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Teachers as Research Instruments: A "Confessional Tale" About a Longitudinal Study

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Abstract

The authors have recently concluded the data collection phase of a three-year intervention study that has tracked one class of elementary pupils learning to make design decisions in a design & technology education classroom. The research design stated that in-depth data would be collected from a purposefully sampled group of four pupils (two boys and two girls) and also from the classroom teacher. However, during the second year of the study the authors encountered several serious problems with the intervention, which in turn led to a data quality problem.

This paper, which offers a "confessional tale", is in four parts. First, it describes the research design of the study, which was intended to begin the process of developing a theoretical model for learning to design. Second, the paper uses excerpts from transcripts to illustrate how the nature of teacher-pupil interactions (a) enabled the success of the research design in Year 1, and (b) led to data quality problems in Year 2. Part three indicates the lessons learned and describes the researchers' response to the problems encountered in Year 2. The paper concludes with a cautionary note for researchers designing a longitudinal study.

Key words

longitudinal research, research design, design education, design decisions

The Research Design

The landscape of pupils' design work in classrooms has been transformed during the past 30 years. Yet the knowledge base on how pupils acquire "designerly ways of knowing" (Cross, 1982, p. 223) or how this acquisition is best mediated by teachers and curriculum materials, while strongly supported by anecdotal evidence and descriptions of practice, lacks empirical support. This gap in the knowledge base underpinned the recently concluded data collection phase of a three-year intervention study that has tracked one class of elementary pupils learning to make design decisions (Barlex, 2004) in a design & technology education classroom.

Two broad and interrelated, but distinct, research questions were the focus of the study: (a) What are the characteristics of tasks that enable pupils to learn to make design decisions? and (b) What is the nature of classroom interactions (teacher-pupils and pupils-pupils) that support learning to make those decisions?

A qualitative methodology was adopted since it (a) is naturalistic (the research took place in a natural setting--the pupils' everyday classroom), (b) is empirical (the researchers observed and collected empirical data in real time), (c) uses multiple sources of evidence (the researchers collected five different forms of data), and (d) is fundamentally interpretive (the data collected will be interpreted to provide insights into pupils' designerly thinking (Creswell, 2003, 2007; Yin, 2003). More specifically, a panel longitudinal research design was adopted. According to Menard (2002):

> Longitudinal research is research in which (a) data are collected for each item or variable for two or more distinct time periods; (b) the subjects or cases analyzed are the same or at least comparable from one period to the next; and (c) the analysis involves some comparison of data between or among periods. (p. 2)

And as Gall, Gall and Borg (2007) describe, a panel longitudinal research design involves "selecting a sample at the outset of the study and then at each subsequent data-collection point surveying the same sample" (pp. 304-305).

The Setting and the Participants

The setting was one class of pupils in a small elementary school located in Eastern Ontario. This was very much a case of convenience sampling, the principal of the school being well known to one of the authors and having, in the past, shown a willingness to involve his staff and pupils in research studies. In Year 1, when the pupils were in Grade 6, the class consisted of 16 girls and 10 boys. In Year 2 one girl and five boys joined the class from other schools. These 32 pupils remained as the participants in Year 3. Attrition, a threat to many longitudinal

studies (McMillan & Schumacher, 2006) was not an issue in this study. In order to create a panel study four focal pupils, two boys and two girls, were purposefully sampled from the class using the following criteria: (a) of average or above average intelligence based on prior classroom performance, (b) articulate, and (c) able to work together. These four pupils were investigated each time data was collected and were anticipated to provide "information-rich cases for study in depth" (Patton, 2002, p. 169) about their ability to make design decisions.

In each of the three years of the study the expectation was that the regular class teacher would teach design and technology to all the pupils. As will be discussed later, this occurred in Years 1 and 2 but not in Year 3.

The Interventions

In order to track the development of pupils' ability to make design decisions, for each year of the study (a) they would complete an increasingly demanding design and make activity, and (b) the activities would require different sets of design decisions to be made. Each curriculum unit required pupils to design and make a particular product for an identified person and consisted of two parts: (a) a series of Support Tasks through which pupils acquired knowledge, understanding and skill likely to be useful in designing and making the product, and (b) the designing and making activity (Barlex, 1995). In Years 1 and 2 teaching occurred every Thursday afternoon for two hours over an eight to ten-week period. The teaching approach in Year 3 was modified in light of experiences in Year 2 and is described later in the paper.

The Professional Development

Technology education is a mandatory part of the Ontario curriculum (Ontario Ministry of Education and Training, 1998). Hence, the researchers anticipated that teachers involved in the study (one per year) would have a basic understanding of the nature of the subject, as well as subject knowledge. The researchers anticipated that two days of professional development, led by the researchers, would be sufficient to familiarize the teacher with both parts of the unit as well as provide an opportunity to (a) discuss pedagogical and logistical issues likely to arise in his or her classroom, (b) explore tools and materials, (c) engage with the researchers' approach to designerly thinking, and (d) explore and develop his or her own creativity. To enhance the level of interaction and discussion during the professional development, the researchers invited two additional participants: (a) the workshop technician, a highly experienced elementary teacher of design and technology, and (b) a former fashion designer who has collaborated with the researchers in the past.

Data Collection

The model of design decisions proposed by Barlex (2004) provided a theoretical framework for the study and for the data collection methods. These methods were designed to provide a rich set of data which could be analyzed to provide (a) a picture of the way the four purposefully sampled pupils made design decisions, (b) the extent to which interaction with the teacher and other pupils influenced pupils' thinking, and (c) the way in which pupils' ability to make effective design decisions changed over time and according to the task tackled.

The four purposefully sampled pupils were audio and video taped throughout all lessons. The teacher was audio and video recorded whilst talking to the whole class and while talking to the four purposefully sampled pupils. Pre- and post-questionnaires were administered to the entire class. The teacher was interviewed, both at the end of the professional development and following completion of the unit. Flat work produced by all the pupils was photocopied, and photographs taken of the 3D products. Photographs were also taken while pupils were designing and making. Once analysis begins, this variety of data will maximize construct validity.

The Classroom Interactions

Year 1: According to Plan

In Year 1, the design brief used read: *Design and make a mobile for a person and place of your choice*. The teacher was a highly effective practitioner with a PhD in literacy and exhibited a great deal of enthusiasm, both for design and technology and for the particular curriculum unit. He devoted considerable time to the preparation of lessons and to planning ways to stimulate pupils' thinking. For example, prior to each Support Task he selected and read a children's book that illustrated and contextualized one or more aspects of the anticipated new learning. When introducing Support Task 2, in which pupils must think creatively to draw outline shapes representing natural objects, the teacher read Weslandia (Fleischman, 1999) which tells the story of Wesley, a geeky boy who grows his own crops to provide the raw materials for a wide range of products he designs in order to create his own, new civilization. This reading was followed by a whole-class discussion:

T	So why did I read this book?
SM4	Because Wesley had a mind of his own.
T	[names SM9]
SM9	He had a mind that shot sparks.
SF4	He designs . . . he just makes all that stuff.
T	What were some of the things that he designed and made?

SF8 The ink.
SF6 A bug spray.
T The bug spray that passed as what?
SF6 Sun repellent and bug spray.
T What else?
SM3 He invented a new language and way of keeping time.
T What did he design and make to keep the time? What did he call it?
SF11 A sundial.
SF2 He made clothes.

This highly dynamic discussion continued for approximately five minutes, until the teacher said:

T Now I'll tell you something, any time I've ever read this book I've read it…with the perspective that this book is about writing, that…you can develop your own language, you can play with language, and this kid develops an alphabet to be able to record things, he's not worrying about grammar and all that punctuation and stuff, but over the last few weeks now that we've been focusing on design I read it again and I thought hey this kid really designs an awful lot and makes an awful lot of things, and I thought it'd be a great book to start us off.

This teacher was expert at using questions to stimulate pupils' thinking. For example, when introducing the designing and making activity he emphasized the importance of the specification and then the design decisions to be made.

T The specification [you wrote] for your mobile [will] describe the user, …where the mobile will be used …why you selected that location…and the theme, based on who you selected it for and where you're going to put it. What are some of the decisions [you have] made?
SM2 I'm going to do one for my dad. I'm going to make a big kind of saw for a beam and three tools hanging down from it. I chose this theme because my dad is always in his workshop.
SM8 Um I'm doing it for me, it's about Star Wars. I absolutely love Star Wars.

This discussion continues until eventually the teacher directs pupils' attention to the design decisions each will make:

T We're going to go through some of the design decisions, which we've been referring to time and again [listed on the chart] at the back of the room and this is building [on] your specifications. We're trying to lead up to a design for the mobile that you're going to make, and you need to think about some of the decisions [Names female pupil] is doing the ocean and her decorative elements [are] shells. What do you think she could use as her hanger?
SM2 Blue string.
T Explain?
SM2 Blue string gives that idea of water falling right.
T Josh is doing one for dad that's something to do with the Boston Bruins, so what could he maybe use for his hangers?
SF8 Hockey sticks.
T So I want you to think about how you could incorporate your theme into every part of the mobile, not just the decorative elements. How can you weave it into your beams, how can you weave it into your hangers, and how can you use your decorative elements? How is this whole thing…going to…scream your theme?

He also encourages pupils to share ideas.

T This really is an opportunity for you to chat with your peers about some of the decisions you're making today. Now is the time to get the input from the people [at your table].

As an example, two of the focal pupils held the following discussion:

SF1 What do you guys think, is there anything else I should do to my [planets theme] mobile, like change the stars?
SF2 Or maybe you could arrange them into a constellation.
SF1 Right. Tell me if you guys can picture this. It's going to hang in like a big circle.
SM1 Are you going to do a whole bunch of circles?
SF1 I'm going to have a crescent moon.

The data reported above illustrates that this teacher is a highly effective professional and as a result the pupils' designerly thinking is being developed.

Year 2: The Problem Emerges

In Year 2 of the study the teacher had responsibility for science education with all Grade 7 and 8 pupils. This suggested to the researchers that she would experience little difficulty with technical aspects of a unit with the following design brief: *Design and make a controllable, self-propelled toy for yourself or to give to a special friend, driven by a small, dc electric*

motor and using card, wood strip, and found materials for construction. Unfortunately, this proved to be not the case.

The pupils' learning and success with this curriculum unit was severely compromised by several factors. First, the teacher's classroom management skills were extremely poor. Pupils' talk was constant for the most part off the task and very loud. Pupils ignored the teacher's request and directions to stop talking or talk quietly. Pupils' behaviour, in a classroom strewn with tools and materials, became so unruly at some points that the researcher, himself an expert classroom teacher, felt it necessary to intervene and to work with individual pupils in order to keep them on task.

Second, the teacher tainted pupils designerly thinking when she misrepresented the design brief in her opening statement to pupils:

T We are going to be having a lot of fun and making remote control cars.

The teacher then reverts to the actual design brief:

T In brief a design, you are going to design and make a controllable self-propelled toy for yourself or to give to a special friend, using card, wood strip, and found materials.

But a few minutes later, having described a Support Task:

T We are going to teach you to explore different types of electrical circuits before we get to build our cars.

And having completed a description of the Support Tasks (with very little teacher-pupil interaction):

T So after going through this list of sub-tasks then we are going to go onto making our car.

As is also evident from the excerpts above, on many occasions the teacher used incorrect technical vocabulary: "build" not "make"; "sub-task" not "Support Task"; "remote control" not "controllable, self-propelled." Often, the teacher--pupil interaction was confusing, as evidenced in the excerpt below:

T Okay, what does self-propelled mean? [names a male pupil]
SM7 You can control it.
T You control it…possibly. [names a female pupil]
SF6 It's controlled by itself.
T It's controlled by itself, which usually means it has a…?
SF3 A motor.

One final example serves to illustrate difficulties encountered in Year 2 of the intervention. At the end of each Support Task there is the following section:

Relating this Support Task to the Big Task
At the conclusion of this Support Task have pupils told you what they have learned about [topic of the Support Task]. Next, ask pupils how this information will help them design and make a [product in the design brief].

The teacher in Year 1 engaged pupils in this essential activity at the end of each Support Task, whereas the Year 2 teacher omitted it from every Support Task. Hence, consolidating the learning and establishing the critical relationship between acquiring knowledge and skills and then using these to design and make were established in Year 1 but completely lost in Year 2.

The data reported above illustrates that this teacher is not an effective professional and as a result the pupils' designerly thinking is not being developed.

Discussion

A panel longitudinal research design is a powerful tool for researchers interested in pupil learning, for it entails following a sample cohort over time and taking repeated measures of the phenomenon being studied (Wagner, Kutash, Duchnowski, & Epstein, 2005). The researchers anticipated that a panel longitudinal research design would provide important information for answering questions about change and growth in pupils' ability to make design decisions. This information would, in turn, lead to the beginnings of a theory grounded in data (Strauss & Corbin, 1990).

This paper has described a data generation and quality problem that emerged during one such three-year study. Year 10 went completely according to plan. The professional development provided for the teacher appeared successful. The resources provided for pupil use were appropriate, sufficient and well used. The teacher's expertise as a literacy teacher resulted in a rich learning environment. The teacher made effective use of stimulus materials and both teacher and pupils responded enthusiastically to the unit of work.
The teacher enabled the co-construction of knowledge by (a) using questions and visual stimulus materials, (b) encouraging pupil-pupil and pupil-teacher interaction, and (c) using questions to consolidate learning and indicate its utility. As a result, the pupils produced a wide array of creative responses to the design brief and the researchers were able to collect rich data.

With this success in mind, the researchers conducted Year 2 of the study according to the original plan. As the data has indicated, this lead to an impoverished learning experience for the pupils. And from a data collection perspective the year was a failure. Transcriptions of the conversations between the

four focal pupils contain little on-task talk, and so their designerly thinking is hidden from the researchers. The teacher's interaction with these four pupils is to a large extent non-existent.

As a result of the Year 2 teacher's repeated misrepresentation of the design brief, repeatedly telling pupils they would be '"making a car," the pupils' designerly thinking was inhibited. The resultant products were less creative than those produced in Year 1. As a result of the teacher's poor making skills and lack of technical knowledge the quality of the work was very poor and a number of the toys worked only intermittently. As a result of poor classroom management four of the pupils did not complete the task.

Lessons Learned and the Researchers' Resonse in Year 3

With hindsight, the researchers now understand that the original research plan was overly, even naively, dependent on the effectiveness of the teacher. Effectiveness was, in this study, a function of both subject knowledge and teacher expertise (Banks & Barlex, 1999). The teacher in Year 1 was highly effective in these areas, whereas the teacher in Year 2 ineffective. The research plan did not meet the "broad contingency" of teacher expertise, although it acknowledged teacher effectiveness as a very important requirement and hence designed and implemented professional development to meet this requirement.

In response to the difficulties experienced in the classroom in Year 2 and the resultant lack of useful data, the researchers made a decision to co-teach the unit. For a number of pragmatic reasons, it was decided that the most efficient way to do this was through an immersion model, in which the pupils spent three whole days on the unit. Furthermore, the teaching would take place off-site in the researcher's Faculty of Education workshop.

Space limitations in this paper do not allow for detailed reporting of the pupil-pupil and pupil-teacher conversations during Year 3. But since both researchers are experienced and expert teachers of design and technology, and the pupils were highly motivated by both the change of instructors and the venue, work of an exceptionally high quality was produced. Cursory examination suggests that extremely rich data was collected.

However, as stated earlier, longitudinal research is research in which the analysis involves some comparison of data between or among periods (Menard, 2002). And so despite the successes in Years 1 and 3 the researchers now face two unanticipated data analysis problems. First, we do not have an unbroken trail of data documenting pupils' developing ability to make design decisions. Second, the nature of the pupils' design and technology experiences in Years 1 and 3 was significantly different, raising questions about the comparability of the data.

Conclusion

This paper offers what Van Maanen (1988) calls a "confessional tale." It is part of the story about a research program that encountered a data production problem. It describes how the fieldwork odyssey was adapted and accomplished by the researchers. It makes no attempt to report an in-depth analysis of data. Rather, it provides a necessarily blurred account, combining a partial description of the intervention, a partial account of the experiences of the researchers, and a partial reporting of data. Missing data, incompleteness, and blind spots have been admitted!

The researchers remain convinced that longitudinal studies as described by Menard (2002) and Gall, Gall and Borg (2007) have great potential for providing much needed information on pupils' learning to make design decisions. So in developing a research design for longitudinal study it would seem to be very important to identify potential weak points and if possible have alternative plans available. In this confessional tale, the weak points which emerged were (a) assumptions on the part of the researchers about the professional competence of the teachers, and (b) the competence of the Year 2 teacher. These weak points led to a situation in which the collection of data useful for answering the research questions could not take place in Year 2.

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