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The impact of a cognitive acceleration programme in science on students in an academically selective high school

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ABSTRACT

This paper describes the impact of a thinking skills programme in science on the cognition of students in an academically selective high school. The research followed a sequential explanatory design with the collection and analysis of quantitative data in the first phase followed by the collection and analysis of qualitative data in the second phase. Participants were 582 Year 8 and Year 9 (ages 12–14) high school students and their science teachers from eight schools who participated in *Thinking Science*, a 2-year classroom intervention and teacher professional learning programme. The schools included one academically selective high school ($n = 144$) and seven non-academically selective schools ($n = 438$). Quantitative data were collected by Piagetian reasoning tasks administered to all students before and after the intervention. Qualitative data included interviews with the head of science and three participating science teachers from the academically selective school. Over the 2-year period, students from the academically selective school had a greater mean gain with a large effect size ($d = 0.995$) when compared with the control ($n = 120$) and when compared with other students who participated in the intervention with a medium effect size ($d = 0.687$). The qualitative data indicated that science teachers in the academically selective school were committed to the intervention and explained how they had changed their pedagogy as a result of the professional learning programme. More specifically, the teachers developed teaching strategies specific to the characteristics of their academically talented students that enabled them to participate in thinking activities such as metacognition and social construction. In conclusion, *Thinking Science* was a worthwhile intervention for all participating students, but particularly for students in the academically selective school where teachers were able to adapt their pedagogy and the approach to suit their students.

1. Introduction

The teaching and learning of thinking is becoming a more prominent aspect of educational policy and curriculum documents in a number of countries (Gallagher, Hipkins, & Zohar, 2012). For example, the European Commission's key competencies for lifelong learning is underpinned by themes including critical thinking and creativity (European Commission, 2007). The OECD's DeSeCo Project (OECD, 2005) recognises that individuals in today's world need to go well beyond the

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basic reproduction of accumulated knowledge and this requires "cognitive and practical skills, creative abilities and other psychosocial resources" (p. 8). Further, "individuals have to learn to think and act in a more integrated way" (p. 9). The Melbourne Declaration on Educational Goals for Young Australians (MCEETYA, 2008) acknowledged that successful learners "are able to think deeply and logically, and obtain and evaluate evidence in a disciplined way" (MCEETYA, 2008, p. 8). As a consequence of the Melbourne declaration, the first national curriculum in Australia, implemented in 2012, included seven general capabilities that are considered to be the skills, behaviours and attributes that students need to succeed in life in the 21st Century. One of these general capabilities is *critical and creative thinking*.

The Australian Curriculum recognises that "thinking that is productive, purposeful and intentional is at the centre of effective learning" (ACARA, 2012, p. 52) and requires teachers to explicitly teach and embed critical, higher order thinking and creative thinking throughout the learning areas. While teaching thinking is now an explicit and required goal of education in Australia, many teachers remain confused about what the teaching of thinking involves, how it might best be achieved and/or how it affects students' learning and achievement (Oliver, Venville, and Adey, 2011). This is an issue internationally, for example, Zohar, Degaini, and Vaaknin (2001) found that 45% of their sample of 40 Israeli teachers believed higher order thinking is inappropriate for low-achieving students. Prior to Israel's national curricular reform focussed on thinking, Gallagher et al. (2012) found that while "projects and local programmes have been quite successful, they have not succeeded in changing the bulk of teaching and learning... rather, such projects and programmes still exist as isolated pockets or 'islands' of exemplary teaching within a 'sea' of much more traditional schooling" (Gallagher et al., 2012, p. 139). Our own research and observations indicate that Gallagher et al.'s island metaphor can be applied to the current situation in Australia where there are examples of excellent practice with regard to the teaching and learning of thinking, but the vast majority of classrooms rarely incorporate activities designed to stimulate cognition in ways that will advance the students' thinking.

1.1. Research rationale

In order for the new Australian Curriculum to make a difference to students' education, evidence is required to support approaches to teachers' professional learning and curriculum development so that Australian children can genuinely become critical and creative thinkers. Two thinking programmes that have been implemented in Australian schools include the Philosophy for Children (P4C) programme (Lipman, 2003) and the *Thinking Science* cognitive acceleration programme originally developed in the UK by Adey, Shayer, and Yates (1989). The research reported in this paper was situated within the initial trialling of the *Thinking Science* cognitive acceleration programme in eight Australian schools. During the implementation of the *Thinking Science* cognitive acceleration programme in Australia, the authors noted contrasting views and opinions from school administrators and teachers with regard to students' levels of achievement and the teaching of thinking skills. On one hand, some educators suggested that a programme on thinking skills that improves cognition should be targeted at low ability students because it is likely to improve their achievement. On the other hand, other educators suggested that such a programme would only be suitable for academically talented students who would be more likely to cope with advanced thinking skills. We were surprised by such responses because evidence to date suggest that all students should be supported by, and can benefit from, excellent teaching and appropriate cognitive stimulation through the explicit teaching of thinking skills (Adey & Shayer, 1993; Adey, Robertson, & Venville, 2002). These contrasting opinions, however, stimulated the inquiry reported in this paper.

1.2. Research purpose

The purpose of this research was to explore the impact of the *Thinking Science* cognitive acceleration programme on the cognition of students in an academically selective school. In particular, we were interested in any change in the academically selective students' cognition compared with students who did not participate in the *Thinking Science* programme and also compared with students in non-academically selective schools who also participated in the *Thinking Science* programme.

1.3. Teaching thinking skills to high and low achieving students

Research shows that quality teaching is fundamental to student achievement (Hattie & Timperley, 2007; Louden, Rohl, & Hopkins, 2008; Rogers, 2007). According to the literature, characteristics of expert teachers include, but are not limited to, concern for students, passion, deep knowledge of the field, flexible instructional repertoires, respect (Matthews, 2009; Rimm, 2009; Van Tassel-Baska, MacFarlane, & Feng, 2006) as well as teaching practices that ensure individual progress (Diezmann & Watters, 2000) and emphasise higher order thinking (Louden et al., 2008). Importantly, good teachers challenge students, they teach skills of thinking and know their subject (Hattie, 2009). Research also has shown that students whose talents are exceptionally higher than their peers should have instruction, resources and activities corresponding to their talents (Feldhusen, 1998) and that school environments that make a difference to the learning of talented students provide opportunities for them to socialise and learn with students of similar achievement levels as well as opportunities to work with a wide range of peers (Gross, 2009; Rogers, 2007).