

Design Research in the Elementary School Classroom

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INTRODUCTION AND BACKGROUND

Over the last 15 years, the study of technology in classroom settings has highlighted the need for a new research paradigm. Past research on educational technologies and software has been impugned due to the impossibility of establishing valid controls for the simultaneous introduction of technological and pedagogical innovations (Cobb, 2000; Brown, 1992; Collins, 1992, 1999). In response to the growing dissatisfaction to traditional paradigms, a relatively new approach called design research (Brown, 1992; Collins, 1992) has gained popularity – for an extensive history, see Edelson (2002). This new framework provides a potential infrastructure for promoting exchange across many different types of investigation (Cobb et al., 2003). Design researchers are able to use varying elements of design to optimize conditions that may result in the increased efficacy of a given educational innovation, since the process is defined by iterative design and formative research in complex real-world contexts (Edelson, 2002). Through careful observation, both quantitative and qualitative, design researchers are able to surmise how different design elements are contributing to observed results (Collins, 1999).

Bereiter (2002a) sharpens the distinctions between traditional and new paradigms by describing four key features that constrain design research in education: (1) design research must be carried out collaboratively with educators; (2) the investigators must also be participant-researchers – with the pretense of objectivity abandoned in order for the researcher working to produce some effect; (3) the immediate goal of the research is to find some form of solution created out of an analysis of recent failures, and (4) design research is guided by the vision

of sustained innovations dependent upon new goals emerging from continual performance analysis.

To clarify the elements of the new paradigm, Collins (1999) provides seven contrasting aspects of more traditional laboratory studies in education to design research experiments with regards to their methodology.

In contrast to action research—which places its main focus on practice—design research concentrates on feeding back data analyses to the theory (Scardamalia, personal communication, 2004). The iterative process of refinements to design in order to inform theory and practice require frequent evaluations and design changes to optimize any given design. However, through refinements in design, such analyses lead to refinements in theory. “Theory must do real design work in generating, selecting and validating design alternatives at the level at which they are consequential for learning” (diSessa & Cobb, 2004, p. 80). Therefore, design research should always have the dual goals of refining both theory and practice (Collins, Joseph & Bielaczyc, 2004).

The critical balance between practice and theory places an immense importance on the relationship between the classroom teacher and the researcher since, as suggested by Bereiter (2002a), design research is intended to be a collaborative endeavor. The nature of this relationship can greatly determine the value of the research that is conducted. Therefore, it is essential that the teacher be receptive to innovation and willing to experiment with the researcher in testing unproven methods (Bereiter, 2002a). Findings from studies (Reiser et al., 2001; Sandoval, 2003) employing a design research paradigm support the notion that teachers may play a key role in capitalizing on the affordances of technologies that support learning. Thus, the collaborative efforts between researcher

Table 1. Collins' (1999) comparison of traditional laboratory studies vs. design experiments.

Traditional Experimental Methodology	Design Experiments
<i>Laboratory settings.</i> Laboratory experiments avoid contaminating effects.	<i>Messy Situations.</i> Design experiments are set in the messy situations that characterize real-life learning, thereby avoiding distortions.
<i>Single Dependent Variable.</i> Typically, one dependent variable is present.	<i>Multiple Dependent Variables.</i> Many dependent variables may matter, even though the researchers may not pay attention to all of them.
<i>Controlling Variables.</i> A method of controlling variables is followed.	<i>Characterizing the Situation.</i> Design experiments do not attempt to hold variables constant, but instead identify all the variables or characteristics that affect any dependent variable of interest.
<i>Fixed Procedures.</i> A fixed procedure to enable careful documentation and replication is followed.	<i>Flexible Design Revisions.</i> Design experiments start with planned procedures and materials, not all completely defined, which are revised depending on their success in practice.
<i>Social Isolation.</i> Often in most traditional psychological experiments, subjects learn in isolation.	<i>Social Interaction.</i> Learning occurs within complex social situations, such as a classroom; therefore, examining social interaction becomes essential.
<i>Testing Hypotheses.</i> Involve a systematic testing of one or more hypotheses.	<i>Developing a Profile.</i> By examining many aspects of design, a qualitative and quantitative profile that characterizes the design in practice is developed.
<i>Experimenter.</i> The experimenter makes all the decisions about the design and analysis of the data.	<i>Co-Participant in Design and Analysis.</i> Design experiments involve different participants in the design, thereby exploiting varied expertise.

and teacher enable a detailed evaluation of design, which is an ongoing process that changes as the design changes (Collins et al., 2004).

In this article, we examine a case study that illustrates how collaboration with the classroom teacher led to a series of innovations that improved the use of handheld computers in a grade-two classroom. Prior to the study, the classroom followed a knowledge-building community model of learning, where individuals are dedicated to sharing and advancing the knowledge of the collective (Hewitt & Scardamalia, 1998). Further, the classroom used the computer supported collaborative learning (CSCL) software program originally known as CSILE, now in second-generation form as Knowledge Forum®. The program provides a computer-supported asynchronous discourse medium, where students need not be engaged in discussions at the same time or place. The program preserves collective knowledge in the form of notes on the database, and enables

their continual search, retrieval, comment, reference and revision (Scardamalia, 2002). Therefore, the central goal of this design experiment was to design innovations using handheld computers in conjunction with Knowledge Forum® that would serve the knowledge goals of students at both the individual and collective levels.

DESIGNING INNOVATIONS

An Illustrative Case

The study consisted of 22 children, ages 7-8, drawn from a grade two class at a downtown, technologically enriched school in Toronto, Canada. The students and teacher—an experienced knowledge-building educator—had been working with computer-supported collaborative software (Knowledge Forum®,

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