A Three-Level Intervention Pedagogy to Enhance the Academic Achievement of Indigenous Students: Evidence From *QuickSmart*

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Indigenous students in the middle-school years experiencing difficulties in basic mathematics are a particularly vulnerable group. During these years gaps in performance between educationally disadvantaged students and their peers widen, potentially leading to ongoing economic and social disadvantage. This chapter reports on a teaching intervention referred to as *QuickSmart*, which has been particularly successful with Indigenous students who perform in the bottom 30% of the achievement spectrum in Australia-wide tests. *QuickSmart* has been used in Australian schools since 2001. The pedagogical approach that underpins this numeracy program can be considered at three levels. The first is as an instructional program that withdraws pairs of students from their classroom instruction for three 30-minute periods each week for a 30-week period. The second level constitutes pedagogical themes that are important within *QuickSmart* lessons. For example, the instruction offered in *QuickSmart* lessons builds on the pre-existing knowledge and understandings of students in order to encourage their self-belief through successful learning experiences and by focusing on what are considered foundational skills in mathematics. This approach is very suited to enhancing the learning of many Indigenous students. The third level of pedagogical emphasis relates to the benefits that flow from recruiting Indigenous teacher assistants as Instructors and examining their involvement in the associated professional learning program. This chapter concludes with evidence drawn from the learning progress of Indigenous middle-school students who completed the *QuickSmart* Numeracy program. These data show, based on effect-size statistics, cognitive growth for students of up to two years over the course of a 30-week program.

Key words: academic achievement; numeracy; basic academic skills, Indigenous students

Background

Over the last ten years, research related to the *QuickSmart* program has accumulated compelling evidence indicating that persistently low-achieving middle-school students, including a significant number of Indigenous students, can meet national numeracy and literacy benchmarks and improve significantly on standardised tests (e.g., Graham, Pegg, & Alder, 2007; Pegg & Graham, 2007). For example, on the 2008 national testing program (NAPLAN) assessments, the Northern Territory (NT) profile of results showed that students' achievement of national minimum standards in numeracy was better than their attainment in reading (MCEETYA, 2008). The *QuickSmart* numeracy program has operated in an increasing proportion of Northern Territory schools since 2005. It is currently implemented in more than half of all NT schools.

The *QuickSmart* numeracy program is a research-based intervention program (e.g., Bellert, 2009; Graham, Bellert & Pegg, 2001; Graham, Bellert, & Thomas, 2005; Pegg, Graham, & Bellert, 2005; Graham, Bellert, Thomas & Pegg, 2007) for middle-school students that addresses current educational needs in schools. Between 2001 and 2011, close to 600 schools from New South Wales, the Northern Territory, Western Australia, South Australia, Tasmania, the Australian Capital Territory and Victoria implemented *QuickSmart* numeracy programs. This represents more than 10,000 participating students, of whom approximately 30% or 3000 identified as Indigenous students. The number of participating numeracy students/schools doubled from 2009 to 2010 and further increased into 2011. Working with Indigenous and disadvantaged students and low socioeconomic schools is an important focus of the Science, Information and Communication Technology and Mathematics Education for Rural and Regional Australia (SiMERR) Research Centre and the *QuickSmart* program. Importantly, the positive results of the project implemented with Indigenous students from 31 schools in Western Sydney were mentioned as a Key Schooling Achievement in the 2010 Prime Minister's *Closing the Gap* Report. *QuickSmart* was the only intensive literacy or numeracy project singled out for particular mention, with students' improved speed and accuracy scores highlighted in the report (p. 37).

Through improving the educational attainment of lower-achieving students, including many Indigenous students, the research described in this chapter addresses core factors that can enhance the life potential of many young Australians. The significance of this research lies in the links that exist between basic academic skills and quality of life outcomes in terms of improving Indigenous health and well-being, enhancing social inclusion and ameliorating systemic disadvantage. The systematic review conducted by DeWalt, Berkman, Sheridan, Lohr, and Pignone (2004) is an example of the evidence available about these links. DeWalt et al. (2004) analysed 684 articles to confirm that individuals with low levels of basic academic skills are

up to three times more likely to experience poorer health because of their lack of knowledge about disease markers and health resources. Aboriginal students with poor levels of basic skills, then, are particularly at risk, with the proportion of the population achieving at least the minimum standard of literacy and numeracy attainment decreasing as their geographic remoteness increases (COAG, 2009; Pegg & Panizzon, 2007).

Pursuing the links between health and academic achievement further, a recent combined report from the Australian Institute of Health and Welfare and the Australian Bureau of Statistics (2009) suggested that poor health hinders many Indigenous children's school attendance and, consequently, restricts their ability to learn. In particular, otitis media (an inflammation or infection of the middle ear) has a detrimental effect on the educational outcomes of many students. Five percent of all Indigenous children are likely to have significant hearing problems, especially partial deafness, compared with one percent of the non-Indigenous population (Malin, 2003). Susceptibility to ear infections and other health challenges makes it particularly important that Indigenous students are given excellent instruction and ongoing support in developing basic academic skills. As Howard, Cooke, Lowe, and Perry (2011) argue, enhanced educational opportunities for Indigenous students are most likely to occur through relevant curriculum, quality instruction, increased student participation and through fostering the engagement of Indigenous community members. The instructional approach and implementation practices of *QuickSmart* include many features that address just these types of educational improvement.

The following chapter is divided into five sections. Each section explores briefly a different aspect of *QuickSmart* and its relationship to Indigenous students, teachers and teacher assistants. The first three sections consider the pedagogic underpinnings of *QuickSmart* as (i) an intervention, (ii) a teaching process, and (iii) a vehicle for the professional development of teachers and teacher assistants. The following two sections concern research. Section four describes the research agenda associated with *QuickSmart*, while the fifth section summarises and explores the findings related to example data sets from two states in Australia.

The Pedagogy of Intervention

The *QuickSmart* instructional approach focuses on the role of automaticity in developing students' fluency and facility with basic academic facts, and is informed by relevant literature associated with learning difficulties/disabilities and quality instruction (e.g., Baker, Gersten, & Lee, 2002; McMaster, Fuchs, Fuchs, & Compton, 2005; Westwood, 2007), effective instruction (e.g., Rowe, Stephanou, & Urbach, 2006), mathematics educa-

tion (e.g., Fuchs & Fuchs, 2001) and educational interventions (e.g., Deshler, Mellard, Tollefson, & Byrd, 2005; Marston, 2005). It provides instruction that is intense enough (30 minutes, three times a week in small group settings) and of sufficient duration (for up to 30 weeks) to make a difference to participating students. A teacher or competent teacher assistant commences instruction after completing the initial two-day workshop that introduces the program. Two more two-day professional learning workshops for school staff members involved in *QuickSmart* (i.e., teachers, teacher assistants and support teachers) are scheduled during the 30-week intervention period during the first year.

QuickSmart is described as a fourth-phase intervention. It is usually implemented following the classroom teacher's initial teaching of the content (first phase), and subsequent attempts to differentiate instruction to address students' difficulties (second phase). The third phase occurs when the teacher receives collaborative support from another teacher or teacher assistant within the classroom. The fourth phase refers to intensive focused instruction that necessitates the student being withdrawn from class for a number of periods a week over an extended timeframe.

It is important to note that the structured approach of the program, with its appropriate use of technology, and emphasis placed on both practice and strategy instruction, is very much in tune with how many teachers consider students can be usefully supported. *QuickSmart* is particularly attractive because it is a carefully structured program that focuses on improving numeracy skills. The program shares many of the features of effective third-wave teaching outlined in the discussion paper prepared for the Taskforce on Indigenous Education (June, 2001). This is particularly important because Indigenous students make up approximately one-third of the total number of *QuickSmart* students who have completed the program since 2001. Specifically, in numeracy lessons:

- there is an emphasis on self-regulation, metacognition and self-esteem building, with the goal of increasing independence in learning;
- there are opportunities for extended deliberate practice of unknown facts and in the application of taught strategies;
- student progress is regularly monitored and extensive, detailed feedback is given in each lesson;
- attention is given to clarifying the mathematical use of language in ways that respect each student's language background;
- reinforcement, initially extrinsic, gives way to intrinsic motivation as the long-term goal;
- there is a focus on problem-solving through developing a strategic approach to understanding the question posed and making a suitable plan to solve it; and,
- problems to be solved are at an appropriate difficulty level for the students and, where possible, reflect classroom demands.

The Pedagogy of *QuickSmart* Lessons

In terms of pedagogical practice, the *QuickSmart* approach contributes a unique combination of instructional features that in combination are innovative and effective for improving the academic achievement of middle-school students. This pedagogy incorporates many features of mathematics instruction (e.g., relevance, explicit explanation and feedback, and the use of focused games) that are specifically suggested as effective for teaching Indigenous students (Al-Yaman & Higgins, 2011; Harrison, 2011; Howard et al., 2011). These include:

(i)   an orientation to using both time and accuracy as key dimensions of learning;

(ii) the use of explicit strategy instruction that is individually tailored to students' needs;

(iii) maximising student on-task time through highly structured but flexible lesson formats;

(iv) the provision of extensive support materials, including a variety of learning/teaching resources;

(v)   the inclusion of formative assessment tasks in each lesson with a focus on individual improvement;

(vi) the use of information obtained from formative assessment to provide opportunities for targeted and deliberate practice of basic academic skills;

(vii) the incorporation into the program of the Cognitive Aptitude Assessment System (CAAS) software which operationalises automaticity by capturing data related to students' response speed and accuracy; and

(vii) a focus on developing metacognitive skills in learners, that is, the ability of learners to monitor their own learning and to set realistic learning goals for themselves.

The overarching aim of *QuickSmart* is to increase students' accuracy and automaticity of basic academic skills. Specifically, the pedagogical approach used focuses on a variety of practice and recall strategies geared to developing understanding and fluency of basic academic skills. Each lesson involves revision of the previous session, a number of guided and deliberate practice activities featuring overt self-talk, discussion and practice of memory and retrieval strategies, timed speed sheet activities followed by independent practice activities, and an educational game.

Ongoing assessment and instruction form a continuous cycle. The instruction delivered by one adult to two students is personal, connected and targeted. Instructors' observations and the information gained from questioning

students about their knowledge and strategy use form the basis of instructional decision-making and individualisation. Assessment information is derived from many of the activities in each lesson such as flashcards, speed sheets and independent practice. A computer assessment system, used in most lessons, provides on-going data related to students' levels of automaticity in basic academic skills. Students are also able to evaluate their own learning through recording and graphing important information, such as how many flashcards they answered accurately. Using this performance information, students are encouraged to set realistic future goals.

In order to develop transfer of learning to other settings the pedagogical approach used in the intervention emphasises equipping students with knowledge that can also be used in the classroom and in many other real-life settings. For example, the relevance and utility of basic academic understandings and skills is emphasised to students. They are explicitly encouraged to link their learning in *QuickSmart* lessons to the 'main game' of classroom learning. As Harrison (2011) notes it is important to clarify the relevance of skills for Aboriginal learners.

As already indicated, *QuickSmart* numeracy programs follow a structured lesson sequence based on a 'focus set' of number facts. An important underlying goal of each lesson is to "structure for success" by providing students with a regular and predictable learning sequence. Instructional time is made available for students to practise and build on what they already 'know', and to learn and practise new knowledge. This pedagogical approach provides potent opportunities for students to be more successful in each successive lesson as the result of enjoyable, achievable and personally challenging deliberate-practice activities. Throughout the lessons, students are frequently and genuinely praised for their efforts to learn and improve their skills. Often this feedback is used as an opportunity to reinforce effort and effective strategy use. For example, an instructor may comment that, "Wow, you got 35 flashcards in a minute! One reason I can see that you've improved is that now you're adding whole tens instead of counting one by one". Throughout each lesson every effort is made to ensure that students spend the majority of time on-task, actively engaged with a variety of learning and practice activities. Such explicit teaching and feedback in a small group situation are important features of pedagogy suited to Aboriginal learners. As Howard et al. (2011) write,

> "There are aspects of mathematics where such explicit teaching is recommended, including mathematical vocabulary, standard algorithms (after much exploration and use of the children's own algorithms) and arithmetic facts. Aboriginal children often find the structure of such explicitness reassuring, provided they are able to trial their developing ideas on their peers and their teachers, and receive helpful feedback from these trials." (p. 137)

In summary, implementation and refinement of the pedagogical approach used in *QuickSmart,* means that many of the common learning obstacles that can preclude students from achieving age-appropriate academic outcomes in numeracy can be addressed. Overcoming basic-skills deficits, however, requires consistent and long-term instruction, explicit strategy knowledge, and the systematic use of timed and deliberate practice activities. It is also important to maintain interest and promote students' intrinsic motivation and sense of self-efficacy through frequent occasions of authentic success.

The research findings collected to date have indicated that the carefully constructed instructional design of the instructional program is successful in supporting most students to overcome learning obstacles. The *QuickSmart* program is also underpinned by a carefully constructed series of professional development workshops. The pedagogy of professional learning is discussed in the next section.

The Pedagogy of *QuickSmart* Professional Learning

A further integral and innovative component of the *QuickSmart* approach is the series of professional learning opportunities that are provided to all teaching and support staff, numeracy co-ordinators and educational leaders. *QuickSmart* uses a nested model of implementation (Resnick, 2010) that sets up:

- groups within a school working at the student level;
- groups of schools within a cluster working at teacher professional learning levels;
- clusters of schools within a region working at the policy level while also ensuring the fidelity of implementation; and finally,
- regions of schools within a State that are working to support and evaluate the program.

Such a comprehensive model that aims to work at the policy, school, teacher and student levels is recommended as an approach "that works" to encourage school completion for Indigenous students (Al-Yaman & Higgins, 2011). To date, school communities' involvement in these professional learning experiences has been affected by a number of factors such as the number of schools in a cluster, the implementation activities at each level of the model, the type of commitment to the support of the program that different tiers of education are prepared to make, and whether it is the first year of implementation or a subsequent year. Of particular interest from the point of view of Indigenous education are the clear attempts to build connections within and between members of the school community that are important to the implementation of this program. An overview of the professional learning pedagogy that accompanies the program is provided below.

Region Staff and Principals' Information Session

The first professional information session provided as part of the program's implementation entails a two-hour meeting for senior administrators, principals and other members of school executives. This meeting offers senior staff the opportunity to engage briefly with details of the program, examine the results of the research that establishes the intervention's effectiveness, and understand the necessary commitments to being involved in the *QuickSmart* program.

At this session participants have the opportunity to ask questions and to address or clarify relevant issues. On the basis of the information presented during this day, principals decide whether their schools will participate.

Principals' Professional Learning Workshop

The first professional learning opportunity provided as part of the *QuickSmart* program's implementation is a workshop session lasting a full day for principals and other members of school executives. The purpose here is for senior school personnel to engage deeply with details of the program including the rationale, theory base and instructor roles, and to examine more thoroughly the results of the research that establishes the intervention's effectiveness and the implications of this to their school context. Where possible, site visits to an existing school that is using *QuickSmart* are arranged.

It is important to inform and encourage the involvement of school leaders in the implementation of *QuickSmart* in order to set up conditions conducive to community involvement and the sustainability of the program. School executive members administer budget allocations and oversee staffing decisions that can affect which programs operate successfully in their schools (see Feldman & Pentland, 2003; Spillane, Parise & Sherer, 2011)

Principals are expected to attend a further workshop day in the second and subsequent years that the program is implemented in their school. During these workshop sessions, the activities undertaken at their school in the previous year are reviewed, and Principals are supported in managing and extending the program's impact in the coming year. Most significantly, the focus in these workshops more explicitly addresses the transformational aspects of *QuickSmart* for all students in the school and also for all members of the school community.

QuickSmart Professional Learning Workshops

The professional learning program consists of an intensive series of professional inputs built around the *QuickSmart* instructional program. School Coordinators and Instructors participate in three two-day professional learning workshops within the first year, three one-day workshops in the second year and an optional one-day workshop in the third year.

The first year is considered basic skills training in *QuickSmart* resulting in certification as a *QuickSmart* Instructor. These workshops introduce the approach to participants who learn about and discuss the program's underlying theoretical perspectives, trial the materials, refine their teaching and assessment techniques, and share their experiences with peers. In the second and third workshops the team from each school reports back about implementation issues to other teams of about 10 to 15 schools. Providing information to parents about *QuickSmart* and encouraging their involvement in and support of the program in their child's school is emphasised during these workshops. Successful strategies for encouraging community involvement are shared between participants.

Workshops undertaken in years two and three focus on advanced skills training. Here participants review in a deeper way the central ideas addressed in the first year. In particular, sessions focus on: the cognitive and neuroscientific underpinnings; features such as deliberate practice, formative assessment, and feedback; issues associated with learnable skills; and evaluative frameworks that are suitable in a *QuickSmart* environment.

In summary, the professional learning program that accompanies the *QuickSmart* program is focused on supporting instructors to understand and provide:

- effective instruction that maximises student on-task time, and provides learning scaffolds to ensure that students experience improvement and success;
- a motivational environment that is safe for vulnerable learners and builds trust between Instructor and students;
- deliberate practice that is integral to every lesson, allows for success and is focused on providing targeted feedback to improve learning;
- guided and independent timed practice activities;
- strategy instruction and concept development;
- evidence of competence and increasing student confidence by encouraging a 'can do' and 'have a go' attitude;
- appropriate teacher and peer modeling; and
- motivational academic activities that provide opportunities for modeling and for developing fluency.
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An important dimension of the research reported in this chapter relates to the involvement of Indigenous paraprofessionals in the professional development program already described. This has been an important feature of *QuickSmart* since its inception and has contributed to several Instructors obtaining full-time employment at their schools and a number beginning and progressing through teacher education courses. As one such participant reflected, "My role as a *QuickSmart* tutor has been nothing but positive. The children I have had the pleasure of working with have been happy to partici-

pate in lessons and I have learnt probably as much as they have".

As most schools in remote areas have little staff stability (Sharplin, 2002), the involvement of Indigenous paraprofessionals has also been a way of involving community members and addressing program sustainability concerns (Watson, Partington, Gray & Mack, 2006). Additionally, the explicit involvement of Aboriginal education workers has been identified as a factor that contributes to successful numeracy development through the "empowerment of paraprofessionals to take an ongoing, collaborative and proactive role in students' numeracy development (Efthymiades, Roberts & Morony, 2000, p. 28).

QuickSmart **Research Agenda**

QuickSmart can be considered applied research "that is undertaken to acquire new knowledge but directed towards a specific, practical aim or objective"(HERDC, 2011, p.8). It does not represent a single research activity. Informing *QuickSmart* is a longitudinal programmatic coordinated set of research projects aimed at understanding and addressing numeracy and literacy under-performance in middle-school students across Australia. The research that underpins *QuickSmart* is focused particularly on cognitive processing, the conditions necessary for gaining facility with lower order tasks or basic academic skills, and the potential complementary effects of improved mastery of these skills on higher order learning processes. Accordingly, the research has three overall goals:

- to investigate the nature of improved fluency on the acquisition of basic academic skills;
- to observe whether improved fluency with the basics has any effect on the performance of more demanding academic tasks, such as comprehension and mathematical problem solving, as reflected in students' performance on state-wide tests or standardised achievement tests; and
- to monitor longitudinally the retention or further development and refinement of both basic and higher-order skills.

As *QuickSmart* has been evolving for ten years the focus of research has expanded to consider:

- ways to improve the provision of professional development through a deeper analysis of the results that highlights differences in the approaches of the clusters/schools that achieve greater learning growth for their students;
- documenting the occurrences of 'learnable' features of instruction that are evident after students have graduated out of the program

(e.g., goal-setting, classroom engagement);

- the assessment of 'self-factors' such as student self-efficacy, self-confidence, and scaffolded risk taking that are an important part of the research framework;
- links between the qualitative and quantitative data associated with particular learning obstacles;
- models for successfully scaling-up evidence-based interventions across schools in different states and territories;
- creating closer links between learning theory and educational neuroscience.

The *QuickSmart* project uses a quasi-experimental research design involving collecting and analysing pre-test and post-test data from two groups of students: (i) the '*QuickSmart* students', who participate in the numeracy and/or literacy intervention programs; and (ii) 'comparison students', who do not participate in the intervention programs. The decision to use a quasi-experimental design (whereby participants and non-participants are carefully selected according to set criteria) rather than an experimental design (where participants and non-participants are randomly assigned) was informed by ethical considerations. A paramount consideration was to offer appropriate support to as many students as possible to give them the opportunity to improve their academic performance.

Another consideration in developing the program was to commit to serious data collection involving gathering information from all sites involved. It is the accumulation of evidence from multiple jurisdictions across a range of geographic and socio-economic contexts that should take precedence in establishing the veracity, usefulness, effectiveness and sustainability of an intervention program rather than some large-scale single definitive study.

Primary school students who participate in *QuickSmart* programs meet the following criteria:

- experiencing persistent difficulty in either literacy or numeracy;
- displaying a good attitude to working in small groups, and
- having average cognitive potential without major attention difficulties.

Likewise, participants from high school settings are selected by secondary head teachers using the criteria that the students:

- are experiencing learning difficulties in either literacy or numeracy;
- performed in the lower bands on the State-wide Year 7 screening tests; and
- had a regular school attendance pattern.

In order to gain a clearer indication of the effectiveness of *QuickSmart* in improving target students' accuracy and automaticity of basic academic skills, response time and accuracy and standardised test data are also collected from comparison students. In general, the group of comparison students includes average-achieving students as nominated by their teachers. Com-

parison data afford important opportunities to examine the differences in performance levels for students with learning difficulties compared to a sample of average-achieving students.

Pre-test and post-test data are collected by instructors/co-ordinators for *QuickSmart* and Comparison students using two forms of assessment: the Cognitive Aptitude Assessment System (CAAS) tests and independent state-wide or standardised achievement tests. Independently prepared tests in the form of state-wide tests or standardised achievement tests are used to provide data about the transfer of basic fact knowledge to more complex academic and cognitive tasks. To date, the Progressive Achievement Tests in Mathematics (PATMaths) are being used in New South Wales, Western Australia, South Australia, Tasmania, and the Australian Capital Territory, with a version of the Multilevel Assessment Program (MAP) used in the Northern Territory, and the computer-based On-Demand tests utilized in Victoria.

Research Evidence and Interpretation

This section focuses on the achievement of Indigenous students who have participated in the numeracy intervention. Increasing numbers of Indigenous students have participated in the *QuickSmart* numeracy program in the North Coast Region and the New England Region of New South Wales (NSW), and the Northern Territory since 2006. As demonstrated by the sample analyses discussed below, Indigenous students who participated in the Numeracy intervention in all these regions have made impressive academic gains that are comparable to the academic gains made by non-Indigenous *QuickSmart* students.

To explore these research findings the following summary tables (Table 1 and Table 2) have been created to consider data for New South Wales and the Northern Territory, respectively. These tables focus on the independent tests used to assess the efficacy of the program. In NSW the test administered is the Progressive Achievement Test in Mathematics (PATM) produced by the Australian Council for Education Research (ACER). In the Northern Territory, the test used was developed by the Numeracy and Assessment branch within the NT Department of Education and Training based on previous Territory-wide Multi-level Assessment Program (MAP) tests.

Table 1 and Table 2 below show the data for indigenous *QuickSmart* students, non-Indigenous *QuickSmart* students and average-achieving comparison students from the same school settings. In terms of gain scores, the *QuickSmart* groups exceeded the comparison group in all analyses. This means that *QuickSmart* students were able to 'close the gap' on their average-achieving peers at the basic level of increased scores. Also, all growth scores for *QuickSmart* students were above the anticipated five units of

growth over the period of a year suggested by ACER, despite students not having access to a calculator during the test.

Table 1: Paired data for NSW Indigenous, non-Indigenous and comparison students on PATM assessments

Students Groups	Students with paired data	Pre-Mean Scores (Standard Deviation)	Post-Mean Scores (Standard Deviation)	Average Gain Scores	Effect Size
Indigenous *QS* students	195	39.57 (9.77)	46.18 (10.79)	6.61	0.64
Non-Indigenous *QS* students	511	43.25 (9.56)	49.77 (9.54)	6.52	0.68
Comparison students	216	52.03 (10.47)	55.06 (11.42)	3.03	0.28

Analysis in terms of effect size also supports the findings associated with gain scores. In the analyses of data from *QuickSmart* cohorts shown in Table 1 and Table 2, the effect sizes reported were in excess of 0.4, which indicates an important level of growth. The effect sizes for the *QuickSmart* cohorts were also considerably higher than the growth recorded for the comparison students, which fell within the expected range for average-achieving students of 0.2 to 0.4. Overall, the results of the program for Indigenous students mirror very closely the findings of the larger non-Indigenous cohort. The key point here is that despite starting from a lower base, the Indigenous students recorded gains equivalent to those of the larger cohort of *QuickSmart* students. Hence, participation in the numeracy program facilitates work with students at their level and enables them to achieve similar rates of growth as non-Indigenous students as measured by a standardised assessment.

Table 2: Paired data for Indigenous, non-Indigenous and comparison students on Northern Territory-developed assessments

Students Groups	Students with paired data	Pre-Mean Scores (Standard Deviation)	Post-Mean Scores (Standard Deviation)	Average Gain Scores	Effect size
Indigenous QS students	258	17.68 (8.62)	23.45 (9.07)	5.77	0.65
Non-Indigenous QS students	268	23.10 (7.84)	29.41 (7.46)	6.31	0.82
Comparison Indigenous students	82	24.96 (9.24)	28.43 (9.14)	3.47	0.38
Comparison Non-Indigenous students	167	31.54 (8.98)	34.51 (8.07)	2.97	0.35

These quantitative data complement the extensive qualitative data from parents, teachers and the students themselves collected at participating schools. Teachers' reports indicate that many students who undertake *QuickSmart* exhibit positive behaviours and attitudes such as: improved attention and participation in class; a willingness to take risks with and to enter into discussions about their learning; a decrease in behaviour issues inside and outside the classroom; improved school attendance; and a willingness to see themselves as learners. Some representative quotes presented below clearly illustrate the impact of the program on those involved.

Table 3: Representative Comments from Stakeholders

Group	Representative Comment
QuickSmart Students	Well when I'm in *QuickSmart* I feel really smart. When I wasn't doing *QuickSmart* I didn't really know how to do maths. It helped me in a lot of ways. Like how to do problems, teaching me all my times tables. If it wasn't for *QuickSmart* I don't know where I would be right now. (QS Student, Western NSW Region) Makes me feel like I can do the work. (Student, Lismore Diocese) Good because it gets me out of class and helps me with maths. (Student, Western NSW Region)
Parents /Carers	S.... writes out his own maths problems at home and asks for us to write some for him to do. This is a big change. (Parent, NT) She is trying a lot harder when doing homework and occasionally uses maths in every-day things. (Parent, Northern NSW) One of the best things about *QuickSmart* is that it seems to sponsor a really positive interested attitude to maths – even if you're not really good at it. But then that could be coming from the class teacher and school as a whole as well. Well done. (Parent, NT)
Instructors	As a newcomer to this program I think I expected too much and felt that the students did not progress fast enough. Now at the end of the year I can see the enormous benefits it had. They feel more confident with their number facts – they had a real sense of achievement and a great boost to their self-confidence. Students that find it hard to stay on task or get much work done in class participated with enthusiasm. The achievements for our disadvantaged students, many with added learning difficulties were quite remarkable. (Instructor, North Coast NSW) It has been effective because it is small group work. Enabling students to have a 1: 2 ratio to a teacher gives them more courage to ask questions and the teacher is able to monitor more closely exactly what the child is doing when problem-solving. They are also only risk taking in front of one peer, who they trust not to ridicule them (Instructor, Northern NSW). A lot of the students ask me if they can go with me when some of the students don't want to come or are away. I wish I had more hours in the day and could take everyone. (Instructor, NT)
Principals	As a principal, I've been really thrilled that it means that we're catering for those kids in a way that we probably wouldn't have been. (Principal, New England NSW) It was good to have a very explicit role for the tutor. Other tutors sometimes aren't sure of what they should be doing in the classroom. Tutor was very confident working with all the kids. Developed a sense of ownership for her, helped to build up her expertise. (QS Principal, NT) The students responded well to the concentrated attention of small group tuition. The three sessions a week of organised work focused on their personal profile encouraged students to improve their results and take pride in their achievements. We were lucky to have a calm and nurturing tutor running the program. (QS Principal, New England NSW)
Classroom Teachers	The program was offered to some of my Yr5, Yr6 and Indigenous students. Students showed an improvement in speed at solving basic number facts. The greatest improvement was in their attitude to mathematics. (Class Teacher, North Coast NSW) *QuickSmart* has been an excellent program to develop our Koori students' skills in Maths. As we are a small school many students have benefited from the program. (Class Teacher, Northern NSW)

Implications and Conclusion

National test data (Ainley, Kos, & Nicholas, 2008; Council of Australian Governments, 2008) provide a compelling case for the need to develop programs that improve the literacy and numeracy outcomes for students who are performing at or below the National Literacy and Numeracy Benchmarks. There is a specific need for such programs to be effective for Indigenous and rural students and those with a language background other than English (Commonwealth of Australia, 2008a). Overall, the data discussed in this chapter highlight the impressive gains in academic growth that *QuickSmart* Indigenous students have achieved. In most cases, these students have more than doubled the effect size of the comparison students' academic growth.

Without doubt, the focus of this research program on low-achieving Indigenous students is an important one for research in school education. It is particularly important that findings are rigorously evaluated because the student population targeted in this work is among the most vulnerable in our education system (Dobson, 2001; Fuchs & Fuchs, 2001). It is obvious that educationally disadvantaged students should only participate in support programs that are accepted as educationally sound. Interventions based on unsubstantiated ideas have the potential to take up these students' valuable instructional time and to result in little, or no, maintained gains in performance (Strain & Hoyson, 2000).

In terms of the significance of this research program, assessment data from national testing programs (e.g., National Assessment Program Literacy and Numeracy (NAPLAN), 2008) underscore the necessity to improve educational outcomes for students who are not reaching minimum standards. Further, because of the widening gap between outcomes for Indigenous and non-Indigenous students in Year 3, Year 5 and Year 7, there is a particular need to identify approaches that are effective for Indigenous students early in their schooling experiences and during their middle school years (Frigo, Corrigan, Adams, Hughes, Stephens, & Woods, 2004).

In summary, the research program described in this chapter is concerned with the provision of appropriate instruction with the aim of improving the basic academic skills and performance of low-achieving students, including Indigenous students. Such improvement has clear educational benefit and accompanying positive long-term social implications.

We conclude this chapter with comments taken from an Independent report prepared by Thomas and Murphy (2008) based upon an evaluation of a federally funded *QuickSmart* project in late 2008. After five months of implementation, the effect size growth for Indigenous students (*n*=105 matched pairs) of 0.42 on a standardised test of basic mathematics represented a wa-

tershed of successful learning for these children, and their instructors. Thomas and Murphy (2008) concluded that:

> The evaluators have been impressed with the outcome of the *QuickSmart* (QS) intervention program... This success must obviously be attributed to the structure and delivery of *QuickSmart* – its theoretical and practical underpinnings are substantial and impressive–and also to its inherent attractiveness to students. In the nine schools in which the evaluators observed lessons being conducted students' enthusiasm was obvious and elements of both competition and cooperation spurred them on to further achievement… Most noticeable to the evaluators is the importance of the tutors in the QS program. The *QuickSmart* team at University of New England has devoted and continues to devote attention to the elevation of tutors' standards. Of particular satisfaction to the evaluators has been the observation of so many Indigenous tutors conducting QS lessons. These tutors are enthusiastic and devoted and with few, if any, exceptions, keen to expand their knowledge of QS in future professional development workshops.

References

Ainley, J., Kos, J. & Nicholas, M., (2008). Participation in Science, Mathematics and Technology in Australian Education. *ACER Research Monographs.* http://research.acer.edu.au/acer_monographs/4.

Al-Yaman, F. & Higgins, D. (2011). *What works to overcome Indigenous disadvantage: Key learnings and gaps in the evidence.* Produced for the Closing the Gap Clearinghouse. Canberra: Australian Institute of Health and Welfare.

Australian Institute of Health and Welfare and the Australian Bureau of Statistics. (2009). *The health and welfare of Australia's Aboriginal and Torres Strait Islander peoples.* ABS cat. No. 4704.0.

Baker, S., Gersten, R., & Lee, D.S. (2002). A synthesis of empirical research on teaching mathematics to low-achieving students. *Elementary School Journal, 10*, 51-73.

Bellert, A. (2009). Narrowing the gap: A report on the QuickSmart mathematics intervention. *Australian Journal of Learning Disabilities*, *14*(2), 171-183.

Council of Australian Governments. (2008). *National partnership agreement on closing the gap in Indigenous health outcomes*. Canberra: Australian Government.

Council of Australian Governments. (2009). *Indigenous Reform Agreement (Closing the gap)*. Canberra: Australian Government.

Deshler, D., Mellard, D. F., Tollefson, J. M., & Byrd, S. E. (2005). Research topics in responsiveness to intervention. *Journal of Learning Disabilities*, *38*(6), 483-484.

DeWalt, D. A., Berkman, N. D., Sheridan, S., Lohr, K. N., & Pignone, M. P. (2004). Literacy and health outcomes: systematic review of the literature. *Journal of General Internal Medicine*, *19*, 1228-1239.

Dobson, P. J. (2001). Longitudinal case research: A critical perspective. *Systemic Practice and Action Research*, *14*(3), 283-296.

Efthymiades, D., Roberts, J. & Morony, W. (2000). Numeracy development of Indigenous students: An introduction to research (pps 27-30). Paper presented at the ACER Research Conference, Brisbane.

Feldman, M.S. & Pentland, B.T. (2003). Reconceptualizing organizational routines as a source of flexibility and change. *Administrative Science Quarterly*, *48*, 94-118.

Frigo, T., Corrigan, M., Adams, I., Hughes, P., Stephens, M., & Woods, D. (2004). *Supporting English literacy and numeracy learning for Indigenous students in the early years*. (ACER Research Monograph No. 57), Melbourne: ACER.

Fuchs, D. & Fuchs, L. S. (2001). Principles for the prevention and intervention of mathematical difficulties. *Learning Disabilities Research and Practice*, *16*, 85-95.

Graham, L., Bellert, A. M., & Pegg, J. E. (2001). Enhancing the automaticity of basic academic skills for middle school students, Paper presented at the *Annual meeting of the Australian Association of Special Education*, October, Melbourne, Victoria.

Graham, L., Bellert, A., Thomas, J., & Pegg, J. (2007). A basic skills intervention for middle school students with learning difficulties. *Journal of Learning Disabilities*, *40*(5), 410-419.

Graham, L., Bellert, A., & Thomas, J. (2005). *QuickSmart*: Improving literacy for students with learning difficulties. *Multiliteracies and English Teaching K-12 in the Age of Information and Communication Technologies*, *1*, 1-27.

Graham, L., Pegg, J., & Alder, L. (2007). Enhancing secondary school students' literacy performance through a basic skills intervention. *Australian Journal of Language and Literacy*, *30*(3), 221-234.

Harrison, N. (2011). *Teaching and learning in Aboriginal education* (second edition). South Melbourne: Oxford.

Higher Education Research Data Collection (HERDC) (2011). *Specifications for the collection of 2010 data.* Research Funding and Policy Branch, Department of Innovation, Industry, Science and Research. Canberra: Australian Government.

Howard, P., Cooke, S., Lowe, K., Perry, B. (2011). Enhancing quality and equity in mathematics education for Australian indigenous students. In B. Atweh, M. Graven, W. Secada & P. Valero (Eds.), *Mapping equity and quality in mathematic education* (pp. 365-378). New York, USA: Springer Science and Business.

Howard, P., & Perry, B. (2011). Aboriginal children as powerful mathematicians. In N. Harrison (Ed.), *Teaching and learning in Aboriginal education* (second edition), South Melbourne: Oxford.

Malin, M.A. (2003) *Is schooling good for Aboriginal children's health?* Casuarina, N.T.: Cooperative Research Centre for Aboriginal and Tropical Health.

Marston, D. (2005). Tiers of intervention in responsiveness to intervention: Prevention outcomes and learning disabilities patterns. *Journal of Learning Disabilities*, *38*(6), 539-544.

Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA). (2001). *Report of the MCEETYA taskforce on Indigenous education*. Canberra: MCEETYA.

Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA). (2008). *National Assessment Program Literacy and Numeracy: Summary Report*. Canberra: MCEETYA.

McMaster, K. L., Fuchs, D., Fuchs, L. S., & Compton, D. L. (2005). Responding to nonresponders: An experimental field trial of identification and intervention methods. *Exceptional Children*, *71*(4), 445-463.

National Assessment Program Literacy and Numeracy (NAPLAN). (2008). *National Assessment Program Literacy and Numeracy: Summary Report.* Canberra: MCEETYA.

Pegg, J. & Graham, L. (2007). Addressing The Needs Of Low-Achieving Mathematics Students: Helping Students 'Trust Their Heads'. Keynote. In K. Milton, H. Reeves, & T. Spencer (Eds.) *Proceedings of the 21st biennial conference of the Australian Association of Mathematics Teachers*.

Pegg, J. E., Graham, L. J. & Bellert, A. (2005). The effect of improved automaticity of basic number skills on persistently low-achieving pupils. *Learners and Learning Environments, 29th Conference of the International Group for the Psychology of Mathematics Education*, *4*, 4-49.

Pegg, J. & Panizzon, D. (2007). Inequities in student achievement for literacy: Metropolitan versus rural comparisons. *Australian Journal of Language and Literacy, 30*(3), 177-190.

Poirier, L. (2007). Teaching mathematics and the Inuit community. *Canadian Journal of Science, Mathematics and Technology, 7(*1), 53-67.

Progressive Achievement Tests in Mathematics (PAT Maths, 3rd Edition). (2005). Melbourne: ACER.

Resnick, L. B. (2010). Nested learning systems for the thinking curriculum. *Educational Researcher*, *39*, 183-197.

Rowe, K., Stephanou, A., & Urbach, D. (2006). *Effective teaching and learning practices initiative for students with learning difficulties*. Report to the Australian Government Department of Education, Science and Training (DEST). Canberra: Australian Government Printery.

Sharplin, E. (2006). Rural retreat or outback hell: Rxpectations of rural and remote teaching. Issues in Educational Research, 12 (1), 49-61.

Spillane, J.P., Parise, L.M. & Sherer, J.Z. (2011). Organizational Routines as Coupling Mechanisms: Policy, School Administration, and the Technical Core. *American Educational Research Journal*, *48*(3), 586-620.

Strain, P. S. & Hoyson, M. (2000). The need for longitudinal intervention: Follow-up outcomes for children. *Topics in Early Childhood Special Education*, *20*(2), 116-122.

Thomas, A.R. & Murphy, L. (2008). *Report on the QuickSmart Numeracy Program for Indigenous Students in the New England Region.* University of New England, Armidale: SiMERR.

Watson, P., Partington, G., Gray, J. & Mack, L. (2006). *Culture, Communities and Students. Perth*, W.A.: Aboriginal Education and Training Council.

Westwood, P. (2007). What teachers need to know about numeracy. Melbourne: ACER.

Bio

John Pegg's work is far ranging, and he is particularly known internationally and nationally for his contribution to theory-based cognitive research in Mathematics Education and Assessment. Highlights of his work in this area include over 50 Keynote addresses to national and international research forums, and state and national teacher conferences. Recently he has been the team leader involved in many large-scale nationally significant projects linked to: the validation of teaching standards for the Australian Institute for Teaching and School Leadership; underachieving students in mathematics; state-wide diagnostic testing programs in science; developmental-based assessment and instruction; the validation of the New South Wales professional teaching standards; the 'Maths? Why Not?' project; and investigating junior high school faculties achieving outstanding student learning outcomes.

Lorraine Graham began teaching primary school in the early 1980s. Like many teachers, she was most challenged by those students who didn't learn as easily as their classmates. Subsequently, she completed a postgraduate Diploma in Teaching Exceptional Children from the University of Southern Queensland and then sought to continue further study overseas. Lorraine completed her Master of Arts (Education) (Honours) degree and then her Ph.D. in Instructional Psychology at Simon Fraser University, Vancouver, Canada. During this time she developed and researched the 3H Strategy for improving reading comprehension. She is most interested in developing effective instructional interventions, the teaching of comprehension strategies and general approaches to improving the academic performance of low-achieving students. Her work with *QuickSmart* brings together her major research interests and provides contact with a collegial team of educators at UNE and in *QuickSmart* schools. In recognition of her contributions to her disciplinary area, Lorraine was recognized as a Fellow of the International Association for Research in Learning Disabilities in 2007.

Index words

Provide a list of words that will be used in the index.

academic achievement; numeracy; basic academic skills, Indigenous students; *QuickSmart*; professional learning; effect size; Cognitive Aptitude Assessment System (CAAS)