

The research encompassed a longitudinal study that lasted three years. It is a case study of one school with multiple case studies of teachers at the school. It mainly utilized qualitative methodology principles (Lincoln & Guba, 2000). The methodology consists of a combined exploratory case study approach and a collective case study approach. It relates to each teacher as a separate case study, while simultaneously relating to all the teachers, holistically, as a group (Yin, 1992). Six teachers, in grades 4 to 6, participated in the study.

Instruments

Four data sources were examined: open questionnaires, interviews, classroom obsrvation, and closed questionnaires. The open questionnaires and interviews were mainly used to study explicit educational beliefs and knowledge; the classroom observations and weekly meetings with participating teachers enabled the researchers to study the teachers' practices in real life teaching and learning situations and provided indirect or implicit measures of the teachers' beliefs.

The open questionnaires were administered annually to teachers and the interviews followed researchers' observation of teachers in their classrooms and in the course of in-service training. The questionnaires and interviews probed teachers' opinions of the differences they had observed both in themselves and their professional environment and examined what they thought had assisted or impeded their classroom work. The closed questionnaire structure was inspired by Chinn and Brewer's (1993) model of knowledge restructuring, which deals with dimensions relevant to the present study and was helpful in establishing a profile of the knowledge restructuring experienced by the individual teachers. Each dimension relating to this study was structured as a differential semantic scale.

The unique contribution of the questionnaire was that a) it provided a precise and concise picture of each teacher's experiences, b) it clarified the teachers' personal beliefs and feelings, and c) it provided a unique profile of the self-perceived change that each teacher underwent.

Data Analysis

The data was analyzed in two stages: first, the researchers used the responses to the teachers' questionnaire to create a portrait of the individual teacher's views with regard to the factors that supported or hampered their teaching in a technology-rich environment. The analysis of the changes in each teacher's views at three points in time: the first, second, and third years of the study, allowed the researchers to identify critical dimensions in the professional development of the teachers as a group and pinpoint a developmental pattern in their views.

Stage two of the data analysis focused on three teachers in an effort to reach a deeper understanding of the relations between the individual teacher's profile of change in educational beliefs and practices during the study and her views on the factors furthering and inhibiting her efforts. The three teachers chosen had highly divergent change profiles in terms of their beliefs, knowledge restructuring, classroom practice, and views on technology. Their names were Zipi who only manifested surface change, and whose pedagogical views were mainly positivist and behaviorist-based; Ziora who evinced the greatest change and moved from a positivistic to a relativistic ideology; and Hadasa whose experiences reflected the most significant change by moving from a positivistic to a constructivist educational ideology (Wadmany & Levin, 2004).

Results

1. On examining the teachers' views as a group with relation to the factors that enhanced their experiences in a technology-based learning environment, the study revealed a developmental pattern relating to ***the source of influence*** on technology adoption. This pattern points to a move away from factors reflecting external legitimacy, reinforcement, encouragement, and emotional support (*"I needed the school principal to support the new educational ideas and encourage me through the difficulties"; "The school superintendent's view affects the success of the change in the classroom — her participation in the workshops shows that she thinks the project is important"*), through factors emphasizing the benefit of learning with partners, colleagues, and students ("*Interacting with my colleagues, who were very supportive and important, helped me to understand things better"; "I became friendlier with my colleagues; working with them gave me the courage and confidence to try out new ideas")*; to factors involving the teacher's learning from her teaching experiences, her need for ongoing support, and the learning opportunities she encountered ("*My new experiences in the classroom, allowed me to see that my views on teaching had changed and that I had made a success of the project).*

That is, the developmental pattern exhibited by the teachers defines a continuum at one end of which lies the external influences on the teacher, and at the other end of which is the teacher's internal behaviors, in other words, her self-regulated, reflective behaviors. Between the two extremes lies the teachers' dialogue with colleagues and students, which the teachers' perceived as an important factor in helping them to implement the considerable innovation required by the project.

2. The second developmental pattern exhibited by the teachers describes the kind of influences required for technology adoption, which we labeled ***the nature of influence***. The factors fall into three main categories. The first category relates to the technical and organizational aspects of introducing a new approach ("*There are inevitably technical hitches when working with computers, and this interferes with teaching and learning*"; *"The school didn't always have the right courseware for the curriculum")*. The second category relates to the interplay that occurs between the teacher's personal strengths and weaknesses when adopting an innovation; for example, her ability to deal with the unexpected; her sense of confidence or feelings of anxiety ("*I found it hard to plan lessons whose course was unpredictable*"; "*I had some difficulty understanding the sequence of the instructional design*). The third category concerned the changes that occurred in conceptual thinking as a result of teaching in a technology-rich classroom and how those changes affected the regular school curriculum (*"I had to change my ideas about teaching and learning, which was hard*"; "*It is hard to accept the idea that a teacher no longer supplies knowledge, and that you are supposed to learn from your students")*.

Regarding the inhibiting factors, during the three-year study, the teachers' views showed no definitive development pattern. However, the teachers did realize that they found teaching in a rich technology-based classroom difficult because they needed to restructure their knowledge and alter their conceptions of teaching and learning. Most of the teachers expressed this idea, though only in the third year of the study. Even in the third year, not all the teachers believed that the need for them to change their conceptions had inhibited the project's success. Furthermore, only some of the teachers realized that they had found teaching with technology difficult because of their lack of confidence and anxiety.

3. The study identified three profiles, which describe the relation between teachers' views on the factors affecting their use of technology in teaching and their change in educational beliefs and practice:

A. The first profile reflects superficial change or no change in educational beliefs, holding mainly positivist and behaviorist-based pedagogical ideology, a technical view of information technology, and a regular use of direct instruction. According to this profile, traditional professional development and

support from authorities are the main factors responsible for encouraging teaching in a technology-based classroom. Interaction with students is also an important factor that develops in this profile, although it only appears in the teacher's second or third year of experience.

B. The second profile involves significant change in the teacher's educational beliefs and considerable knowledge restructuring, implementing a collaborative learning environment, and appreciating learning from students and colleagues. This is combined with a shift away from a view of technology as an instrument that supports learning, towards a view of technology as a partner that empowers students and teachers. If the teacher is positive about learning from students and colleagues, then the above factors, along with a focus on collaborative learning can successfully support the use of technology in teaching and learning. These views also correlate with the teachers' strong awareness of the need for conceptual change regarding school learning. The teachers also believed in the importance of learning from personal experience, but only in the third year of the study.

C. The third and most radical change in the teachers' beliefs reflects a remarkable change moving from positivistic to constructivist educational ideologies; a realization that technology is a partner in teaching and learning, and using classroom practices that promote discovery learning, enhancing self-regulatory capabilities of both students and the teacher. In this case, the teacher perceives students as highly capable — not only of seizing open-ended, creative learning opportunities and employing diversified modes of learning — but of offering curriculum-related suggestions, helping with planning classroom activities, and supporting the teacher's experiences within an innovative environment. Radical change of this nature also correlates with a desire to continue learning "with and from colleagues" and "with and from" professional authorities. In this change scenario, the teacher is aware of the difficulty of changing conceptions and beliefs and overcoming anxiety.

4. The case studies illustrate the complex relationships between the teachers' views on technology usage and the changes they experienced when working in a rich technology classroom. They also reflect the complex, internal, cognitive and emotional dialogue underlying teachers' perceptions of pedagogical innovation as a professional learning process. This suggests that it is important to tolerate uncertainty and reflect on personal beliefs during the activities and thinking required for technology-based classroom reform. The case studies also showed that tolerance of uncertainty and intolerance of dissonance (the gap between the desired and actual classroom processes and products), and appreciating the positive aspects of learning in a community of learners — colleagues or students

— assist teachers in overcoming negative and discouraging emotions, such as anxiety and indecision.

Discussion

The teachers' views of the factors inhibiting and encouraging learning and teaching in a rich technology-based climate demonstrate that perceptions arise as a result of activities involving other people and situations, and are not simply confined to the individual's mind. This supports Engestrom's activity theory (1987), according to which humans learn through their actions and use what they have learned to plan and carry out other actions, which ultimately affect their beliefs and behaviors. It also supports the activity theory conception that internal-mental activities cannot be understood when analyzed in isolation from external activities due to mutual transformation between the two activities: internalization and externalization. Rather, the context of the activity determines when and why external activities become internal and vice versa, while the social context and interaction between actors and agents in the environment activates the internalization /externalization mechanisms.

The study therefore demonstrates that not only computer technology but also a complex web of interrelated factors and expectations, a didactic and pedagogical task structure, and an organizational and educational mindset, are required in order to ensure that computer technology is successfully introduced into the classroom with the desired effect. This study therefore supports the view that schools and classrooms can become learning communities of teachers, students, and experts (Levin, 1999). It also recommends the use of tools that not only influence teachers' outward behavior, but also their mental performance. In practical terms, the study suggests that when planning professional development for teachers, learning from experts, colleagues and self and experiencing different learning settings should be encouraged, planned, and supported (Balanskat et al., 2006; Sahin et al., 2007). It further suggests the most successful professional development models engage and empower teachers to have a stronger voice in directing their own learning (Robb, 2000). In addition, the results support the idea that when viewed within the teacher's broader belief profile, doubts, uncertainty, and lack of confidence can be regarded as an acceptable and normal part of a teacher's professional development. The results also endorse Saye's finding that for both students and teachers, comfort with uncertainty strongly relates to the ability to use technology innovatively (1997).

The findings regarding the three case studies imply that the "one size fits all" metaphor is inappropriate if we are to meaningfully influence teachers' use of technology in the classroom and develop their capabilities to work in technology-

based environments. In fact, the study calls for technology-based and school-based reformers to reach the right balance between working with teachers individually and working with meaningful groups/communities of teachers. Moreover, with reference to Cuban (2002), who claims that factors inside and outside the school affect the ability of ICT-based innovation to diffuse into and improve the school, this study also adds that there is a need to consider personal variables. It demonstrates that not only should we consider the fit of technology use within the localized classroom setting of each teacher, but we should consider the broader profile of teachers' educational beliefs, their cognitive and emotional disposition to face novel, uncertain, situations, their actual teaching practices, and their views on technology and its supportive and restrictive nature.

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