TEACHER EDUCATION AND CONSTRUCTIONISM WHEN TEACHING WITH DIGITAL TECHNOLOGIES

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Abstract

Today's university graduates might be avid users of social networking communication, but this does not make them skilled users of IT. It is probable that there is little transfer of social media technological skills into teaching with IT in schools. The concepts of *constructionism* are appraised, and reports on changes to classroom pedagogical theory and practice using IT are reviewed. A trend towards emphasising the technology rather than the pedagogy used or the content taught is noted. The trend is linked to a project that involved introducing constructionist principles and practices to a cohort of prospective secondary teachers. This paper is an initial report of that project.

Introduction and Setting

In common with other developed countries, education authorities in Australia have made significant investments in promoting effective teaching with computers and other digital technologies. While expenditure figures are not available, considerable expenditure is implied by the fact that in Australian schools "on average, every three students had access to one computer" while the international average was 18 students to a computer (De Bortoli, Buckley, Underwood, O'Grady, & Gebhardt, 2013, p.116). Although there has been research into teaching strategies with digital technologies (for example Webb, 2002; Mishra & Koehler, 2006), many researchers and practitioners feel there is a lack of useful documentation on practical classroom strategies.

A survey of Australian teachers in 2010 found that the average age of primary teachers was 42.1 years and secondary teachers 44.5 years (McKenzie, Rowley, Weldon, & Murphy, 2011, p.24). This appears to imply that few current Australian teachers experienced learning with computers when they were students, and so they lack personal experiences to draw on when they teach with technology. This is very different to a range of subjects they would have studied for up to thirteen years at school. As a result, teaching with digital technologies is conceptually different to teaching in any other mode or subject area for many teachers.

This paper discusses reasons for considering the reconceptualization of pedagogical decision making for teaching with digital technology and then reports on some experiences of pre-service teachers. Pedagogical models advocated by Cope and Kalantzis (2000), Haydn (2014), and Webb (2002) form the basis for this discussion, but all of these can be traced back to research reported by Harel and Papert (1993). This will be expanded on in the later section focussing on constructionism. It was hoped that such a

reconceptualization would provide an analytical framework that focused on the structure of classroom teaching practice involving IT. It was also hoped that the framework would offer an interpretive research tool with which to better understand classroom practice involving teacher use of digital technology. In the research project it was found that pre-service teachers experienced difficulties following constructionist principles with IT, at least partly because personal experiences were far removed from constructionism. Because there is no world-wide agreement on terminology, the terms *digital technology*, *information and communications technology* (ICT), *informatics,* and *information technology* (IT) are used interchangeably, as are *beginning* and *pre-service* teachers.

Pedagogic Strategies and Teaching with IT in Schools

Using meta-analytical methods researchers including Tamim, Bernard, Borokovski, Abrami, & Schmid (2011) have analysed research into IT and education that has been reported over several decades. In general the research has indicated that IT can alter the traditional balances and interactions between teacher and learner and make learning more effective, but with some caveats. Among suggested positive effects that IT can have on learning are stimulating the development of intellectual skills; contributing to ways of acquiring knowledge, skills and attitudes; increasing interest and motivation; and enhancing concentration and time on task. However, these benefits from classroom use of technology are dependent on teacher skills with the technology and teacher attitudes to using technology for teaching, which in turn are dependent on the professional education of the teacher in this area. Gobbo and Girardi (2002) also noted a connection between teachers' personal theories of teaching and skill in using technology and believed that these correlated positively with how teachers described their pedagogical style and their views on epistemology.

In their OECD project report on a project that included case studies from 23 countries, Venezky and Davis (2002) found that "successful implementation of IT depends mostly upon staff competence in the integration of IT into instruction and learning" (p.11). They reported that while it is rare for technology by itself to act as a catalyst for school change, technology is a potent lever for planned change implementation. Discussing the WWW and education they stated that a "quality issue relates to the pedagogy employed in educational sites on the WWW" (p.33), and noted that teachers who are neither aware nor competent with pedagogical strategies appropriate for using technology to enhance teaching and learning are unable to make effective use of what is available on the WWW.

Multiliteracies augment the traditional text-based literacy with literacies related to images, sound, and technology, and can be considered as the new forms of literacy now considered essential for citizens in a technological society. The New London Group (Cope & Kalantzis, 1996) created a theoretical underpinning for a pedagogy of multiliteracies and proposed four components for multiliteracy pedagogy: situated practice, overt instruction, critical framing, and transformed practice. In a related but different area, Kress and others have investigated the effects of technology and policy on teaching

secondary school English using the descriptor *multimodality* (Jewitt, Bezemer, Jones, & Kress, 2009).

Webb (2002) studied teacher pedagogy in subjects that used and taught about IT. She noted reports indicating that teachers were unable to develop adequate levels of IT knowledge and skills in their students, while other reports suggested general agreement (at least across Europe) about the content that could be taught at most levels of schooling. "However these specifications are restricted to what is to be taught and make few suggestions as to what pedagogical skills teachers need to teach these courses" (Webb, 2002, p.239).

Instead of defining pedagogy in relation to teaching IT, Webb considered the processes that make up pedagogical reasoning by comparing features of two existing frameworks and found much that was complementary. It should be remembered that most pedagogical models applied to teaching with and about ICT originated in non-ICT contexts, such as Shulman's (1987) model of pedagogical reasoning, which described processes used by teachers in the planning, teaching and evaluating of lessons and identified the need for teachers to possess knowledge about learners, the curriculum and associated resources, and about pedagogy. While Shulman's pedagogical content model emphasised pedagogy, some later models seem to shift the emphasis to technology (Mishra & Koehler, 2006; Polly & Brantley-Dias, 2009). As will be discussed later, this technocentric perspective appears to be in opposition to the principles of constructionism.

Constructionism

When considering pedagogy from a constructionist perspective it is interesting to note that the term *pedagogy* does not appear in the index of either Papert (1980) or Harel and Papert (1993). Both these seminal texts concentrate on learners and learning, and both contain discussion of teachers and teaching with IT. Constructionists argue that constructionism is a framework for action, with many going further and arguing that a framework is insufficient on its own. From its beginnings in the 1960s, Papert, Feurzeig and the other developers of Logo wanted to use technology to change learning in schools. Papert contrasts instructionism and constructionism claiming that there is a difference "that goes beyond the acquisition of knowledge to touch on the *nature of knowledge* and the *nature of knowing* (Harel & Papert, 1993, p.8). Feurzeig has argued that the dichotomy between instructionism and constructionism exposes weaknesses in some common classroom practices where students are told and get little opportunity to construct knowledge for themselves. He noted, "Constructionism is not a rejection of instruction. Learning requires both instruction and construction. They are mutually supportive learning components" (Feurzeig, 2010, p.4).

Edith Ackermann, another early user of Logo, examined the shared concepts of Piaget's constructivism, Papert's constructionism, and Vygotsky's socio-cultural theories. She claims that constructionism "spreads light on how ideas get formed and transformed when expressed through different media, when actualized in particular contexts, and when worked out by individual minds" (Ackermann, 2010, p.4), and also:

> With Papert, we suggest that diving into the unknown, at the cost of experiencing a momentary sense of loss, is a crucial part of learning. Without immersion there is no empathy, and without empathy there is no way to feel for others or grasp a situation from-within. (Ackermann, 2010, p.7)

To conclude this section we note the arguments of Haydn (2014) in his review of problems associated with pre-service teachers effectively integrating IT into their pedagogical practices. He strongly argued that it is "not about students developing advanced technological capabilities" (p.458), but rather about their perceptions and approaches to IT in their classroom. In particular, he claims that there is a need to move away from being primarily concerned with pre-service teachers developing basic skills, because successful education in this area is "not a list of skills but about attitudes to ICT, open-mindedness, willingness to try things out, develop critical appreciation of the potential of various ICT applications" (p. 460).

Studying Teaching with IT

For several years the researchers from the International Centre for Classroom Research (ICCR) at the University of Melbourne have collected data by video-recording mathematics lessons using multiple cameras across different cultures and countries. In the next section there is a brief discussion based on observations from a typical lesson in a specialist IT room, before changing the focus to an attempt to apply contructionist principles when the learning environment is any classroom environment where students have computer access. The main reason for this choice is that it appears more difficult for teachers to apply constructionist strategies in an environment in which students spend most of the time as individuals interacting with a computer. When students are away from computers, it is feasible for teachers to employ a variety of pedagogical strategies, but this changes as soon as students begin to work as individuals at a computer. The pre-service teachers who participated in the project reported that this is what they observed and experienced at the schools they were attached to – instructionist approaches used by teachers with little or no opportunity for students to construct knowledge for themselves.

Experienced IT Teacher in a Computer Room

Several years ago a series of Year 10 IT lessons were video-recorded at a secondary school in Melbourne (Jones & Martin, 2006). Two cameras were used to record lesson events. One camera followed the teacher as she/he moved around the room. The teacher carried a wireless microphone that allowed all comments to be recorded. A second camera was set up in a corner and provided a panoramic view of the computer room, and provided an indication of what students were doing. For this project the actions and words of the teacher were considered the primary source of data, so the image of the teacher occupied the whole screen. A small window at the top left corner of the screen showed the panoramic view of the students.

This manner of research – focussing on the teacher – is being replaced, with more emphasis being placed on how and what students learn with and through

IT. At the conclusion of the project, the researchers believed they had a comprehensive record of events in these lessons, but these did not identify or help explain the pedagogical approaches employed by the teachers. The next section details a planned attempt to encourage pre-service teachers to follow and understand some constructionist principles when teaching with IT.

Constructionism as an Overt Practice in Pre-service Teacher Education

As Logo began to be used more widely in the 1970s, Papert and the other developers clearly saw Logo as a means to involve users in computer programming at all levels from beginner to expert (Abelson & diSessa, 1980; Harvey, 1985). Others, including Papert, Harel, and Resnick saw programming in Logo as an aid to enhancing learning in areas not at that time linked to computer use, and at all levels from kindergarten to university. Around the time desktop computers became available for school use Papert stated:

> In my vision, *the child programs the computer* and, in doing so, both acquire a sense of mastery over a piece of the most modern and powerful technology and establishes an intimate contact with science ... mathematics … and intellectual model building. (Papert, 1980, p.5)

A consideration of the lesson analysis presented above raises several questions, including: "Do teachers in training know anything about constructionist principles, and how can they be introduced to them?" Studying classroom activities and lesson events might report on the actions of teachers. However, it does not inform observers about the pedagogical approaches employed by the teacher.

A group of prospective secondary school teachers in the Master of Teaching course at the University of Melbourne came into contact with a different programming environment in a constructivist manner. These beginning teachers had completed an undergraduate degree and tended to possess a good knowledge of IT in general, gained from personal use in university study and work experiences. However, this bears little relation to the knowledge required for teaching with IT in secondary schools. They have even less knowledge and experience of how to teach in any mode other than the typical lecture, tutorial, workshop approach used in most tertiary studies.

In an attempt to provide a constructionist-like experience to these beginning teachers, a weekly workshop in a computer room explored the use of Scratch to create digital stories. As secondary teachers, they will be expected to teach two subject/curriculum areas. Using Scratch they developed a multimedia product that could be used in the teaching of any non-IT subject. This point is important, as the focus was to be on teaching and learning across the secondary school curriculum. In the first week the twenty-seven beginning teachers and the tutor introduced themselves to each other and then discussed their perceptions of, and attitudes to, classroom programming activities. Unsurprisingly few reported knowledge of a programming language. A very brief summary of the development of Scratch was presented, with links being made to the statement by Feurzeig (2007, p.7) that for the creators of Logo the "intent was not to teach programming as a subject in its own right, but to

exploit programming to teach mathematical thinking. A stronger claim would have been to teach generic (i.e., domain-independent) thinking skills."

Following the introductions the tutor demonstrated a short Scratch program that contained some basic animation and sound. As the demonstration was in presentation mode, the students were not aware of either the format or process of the Scratch coding. Through directed questioning the tutor focused the discussion on what elements in the limited programming they knew that might have been used in the demonstration. The students were also asked whether they thought secondary school students might be able to create multimedia products and whether such an activity would engage them. They were also alerted to the fact that the new Australian curriculum that was being developed would contain computational thinking as part of digital technology.

Students then downloaded and opened the Scratch program from the subject page on the university LMS. The downloaded program opened in the default small stage mode, which displayed commands, scripts, sprites, stages, and a small screen. The tutor briefly showed how to start and stop a program and then suggested they explore as much of Scratch as they could in fifteen minutes. Another sharing of ideas and experiences, including some students using a computer connected to a data projector to show what they had found, followed this. This concluded the first one-hour session. The computer room was free for the next hour, and it was suggested that this was a good time to make notes and store information that could be useful in the future.

In the second session students were presented with the challenge of controlling a sprite (Scratch screen object) as though it was a car to be parked in a parking lot. They were shown two examples, but without access to the Scratch programming. A basic method of controlling a sprite from the keyboard was demonstrated and discussed before the students were encouraged to spend about ten minutes exploring ways of developing other control instructions. This was followed by a discussion in which students were asked to demonstrate what they had been doing, and to discuss and recommend things to try. The students then returned to the task, and were encouraged to share ideas and findings with others. All sessions concluded with a plenary session in which the question was asked, "What have you learned today?"

Students were emailed before the next session asking them to think about how they might have a series of animations activated by the mouse, a task based on an idea suggested by Romeike (2008). The second session began with a brainstorming discussion of the task, particularly what might be possible in the Scratch environment. Students then investigated what was available in Scratch and shared their findings with the group. An interactive whiteboard was used, which assisted students to suggest connections or re-arrangements of ideas. Except for the final five minutes, students worked on their individual projects for the remainder of this session. The session concluded with a whole class discussion of what had been discovered and what worked or didn't work.

The next session commenced with some students sharing features they had added to their project since the previous session. Discussion was then directed towards creating a multimedia story in Scratch. When consensus had been reached on what this might entail in the context of middle secondary years, an adaption of an Aesop fable was downloaded from the Scratch website and shown. Issues including story planning and techniques for animation, changing sprite shapes, changing backgrounds, and adding sound and text were investigated. Students were left with the task of preparing an outline or storyboard of a text-based story they would convert into multimedia format.

At the start of the fifth session several students shared their plans for a multimedia story. It was agreed that everyone would approach the task from the perspective of a teacher wanting to make a demonstration for use with a class at Year 9 or 10 levels at the school they were attached to. Apart from sharing ideas and progress at the start and conclusion of sessions five and six, students worked at creating their multimedia story.

As the weeks passed, the students were guided through a range of experiences based on constructionist principles. Later, approximately two weeks prior to the commencement of a three-week practicum in a school, students were formally introduced to constructionist ideas and asked to reflect on differences and similarities in the way they acquired knowledge about Scratch and other programming languages.

The students and the tutor were aware that it was unlikely for opportunities to arise during this teaching practicum to try out some of the constructionist ideas that had been discussed. However the students were asked to reflect on the approaches they used in the lessons they taught, whether IT was involved or not, and consider whether they had used any constructionist ideas. They were also asked to reflect on the use or non-use of technology in the lessons they taught, especially considering whether technology could have been used to improve their teaching and the student learning.

Conclusion

The review of research presented earlier appeared to show two disturbing trends. First a tendency to for teachers to focus on technology rather than either pedagogy or content, and second that instructionist approaches were much more common than constructionist approaches in lessons using IT.

Today researchers have access to equipment for video-recording many aspects of classroom teaching. A small project that utilised this technology, but did not clearly enable teaching approaches to be discerned, was briefly discussed. Prior to investigating constructionism in school classrooms it was decided to explore aspects of learning constructionistly with a group of pre-service teachers. Interviews and discussion with these participants showed that their IT for learning experiences were wholly instructionist in nature.

Research reviewed for this paper suggested that beginning teachers come with knowledge and skills in technology that do not translate easily into classroom practice, and also that much school IT use is teacher-centred and instructionist

in style. These fit with the key question asked by Haydn (2014, 467), "To what extent can student teachers demonstrate that they are able to make use of the potential of new technologies to improve teaching and learning?"
The two examples presented suggest there is much to be investigated and analysed. In the future it is hoped to conduct research using the ICCR facilities in order to more thoroughly investigate the place of constructionist approaches to teaching with IT in school classrooms.

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