Chapter 6
Insights into Students’ Thinking with Handheld Computers

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ABSTRACT
The handheld computer as a pedagogical tool has the capacity to enable students to demonstrate understanding through different modes of representations, for example, verbal, text, tables and graphs, drawings, writing or written formulas, concept mapping and animations through Flash or Pocket Slides PowerPoint. Its impact as a motivational learning tool has been described in numerous articles. The purpose of this chapter is to describe its use as a research tool for capturing students’ thinking processes as they construct representations in science and mathematics, or solve problems in these learning areas on the handheld. By using an avi-screen capture software operating in the background to do this, the research is a non-intrusive method of capturing the verbal and screen-based (visual) elements of students’ thinking as they use the handhelds to complete individual or collaborative tasks.

INTRODUCTION
Despite their basis in business practices, handheld computers (also known as PDAs, pocket PCs or Palms) have appealed to schools as educational tools because they have the potential to offer school children unique educational affordances (Kimber & Wyatt-Smith, 2006; Perry, 2003, 2006; Sharples, 2003, 2006; Waycott, Jones, & Scanlon, 2005) that include (i) personalised learning (ii) portability (iii) social interactivity (iv) context sensitivity (v) connectivity to networked learning communities and (vi) affordability.

Handheld computers have evolved dramatically over the past decade from electronic organisers to devices with a wide range of features and capabilities that enable them to be useful pedagogical tools in education. These features provide the capacity for students to learn individually and collaboratively in activities that include note taking, audio recording, writing short texts, researching on the Internet, constructing graphs...
and presentations, organising daily activities, taking images, video recording and working collaboratively using Bluetooth in class or emailing outside of class (Nicholas & Ng, 2009). These capacities, together with the small size and reduced price of handhelds compared to other technologies such as laptops or tablet computers offer students and teachers flexible access to the powers of computing.

Most research into handhelds to date has focused on the identification of pedagogical uses of the devices, resulting in the development of a vast array of software for teaching and learning (Becta, 2003; Finn & Vandenham, 2004; Ng & Nicholas, 2007; Palm, 2002; Perry, 2003; 2006; van ’t Hooft, 2006). Only a few studies have reported on the impact of handheld computers on conceptual development in the school years. For example, Swan, van’t Hooft, Kratcoski and Jason (2007) investigated the impact of ubiquitous computing on representations, conceptualisations and uses of knowledge. They found that the availability of technology, including a variety of handhelds, encouraged students to construct representations in multiple forms through which significant gains in conceptual understandings among the students were demonstrated.

This chapter describes the capturing of the construction of multimodal representations by school students learning science and mathematics through the exploitation of the multimedia capacity of the PDA. To capture the thinking and decision-making processes of students as they construct representations to demonstrate their understandings, the use of a video capturing software operating in the background of the PDAs to record verbal and screen-based actions will be described and discussed. The discussion will address the capacity of the handheld computer as a research tool in recording the dynamic (real-time) development of multiple and multimodal representations and recording of the cognitive processes of these students in solving problems in science and mathematics.

THEORETICAL FRAMEWORK UNDERPINNING RESEARCH INTO CAPTURING THINKING WITH HANDHELD COMPUTERS

Science and Mathematics Learning

Many school students find learning mathematics and science concepts difficult, lack confidence in their own abilities and are disengaged from learning the subjects (Dowker, 2004; Goodrum, Hackling & Renniel, 2001; Hart, 1981; Parliament of Victoria Education and Training Committee, 2006; Pierce & Stacey, 2006; Steward & Nardi, 2003). Contributing to the disengagement are factors such as textbook-based work, repetitive exercises, memorisation of facts, formulas and procedures and a lack of connection between classroom content and the real-world context. These factors leave gaps in the students’ knowledge and understanding of mathematics and science. One of the means of overcoming the gaps is for teachers to have a greater insight into how their students learn and a greater capacity to engage with students’ development of representations of those concepts. Ultimately, learning about science and mathematics is not only about test scores but students’ educational and practical functioning in mathematics (Dowker, 2004) and science, so as to produce mathematically and scientifically literate future citizens who are able to apply mathematical and scientific knowledge and understanding to enable them to think critically about decisions that affect their lives (Goodrum, et. al, 2001; Hurd, 1998; Miller, 1998; Thomson, Cresswell & De Bortoli, 2004)

Modes of Representations

Nuthall (1999) proposes that in order to establish more permanent understandings, learners will require multiple exposures to the same concept. Russell and McGuigan (2001) assert that in order to learn, learners need to be provided with oppor-
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