ABRACADABRA (ABRA) EARLY CHILDHOOD LITERACY PROJECT

ANNUAL REPORT NO. 3

A MULTI-SITE RANDOMISED CONTROLLED TRIAL AND CASE STUDY OF THE ABRA LITERACY SOFTWARE IN NT SCHOOLS

Jennifer Wolgemuth, Janet Helmer, Helen Harper, Kalotina Chalkiti and Tess Lea
The Northern Institute
Charles Darwin University
Darwin, NT

Adrienne Kirby
NHMRC Clinical Trials Centre
University of Sydney
Sydney, Australia

PhilAbrami
Centre for the Study of Learning and Performance
Concordia University
Montreal, Canada

Rob Savage
Centre for the Study of Learning and Performance
McGill University
Montreal, Canada

July 2011
CITATION
ACKNOWLEDGEMENTS

The 2010 ABRA Project was made possible by a founding grant from the Telstra Foundation, with additional funds from The Fred Hollows Foundation, Collier Charitable Fund, the Channel 7 Children’s Research Foundation and the Australian Institute of Aboriginal and Torres Strait Islander Studies. An additional Australian Research Council Industry Linkage Grant in partnership with the Telstra Foundation, the Centre for the Study of Learning and Performance, and the Northern Territory Department of Education and Training (NTDET) enabled the 2010 Randomised Control Trial.

The ABRA Project would not have been possible without the schools, teachers, and students who participated in the research. We are especially indebted to the ABRA teachers who spent long hours learning ABRA, assisting researchers during data collection, and diligently completing logbooks.

Specific advice was provided by staff members at the Menzies School for Health Research at Charles Darwin University (CDU), the University of Western Australia and the NHMRC Clinical Trials Centre at the University of Sydney. As Chief Investigators for the research, Professor Jonathan Carapetis, Associate Professor Peter Morris, Professor Bill Louden and Ms Adrienne Kirby provided research design and statistical advice. In addition, Dr Steven Humphrey from the University of Western Australia guided the Rasch analyses and Adrienne Kirby advised on the ANCOVA analyses. Professor Paul Torzillo from the University of Sydney facilitated our project meetings, assisted with student testing and guided us to Ms Adrienne Kirby and the Clinical Trials Unit.

The following current and former Telstra employees volunteered their time to assist during the pre- and post-testing phases: Ms Christine H. Barnden, Mr Gregory Bourke, Ms Christine Brauner, Ms Anoma Crowley, Mr Colin Jones, Ms Annette Jones, Ms Patricia Kelly, Ms Shona McKeen, Mr Donald Pennell, Mr Robert Preston, Ms Ginette Preston, Ms Laurice Tanios and Ms Pauline White. They spent six hours a day for one week each in February and June 2010 testing the students. The pre- and post-testing would not have been successful without their support.

Mr Greg Moo and staff within the Information Technology Services Division in NT DET assisted with maintaining and updating the software onto the Department’s servers. Mr Michael Duffy provided editorial advice and assistance in producing the final version of this document.
TABLE OF CONTENTS

EXECUTIVE SUMMARY .................................................................................................................. 1
SUMMARY OF KEY FINDINGS, FUTURE RESEARCH AND RECOMMENDATIONS .......................................................... 3
1. INTRODUCTION ......................................................................................................................... 5
2. LITERATURE REVIEW ............................................................................................................... 11
3. RCT METHODS ....................................................................................................................... 19
4. RCT STUDENT LITERACY OUTCOMES .................................................................................. 31
5. IMPLEMENTATION FIDELITY ................................................................................................. 47
6. TEACHER TRAINING AND SUPPORT .................................................................................. 51
7. TEACHER AND STUDENT PERCEPTIONS ............................................................................ 55
8. CASE STUDY .......................................................................................................................... 61
9. KEY FINDINGS, FUTURE RESEARCH DIRECTIONS AND RECOMMENDATIONS .................. 69
10. REFERENCES .......................................................................................................................... 73
11. APPENDICES ........................................................................................................................ 85
    APPENDIX 1: ABRA IMPLEMENTATION FIDELITY INSTRUMENT AND RESEARCHER LOG .......................................................................................................................................................... 87
    APPENDIX 2: ABRA LITERACY LESSON OBSERVATION INSTRUMENT ............................................ 93
    APPENDIX 3: ABRA RAW SCORE ANALYSIS ........................................................................... 97
    APPENDIX 4: RCT ABRA LITERACY LESSON ........................................................................ 99
    APPENDIX 5: ABRA STUDENT INTERVIEW ............................................................................ 103
    APPENDIX 6: ABRA TEACHER TRAINING SURVEY .............................................................. 105
ABRACADABRA (A Balanced Reading Approach for Canadians Designed to Achieve Best Results for All, or ABRA) was developed by the Centre for the Study of Learning and Performance (CSLP) in Montreal, Canada (CSLP, 2009). ABRA aims to help young and emerging readers master foundational literacy skills by engaging them in literacy instruction that captures their interest and sustains engagement. It also helps educators to support students with scaffolded instruction.

The three year ABRA Project in the Northern Territory (NT) included a pilot study in year one (2008) to establish the feasibility of using ABRA in the NT, a quasi-experimental study in year two (2009) to provide preliminary evidence of ABRA’s effect on student literacy outcomes and a randomised controlled trial (RCT) in year three (2010) to test the hypothesis that ABRA will improve student literacy significantly more than traditional instruction alone. An ethnographic case study was also conducted in year three to provide information about the everyday challenges that teachers face using ABRA outside of research conditions. The purpose of this report is to describe the activities and findings of the year three RCT research and ethnographic cases studies.

The RCT was conducted to determine whether using ABRA causes gains in students’ literacy scores above and beyond regular instruction. One week prior to and one week after the RCT intervention, students were tested using the Group Reading Assessment and Diagnostic Evaluation (GRADE) K and Performance Indicators in Primary Schools Baseline Assessment (PIPS-BLA) instruments. The primary outcome was the students’ combined phonological awareness and word reading ability scores on the GRADE K; while the secondary outcomes were other literacy subscales on the GRADE K and PIPS-BLA. Secondary analyses included attendance and age as covariates and comparisons between Indigenous and non-Indigenous students.

A key finding was that ABRA students across all schools and of varying ages and rates of attendance performed consistently and significantly better than control students on phonological awareness and phoneme-grapheme correspondence. ABRA was also equally effective for Indigenous and non-Indigenous students.

The results of the RCT research are limited to the schools and types of students who participated in the study. Findings should also be interpreted in the light that ABRA was delivered over one semester in ‘ideal’ conditions: that is, by teachers who were hired, trained and extensively supported to give ABRA lessons. Further research is needed to evaluate ABRA’s long term impact and its effectiveness when used by classroom teachers who receive less intense and frequent support; and to develop means of implementing interventions which can be sustained over the long term.

The case studies used classroom observations and teacher and student interviews to examine how teachers were using ABRA. They included the perceptions of school staff and of students about (a) working in intercultural contexts and (b) teaching literacy through ICTs. It was found that the case study schools, particularly the remote schools, experienced frequent technological problems with ABRA and did
not always have consistent in-school mentoring to support their teaching practices. Managing students’ behaviour while on the computers was also a key challenge. While some teachers were comfortable integrating ABRA into their regular literacy program, other teachers struggled to make connections between the ABRA activities and other aspects of their literacy learning.

Both the RCT and ethnographic case study research confirm that teachers require a high level of support to achieve strong implementation fidelity when they first begin using ABRA.
SUMMARY OF KEY FINDINGS, FUTURE RESEARCH DIRECTIONS AND RECOMMENDATIONS

Key Findings

ABRA is feasible and effective across the NT context, provided that:

• teachers are well-trained and supported professionally to use ABRA to greatest effect
• ABRA is integrated into the overall literacy program
• it has reliable levels of technical support
• it is accepted by the teachers and the wider school community (a high level of support for Information and Communication Technologies (ICTs) in the classroom)
• the school is properly equipped to deliver ABRA (interactive electronic whiteboards, including a sufficient number of computers for classes.

The evidence showed that ABRA use improves students’ phonological awareness and phoneme-grapheme correspondence to a greater extent than other programs in use.

It also showed that ABRA is effective even with students who have less than ideal attendance and who are from Indigenous or ESL (‘disadvantaged’) backgrounds.

Despite a positive response from teachers in the case study schools, many of whom had integrated ABRA into their overall literacy programs, much of its implementation was less than ideal.

Despite some early apprehension, ABRA’s Canadian provenance was not problematic.

The findings from the ABRA project are broadly consistent with several key factors identified during the course of the Literature Review for the project as necessary for the success of ICTs in classroom literacy programs.

Future Research Directions

• Closer investigation needs to be made into how ABRA compares with other literacy resources and whether its impact would be magnified by a systemic scale-up. A longitudinal study would help assess the impact on later reading outcomes.
• There needs to be research into what constitutes the optimal conditions for teachers to integrate an innovation like ABRA into a balanced literacy program. Among these conditions for investigation are the nature and extent of training, continuing professional development and support, and the nature of the classroom dialogue through which teachers frame literacy instruction.
More research into ICTs being used with special needs and other at risk sub-groups, including Indigenous children with hearing loss or deficiency, would help in understanding whether the use of ICTs was in fact effective and, if they were, what factors contribute to literacy gains.

Questions related to the above, but involving additional investigation, include how teachers could more effectively embed technology into everyday teaching practice, rather than using it as an add-on activity; and whether students would benefit from teachers using ABRA more broadly than they have in this study, in which they focused mainly on ABRA’s alphabetic activities.

A number of students from the intervention group either left the school or were absent during testing periods. These students need to be tracked to assess the impact, if any, ABRA may have had on their literacy development.

Research should also evaluate whether ABRA works more effectively to improve specific types of phonics skills.

PIPS-BLA’s reliability and validity as a measurement of phonics needs further investigation.

It is important that future research address the question of how best to disseminate research findings to teachers as well as to policy-makers and the wider research community.

**Recommendations**

On the basis of this study, the project team recommends that if ABRA is adopted that

- it be used by teachers to support phonological awareness and letter sound knowledge
- it be used at least twice a week for continuity and familiarity, for 30-40 minutes per day, for a total of between 20 and 30 hours over the year
- teachers using ABRA be adequately trained, with at least one full day’s in-service professional development, and supported intensively with bi-weekly visits during the first three months of using ABRA
- regular professional development sessions addressing the integration of ABRA into the broader literacy curriculum would make teachers’ use of ABRA more effective
- teachers should receive additional training in the use of the Literacy Tool Kit as an effective class monitoring tool.

In terms of evidence based research it is further recommended that

- the kind of systematic research used to evaluate ABRA be considered feasible in regional and remote settings and the minimal standard for evidence generation
- interventions in other areas of learning (e.g. maths and science particularly) should be similarly studied
- research transfer be seen as a critical element in the adoption of resources like ABRA.
- the use of ICT-based literacy interventions in comparable international Indigenous contexts should be studied, with a view to better understanding broader issues of implementation.
1. INTRODUCTION

In recent years there has been intense pressure on Australian governments and schools to lift literacy standards, particularly amongst underachieving Indigenous students. Despite well-intentioned efforts to narrow the disparity between non-Indigenous and Indigenous literacy outcomes, and despite considerable government investment through initiatives such as Closing the Gap (DEEWR, 2010), Indigenous students continue to lag behind their non-Indigenous peers. The achievement difference is exacerbated in remote and very remote areas and is particularly acute in the Northern Territory (NT), where Indigenous students make up nearly half of the student population (DET, 2011). For example, according to the results of the National Assessment Program - Literacy And Numeracy (NAPLAN) tests in 2009, while 93.7% of Year 3 students nationally achieved at or above the national minimum standard in reading, only 39.9% of Year 3 Indigenous students in the NT achieved at or above the national minimum standard (ACARA, 2010).

The reasons for these poor results stem from a complex historical, social and cultural dynamic, and form part of a colonial legacy that resists straightforward delineation. Economic disadvantage, poor attendance rates, and the remoteness of many Indigenous communities are often cited as contributing factors to the low literacy outcomes, along with the non-English speaking background of the children, the prevalence of otitis media and related hearing loss, high rates of teacher turnover, and a shortage of teachers trained specifically to teach Indigenous students (Aithal, Yanovitz, & Aithal, 2008; Bourke et al., 2000; Collins & Lea, 1999; Gray & Hunter, 2000; Louden et al., 2005).

Clearly, there is no one strategy that can address all of these issues. However, given the growing body of evidence suggesting that students who fail to acquire basic reading skills in their early years are less likely to attain educational parity with the passing of each school year (Good, Simmons, & Smith, 1998; Leigh & Gong, 2008; Rowe, 2005), it is likely that interventions targeting children very early in their formal schooling could have a significant impact on their later progress (cf. Wise et al., 2005). At the same time, while there is an understandably strong push for ‘quick fixes’ in Indigenous education generally, it is vital that any claims of effect from specific interventions be subject to rigorous appraisal.

This document reports on the final year of a three year study to evaluate the impact of one such intervention in the NT, the ABRACADABRA (ABRA) Project. ABRA is a free, online (http://abralite.concordia.ca) interactive computer tool that was designed to help teachers instruct young children in fundamental literacy skills and that had previously been systematically trialled in Canada, where it was originally developed. The study reported here was designed to test ABRA to the highest standard and to set an example of rigorous, high-quality educational research that provides educational practitioners and policy makers with trustworthy information about what different practices and interventions might achieve.

The ABRA trial was predicated on the hypothesis that an evidence-based tool such as ABRA—that is, an easily delivered, self-paced literacy program that supports
ABRACADABRA 2010: ANNUAL REPORT NO. 3

teachers to provide direct early literacy instruction—may prove to be a practical and efficient form of assisting teachers in teaching foundational literacy skills. Previous studies demonstrating a positive impact of interactive computer programs on Indigenous student motivation (Fleer, 1989; O’Donoghue, 1992; Steen, 1997; Stanton, 1992), together with the substantial Canadian research showing ABRA significantly improves early literacy skills, suggested ABRA may be a highly effective literacy tool in NT early childhood classrooms. Moreover, because ABRA is computer based, it was hypothesised that it would be relatively easy to support in comparison to pedagogical reforms which require entire school transformations (cf. Robinson et al., 2009).

The three-year ABRA Project was designed to subject these predictions to increasingly rigorous standards of proof. The study was conducted in NT Government primary schools with high numbers of Indigenous students. In the first year (2008), a pilot study testing ABRA’s feasibility in three schools produced positive results (REF). This was followed in 2009 by a quasi-experimental study in six schools, which showed, consistent with the earlier Canadian studies, significant gains in phonological awareness and word reading in students who had been exposed to ABRA (REF). The final year of the study, which is the subject of this report, was a multisite randomised controlled trial (RCT) in 2010, also conducted in six schools, and complemented by a set of ethnographic case studies of the implementation of ABRA in four schools.

The intention of the research throughout has been twofold. First, the study aimed to monitor the applicability of an internationally-developed educational tool in the NT context. Second, the research aimed to demonstrate a rigorous process of systematically testing new educational interventions, and to show that experimental research in the context of Indigenous education is neither impractical nor unfeasible. RCTs are relatively rare in Australian educational research, and particularly so in the NT, because they are expensive and difficult to conduct and rely on expertise that is rarely available. However, not to conduct such critical trials may arguably be more costly in the long run. The case studies were additionally conducted to give preliminary insight into issues of implementing ABRA beyond a controlled trial; that is, in ordinary classroom environments with minimal school-based supports.

Background to ABRA
Drawing on best-practice recommendations from the United States National Reading Panel (National Institution of Child Health and Development, 2000), ABRA was originally developed in 2002 at the Centre for the Study of Learning and Performance (CSLP) in Canada to improve the literacy of students four to eight years old (for a description of ABRA’s development, see Hipps, Abrami, & Savage, 2005).

ABRA implements a balanced reading curriculum in a digital environment, helping students to develop word, text, fluency, and eventually writing skills. ABRA aims to develop and enhance the literacy skills of students at risk of failure by helping these students master foundational skills in the early years of schooling, engaging students in literacy instruction that captures interest and sustains engagement, and assisting educators to support students by providing scaffolded instruction.
ABRA is organised into 32 instructional activities embedded in 17 stories. These support instruction in alphabettics, fluency, comprehension and writing (the foundations of literacy acquisition), and allow teachers to target specific skills or guide students to progress from basic skills to complex tasks. The ABRA alphabettics activities include phonological awareness (focusing predominantly on listening skills and auditory discrimination), letter naming, word family manipulation, decoding games and blending tasks with text support. Reading fluency activities cover reading expression and speed. Students can monitor their improvement, as well as decode words within the context of the story. Comprehension activities are levelled and range from more simple tasks like placing a familiar story in order (beginning, middle, and end) to summarising an entire text. Other activities include question prompts that encourage students to think critically about the text and to respond appropriately. ABRA’s writing component is designed for children to apply principles of phonics and their literacy experiences to the writing of words and sentences. Scaffolding mechanisms are built in so that students can complete the writing activities on their own.

Research in Canada has shown ABRA to be popular with students, teachers and parents and that children respond positively to the characters and activities (Hipps, Abrami, & Savage, 2005). It has also been shown to enhance student literacy in Canada with a wide range of learners. Since 2004, several RCTs and quasi-experimental studies have been conducted in Canadian classrooms to measure ABRA’s impact on Kindergarten (Transition) and Grade 1 students’ literacy. The Canadian RCT data to date has shown that ABRA aids typical students in Grade 1 (Savage et al., 2010) as well as children with poor attention (Deault, Savage, & Abrami, 2009) and low socioeconomic pre-reading students in transition level classrooms (Comaskey, Savage, & Abrami, 2009). An RCT comparing two different ABRA treatments (ABRA with a focus on synthetic phonics and ABRA with a focus on analytic phonics) to typical instruction revealed significant advantages for ABRA students on key literacy skills of letter-sound knowledge, phonological blending, listening comprehension and reading comprehension (Savage et al., 2009; Savage, Pillay, & Melidona, 2008). Preliminary results of an RCT conducted in kindergarten, first and second grade classrooms in Canada showed ABRA students significantly outperform non-ABRA students on measures of sight word reading and phonological blending (Savage, Pillay, & Melidona, 2008).

The ABRA developers regularly solicit stakeholder feedback and are additionally informed by research projects such as the current Australian study. This allows the resource to be continually updated through an iterative process of research and development to ensure its efficacy, usability and practicality—which is also why it is delivered via the internet as opposed to static packages such as CDs or DVDs.

Because ABRA is embedded in a framework of rigorous testing and development, it has an advantage over other literacy education software in Australia and North America (such as Reader Rabbit, Hooked on Phonics and Word Shark), for which studies have been limited to small-scale qualitative designs (e.g., Lefever-David & Pearman, 2005).
The ABRA Project Three Year Trial
The study documented in this report follows from and builds on the two preceding years of research that laid the foundations for the Australian RCT.

Following the recommendation of Shadish and colleagues (2002) for testing a new educational intervention, the three year ABRA Project proceeded through three discrete phases: a pilot study to establish the feasibility of using ABRA in the NT; a quasi-experimental study to provide preliminary evidence of ABRA’s effect on student literacy outcomes; and a randomised controlled trial to test the hypothesis that ABRA will improve student literacy significantly more than traditional instruction alone.

The year one pilot study (Wolgemuth et al., 2009) was conducted in three schools in 2008 to establish the feasibility of using the ABRA software in NT classrooms, the fidelity of implementation (or how well ABRA was used in the classrooms) and ABRA’s potential impact on student literacy outcomes. The study also aimed to determine feasible ways of providing relevant classroom support in the NT context, to alert the researchers to any potential problems in the cross-cultural translation of ABRA (from the Canadian to the Australian setting) and to allow the researchers to gain some familiarity with the information and technology systems in NT schools. The year one pilot study also sought teachers’ feedback about ABRA in order to modify the ABRA software to make it more suitable for the Australian context. A request for some small revisions, including the elimination of words that do not rhyme in Australian English, the elimination of letter sounds difficult to distinguish and the need to add Australian stories to the catalogue that were read by an Australian-accented reader, was sent to the CSLP in Canada. All revisions were enacted prior to the commencement of the year two study.

Results from the year one pilot study indicated that, on average, all students gained significantly from pre-test to post-test, especially on measures of phonological awareness; that non-Indigenous students gained significantly more than Indigenous students; that there was no difference between students with high, medium and low implementing teachers; and that attendance was significantly related to student performance (Ehrich et al., 2010).

Due to the limitations of a single-group design, the year one pilot study did not make any claims about causality. Yet there were two reasons to believe ABRA played at least some part in the students’ literacy gains. First, the students experienced the greatest gains in phonological awareness. According to the teachers, these were the skills they felt least prepared to teach and the ones for which they most used ABRA. Second, and significantly, the gains represented seven and four months of learning; far above and beyond what would be expected over a 10 week period of regular instruction.

The year two quasi-experimental study (Wolgemuth et al., 2010) was designed to expand on the year one findings by researching whether ABRA improves student literacy as compared to regular instruction. In 2009, six schools participated in the year two study with at least two classes from each school self-selected to either the
intervention (ABRA instruction) or control (typical instruction) conditions. Student attendance and the quality of implementation and literacy instruction were monitored to determine whether these variables impacted students’ literacy gains. The year two study also included an evaluation of the teacher training and support strategy, and student and teachers’ perceptions of the ABRA software.

Findings of the year two study provided evidence that ABRA worked to improve the phonological awareness of students who attended provincial to very remote schools infrequently to consistently and received varying qualities of literacy instruction.

The year three randomised controlled trial (RCT) was designed to determine, by the highest standard of experimental research, whether using ABRA causes gains in students’ literacy scores above and beyond regular instruction. Specifically, the study aimed to find out if students aged 4-8 years who receive 4 hours of ABRA instruction per week will have greater gains in early literacy concepts than students who receive equivalent amounts of traditional literacy instruction. The RCT protocol was developed according to established clinical trial standards and was registered through the Australian New Zealand Clinical Trials Registry (ANZCTR), the first social science project to be so registered. Registration through the ANZCTR held the researchers publically accountable to design, implement and analyse the research as planned and to make the research findings available for systematic reviews and meta-analyses. The RCT was conducted in 6 schools in the NT with 360 students individually randomly assigned to ABRA or control groups. The teacher training and support strategy and implementation fidelity were also evaluated.

A set of ethnographic case studies was also conducted in this final year of the ABRA study to examine qualitative questions about how ABRA works and under what conditions. The case studies were designed to provide information on the ordinary challenges that teachers face using ABRA outside of research conditions, and to identify ways to improve the implementation of the program in schools with high Indigenous student cohorts. In contrast to the fortnightly support received by teachers in the RCT schools, teachers participating in the case studies received a minimal level of training and support; consistent with the level of support they would receive when beginning to use other literacy resources. Four schools participated in the case studies, and the data gathered comprised classroom observations, teacher and student interviews and various sources of background literature.

**Report Structure**

The purpose of this report is to describe the activities and findings of the third year of the ABRA Project. The following section (Section 2) is a review of the literature on the impact of using Information and Communication Technologies (ICTs) in the literacy instruction of disadvantaged children. The report then describes the RCT study methods (Section 3) and the RCT results (Section 4). This is followed by an analysis of the fidelity of implementation (Section 5), teacher training and support (Section 6); and teacher and student perceptions (Section 7). Section 8 reports on the case studies, while Section 9 provides a summary of the study and recommendations for future research.
2. LITERATURE REVIEW

Introduction
This literature review examines what is known about the impact of using Information and Communication Technologies (ICTs) in the literacy instruction of disadvantaged students generally and Indigenous Australian students specifically. The literature reported here has informed the conceptualisation of the three year research project into the impact of ABRA on the literacy attainment of primary school students in the NT (cf. Wolgemuth et al., 2009; Wolgemuth et al., 2010). The review begins with the methods employed to select relevant literature, which is then organised into two sections. The first section reviews literature about the effectiveness of literacy ICTs across general populations of students, and literature that discusses the various factors that underpin the effectiveness of literacy instruction through ICTs. The review then focuses explicitly on the use of ICTs in the literacy instruction of disadvantaged students.

Methods
A literature search identified studies about the effectiveness of literacy ICTs, including some targeting disadvantaged students, as well as studies that aimed to identify the strategies or best practices contributing to the reported effectiveness. For the first section of this review, only studies with high internal validity (e.g., those that used quasi-experimental or randomised controlled trials) were included. The second section of the review also includes qualitative studies.

The review used as a starting point a tertiary review carried out by Torgerson (2007) which included literature between 1983 and 2004. An additional literature search was carried out to identify literature published between 2004 and 2010 inclusive.

Literature was located through electronic searches of relevant databases (A+Education – Informit; Education Research Complete – EBSCO; Family + Society Plus and PsycINFO – EBSCO), a hand search of selected Australian journals (such as the Australian Journal of Language and Literacy) as well as a review of articles from reference lists of existing literature of systematic and tertiary reviews.

Search terms included: literacy, ICT (s), software, computers, ESL, disadvantaged children, at-risk children, poverty, Indigenous children, remote schools, primary schools and age range 4-8 years old. The review presented here was informed by nineteen papers consisting of a collection of review papers (literature, systematic, tertiary), randomised controlled trials and quasi-experimental studies.

Effectiveness of ICTs for literacy instruction
Torgerson (2007) conducted a tertiary evaluation of systematic reviews from 1983 to 2004, concluding that there was little evidence available to support the idea that ICTs have a beneficial impact on students’ literacy learning. As part of the tertiary review, Torgerson (2007) examined four systematic reviews on the use of ICT to improve literacy. Overall there was little evidence of positive effects of using ICTs in spelling or reading instruction, although two of the cited studies found that learning word-processing skills appeared helpful for weaker writers. In the same year,
Andrews and colleagues (2007) published a similar review of RCT and non-RCT studies between 1998 and 2003 on the effectiveness of ICTs on the learning of written English for five to sixteen year-olds. The authors concluded that causal and/or reciprocal relationships between English, literacy and ICTs have not been yet fully theorised and more research is needed. Finally, Torgerson and Zhu (2004), reviewing only RCTs, reported little evidence supporting the beneficial role of ICTs for literacy learning.

Recently, sixteen RCT and quasi-experimental studies, published between 2004 and 2010, have reported evidence favouring the effectiveness of ICTs in supporting the instruction of alphabetics, comprehension, fluency and writing. Most of the studies reviewed focused on instruction in alphabetics and showed very encouraging effects by reporting low to large effect sizes. A smaller number of studies reported zero to medium effect sizes on comprehension and fluency. Finally, only one study reported large effect sizes on writing. Table 1 presents the results of these studies by outcome categorisation. If a study used multiple measures, its results are presented under each measure categorisation. Studies with outcome measures in more than one categorisation are reported under the categorisation that was most representative.

### Table 1

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Effectiveness</th>
<th>Measure</th>
<th>Intervention intensity and duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Savage et al. (2010)</td>
<td>RCT</td>
<td>No effects, Large effect: Letter sounds ($\eta_p^2=.018$), word attack ($\eta_p^2=.094$), blending ($\eta_p^2=.10$), elision $\eta_p^2=.242$</td>
<td>Letter sounds, Woodcock Johnson III word attack, Comprehensive Test of Phonological Processing - blending and elision</td>
<td>Thirteen hours in total broken down in four 20 minute sessions for twelve weeks</td>
</tr>
<tr>
<td>2. Johnson et al. (2010)</td>
<td>Quasi</td>
<td>Large effect: Total score on DIBELS, comparing gain scores of control and mastery-sequence groups (d=.66).</td>
<td>DIBELS initial sound fluency, letter naming fluency, phoneme segmentation fluency, and nonsense word fluency</td>
<td>Forty minutes a week for thirteen weeks</td>
</tr>
<tr>
<td>3. Davidson et al. (2009)</td>
<td>RCT</td>
<td>No to small effects: Letter naming fluency (d=−.10), initial sound fluency (d=.21). Authors suggest small effect sizes due to teachers’ low implementation levels.</td>
<td>DIBELS letter naming fluency, initial sound fluency</td>
<td>One hour per day for ten months</td>
</tr>
<tr>
<td>4. Savage et al. (2009)</td>
<td>RCT</td>
<td>No effects, Medium effects: Immediate post-test – Synthetic phonics vs Control: blending (d=.48), non-significant results for letter-sound knowledge, word attack, elision, rapid objects and rapid letters. Analytic phonics vs Control: letter-sound knowledge (d=.38), non-significant results for blending, word attack, elision, rapid letters and rapid objects. Delayed post-test – Synthetic phonics vs Control: blending (d=.27), non-significant results for remaining comparisons. Analytic phonics vs Control – No significant results.</td>
<td>Woodcock-Johnson III word attack; CTOPP elision, blending, rapid letter naming, rapid object naming; letter-sound knowledge test.</td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Design</td>
<td>Effect Size</td>
<td>Measures</td>
<td>Duration</td>
</tr>
<tr>
<td>-------</td>
<td>--------</td>
<td>-------------</td>
<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td>Davidson et al. (2009)</td>
<td>RCT</td>
<td>Small to medium effects: Blending (κ=0.35) and rhyming (κ=0.19). Authors suggest small effect sizes are due to teachers’ low implementation levels. Gains reported in phonological skills (e.g., word blending, rhyming and letter-naming) for high implementing teachers instructing children from multilingual and high poverty backgrounds.</td>
<td>CTOPP blending, Woodcock-Johnson III rhyming</td>
<td>One hour per day for ten months</td>
</tr>
<tr>
<td>Wild (2009)</td>
<td>RCT</td>
<td>Small effects: PhAB combined alliteration (κ effect size = 0.19), PhAB combined rhyming (κ effect size = 0.22)</td>
<td>PhAB phonological awareness test</td>
<td>Two days a week for ten to twelve weeks for twenty minutes each time</td>
</tr>
<tr>
<td>Deault et al. (2009)</td>
<td>RCT</td>
<td>No effects, Medium effects: Synthetic phonics vs Control: blending (κ=0.48), non-significant results for letter-sound knowledge, word attack, elision, rapid objects and rapid letters. Analytic phonics vs Control: letter-sound knowledge (κ=0.34), non-significant results for blending, word attack, elision, rapid letters and rapid objects.</td>
<td>Woodcock-Johnson III word attack; CTOPP elision, blending, rapid letter naming, rapid object naming; letter-sound knowledge test.</td>
<td>Four times a week, twenty minutes each for 8-12 weeks</td>
</tr>
<tr>
<td>Chambers et al. (2008a)</td>
<td>RCT</td>
<td>No to small effect: Word attack phonetic skills (κ=0.06, all schools); (κ=0.28, fully implementing schools)</td>
<td>Woodcock-Johnson III word attack</td>
<td>Twenty minutes daily for a year</td>
</tr>
<tr>
<td>Chambers et al. (2008b)</td>
<td>RCT</td>
<td>Small effect: Word attack phonetic skills (κ=0.28)</td>
<td>Woodcock-Johnson III word attack</td>
<td>Twenty minutes daily for a year</td>
</tr>
<tr>
<td>Tracey &amp; Young (2007)</td>
<td>Quasi-experiment</td>
<td>No effect: Effect size not reported and not calculable from data provided. Authors found no significant differences between control and experimental groups (κ=0.53)</td>
<td>Lindamood Auditory Conceptualisation Test</td>
<td>Fifteen minutes daily for a year</td>
</tr>
<tr>
<td>Chambers et al. (2006)</td>
<td>RCT</td>
<td>Small to medium effects: Word attack (κ=0.32); DIBELS (κ=0.12)</td>
<td>Woodcock Reading Mastery Test – Revised, Word attack; Dynamic Indicators of Basic Early Literacy Skills (DIBELS)</td>
<td>Ninety minutes daily for a year</td>
</tr>
<tr>
<td>Macaruso et al. (2006)</td>
<td>Quasi</td>
<td>Large effects: Gates-MacGintie Reading Test total score (letter sound correspondence and word reading) gain scores (κ=0.36). Effect for Title 1 (disadvantaged students) was κ = 2.20 for letter sound correspondence.</td>
<td>Gates-MacGintie Reading Test</td>
<td>Thirty to sixty minutes daily for six months</td>
</tr>
<tr>
<td>Wood (2005)</td>
<td>Quasi-experiment</td>
<td>No effect: Effect size not reported and not calculable from data provided. Author reports “…there was no significant association between membership of any of the conditions of the study and an increase in performance from pre- to post-test on any of the phonological awareness measures, thereby indicating that contact with the software was not significantly better than one-to-one contact with the adult tutor…” (p. 176)</td>
<td>PhAB phonological awareness test</td>
<td>Six fifteen minute sessions</td>
</tr>
<tr>
<td>Segers &amp; Verhoeven (2005)</td>
<td>Quasi-experiment</td>
<td>Large effect: First grade retest of phonological awareness and literacy tasks (κ=0.20).</td>
<td>Verhoeven’s (1991, 1997 &amp; 1995) assessments of rhyming, phonemic segmentation, auditory blending, grapheme knowledge, and decoding.</td>
<td>Fifteen minutes per week for a school year</td>
</tr>
</tbody>
</table>

Comprehension
<table>
<thead>
<tr>
<th>#</th>
<th>Study details</th>
<th>Design/methodology</th>
<th>Measures</th>
<th>Results</th>
<th>Duration of intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Savage et al. (2010)</td>
<td>Quasi-experiment</td>
<td>Small to large effects: Listening comprehension ($\eta^2 = .809$), sentence comprehension ($\eta^2 = .027$), passage comprehension ($\eta^2 = .118$), comprehension total ($\eta^2 = .211$)</td>
<td>Group Reading and Diagnostic Evaluation (GRADE) listening, sentence and passage comprehension</td>
<td>Sixteen hours in total broken down in two hour sessions for eight weeks</td>
</tr>
<tr>
<td>2</td>
<td>Davidson et al. (2009)</td>
<td>RCT</td>
<td>No to small effect: Passage comprehension ($d=.99$)</td>
<td>Woodcock-Johnson III passage comprehension</td>
<td>One hour per day for ten months</td>
</tr>
<tr>
<td>3</td>
<td>Savage et al. (2009)</td>
<td>RCT</td>
<td>No effect, Medium effect: Immediate post-test -- Analytic phonics vs control: Listening comprehension ($d=.35$), reading comprehension ($d=.34$); Synthetic phonics vs control: No significant results. Delayed post-test -- No significant results.</td>
<td>GRADE reading and listening comprehension</td>
<td>Thirteen hours in total broken down in four 20 minute sessions for twelve weeks</td>
</tr>
<tr>
<td>4</td>
<td>Deault et al. (2009)</td>
<td>RCT</td>
<td>No effect, Medium effect: Analytic phonics vs control: Listening comprehension ($d=.35$), reading comprehension ($d=.34$); Synthetic phonics vs control: No significant results.</td>
<td>GRADE reading and listening comprehension</td>
<td>Four times a week, twenty minutes each for 8-12 weeks</td>
</tr>
<tr>
<td>5</td>
<td>Chambers et al. (2008a)</td>
<td>RCT</td>
<td>No effect: Comprehension ($d=.02$, all schools; $d=.05$, fully implementing schools.)</td>
<td>Gray Oral Reading Test – Comprehension</td>
<td>Twenty minutes daily for a year</td>
</tr>
<tr>
<td>6</td>
<td>Chambers et al. (2008b)</td>
<td>RCT</td>
<td>Small effect: Comprehension ($d=.17$)</td>
<td>Gray Oral Reading Test – Comprehension</td>
<td>Twenty minutes daily for a year</td>
</tr>
<tr>
<td>7</td>
<td>Chambers et al. (2006)</td>
<td>RCT</td>
<td>No effect: Comprehension ($d=.08$, all schools; $d=.05$, fully implementing schools.)</td>
<td>Woodcock Reading Mastery Test -- Revised, Passage Comprehension</td>
<td>Ninety minutes daily for a year</td>
</tr>
<tr>
<td>8</td>
<td>Segers et al. (2004)</td>
<td>Quasi-experiment</td>
<td>Small non-significant effect: Reading comprehension ($d=.15$)</td>
<td>Researcher designed reading comprehension test</td>
<td>Unclear</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fluent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Savage et al. (2010)</td>
<td>Quasi-experiment</td>
<td>Medium to large effects: Word reading ($\eta^2 = .85$), Vocabulary composite ($\eta^2 = .030$).</td>
<td>Group Reading and Diagnostic Evaluation (GRADE) word reading, word meaning and vocabulary composite</td>
<td>Sixteen hours in total broken down in two hour sessions for eight weeks</td>
</tr>
<tr>
<td>2</td>
<td>Wild (2009)</td>
<td>RCT</td>
<td>Small effect: PhAB combined fluency ($f^2$ effect size $=.14$)</td>
<td>PhAB fluency</td>
<td>Two days a week for ten to twelve weeks each day</td>
</tr>
<tr>
<td>3</td>
<td>Deault et al. (2009)</td>
<td>RCT</td>
<td>No effect: Analytic phonics vs control: No significant results; Synthetic phonics vs control: No significant results.</td>
<td>GRADE vocabulary, Woodcock Johnson III Reading Fluency</td>
<td>Four times a week, twenty minutes each for 8-12 weeks</td>
</tr>
<tr>
<td>4</td>
<td>Savage et al. (2009)</td>
<td>RCT</td>
<td>No effect, medium effect: Immediate post-test -- Analytic phonics vs control: No significant results; Synthetic phonics vs control: No significant results. Delayed post-test -- Analytic phonics vs control: No significant results; Synthetic phonics vs control: reading fluency ($d=.33$).</td>
<td>GRADE vocabulary, Woodcock Johnson III Reading Fluency</td>
<td>Thirteen hours in total broken down in four 20 minute sessions for twelve weeks</td>
</tr>
<tr>
<td>5</td>
<td>Ecalle et al. (2009)</td>
<td>RCT</td>
<td>Large effects: Word recognition ($d=.80-1.15$, at 3 testing intervals after intervention) and word reading aloud ($d=.86$ at last post-test)</td>
<td>Batterie d’Evaluation du Langage Ecrit (BELEC)</td>
<td>Ten hours over five weeks</td>
</tr>
<tr>
<td>6</td>
<td>Chambers et al. (2008a)</td>
<td>RCT</td>
<td>No to small effect: Fluency ($d=.06$, all schools $d=.23$, fully implementing schools)</td>
<td>Gray Oral Reading Test - Fluency</td>
<td>Twenty minutes daily for a year</td>
</tr>
<tr>
<td>7</td>
<td>Chambers et al. (2008b)</td>
<td>RCT</td>
<td>Small effect: Fluency ($d=.28$)</td>
<td>Gray Oral Reading Test – Fluency</td>
<td>Twenty minutes daily for a year</td>
</tr>
<tr>
<td>8</td>
<td>Macaruso et al. (2006)</td>
<td>Quasi-experiment</td>
<td>Medium effect: Word reading for Title 1 (disadvantaged) students ($f^2 = .36$)</td>
<td>Gates-MacGintie Reading Test</td>
<td>Thirty to sixty minutes daily for six months</td>
</tr>
<tr>
<td>9</td>
<td>Segers et al. (2004)</td>
<td>Quasi-experiment</td>
<td>Medium effect: Vocabulary ($d=.38$)</td>
<td>Researcher designed curriculum dependent vocabulary tests</td>
<td>Unclear</td>
</tr>
</tbody>
</table>

**Writing**
Factors underpinning the effectiveness of ICTs in literacy instruction

This section reviews literature that suggests various factors that underpin effective Information and Communication Technology (ICT) enabled literacy instruction, namely (i) the technical capabilities of the ICT software, (ii) the intensity and duration of the intervention using ICTs, (iii) whether phonics-based interventions involve synthetic or analytic phonics, and (iv) teachers’ skills in adopting and implementing ICTs.

Technical capabilities of ICTs

The technical capabilities of literacy ICTs can have an impact on the success of the instruction. Chambers and colleagues (2006) reported that multimedia applications embedded in ICTs support gains in alphabolics and that a combination of multimedia applications and computer-assisted tutoring can explain gains in comprehension, alphabolics and fluency (Chambers et al., 2008a; 2008b). Although more research is needed to understand how various technological features impact teaching and literacy gains for children (whether, for example, gains are related to cognitive processes or to increased student motivation), it is argued that ICTs can offer both visual and auditory content and this combination allows for greater literacy gains (Chambers et al., 2008a; 2008b).

The interactivity opportunities offered by ICTs can positively impact student engagement. For example, Wild (2009) reported literacy gains related to the opportunity for students to obtain feedback with ‘spatial and temporal contiguity’ (p. 416). Student gains can also be related to the method used to present the information in literacy software programs. Three methods of presenting material with ICTs are identified from the literature: learner-controlled picture menus, linear sequencers and mastery-based adaptive sequencers (Johnson, Perry, & Shamir, 2010; Scheiter & Gerjets, 2007). Young children seem to benefit more from the use of sequencers rather than learner-controlled picture menus (Johnson, Perry, & Shamir, 2010). On the other hand, older students may be more competent in participating and responding to a self-determined learning environment (Scheiter & Gerjets 2007).

Further empirical evidence relating to how information is presented and how literacy instruction is supported comes from Ecalle, Magnan, & Calmus (2009), who reported gains in word spelling attributable to the segmentation feature of the computer-assisted-learning program used in the study.

Intensity and duration of ICT interventions

The intensity and duration of an intervention may also impact on children’s literacy gains. For example, interventions with a short duration (e.g., less than 13 hours in total) tend to support gains in alphabolics rather than in other literacy aspects such as fluency or writing (Savage et al., 2009; Deault, Savage, & Abrami, 2009; Segers & Verhoeven, 2005). A study by Segers & Verhoeven (2005), did not report gains in

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Effect Size</th>
<th>Test Used</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Savage et al. (2010)</td>
<td>Quasi-experiment</td>
<td>No effect: Spelling ($\eta_p^2 = 0.06$)</td>
<td>Wide Range Achievement Test III</td>
<td>Sixteen hours in total broken down in two hour sessions</td>
</tr>
<tr>
<td>Ecalle et al. (2009)</td>
<td>RCT</td>
<td>Large effects: Word spelling ($d=0.79-1.05$, at 3 testing intervals)</td>
<td>Batterie d’Evaluation du Langage Ecrit (BELEC)</td>
<td>Ten hours over five weeks</td>
</tr>
</tbody>
</table>
the decoding skills of kindergarten children, but suggests that kindergarten children may need to interact with literacy software for longer periods to be able to advance in writing literacy skills. In contrast to this view, a handful of studies (see Table 1) have reported fluency and writing gains from interventions of a short duration. It may be that differences in gains reflect the different strengths of specific ICTs to deliver literacy instruction. For example, some ICTs may be better in supporting and helping children gain in alphabolics rather than other literacy aspects (Deault et al., 2009).

**Teachers’ skills in adopting and implementing ICTs**

Studies have pointed to the importance of teachers’ skill-sets in using ICTs to support literacy instruction (Savage et al., 2009; Wild, 2009). For example, Comaskey, Savage, & Abrami (2009) found that small effect sizes for instruction in blending and sound fluency could be attributed to teachers’ low levels of implementation using ICTs.

In a recent review of challenges to the successful integration of ICTs, Bingimlas (2009) highlighted a number of barriers to the adoption and implementation of ICTs. These include teachers’ lack of confidence and competence with the technology, and teachers’ resistance to change. Such challenges can be overcome by better preparing and equipping teachers for ICT-supported instruction and by providing support for teachers as they learn to use the ICTs (Davidson, Fields, & Yang, 2009; Savage et al., 2009; 2010). Teachers also need to be competent in the elements of literacy instruction itself. For example, Davidson, Fields, & Yang (2009) proposed that training in phonological awareness instruction will better equip teachers to use ICTs to help teach phonological awareness.

**Literacy ICTs for disadvantaged students**

While there is relatively scant empirical literature addressing the impact of ICTs in the instruction of disadvantaged students specifically (Floyd, Canter, & Judge, 2008, Lankshear & Knobel, 2003), some of the research reviewed earlier (Table 1) included disadvantaged student populations. These populations appear to benefit from the use of ICTs mostly in alphabitics (eleven studies, as indicated in Table 2) and to a lesser extent in comprehension, fluency and writing. School populations shown to benefit include urban and suburban schools with children of varying socioeconomic status, cultural and language backgrounds (Ecalle, Magnan, & Calmus, 2009; Savage et al., 2009) and children from high poverty and minority schools with multi-cultural and ESL status (Chambers, 2006; 2008a; 2008b; Comaskey, Savage, & Abrami, 2009; Davidson, Fields, & Yang, 2009; Di Stasio, Savage & Abrami, in press; Macaruso, Hook, & McCabe, 2006; Tracey & Young, 2007; Wild, 2009).

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Literacy gains of disadvantaged children (2004-2010)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literacy aspect</td>
<td>No studies</td>
</tr>
</tbody>
</table>

*
*Macaruso et al. (2006) and Segers & Verhoeven (2005) were the only studies to carry out a subgroup analysis of the effect of ICTs on the literacy instruction of disadvantaged children and reported gains in alphabetics.

For the purpose of this review, the limiting factor of the aforementioned studies is that most have not carried out a subgroup analysis to examine the role of literacy instruction via ICTs specifically on disadvantaged children’s literacy gains. Only two of the nineteen studies (Macaruso, Hook, & McCabe, 2006; Segers & Verhoeven, 2005) investigated the role of ICTs on the literacy attainment of disadvantaged children, reporting gains in alphabetics for children deemed at risk of reading failure and with ESL status.

Qualitative studies also suggest that ICTs may be a useful medium to support the literacy development of disadvantaged children and help bridge literacy disparities between Indigenous and non-Indigenous children (Fish et al., 2008). There is little literature relating specifically to the impact of ICTs on the literacy learning of Australian Indigenous students specifically, although some early studies suggest that interactive computer software can be highly motivating as an instructional tool for Indigenous students (O’Donohue, 1992; Steen, 1997; Stanton, 1992).

ICTs have the potential to engage students through the use of colours and animation features (Parette, Hourcade, Boeckmann & Blum, 2008; Weikle & Hadadian, 2003). ICTs may also facilitate the delivery of more intensive interventions to help disadvantaged children or children learning English as a second language acquire emergent literacy skills (Garcia & Arias, 2000; Katims, 1991; Phillips, Clancy-Menchetti, & Lonigan, 2008). ICTs can equalise learning opportunities for disadvantaged children by enabling the adaptation and modification of the delivery of curriculum materials and enabling disadvantaged children to participate more fully in literacy activities (Hitchcock & Noonan, 2000; Hutinger et al., 2006). Further to participation, disadvantaged children may achieve greater independence in developing their literacy because of the motivational value of some technological features (Leloup & Ponterio, 2003). Student-paced activities and immediate generated feedback may not only help literacy outcomes for children but also keep them engaged and motivated (Macaruso, Hook, & McCabe, 2006). Further, ICTs may be well suited for supplementary instruction in reading, offering the possibility for more intensive practice (Magnan & Ecalle, 2006), and helping teachers promote flexible and customised literacy instruction (Hameed, 2007).

Qualitative research also suggests that literacy ICTs be implemented by well-trained teachers and aligned with existing approaches to literacy instruction, recognising the diversity of student needs. For example Donovan (2007) highlights the importance of recognising students’ cultural background when using ICTs. Kozma and Wagner (2006) argue that ICTs alone cannot improve the literacy of disadvantaged children unless ICTs are aligned and integrated with programs that acknowledge and address
the linguistic, academic and social needs of the learners. This explains equivocal findings such as those reported from Davidson, Fields, & Yang (2009) who found no gains for low implementing teachers but recorded literacy gains in word blending, rhyming and letter-naming for high implementing teachers instructing students from multilingual and high poverty backgrounds. To address the need for well trained teachers to deliver literacy ICTs to disadvantaged children it is recommended that teachers receive extensive training and are continuously supported by professionals or peers (Lee & O’Rourke, 2006; Savage et al., 2010; Umar, 2006).

It should also be noted that ICT implementation and integration in remotely located schools and/or in marginalised communities may require significant networking and telecommunication infrastructure (Thinyane et al., 2006). Adequate technical support is therefore critical to the effective use of ICTs (Bingimlas, 2009) and to ensure instructional consistency. Further, for literacy instruction through ICTs to be effective, it should be embraced by communities (Ayorkor Mills-Tettey et al., 2009; Bingimlas, 2009; Savage et al., 2010), school decision makers (Savage et al., 2009; 2010) and teachers who are qualified to deliver literacy instruction to disadvantaged children with the help of ICTs (Ayorkor Mills-Tettey et al., 2007; Johns, 2006).

Finally, a consideration of ICT-based instruction for Indigenous students specifically should take into account the fact that Indigenous students in the NT are likely to experience varying degrees of intermittent or permanent hearing loss as a result of otitis media (Aithal, Yanovitz, & Aithal, 2008; Couzos, Metcalf, & Murray, 2003; Leach, 1999). This may affect their speech and language development (Couzos, Metcalf, & Murray, 2003; Wallace & Hooper, 1997), impacting on their ability to learn literacy easily (Partington & Galloway, 2005). In particular, there is evidence that hearing loss associated with otitis media may inhibit the performance of Year 1 Indigenous children in phonological awareness (Eimas & Clarkson, 1986; Gravel & Wallace, 1995; Groenen, Crul, Maassen, & van Bon, 1996; Yonowitz, Yonowitz, Nienhuys & Boswell, 1995) as well as other aspects of reading and writing (Walker & Wigglesworth, 2001). For these children, ICTs may be beneficial when they offer visual content and auditory support, particularly to help students develop phonemic awareness and phonics understandings in particular (Easterbrooks & Stephenson, 2006; Trezek & Malmgren, 2005).

This literature review informed the conduct of the research at all stages, particularly the RCT and the case study. These are explored in greater detail later in the review, but their findings are broadly consistent: that using ABRA as the ICT software for delivering more effective literacy development is feasible. There are minor qualifications to that conclusion, which again are broadly consistent with the literature: the training and development of teachers is among the critical success factors; that the ICT program should be integrated with conventional literacy programs and that various factors, including the reliability of ICT infrastructure, may negatively impact on overall effectiveness.
3. RCT METHODS

As discussed earlier, the overall aim of the RCT was to assess whether the use of ABRA, a web-based literacy tool, would improve early literacy skills of 4-8 year old students in the NT, particularly in phonological awareness and reading. A secondary aim was to determine whether ABRA was especially effective for Indigenous students.

Design

The study design was a pragmatic multisite randomised controlled trial (RCT), conducted during the first semester of the 2010 school year. Instead of implementing the web-based tool in ideal conditions, we wanted to determine whether it would work when embedded in daily school environments and routines. This pragmatic approach allowed all the students in our study to receive their normal classroom teaching, which included the usual literacy lessons (Brooks, et al., 2006). However, half of the students were randomised to be withdrawn from the literacy lessons to receive the web-based literacy instruction delivered by teachers specially trained to deliver ABRA lessons and to adhere to specific parameters of this research.

While individual student randomisation is not ideal for an intervention typically delivered at the teacher-level (Hitchcock, et al., 2009), the relatively small number of primary schools in the NT that have sufficient student enrolment, reliable Internet access and are accessible to researchers during the NT ‘wet season’ meant a multisite cluster RCT would not be adequately powered to detect treatment effects. In our design we treated schools as fixed-effects with the intention only to generalise the findings to the participating schools. This approach is supported by Schochet (2008) who argues generalisability can be assessed by examining the pattern of treatment effects across schools and that treating schools as fixed effects provides “credible information on the extent to which specific interventions could be effective and whether larger scale studies are warranted to examine whether they truly are effective” (p. 70).

Setting

The RCT was conducted in 17 Kindergarten to Year 2 classes in six schools located in three NT cities: Darwin (the NT capital, located on the Timor Sea), Palmerston (located 21 km south of Darwin), and Alice Springs (a remote cite 1500 km south of Darwin, in the geographical centre of Australia).

The 17 classes were taught by 19 teachers. Due to turnover, two classes were taught by two different teachers over the semester. The percentage of Indigenous students in each classroom ranged from 0% in Palmerston to 70% in Alice Springs.

1 This clinical trial is registered with the Australia New Zealand Clinical Trials Registry (ANZCTR). See http://www.anzctr.org.au to view the protocol.
**Intervention: ABRA**

Students who were randomised to the treatment left their classes 4 days per week for 30-45 minutes to attend ABRA lessons during Semester 1, 2010. This meant students would receive at least 32 hours of ABRA instruction, well over the 20 hours previous research has suggested is sufficient to achieve optimal results from phonological awareness instruction (Ehri, Satlow, & Gaskins, 2009; NICCHD, 2000). The ABRA lessons were delivered by teachers who were hired and trained specifically for the research. The teachers used the schools’ available technologies, including interactive whiteboards, computer laboratories and laptops to deliver ABRA lessons.

The ABRA teachers were trained both to implement ABRA and to assist in the research over a week prior to the start of the semester. The training included a focus on using ABRA for phonological awareness instruction as previous studies in the NT have indicated this is an area in which students need explicit instruction and teachers feel underprepared to teach (see Wolgemuth et al., 2009; 2010). The ABRA teachers were intensively supported by a university researcher during bi-weekly site visits in which the researchers observed and provided constructive feedback on the ABRA lessons. The ABRA teachers were also encouraged to collaborate on lesson planning to ensure they provided the similar quality and type of instruction.

**ABRA Teachers**

Six teachers were hired to deliver ABRA lessons. Three of these teachers were nominated by the schools and three were recruited through newspaper advertising.

Prior to running advertisements in the local newspapers, we asked the six school principals to nominate teachers with whom they were familiar and who met the job qualifications to deliver ABRA lessons. Three of the six schools nominated teachers who had been casual teachers for them and they felt would be a good addition to the school for the semester.

Of these three, two teachers resigned; one within the first month and the other halfway through the semester, for reasons disconnected to the ABRA research. To fill their vacant positions, the project team ran newspaper advertisements, but no-one suitable applied. Both principals then nominated another teacher to take over so that the research could continue in their schools. In one school the ABRA teacher was an employee who did not have a full-time teaching load, but had experience teaching early childhood for over 15 years. In the other school, the new ABRA teacher had 15 years of experience as a secondary teacher and more recent experience as a casual teacher at the primary level. The teacher turnover resulted in a cessation of ABRA lessons for one week in one school and for four weeks in the other.

Of the three ABRA teachers hired through the newspaper advertisements, one was a recent university graduate, one had over 15 years of experience teaching primary grade and ESL students and the final teacher had taught over 20 years in all levels from early childhood through to high school science.
Control Condition

Students randomised to the control group received the usual literacy instruction from their classroom teachers. In the 2010 ABRA research, two schools used Accelerated Literacy, an approach to teaching literacy developed in Australia with Indigenous students that uses rich literate texts to help teach students read at an age-appropriate level (Gray & Cowey, 2004). Three used First Steps, a balanced literacy program that includes:

all the critical aspects of what and how to teach (as well as why) are explained, including teaching reading strategies, using the Gradual Release of Responsibility Model, improving fluency, developing phonological awareness, teaching graphophonics, developing comprehension and building vocabulary and text form knowledge (Annadale et al., 2004).

The final school used a more eclectic approach by combining best practices from various programmes such as First Steps and Walking Talking Texts. All control classroom teachers were also complementing their literacy instruction with either Jolly Phonics (Lloyd, 1992), a synthetic phonics program that employs a multi-sensory approach to instruct students in the letter sounds and how to blend them to form words or Teaching Handwriting, Reading And Spelling Skills (THRASS) Phonics (Davies & Ritchie, 1998), an approach to teaching synthetic phonics (see Brooks, 2002; Lovegrove, 1998).

Following the ABRA data collection period the control teachers received a full day training session to use ABRA and were encouraged to use ABRA when the study ended. This training was facilitated by the ABRA teachers in each of the RCT schools. In total, fourteen of the seventeen control teachers received ABRA training at the end of Semester 1.

Literacy in the control classes took on different delivery styles such as whole group delivery, a learning centre approach or a combination of the two. Lessons generally started with some type of Phonics instruction followed by group reading. Classes that were using a centre based approach rotated through various learning activities in small groups, with one of the groups receiving direct instruction from the teacher. As half of the students from the full class were out with the ABRA teacher, the control classes were relatively small, and on occasions the control teacher used the available time to work one on one with students while the others worked independently on an assigned activity.

Control Teachers

In the seventeen classes, there were 20 teachers over the semester as a two of the control classes experienced teacher turnover during the ABRA research. One of the classes had three different teachers by the end of the first term and another had two different teachers over the course of the first semester. There were 17 females and 3 males. The 17 classes were taught by teachers whose years of teaching experience ranged from 3 to 37 years and who had been teaching early childhood between 3 and 19 years.
Participants
Six schools expressed interest in participating in the research. All had reliable Internet access; enrolled a minimum of 60 students in Transition, Year one and Year two classrooms; and had a student population comprised of at least 30% Indigenous students participated in the study (see Table 1). The schools were located in regions classified by the Australian Bureau of Statistics (ABS) as ‘provincial’ and ‘remote’.

Table 3
ABRA Schools’ Geo Locations, Classes and Percent Indigenous and Average Attendance Rate during Semester 1, 2010

<table>
<thead>
<tr>
<th>School and ABS Geolocation</th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
<th>Class 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>School 1 Provincial</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year Level</td>
<td>T</td>
<td>1</td>
<td>T</td>
<td>--</td>
</tr>
<tr>
<td>Percent Indigenous</td>
<td>13.6%</td>
<td>0%</td>
<td>9.1%</td>
<td>--</td>
</tr>
<tr>
<td>Average attendance</td>
<td>.92</td>
<td>.93</td>
<td>.96</td>
<td>--</td>
</tr>
<tr>
<td>School 2 Remote</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year Level</td>
<td>T/1</td>
<td>T/1</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Percent Indigenous</td>
<td>70.0%</td>
<td>42.9%</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Average attendance</td>
<td>.88</td>
<td>.90</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>School 3 Remote</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year Level</td>
<td>T/1</td>
<td>1/2</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Percent Indigenous</td>
<td>63.6%</td>
<td>60.0%</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Average attendance</td>
<td>.94</td>
<td>.89</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>School 4 Provincial</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year Level</td>
<td>T/1</td>
<td>T/1</td>
<td>½</td>
<td>--</td>
</tr>
<tr>
<td>Percent Indigenous</td>
<td>42.9%</td>
<td>15.4%</td>
<td>47.1%</td>
<td>--</td>
</tr>
<tr>
<td>Average attendance</td>
<td>.87</td>
<td>.91</td>
<td>.89</td>
<td>--</td>
</tr>
<tr>
<td>School 5 Provincial</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year Level</td>
<td>T/1</td>
<td>T/1</td>
<td>T/1</td>
<td>T/1</td>
</tr>
<tr>
<td>Percent Indigenous</td>
<td>15.8%</td>
<td>17.8%</td>
<td>7.1%</td>
<td>18.8%</td>
</tr>
<tr>
<td>Average Attendance</td>
<td>.91</td>
<td>.94</td>
<td>.93</td>
<td>.92</td>
</tr>
<tr>
<td>School 6 Provincial</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year Level</td>
<td>½</td>
<td>1/2</td>
<td>½</td>
<td>--</td>
</tr>
<tr>
<td>Percent Indigenous</td>
<td>0%</td>
<td>31.3%</td>
<td>21.1%</td>
<td>--</td>
</tr>
<tr>
<td>Average Attendance</td>
<td>.94</td>
<td>.93</td>
<td>.93</td>
<td>--</td>
</tr>
</tbody>
</table>

*Note: The percent of Indigenous students in some classes was well below the percent of Indigenous students in the school. This is due to 1) some schools’ practice of grouping Indigenous students together in classrooms that

2 Schools in Darwin are considered ‘provincial,’ while schools in Alice Springs are designated as ‘remote.’
did not take part in the ABRA study and 2) the higher attrition rates of Indigenous students (numbers reported are for the students who were not lost to follow-up).

All students between the ages of 4 and 8, enrolled in transition, year one and year two classes (n=380) were eligible to participate in the study. Only the students who completed a pre-test (n=354) were enrolled in the study and randomised to treatment and control group. Students who were absent during the pre-testing week or enrolled late were randomly assigned to treatment and control conditions, but were not enrolled in the study.

Participant Flow
At the beginning of the school year in February 2010, class lists were obtained from the seventeen transition, year one and year two classes in each of the six schools that agreed to participate in the study. All 380 students in these 17 classes met the criteria to participate in the study (see Figure 1). Two weeks later at pre-testing, 15 of these students were either absent from, or no longer enrolled in, their schools. One student’s parent did not consent for his/her child to participate and four students were pre-tested, but not randomised as it was known they were leaving their schools.

Figure 1
ABRACADABRA Participant Flowchart
The randomisation lists by classroom and year level were generated after the pre-testing was conducted. A total of 360 students were randomised to treatment and control conditions. Three students enrolled after the randomisation lists had been generated, but within the two week pre-testing period. These students were randomly allocated to treatment or control conditions by assigning them to empty random places that had been generated at the end of each class list. In summary, of the 380 students who were eligible, 360 were randomised, resulting in 173 students in the control and 187 in the treatment groups. Overall, reasons for attrition from the study were: students left the school, students were absent during testing and/or the first week of the study; permission was not granted, or was withdrawn for student to take part in the study.

Of the 173 students allocated to the control group, 145 were post tested. The parent of one student withdrew permission to participate and consent forms were not obtained for 15 students, leaving a total of 157 students enrolled in the study. Students for whom consent was not obtained or was withdrawn were not considered to be part of the study and are excluded from the attrition calculation. Twelve control students left the school or were absent during the post testing week. The attrition rate for the control group was, therefore, 7.6%. Of the 187 students allocated to the treatment group, consent was not obtained for ten and 163 were post tested. Fourteen students left the school or were absent during the post testing week. The attrition rate for the treatment group was 7.9%.
The overall attrition rate for the study was 7.8%.

Randomisation
Prior to randomisation, schools provided class lists containing the student IDs, class and year level to the researchers. This information was used to prepare for pre-testing. Students who did not complete a pre-test were removed from the class lists and excluded from randomisation. Randomisation was conducted after students were pre-tested (but pre-test score was unknown during randomisation) in order to prevent potential bias in post-test impact estimates, which can occur when randomisation and treatment delivery occur before pre-testing (Schochet, 2008). Randomising after pre-testing also addressed the high level of student turnover that occurs during the first weeks of a school year as some parents are still deciding where their children will attend school.

The class lists containing student IDs, class, and class level, but excluding students, who had not been pre-tested, were sent to an independent researcher at the Menzies School for Health Research (MSHR) in Darwin. Randomisation was blind to pre-test score and used permuted blocks, stratified by school, class and class level within a class. Once randomisation was carried out, by week 4 of Semester 1, the ABRA teachers began delivering the intervention.

Sample Size Calculation
It is important our trial was sufficiently large to detect any educationally meaningful effect, one that would be sizeable enough to demonstrate the educational value of using ABRA in support of regular literacy lessons. Using the power analysis equation appropriate for when students are individually randomly assigned to treatment and control groups within sites (schools) and that treated schools as fixed effects (Schochet, 2008), it was calculated that six schools with 50 students each equally allocated to treatment and control groups would have more than an 80% power to detect a difference of 33% of a standard deviation. To account for high student turnover in the NT, identified as 20% in previous research (Wolgemuth et al., 2010), a sample of 360 students (60 per school) was sought.

Implementation of the Intervention
Each student received 30-45 minutes of ABRA instruction four days per week from week 4 to week 18 of Semester 1. ABRA lessons were delivered by teachers specially hired and trained to deliver the intervention. To avoid contamination, ABRA lessons were delivered in separate rooms, and control teachers were asked not to use ABRA. Towards the end of the data collection, three control students from each class were randomly selected to participate in interviews to assess their knowledge about ABRA. These interviews revealed that control students knew ABRA was something the other students did, but were not aware of its content. The treatment students in the ABRA group received ABRA in addition to the regular literacy instruction that may have taken place at other times in the school day, however, the pull-out ABRA lessons were delivered while the control group was also receiving literacy instruction.
Teachers generally opened the ABRA lesson with an introduction such as reading a story or playing a game that reinforced or supported the activity they would later do independently on the computer. Using the interactive whiteboard the teacher would then review the steps students needed to go through to get into the ABRA activities they would be using. Once there as a class they would do several examples of the new task in order to ensure all students understood what was required. Several of the teachers developed an activity chart that they used to display the ABRA activity icon so the students could look back at it if they forgot what to do.

In some schools, the teacher had divided the class into ability groupings as there were not enough computers for each student. Following the introduction, one group would work on literacy activities at their assigned tables while the other group used ABRA. The teacher circulated between both groups. After ten minutes the groups would switch, with the students at the table going to the computers to do the ABRA activities and those at the computers moving to table activities. Table activities might include writing a sentence, sorting groups of words according to their vowel sounds or reading flashcard with a partner. When both groups had finished the teacher would bring the class back together for a short conclusion which provided the students the opportunity to further practice the skills they had been working on and to reflect on their learning.

Implementation Fidelity
Implementation fidelity was assessed through bi-weekly classroom observations using a researcher developed instrument (see APFOR description in Instruments below) to record the types of ABRA activities used and the quality of ABRA lessons. Observations lasted the duration of the 30-45 minute lessons and observers met with ABRA teachers afterwards to provide feedback.

Based on the bi-weekly APFOR observations, the ABRA teachers were categorised as:

- entry (teachers unfamiliar with ABRA)
- adoptive (basic use of ABRA and monitoring of students)
- adaptive (teacher competent with ABRA, clearly monitors students and adjusts instruction as appropriate) or
- differentiated adaptive (adaptation criteria fulfilled and teacher uses extension activities that incorporate higher level skills) implementers.

All teachers met at least the ‘adaptive’ categorisation.

Testing
All students were pre-tested during weeks two and three of Semester 1, before the intervention began and prior to randomisation, and post-tested during the second to last and last weeks of Semester 1, at the end of the intervention. Students were tested using two literacy assessment instruments: (i) GRADE K; and (ii) PIPS-BLA. All tests were administered by trained university researchers and volunteers from Telstra, an Australian telecommunications company whose philanthropic arm, the Telstra Foundation, significantly funded the research. Testing was conducted one-on-one with students and took approximately 30 minutes to complete the GRADE K
and 20 minutes to complete the PIPS-BLA. Students were randomly selected to receive either form A or B of the GRADE K at pre-test. At post-test they were given the test form they did not receive at pre-test. The PIPS-BLA assessment has a stopping rule so that when students miss three consecutive items in a row they move on to the next test section. At post-test students began each section of the test just before where they stopped at pre-test. At both pre- and post-test, testers were blind to students’ assignment to treatment and control groups.

**Instruments and Data Entry**

**APFOR**
The ABRACADABRA Program Fidelity Observation Record (APFOR) was used to monitor implementation fidelity (see Appendix 1). The APFOR consists of three sections: a checklist of activities used during the ABRA lesson, a researcher log to record notes about the lesson including any technology problems encountered and a 15 item lesson quality assessment scaled from 1 to 5 with 1 being “Strongly Disagree” and 5 being “Strongly Agree.” The APFOR was developed based on an observation instrument used by the Centre for the Study of Learning and Performance (CLSP) to evaluate the implementation fidelity of ABRA in Canadian classrooms and on best practices for ABRA implementation (such as the ABRA lesson is pre-planned, lasts at least 30 minutes and includes a conclusion that summarises what was learned during the lesson with the whole group). The two researchers observed four lessons together and their inter-rater reliability was .97. Chronbach’s alpha was .93. Observations using the APFOR were conducted on a bi-weekly basis for a total of 57 observations or an average of 10 observations per teacher.

**CLOS-R**
A revised version of the Classroom Literacy Observation Survey (CLOS) (Louden & Rohl, 2003) was used to assess the quality of the control and ABRA teachers’ literacy lessons (see Appendix 2). The CLOS is a 33 item teacher literacy practice (as opposed to literacy activity) observation instrument divided into 6 key areas: Participation, Knowledge, Orchestration, Support, Differentiation and Respect (Louden & Rohl, 2003; Louden et al., 2005). All items from the CLOS were retained, but the scale was modified from a checklist of present or absent behaviours to a rating scale from 1 to 5 with 1 being “Strongly Agree” and 5 being “Strongly Disagree.” This change was made such that the items would better assess the quality of literacy practices, rather than their presence or absence. The two researchers observed a total of 5 lessons together and their inter-rater reliability was .90 for the overall average rating. Chronbach’s alpha was .96.

Observations using the CLOS-R instrument were conducted on a bi-weekly basis with intervention teachers. As there were 2-4 ABRA and control classes in each school and only one researcher assigned to each location, we were unable to observe all control teachers on a bi-weekly basis as planned. While ABRA teachers were observed an average of 9 times each (30-45 minutes per observation), control teachers were observed an average of 2 times (also 30-45 minutes per observation).
Based on early literacy research (see, for example, Chambers et al., 2008a; Stipek & Byler, 2004) that recommends teachers should be observed at least 3 times to establish the quality of their literacy instruction, it was decided that too few observations (or too few hours of observation) had been conducted on control teachers to make reliable and valid judgements about the quality of literacy lessons their students received. Therefore we did not conduct an analysis of student outcomes which controlled for teachers’ literacy instruction quality as planned. Instead, a description of the control teachers’ literacy lessons and their individual CLOS-R ratings for each observation is included in ‘Program Differentiation’ section of Chapter 5: Implementation Fidelity.

**GRADE K**

The GRADE is a children’s literacy diagnostic tool that reliably measures early reading ability (Fugate, 2003; Waterman, 2009; Williams, 2001), especially in Canada and the United States. GRADE K measures phonological awareness (sound matching and rhyming), early literacy skills (print awareness, letter recognition and ability to recognise same and different words), phoneme-grapheme correspondence (ability to recognise letter sounds) and word reading (ability to read grade-appropriate words). The GRADE K also measures listening comprehension, but this scale was eliminated from the study based on the 2008 pilot study results indicating it was not well targeted (Wolgemuth et al., 2009).

Research has found reliability coefficients for the GRADE K test-retest and alternate form to be close to .90 and concurrent validity with the Iowa Test of Basic Skills, the California Achievement Test and TerraNova has been established (Williams, 2001).

The GRADE K comes in parallel forms, A and B, both of which were used for this study. The GRADE K data was double entered at both pre- and post-test to ensure data quality.

**PIPS-BLA**

The PIPS-BLA is a computer-based assessment developed by the Curriculum Evaluation Management (CEM) Centre at Durham University in England ([www.cemcentre.org](http://www.cemcentre.org)). An Australian version (narrated by an Australian and with Australian imagery) of PIPS-BLA was introduced to educational authorities and schools across Australia in 2001 and is now used in every state and territory and mandated in some (Wildy & Styles, 2008).

The PIPS-BLA assessment consists of three measures: reading, phonics (repeating words, splitting words, making sounds and hearing sounds) and mathematics. Test-retest reliability for the UK version of the PIPS-BLA ranged from .91 to .98 (Tymms, 2002). Studies have shown the scales to be internally reliable with Cronbach’s alphas of 0.95, 0.86 and 0.93 for reading, phonics and mathematics, respectively (Merrell & Tymms, 2007). In Australia, studies have specifically examined the reliability and validity of the PIPS-BLA when used with Indigenous students. Godfrey and Galloway (2004) administered the PIPS-BLA to one hundred
and ninety-one Indigenous students from government primary, Catholic primary and community primary schools. Rasch analysis identified no significant differential item functioning (DIF) between Indigenous and non-Indigenous students. Chronbach’s alpha was .98 and split-half reliability was .98.

The phonics scale for the PIPS-BLA was newly developed for Australians in 2009, and 2010 was its first year of testing. ABRA testers and students had difficulty hearing the audio instructions in the ‘making words’ subtest, and these items often had to be repeated for students to hear. Additionally, the ‘repeating words’ subtest was designed to identify students with more serious speech or hearing problems and its validity as a measure of phonics was questionable to the research team. The results of the Rasch analysis (see Chapter 4) led us to the decision to use only the ‘making words,’ ‘splitting words’ and ‘hearing sounds’ subtests to evaluate the impact of ABRA.

Statistical Analyses
The primary outcome was the composite post-test ability estimate of the GRADE K phonological awareness and word reading subscales after adjusting for the pre-test ability estimate. The ability estimates were calculated through the Rasch logistic model for dichotomous items, which calculates the probability of success by a person on an item as a function of the ability of the person ($\theta_n$) and the difficulty of the item ($\beta_i$) (See Equation 1) (Embretson & Reise, 2000).

$$P[X_{ni} = 1|\theta_n, \beta_i] = \frac{e^{\theta_n - \beta_i}}{1 + e^{\theta_n - \beta_i}}$$  (1)

Since a person’s ability and item difficulty are located on the same scale in Rasch modelling, the person’s ability, $\theta_n$, is calculated as the point where a person has a .50 probability of getting an item of difficulty, $\beta_i$; correct and values typically range from -3 to 3. Therefore Rasch analysis takes into account the difficulty of the individual test items, yielding a more accurate estimate of students’ literacy abilities than their raw scores.

A series of 2 (treatment: intervention versus control) x 6 (schools 1-6) between subject design ANCOVAs were run on the post-test data with pre-test scores on the primary outcome (and later the secondary outcomes). The alpha was set at .05. A Type I SS (entry order: pre-test covariate, school, treatment and school by treatment interaction) was used in the initial model so that the treatment effect was adjusted for all other terms except for the treatment by school interaction due to marginality constraints (Aitkin, 1978; Nelder, 1977). If the interaction was not significant, a Type III SS was used.

Secondary analyses were conducted on the PIPS-BLA reading; phonics splitting words and hearing sounds and mathematics ability scores and the GRADE K subscales (phonological awareness, early literacy skills, phoneme grapheme correspondence and word reading ability). We also undertook 1) an analysis that took into account student age and attendance, 2) subgroup analyses of the treatment effect on Indigenous and ESL students and 3) an analysis of treatment exposure...
(average ability score gain per hour of ABRA lesson). Finally, we conducted all above analyses on the PIPS-BLA and GRADE K raw scores. Because the results were essentially the same, only the results of Rasch ability estimate analyses are presented.

Analysis of co-variance or logistic regression models were used to evaluate the secondary outcomes. Logistic regression was used on the GRADE K early literacy skills and phoneme grapheme correspondence outcomes, whose distributions were highly positively skewed. The post-test scores for these two outcomes were categorised into two groups: below the pre-test 75th percentile and above the pre-test 75th percentile.
4. RCT STUDENT LITERACY OUTCOMES

Baseline Characteristics of Students who were Lost to Follow-up and Remained in the Intervention and Control Groups

Analyses were conducted to determine whether there were characteristic and/or pre-test score differences between control and intervention students who were lost to follow-up and control and intervention students who remained in the study. Raw scores were used for comparison as ability estimates were only calculated for students who were included in the study.

As shown in the Table 4, students in the intervention who were lost to follow-up (n=14) were less likely to be Indigenous and to speak English as a second language than control group students who were lost to follow-up (n=12). Intervention students who were lost to follow-up also had lower pre-test raw scores and lower attendance rates than their control group peers. There is no reason to suspect a systematic reason for lower scoring students to leave the intervention and it appears this differential attrition was a chance occurrence.

Table 4

<table>
<thead>
<tr>
<th>Pre-test Variable</th>
<th>Left the Study (n=26)</th>
<th>Remained in Study (n=308)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intervention (n=14)</td>
<td>Control (n=12)</td>
</tr>
<tr>
<td>Age (years) M (SD)</td>
<td>6.00 (.68)</td>
<td>6.27 (.79)</td>
</tr>
<tr>
<td>Percent Indigenous</td>
<td>40%</td>
<td>50%</td>
</tr>
<tr>
<td>Percent ESL</td>
<td>14.3%</td>
<td>25%</td>
</tr>
<tr>
<td>Attendance rate M (SD)</td>
<td>.82 (.18)</td>
<td>.87 (.12)</td>
</tr>
<tr>
<td>Primary Outcomes (Raw Score)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRADE K Phonological Awareness</td>
<td>9.12 (3.67)</td>
<td>13.54 (2.93)</td>
</tr>
<tr>
<td>and Reading M (SD)</td>
<td></td>
<td>9.57 (4.16)</td>
</tr>
<tr>
<td>Secondary Outcomes (Raw Score)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRADE K Phonological Awareness</td>
<td>13.64 (5.46)</td>
<td>19.58 (3.87)</td>
</tr>
<tr>
<td>and M (SD)</td>
<td></td>
<td>14.07 (6.24)</td>
</tr>
<tr>
<td>GRADE K Word Reading M (SD)</td>
<td>4.57 (3.16)</td>
<td>7.50 (2.64)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.06 (3.09)</td>
</tr>
</tbody>
</table>
GRADE K Early Literacy Skills, % below 75th percentile value

<table>
<thead>
<tr>
<th>Percentage</th>
<th>(n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>35.7%</td>
<td>(5)</td>
</tr>
<tr>
<td>25.0%</td>
<td>(3)</td>
</tr>
<tr>
<td>63.8%</td>
<td>(104)</td>
</tr>
<tr>
<td>59.3%</td>
<td>(86)</td>
</tr>
</tbody>
</table>

GRADE K Phoneme Grapheme Correspondence, % below 75th percentile value

<table>
<thead>
<tr>
<th>Percentage</th>
<th>(n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>64.3%</td>
<td>(10)</td>
</tr>
<tr>
<td>58.3%</td>
<td>(7)</td>
</tr>
<tr>
<td>73.0%</td>
<td>(119)</td>
</tr>
<tr>
<td>71.0%</td>
<td>(103)</td>
</tr>
</tbody>
</table>

PIPS-BLA Reading M (SD)

<table>
<thead>
<tr>
<th>Percentage</th>
<th>(SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>65.62</td>
<td>(38.4)</td>
</tr>
<tr>
<td>94.17</td>
<td>(50.1)</td>
</tr>
<tr>
<td>66.21</td>
<td>(42.8)</td>
</tr>
<tr>
<td>65.70</td>
<td>(43.4)</td>
</tr>
</tbody>
</table>

PIPS-BLA Phonics M (SD)

<table>
<thead>
<tr>
<th>Percentage</th>
<th>(SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.38</td>
<td>(4.44)</td>
</tr>
<tr>
<td>15.58</td>
<td>(7.88)</td>
</tr>
<tr>
<td>10.74</td>
<td>(7.19)</td>
</tr>
<tr>
<td>9.76</td>
<td>(6.53)</td>
</tr>
</tbody>
</table>

There was a disparity between the numbers of students who left the intervention and control groups. Table 4 shows this did not substantially affect the final analysis, as students who remained in the treatment and control groups were similar on all baseline characteristics.

**Item Analysis**

Rasch analyses were conducted on the GRADE K forms A and B and the PIPS-BLA instruments to a) eliminate any misfitting and differentially functioning items, b) assess the Person Separation Index (internal consistency) and determine the fit of the items to the Rasch model, c) to assess whether the assessment was well-targeted for the sample, and d) generate ability estimates for analysis. For the PIPS-BLA, the reading, phonics subtest and mathematics items were analysed separately.

**Item elimination.** Items were eliminated from the analyses based on the conservative criteria that their fit residuals were between +2.5 and -2.5 and the Bonferroni adjusted p-value was <.01. Items were also assessed for Differential Item Functioning (DIF) between Indigenous and non-Indigenous students. No items on the GRADE K or PIPS-BLA instruments displayed significant DIF (Bonferroni adjusted p-value <.01). Six items (Rhyming 1, Rhyming 13, Print Awareness 3, Letter Recognition 5, and Phoneme-Grapheme Final 3) were removed from the analysis of GRADE K form A and eight items (Rhyming 9, Sound Matching – Begins 6, Sound Matching – Ends 1, Letter Recognition 1, Letter Recognition 2, Letter Recognition 4, and Phoneme-Grapheme Initial 5) were removed from GRADE K form B.

Twenty-seven of the 122 items that did not fit the Rasch model were removed from the PIPS-BLA Reading. Eleven items on the PIPS-BLA phonics had high fit residuals and Bonferroni adjusted p-values <.01. Seven of these items were from the 8-item ‘repeating words’ subscale. It was therefore decided to drop the repeating words subscale from the analyses. The final PIPS-BLA Phonics scale consisted of 22 items from the ‘splitting words,’ ‘making words,’ and ‘hearing sounds’ subscales. Five items of 74 were removed from the PIPS-BLA math.

**Person Separation Index and mean item fit.** The Person Separation Index for the GRADE K A and B and the PIPS-BLA Reading, Phonics and Math were all high.
indicating a good fit of the data to the model ($r_\beta=.92, .93, .97, .87$ and .93, respectively). Consistent with the Separation Index, the mean Fit Residuals all indicated good fit for the items of each test (GRADE K A, M=.49, SD=1.68; GRADE K B, M=.44, SD=1.75; PIPS-BLA Reading, M=.21, SD=1.07; PIPS-BLA Phonics, M=.17, SD=.74; PIPS-BLA Math, M=.19, SD=1.66). Separation indices for the GRADE K subscales were acceptable, ranging from .58 to .84. Separation indices for the three PIPS-BLA Phonics subscales were also acceptable, ranging from .61 to .86.

Test Targeting and Form Equivalence. For all students taking the GRADE K A and B at pre- and post-test, item difficulties ranged from approximately -3 to 2.5 while student abilities ranged from under -5 to just over 5. The average ability estimates for forms A and B were 1.54 (SD=1.62) and 1.28 (SD=1.54), indicating the tests were sufficiently similar that they could be analysed together (see Figures 2 and 3). The high means, however, suggest the overall test was not well-targeted (a well targeted test would have a mean close to 0); it was too easy for many students and the absence of items at the higher end of the distributions indicates the test is less precise in assessing the ability of students who had the highest results.

Figure 2

Person-Item Distribution for the GRADE K Form A

Figure 3.

Person-Item Distribution for the GRADE K Form B
The average ability estimates for the GRADE K subscales showed that, while the overall test was easy for students, some sections were better targeted than others. A well-targeted test would have a mean score of zero and a normal distribution of student scores around that mean. Word reading was the most difficult for students in our study and the best targeted (GRADE K A, M=.58, SD = 1.49, GRADE K B, M=.35, SD= 1.53) followed by phonological awareness (GRADE K A, M= .65, SD= 1.53, GRADE K B, M =.48, SD= 1.47), phoneme-grapheme correspondence (Mean A = 1.46, SD= 1.76, GRADE K B, M=1.37, SD= 1.76) and early literacy skills (GRADE K A, M=2.55, SD= 1.43, GRADE K B, M=2.31, SD= 1.36).

For all students taking the PIPS-BLA Reading and Phonics tests at pre- and post-test, item difficulties ranged from approximately to -4.5 to just over 4 while student abilities ranged from -4 to just over 4.5. The PIPS-BLA Reading test was well-targeted with an average ability estimate of .08 (SD=2.47). The average ability estimate for the PIPS-BLA Phonics was -0.89 (SD=1.62), indicating the test was a bit difficult for the students in the study. The average ability estimate for the mathematics subtest was .81 (SD=1.97).

Overall, the primary outcome (GRADE K phonological awareness and reading) was well-targeted for the students in our study. The GRADE K early literacy skills and phoneme-grapheme correspondence subtests, however, were too easy for the students, resulting in highly skewed distributions for these secondary outcomes. The PIPS-BLA Reading and Math were well-targeted, while the PIPS-BLA Phonics was slightly difficult.

**Primary Outcome: Phonological Awareness and Reading**

The analysis of covariance results for treatment (control versus intervention) and school (schools 1 to 6) with GRADE K combined measure of phonological awareness and reading ability revealed students in the intervention group outperformed students in the control group on the GRADE K phonological
awareness and reading post-test ability ($F_{1,295}=8.93$, $p=.003$, $d=.40$)\(^3\) (See Table 5). The ability scores of students who received ABRA ($M=.97$, $SD=1.28$) were about a third of a standard deviation higher than students who did not receive ABRA ($M=.69$, $SD=1.31$). The effect size ($d=.40$) was medium (Cohen, 1988), which suggests that the post-test ability difference between the two groups of students was of sufficient size to be observed by a teacher. The interaction was not significant indicating that the impact of the intervention did not differ between schools (e.g., ABRA did not work better or worse in any particular school or set of schools). There was a significant difference between schools, indicating that some schools had students who performed better on the primary outcome overall (regardless of whether they received ABRA or not). Post-hoc analyses predictably revealed the schools that had proportionally more students in higher grades (Remote School 3, Provincial School 5 and Provincial School 6) had significantly higher scores than schools with proportionally more students in lower grades (Provincial School 1, Provincial School 2 and Provincial School 4).

Table 5
GRADE K and PIPS-BLA Analysis of Variance (ANCOVA) Results for Intervention as a Function of School Controlling for Pre-test Ability

<table>
<thead>
<tr>
<th>School</th>
<th>Intervention (n=163)</th>
<th>Control (n=145)</th>
<th>ANCOVA F, Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$N$</td>
<td>$Pre M (SD)$</td>
<td>$Post M (SD)$</td>
</tr>
<tr>
<td>Primary Outcome</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRADE K</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phonological</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awareness and</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td>163</td>
<td>.16 (1.33)</td>
<td>.97 (1.28)</td>
</tr>
<tr>
<td>1 Provincial</td>
<td>33</td>
<td>.34 (1.01)</td>
<td>.43 (1.09)</td>
</tr>
<tr>
<td>2 Remote</td>
<td>22</td>
<td>-.69 (.78)</td>
<td>.22 (1.24)</td>
</tr>
<tr>
<td>3 Remote</td>
<td>16</td>
<td>-.28 (1.08)</td>
<td>1.35 (1.22)</td>
</tr>
<tr>
<td>4 Provincial</td>
<td>22</td>
<td>.32 (.84)</td>
<td>.52 (.90)</td>
</tr>
<tr>
<td>5 Provincial</td>
<td>39</td>
<td>-.12 (1.70)</td>
<td>1.15 (1.29)</td>
</tr>
<tr>
<td>6 Provincial</td>
<td>31</td>
<td>1.35 (1.03)</td>
<td>1.98 (1.05)</td>
</tr>
<tr>
<td>Secondary Outcomes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRADE K</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phonological</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awareness</td>
<td>163</td>
<td>.26 (1.49)</td>
<td>1.01 (1.42)</td>
</tr>
<tr>
<td>1 Provincial</td>
<td>33</td>
<td>.34 (1.13)</td>
<td>.46 (1.19)</td>
</tr>
<tr>
<td>2 Remote</td>
<td>22</td>
<td>-.28 (1.27)</td>
<td>.48 (1.61)</td>
</tr>
<tr>
<td>3 Remote</td>
<td>16</td>
<td>-.52 (1.20)</td>
<td>1.36 (1.51)</td>
</tr>
</tbody>
</table>

\(^3\) ANCOVA assumptions of homogeneity of variance, linearity of the covariate and the primary outcome and homogeneity of regression slopes were met.
<table>
<thead>
<tr>
<th>Province</th>
<th>Grade</th>
<th>Mean</th>
<th>SD</th>
<th>95% CI Lower</th>
<th>95% CI Upper</th>
<th>Effect Size (d)</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GRADE K Word Reading</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Provincial</td>
<td>22</td>
<td>.09</td>
<td>.72</td>
<td>.38</td>
<td>.48</td>
<td>.92</td>
<td>.82</td>
</tr>
<tr>
<td>5 Provincial</td>
<td>39</td>
<td>-.12</td>
<td>1.0</td>
<td>.18</td>
<td>.92</td>
<td>.82</td>
<td>.82</td>
</tr>
<tr>
<td>6 Provincial</td>
<td>31</td>
<td>1.58</td>
<td>2.04</td>
<td>1.59</td>
<td>1.62</td>
<td>.92</td>
<td>.82</td>
</tr>
<tr>
<td><strong>PIPS-BLA Reading</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Provincial</td>
<td>22</td>
<td>-.55</td>
<td>.34</td>
<td>.38</td>
<td>.54</td>
<td>.10</td>
<td>.10</td>
</tr>
<tr>
<td>5 Provincial</td>
<td>39</td>
<td>-.12</td>
<td>1.31</td>
<td>31</td>
<td>1.00</td>
<td>.10</td>
<td>.10</td>
</tr>
<tr>
<td>6 Provincial</td>
<td>31</td>
<td>1.12</td>
<td>1.93</td>
<td>28</td>
<td>1.69</td>
<td>.10</td>
<td>.10</td>
</tr>
<tr>
<td><strong>PIPS-BLA Phonics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Provincial</td>
<td>22</td>
<td>-.61</td>
<td>1.21</td>
<td>10</td>
<td>.57</td>
<td>.10</td>
<td>.10</td>
</tr>
<tr>
<td>5 Provincial</td>
<td>39</td>
<td>-.01</td>
<td>1.56</td>
<td>30</td>
<td>.94</td>
<td>.10</td>
<td>.10</td>
</tr>
<tr>
<td>6 Provincial</td>
<td>31</td>
<td>1.30</td>
<td>2.71</td>
<td>28</td>
<td>2.62</td>
<td>.10</td>
<td>.10</td>
</tr>
<tr>
<td><strong>Secondary Outcomes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GRADE K and PIPS-BLA subscales</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

α Effect size (d) calculated using adjusted means: \( \frac{X'_r - X'_c}{\text{MSE}} \)

*p<.05

**p<.01

***p<.001

**Secondary Outcomes**

**GRADE K and PIPS-BLA subscales**
Analysis of covariance with treatment (intervention versus control) and school (schools 1-6) with pre-test covariate revealed students in the intervention group significantly outperformed students in the control group on the GRADE K post-test phonological awareness subscale ($F_{1,295}=10.02$, $p=.002$) (see Table 3)\(^4\). The effect size for this difference was medium ($d=.38$). There were no differences between the two groups on GRADE K word reading ($F_{1,295}=1.85$, $p=.18$). This indicates that the significant difference between the intervention and control groups on the primary outcome was driven by phonological awareness.

Backward logistic regression analyses showed that participation in control or intervention groups significantly predicted whether students scored above or below the pre-test $75^{th}$ percentile on the GRADE K phoneme-grapheme correspondence (Wald=5.61, $p=.018$) (see Table 6). After adjusting for school and PGC pre-test ability, the odds of an intervention student being above the $75^{th}$ percentile for PGC in the post-test was twice that of a control student (Odds Ratio = 2.03, 95% confidence interval 1.13 to 3.64). Participation in control or intervention group did not predict whether students scored above or below the pre-test $75^{th}$ percentile on the GRADE K early literacy skills when controlling for the pre-test ability (Wald=1.36, $p=.24$, Odds Ratio=1.39, 95% confidence interval .80 to 2.42).

There were no differences between intervention and control group students on the PIPS-BLA reading ($F_{1,283}=3.71$, $p=.055$) or PIPS-BLA phonics ($F_{1,282}=1.62$, $p=.20$). While the PIPS-BLA reading findings align with those of the GRADE K, findings differed between the PIPS-BLA phonics and the GRADE K phonological awareness. As mentioned previously, the PIPS-BLA phonics scale for Australia was newly developed in 2009 and our analysis excluded the repeating words subscale that showed poor fit to the Rasch model and low reliability. Our concerns about the reliability and validity of the PIPS-BLA phonics scale preclude any meaningful interpretation of the difference between the GRADE K and PIPS-BLA phonics findings. We are inclined to conclude that the GRADE K phonological awareness scale was a better measure in terms of its psychometric properties and that it therefore better captured the impact of ABRA.

Table 6.

<table>
<thead>
<tr>
<th>School</th>
<th>Intervention (n=163)</th>
<th>Control (n=145)</th>
<th>Logistic Regression Results</th>
</tr>
</thead>
</table>

\(^4\) Interactions for all analyses were not significant unless otherwise stated. ANCOVA assumptions of homogeneity of variance, linearity of the covariate and the primary outcome and homogeneity of regression slopes were met for all analyses except phonological awareness where the assumption of homogeneity of variance was violated. The analysis proceeded based on the robustness of ANOVA to this violation.
<table>
<thead>
<tr>
<th>Secondary Outcomes</th>
<th>Pre 75th Percentile Value</th>
<th>N</th>
<th>Percent above Pre-test 75th Percentile</th>
<th>Percent above Pre-test 75th Percentile</th>
<th>Intervention Odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRADE K Early Literacy Skills</td>
<td>3.632</td>
<td>163</td>
<td>28.2%</td>
<td>50.9%</td>
<td>1.39 (.80 to 2.42)</td>
</tr>
<tr>
<td>GRADE K Phoneme-Grapheme Correspondence</td>
<td>3.204</td>
<td>163</td>
<td>27.6%</td>
<td>48.5%</td>
<td>2.03* (1.13 to 3.64)</td>
</tr>
</tbody>
</table>

*P<.05  
**P<.01

**PIPS Mathematics**

To evidence discriminate validity of the intervention (that ABRA is a literacy intervention and should improve student literacy scores as opposed to other subject area scores), an analysis of covariance of treatment (intervention versus control) and school (schools 1-6) with pre-test covariate on the PIPS-BLA mathematics post-test ability score was conducted. The analysis revealed no differences between the treatment (M_{adj}=1.28, SE=.12) and control students (M_{adj}=1.18, SE=.11) (F_{1,291}=.35, p=.56) providing discriminate evidence that receiving ABRA instruction does not improve students’ math skills. Neither the main effect of school was significant (F_{1,291}=1.33, p=.25) nor was interaction between treatment and school (F_{1,291}=1.87, p=.10).

**Raw Scores**

All primary and secondary ANCOVA and logistic regression analyses were conducted on the raw scores. No differences were found between the raw score and ability score results (see Appendix 3).

**Covariates**

Student age and attendance were included as additional covariates in the primary and secondary outcome ANCOVA and logistic regression analyses to determine whether they had an impact on the findings. Analyses revealed age to be a significant predictor of GRADE K word reading (F_{1,287}=4.23, p=.04) post-test ability scores and attendance was a significant predictor of GRADE K word reading (F_{1,287}=5.89, p=.016), PIPS-BLA reading (F_{1,271}=13.13, p<.001) and PIPS-BLA phonics (F_{1,272}=5.02, p<.01). Including attendance and student age in the analyses did not impact on the significance of the treatment (intervention versus control) comparisons.

These findings suggest two things. First, age and attendance matter when it comes to teaching students how to read, but are less important for predicting earlier reading skills such as phonological awareness. Earlier literacy skills may well be ‘dose dependent,’ meaning they can be mastered when students are developmentally ready and by receiving a sufficient amount and quality of direct instruction. In contrast,
reading is a skill that is acquired and mastered over a much longer period of time and would, therefore, be more sensitive to variations in age and school attendance.

Second, ABRA was effective (or not effective) for students of varying ages and school attendance as compared to students who did not receive ABRA. This means ABRA is not differentially effective for students of younger or older ages or for students who attend more or less than others and lends strength to the positive findings for ABRA on phonological awareness and phoneme-grapheme correspondence.

Subgroup analyses
Treatment differences between Indigenous and non-Indigenous students and students who spoke English as a second language (ESL) were examined using analysis of covariance and logistic regression (separate analyses were conducted for each subgroup). The treatment effect did not significantly differ between Indigenous and non-Indigenous students for either the primary or the secondary outcomes. However, the treatment by Indigenous status interaction approached significance for the GRADE K phonological awareness ($F_{1,295}=3.80$, $p=.052$). Indigenous students in the treatment group ($M_{adj}=1.34$, $SE=.19$) had adjusted post-test scores almost three times the size of Indigenous students’ in the control group ($M_{adj}=1.52$, $SE=.18$) and larger than non-Indigenous students’ in the treatment group ($M_{adj}=1.94$, $SE=.11$). Non-Indigenous students in the control group had an average adjusted post-test score of ($M_{adj}=1.69$, $SE=.12$).

While these differences were not significant in this study, the pattern of results suggests that ABRA instruction may be particularly beneficial for Indigenous students’ phonological awareness and, indeed, may raise their scores above those of non-Indigenous students. A larger study would need to be carried out to replicate these findings and support our interpretation.

The main effect of Indigenous status was significant only for the PIPS-BLA phonics ($F_{1,271}=10.02$, $p=.002$) (see Table 7) where non-Indigenous students ($M_{adj}=-.75$, $SE=.11$) had higher adjusted posttest means than Indigenous students ($M_{adj}=-.21$, $SE=.17$). A possible explanation is that the audio problems with the PIPS-BLA phonics may have advantaged non-Indigenous students. Indigenous status was not significant for predicting whether students scored above or below the pre-test 75th percentile on the GRADE K phoneme-grapheme correspondence ($Wald=.37, p=.54$; Odds ratio=.78, 95% CI=.36 to 1.71) or early literacy skills ($Wald=3.07, p=.08$; Odds ratio=.52, 95% CI=.25 to 1.08).

The treatment effect did not differ by ESL status for either the primary or the secondary outcomes (see Table 7). The main effect of ESL status was significant for the primary outcome. Students who spoke English as a second language had lower ability scores on the posttest GRADE K phonological awareness and reading than

---

5 The school by Indigenous status interaction was significant for this analysis ($F_{5,270}=2.57$, $p=.03$). Post-hoc analyses revealed non-Indigenous students at schools 1, 2 and 3 significantly outperformed Indigenous students in these same schools. Indigenous students significantly outperformed non-Indigenous students at school 6.
students whose first language was English ($F_{1,295}=5.82$, $p=.02$). As shown in Table 8, ESL status was also significant for the following secondary outcomes: GRADE K word reading and PIPS-BLA phonics. In both instances, students whose first language was English outperformed ESL students. ESL status was not significant for predicting whether students scored above or below the pre-test 75th percentile on the GRADE K phoneme-grapheme correspondence ($Wald=2.27$, $p=.13$; Odds ratio=$1.67$, 95% CI=$.86$ to $3.23$) or early literacy skills ($Wald=1.11$, $p=.23$; Odds ratio=$1.41$, 95% CI=$.74$ to $2.68$).

Table 7.  
GRADE K and PIPS-BLA Mean Adjusted Ability Post-test Score, Standard Errors, and Analysis of Variance (ANCOVA) Results for Intervention and Indigenous Status as a Function of School Controlling for Pre-test Ability

<table>
<thead>
<tr>
<th>School</th>
<th>Indigenous (n=79)</th>
<th>Non-Indigenous (n=218)</th>
<th>ANOVA F, Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Post Adjusted M (SE)</td>
<td>Post Adjusted M (SE)</td>
<td>Indigenous Status F, $d^a$</td>
</tr>
<tr>
<td>Primary Outcome</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRADE K Phonological Awareness and Reading</td>
<td>79</td>
<td>.86 (.10)</td>
<td>218</td>
</tr>
<tr>
<td>Secondary Outcomes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRADE K Phonological Awareness</td>
<td>79</td>
<td>.81 (.13)</td>
<td>218</td>
</tr>
<tr>
<td>GRADE K Word Reading</td>
<td>79</td>
<td>.75 (.12)</td>
<td>218</td>
</tr>
<tr>
<td>PIPS-BLA Reading</td>
<td>77</td>
<td>.73 (.13)</td>
<td>202</td>
</tr>
<tr>
<td>PIPS-BLA Phonics</td>
<td>77</td>
<td>.03 (.16)</td>
<td>202</td>
</tr>
</tbody>
</table>

$a$ Effect size ($d$) calculated using adjusted means: $X'_c - X'_t / MSE$  
* $p<.05$  
** $p<.01$  
† $p<.00$

Table 8.  
GRADE K and PIPS-BLA Mean Adjusted Ability Post-test Score, Standard Errors, and Analysis of Variance (ANCOVA) Results for Intervention and Indigenous Status as a Function of School Controlling for Pre-test Ability

<table>
<thead>
<tr>
<th>School</th>
<th>ESL (n=106)</th>
<th>Non-ESL (n=198)</th>
<th>ANOVA F, Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$6$ The school by ESL status interaction was significant for this analysis ($F_{5,279}=2.41$, $p=.04$). Post-hoc analyses revealed non-ESL students at schools 1 and 2 significantly outperformed ESL students in these same schools.
### Exposure Analyses

Analyses were conducted to determine how much students gained per hour of exposure to ABRA lessons. Total exposure in minutes took into account the length of the teachers’ lessons, how often lessons were delivered and whether students were present for the lesson. The students’ total minutes of exposure was divided by 60 to convert to hours. Table 9 shows the total average hours of exposure and ability score gains for the GRADE K and PIPS-BLA subscales by Indigenous and ESL status. As seen in Table 10, all students received the minimum 20 hours of ABRA lessons as recommended and Indigenous students received less exposure (M=24.2, SD=7.94) than non-Indigenous students (M=31.0, SD=7.29). Similarly, ESL students received less ABRA exposure (M=26.1, SD=9.23) than non-ESL students (M=30.8, SD=6.88). These differences in exposure did not, however, mean that Indigenous and ESL students had lower gains than their non-Indigenous and English speaking counterparts. Indigenous students had greater gains on the primary outcome (GRADE K phonological awareness and reading) and the GRADE K phonological awareness and early literacy skills secondary outcomes while ESL students had greater gains on the GRADE K phonological awareness and phoneme-grapheme correspondence.

Overall, the students gained between .03 (GRADE K phonological awareness and reading and PIPS-BLA phonics) and .06 (PIPS-BLA reading) ability score units per hour of intervention. This means that the average exposure to ABRA (M=29.4 hours, SD=7.95) raised the students’ scores by about half a standard deviation for all measures. Table 8 shows the average ability score gain per hour of intervention for the primary and secondary outcomes by Indigenous and ESL status.

---

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Post Adjusted M (SE)</th>
<th>n</th>
<th>Post Adjusted M (SE)</th>
<th>ESL Status F, d α</th>
<th>School F, Eta²</th>
<th>Intervention F, d α</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary Outcome</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRADE K Phonological</td>
<td>106</td>
<td>.69 (.09)</td>
<td>198</td>
<td>.96 (.07)</td>
<td>5.82*, .36</td>
<td>10.50†, .15</td>
<td>7.71**, .38</td>
</tr>
<tr>
<td>Awareness and Reading</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Secondary Outcomes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRADE K Phonological</td>
<td>106</td>
<td>.67 (.12)</td>
<td>198</td>
<td>.96 (09)</td>
<td>3.74, .22</td>
<td>6.82†, .09</td>
<td>8.27**, .30</td>
</tr>
<tr>
<td>Awareness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRADE K Word Reading</td>
<td>106</td>
<td>.66 (.11)</td>
<td>198</td>
<td>.97 (.08)</td>
<td>5.68*, .27</td>
<td>9.98†, .14</td>
<td>1.43, .16</td>
</tr>
<tr>
<td>PIPS-BLA Reading</td>
<td>102</td>
<td>.66 (.11)</td>
<td>186</td>
<td>.91 (.09)</td>
<td>2.78, .20</td>
<td>1.37, .02</td>
<td>2.43, .17</td>
</tr>
<tr>
<td>PIPS-BLA Phonics</td>
<td>102</td>
<td>.04 (.14)</td>
<td>186</td>
<td>.51 (.10)</td>
<td>25.93†, .40</td>
<td>2.75*, .05</td>
<td>.83, .06</td>
</tr>
</tbody>
</table>

α Effect size (d) calculated using adjusted means: $X_1' - X_2' / \text{MSE}^{1/2}$

* p<.05
** p<.01
*** p<.001
Table 9
Average hours of ABRA exposure and GRADE K and PIPS-BLA ability score gains and standard deviations by Indigenous status and ESL status

<table>
<thead>
<tr>
<th>Hours of exposure</th>
<th><strong>GRADE K Phonological Awareness and Reading</strong></th>
<th><strong>GRADE K Phonological Awareness</strong></th>
<th><strong>GRADE K Reading</strong></th>
<th><strong>GRADE K Phoneme-Grapheme Correspondence</strong></th>
<th><strong>GRADE K Early Literacy Skills</strong></th>
<th><strong>PIPS Reading</strong></th>
<th><strong>PIPS-BLA Phonics</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>M (SD)</strong></td>
<td><strong>M (SD)</strong></td>
<td><strong>M (SD)</strong></td>
<td><strong>M (SD)</strong></td>
<td><strong>M (SD)</strong></td>
<td><strong>M (SD)</strong></td>
<td><strong>M (SD)</strong></td>
<td><strong>M (SD)</strong></td>
</tr>
<tr>
<td><strong>Indigenous Status</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indigenous</td>
<td>24.2 (7.94)</td>
<td>.80 (1.06)</td>
<td>1.45 (1.57)</td>
<td>.76 (1.26)</td>
<td>.81 (1.45)</td>
<td>.90 (1.33)</td>
<td>1.31 (1.01)</td>
</tr>
<tr>
<td>Non-Indigenous</td>
<td>31.0 (7.29)</td>
<td>.60 (1.00)</td>
<td>.54 (1.24)</td>
<td>.77 (1.31)</td>
<td>.93 (1.44)</td>
<td>.78 (1.10)</td>
<td>1.42 (1.12)</td>
</tr>
<tr>
<td><strong>ESL Status</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ESL</td>
<td>26.1 (9.23)</td>
<td>.52 (0.96)</td>
<td>.78 (1.16)</td>
<td>.54 (1.28)</td>
<td>1.08 (1.46)</td>
<td>.76 (1.06)</td>
<td>1.02 (1.21)</td>
</tr>
<tr>
<td>Non-ESL</td>
<td>30.8 (6.88)</td>
<td>.72 (1.07)</td>
<td>.74 (1.46)</td>
<td>.89 (1.31)</td>
<td>.62 (1.44)</td>
<td>.84 (1.18)</td>
<td>1.49 (1.05)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>29.4 (7.95)</td>
<td>.65 (1.03)</td>
<td>.75 (1.36)</td>
<td>.77 (1.31)</td>
<td>.92 (1.47)</td>
<td>.81 (1.14)</td>
<td>1.39 (1.12)</td>
</tr>
</tbody>
</table>
Table 10

Average ability score gain per hour of ABRA exposure and standard deviations for the GRADE K and PIPS-BLA subscales by school, Indigenous status and ESL status

<table>
<thead>
<tr>
<th></th>
<th>GRADE K Phonological Awareness and Reading</th>
<th>GRADE K Phonological Awareness</th>
<th>GRADE K Reading</th>
<th>GRADE K Phoneme-Grapheme Correspondence</th>
<th>GRADE K Early Literacy Skills</th>
<th>PIPS-BLA Phonics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>M (SD)</td>
</tr>
<tr>
<td>Indigenous Status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indigenous</td>
<td>.04 (.06)</td>
<td>.06 (.04)</td>
<td>.02 (.06)</td>
<td>.05 (.07)</td>
<td>.06 (.07)</td>
<td>.06 (.04)</td>
</tr>
<tr>
<td>Non-Indigenous</td>
<td>.02 (.04)</td>
<td>.02 (.07)</td>
<td>.03 (.06)</td>
<td>.04 (.06)</td>
<td>.03 (.04)</td>
<td>.05 (.04)</td>
</tr>
<tr>
<td>ESL Status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ESL</td>
<td>.02 (.05)</td>
<td>.03 (.05)</td>
<td>.01 (.07)</td>
<td>.04 (.07)</td>
<td>.04 (.06)</td>
<td>.06 (.05)</td>
</tr>
<tr>
<td>Non-ESL</td>
<td>.03 (.04)</td>
<td>.03 (.05)</td>
<td>.04 (.05)</td>
<td>.04 (.06)</td>
<td>.04 (.05)</td>
<td>.05 (.04)</td>
</tr>
<tr>
<td>Total</td>
<td>.03 (.04)</td>
<td>.03 (.06)</td>
<td>.03 (.06)</td>
<td>.04 (.06)</td>
<td>.04 (.05)</td>
<td>.06 (.04)</td>
</tr>
</tbody>
</table>

Discussion

Overall our research found that ABRA is more effective than regular instruction in improving students’ phonological awareness and phoneme-grapheme correspondence skills. This finding was consistent across schools in provincial and remote regions and among students with varying levels of attendance and ages. The effect size for the comparison between students who did and did not receive ABRA was medium for both outcomes, indicating that trained professionals, such as teachers, should recognise the impact of ABRA on their students.

ABRA’s positive impact on phonological awareness and phoneme-grapheme correspondence echoes the findings from the 2009 study (Wolgemuth, et al., 2010) and research on ABRA in Canada (Comaskey, Savage, & Abrami, 2009; Savage et al., 2009). These findings are also consistent with recent literature that indicates literacy ICTs, used by trained teachers and aligned with quality literacy curricula, effect positive gains in student literacy, especially phonological awareness (e.g. Chambers et al., 2008a; 2008b). The findings may be somewhat explained by the ABRA teacher training, which gave emphasis to direct instruction of phonological awareness.

It seems promising that students receiving instruction with ABRA demonstrated greater gains in phonological awareness than the control students given (i) phonological awareness has been shown to be an excellent predictor of outcomes at
the end of primary education in the UK and Canada, even after SES and reading ability were taken into account (see, for example, Savage, Carless, & Ferrero, 2007), and (ii) direct phonological awareness instruction is particularly important for improving the reading and writing skills of low-SES (NICHHD, 2000) and language minority students (Ehri, 2009; Geva & Siegel, 2000). In the Handbook of Research on Literacy and Diversity, Ehri (2009) argues language minority children are more likely to begin school with very little foundational reading knowledge, noting that “Whereas well-prepared children may scarcely be affected by instruction that slight foundational and word reading skills, ill-prepared children may find it devastating and may make little progress” (Ehri, 2009, p. 293).

Indigenous children in the NT, apart from being ESL or from low-SES backgrounds, also experience varying degrees of hearing loss as a result of otitis media infections (Aithal, Yanovitz, & Aithal, 2008; Couzos et al., 2001; Couzos et al., 2003; Leach 1999; Preston, 1994). There is some literature to suggest that students with hearing loss struggle particularly with phonological awareness (Moeller et al., 2007). The finding that ABRA was most effective in improving Indigenous students’ phonological awareness skills may lend support to the arguments that (i) the visual and audio enhancements of literacy ICTs better support students with hearing loss (Easterbrooks & Stephenson, 2006; Trezek & Malmgren, 2005), although we do not know the extent of hearing loss in our student sample and (ii) the content and mode of delivery of literacy ICTs promotes social integration and engagement with the learning environment, fellow students and teachers (Kozma & Wagner 2006) and in turn encourages literacy gains.

In the absence of structured supplementary tools such as ABRA, direct phonological awareness instruction is highly dependent on teacher expertise and prior training. The 2009 ABRA research revealed that teachers in the NT feel underprepared to deliver phonological awareness lessons and those participating teachers who delivered medium to high quality ABRA lessons had students with better literacy gains than teachers who delivered lower quality lessons (Wolgemuth et al, 2010). This too is consistent with other literacy ICT research on disadvantaged student populations, which finds positive literacy gains only for students of high implementing teachers (e.g., Davidson, Fields, & Yang, 2009).

In contrast to ABRA’s strong impacts on phonological awareness and phoneme-grapheme correspondence, there was less clear evidence that ABRA directly affected the outcomes for early literacy skills and reading. As explained in the chapter on methods, the early literacy skills subtest was too easy for the vast majority of the sample, suggesting that most students began the study knowing, for example, the difference between capital and lower case letters and how to correctly identify question marks. Therefore it is unsurprising that ABRA did not demonstrably improve students’ early literacy skills as compared to control students.

It is less evident why ABRA did not improve students’ reading scores. It is worth noting that research has found large effects for phonological awareness, but not word reading, at immediate post-test in Canadian studies of ABRACADABRA with high-risk urban low SES students, many of whom experience English as an additional
language (Comaskey, Savage, & Abrami, 2009). While clearly quite distinct from the Australian ABRA reading scores, it may be that there exists some commonality between the samples. It is worth noting that a Canadian follow-up study one year later indicated that the effects of using ABRA were evident on reading comprehension and a range of other literacy measures (Di Stasio, Savage, & Abrami, 2010). It is possible that the benefits of improved phonological awareness may take time to directly impact reading ability and a similar follow-up study of students in the NT would yield similar results.

Limitations and Future Research
While an RCT is designed to minimise threats to internal validity (e.g., the ability to say that ABRA causes gains in student literacy), there are several limitations to our study’s external validity that need to be considered when evaluating the results.

First, our results are limited to the schools that participated in the study. These were six primary schools in provincial (e.g., Darwin) and remote (e.g., Alice Springs) locations. The study did not include schools from very remote locations because of the financial and logistic challenges of placing, supporting and monitoring ABRA teachers in these contexts. However, evidence from the 2009 study suggests that trained teachers in very remote schools can use ABRA effectively to improve students’ phonological awareness. What remains unknown after three years of research is whether ABRA installed on a local server or stand-alone computer can be used in schools that are so remote that they have very limited or no Internet connectivity; and less regular access to teacher support. Future research is needed to determine the feasibility and effectiveness of using ABRA in these contexts.

Second, our results are limited to the students who participated in the study. Because of the location of the participating schools the students in our study were from urban backgrounds and were therefore unlikely to experience the full range challenges faced by Indigenous students in very remote regions (e.g., lack of access to educational and health services). While student attrition was lower in the present study than in previous years, our findings are also limited to students who were present for both the pre- and post-testing. Students who left the study were more likely to speak English as a second language and to be Indigenous. Similar to the findings for the 2009 study, we do not have a means to estimate the impact of ABRA on students with very poor attendance or who attend only a few lessons prior to moving to a different school, although we do have a sense of how much we can expect students to gain per hour of intervention and that 20 hours of instruction is enough to raise students a half a standard deviation on phonological awareness. Future research is needed to track students who leave their schools or who are absent during testing periods to assess the impact, if any, ABRA may have on their literacy development.

Third, while hiring teachers specifically to deliver ABRA maximised our ability to ensure consistency and quality of the ABRA lessons delivered, it decreased the ecological validity (or naturalness) of the study. Our previous research suggests that even trained and bi-weekly supported teachers deliver ABRA lessons of variable quality (Wolgemuth et al., 2010) and that variations in the use of ABRA affect
student outcomes (Savage et al., 2010; Wolgemuth et al., 2010). The results of the present study were found in ideal conditions and may not be replicated in all classrooms in the NT. Future research is needed to determine the amount of training and support required for all teachers to deliver high quality ABRA lessons (see Chapter 5: Implementation Fidelity for a discussion of the best practices for ABRA training and support).

Finally the inconsistent findings for phonics between the GRADE K and the PIPS-BLA may warrant further investigation. Because the PIPS-BLA was newly developed in 2009 and the first scale was eliminated from the analysis due to problems with reliability, we are inclined to concluded that the PIPS-BLA may be a less reliable and valid measure of phonics than the GRADE assessment. Future research is called for that examines (i) the reliability and validity of the Australian PIPS-BLA phonics scale and (ii) ABRA’s impact on phonics at a more granular level (e.g., to answer whether ABRA works better to improve specific types of phonics skills).
5. IMPLEMENTATION FIDELITY

Aspects of Implementation Fidelity
Implementation fidelity, or treatment integrity, relates to the extent to which a program is well delivered (Carroll et al., 2007). Following Dane and Schneider (1998), we examine a number of aspects of implementation fidelity, including adherence (whether the program was implemented as prescribed), exposure (how much program content was received by participants), quality of delivery (whether the program was implemented according to ideal practice) and program differentiation (the unique features of the program that differentiate it from other programs). A further aspect of implementation fidelity, how teachers and students responded to ABRA, is addressed in Section 6 of this report.

In the case of ABRA, good implementation fidelity was defined by teachers delivering ABRA lessons for at least 30 minutes per day for 4 days each week or some other combination of days and times to equal at least 2 hours of ABRA instruction per week. This meant teachers would deliver at least 30 hours of ABRA instruction in total, well over the 20 hours research suggests is sufficient to achieve optimal results for phonological awareness instruction (Ehri, 2009; NICCHD, 2000).

Good implementation fidelity was also defined by ABRA being used as an instructional tool embedded within structured literacy lesson plans, rather than as a free time computer game. Calculating this involved monitoring how students responded to ABRA. Finally implementation fidelity entailed examining how ABRA was different from the students’ regular literacy instruction.

Data Sources
Researchers visited teachers bi-weekly, providing technological and pedagogical support. The researchers observed the teachers’ lessons and monitored implementation fidelity through:

1. The Classroom Literacy Observation Survey-Revised (CLOS-R) (completed during every site visit with treatment and control teachers) (Appendix 1)
2. The ABRA Program Fidelity Observation Record (APFOR) and researcher log (completed during every site visit) (Appendix 2)
3. Teacher logbooks (four times per week) (Appendix 4)

The researchers observed a total of 57 lessons delivered by the 6 teachers for an average of 9 lessons per teacher. Each teacher taught between 2 and 4 classes each day depending on the number of classes the school had nominated to participate in the research. However, teachers were usually only observed once or twice during each visit as they repeated the same lesson for each group unless they had a class that was of a different grade level. The APFOR and CLOS-R instruments were used to categorise teachers into Adoptive (High), Adaptive (Medium), and Entry (Low) level implementers. Classes taught by more than one teacher were assigned the average implementation value of their teachers.
Results

Adherence

Teachers were asked to use ABRA with their students for a minimum of 30 minutes each day for at least four days per week for 15 weeks. This ensured the teachers would deliver at least 30 hours of ABRA instruction. Observed ABRA lessons averaged 40 minutes in length. It should be noted that it was not possible to monitor the exact number of hours spent in ABRA instruction. The ABRA software is embedded within a larger Learning Toolkit (LTK) that has the capacity to monitor the frequency and intensity with which students and teachers use ABRA. However, the LTK was inadequate as a sole measurement of exposure, as a typical ABRA class included a 5–10 minute whole class introduction and a 5 minute conclusion. Teachers generally used the interactive whiteboard for lesson introductions and conclusions, logging in using their own passwords. Further, teachers occasionally encountered technological problems using the LTK and consequently reverted to the ABRA lite version that anyone can access through the Internet but that has no capacity to monitor student use. Therefore we cannot state with absolute certainty the number of hours of ABRA instruction or identify the time spent on specific ABRA activities.

However, bi-weekly observations and classroom schedules indicated that teachers were conducting their ABRA lessons for 40 minutes, 4 times per week. Only the one school where the teacher resigned within the first couple of weeks received less ABRA instruction, as we were unable to hire another teacher replacement for another eight weeks of school time. Nevertheless, our observations and teacher records indicated even this class used ABRA for approximately 20 hours which is the amount of time research suggests is sufficient for phonemic awareness instruction to be optimally effective (Ehri, 2009; NICCHD, 2000).

Exposure

Student absenteeism presented a potential threat to ensuring implementation fidelity. Census data indicates that there is approximately a 20% drop in school attendance from cities to remote areas (Purdie & Buckley, 2010). However, as the RCT schools were in provincial rather than remote locations, attendance for students in the 2010 research was considerably less problematic than in the previous two years.

The ABRA teachers maintained daily attendance logs and records of the duration of their ABRA lessons, which were both used in the exposure calculation. Student exposure to ABRA in hours was calculated by adding the total number of minutes the students were present for ABRA lessons and dividing by 60. The average exposure for all students was 29.4 hours (SD=7.95). This means that more than 88% of the students had 20 or more hours of exposure to ABRA. Non-Indigenous students received, on average, 31.0 (SD=7.29) hours of ABRA instruction while Indigenous students received 24.2 hours (SD=7.94). Students who spoke English as an additional language had an average of 26.1 hours (SD=9.23) of ABRA exposure while English as first language speakers received 30.8 hours (SD=6.88). These data indicate the majority of students received the recommended 20 hours of ABRA instruction, but non-Indigenous students had more exposure to ABRA lessons than
Indigenous students and non-ESL students had more exposure to ABRA lessons than ESL students.

**Quality of the Delivery**

In contrast to the previous years’ ABRA studies, the researchers observed very little variation in the quality of lesson delivery between the teachers delivering ABRA lessons to students. At three schools, teachers used a learning centre approach that involved four or five students on laptops or computers whilst others worked on other supporting literacy activities following a whole group introduction of the activities for that lesson. Half way through the lesson the groups would switch so that all students had as nearly equal time using ABRA. Teachers circulated the classroom, monitoring the students as they worked on the computer or at the tables doing other supportive literacy activities such as rhyming worksheets, or sorting picture cards according to their initial sound. After each group had been on the computers, the teacher brought students together for a whole class conclusion. At the other three schools, teachers used an interactive whiteboard to introduce lessons and then moved to the larger computer lab where students practiced activities on their own computers. On some occasions the interactive whiteboard was used for the whole lesson.

During ABRA lessons teachers were most often observed using alphabetic activities (e.g., blending, decoding, rhyming) (n=79, 66.4%), followed by text-level activities (e.g., fluency and comprehension) (n=36, 30.2%), and writing activities(n=4, 3.4%) . The strong emphasis on alphabetic activities is appropriate to the age, grade level and reading level of students in the study and is also consistent with the ABRA training the teachers had received, which explicitly emphasised using ABRA to reinforce phonological awareness instruction.

Overall the observers’ average rating of the ABRA lessons was 4.39 (SD=1.01), between “agree” and “strongly agree” on the APFOR rating scale. Teachers’ average implementation of ABRA ranged from 3.2 (SD=1.49) for item 4 “Lesson content is balanced” (i.e. Alphabetic, Word and Text level activities” to 4.98 (SD=.13) for item 16 “Lesson is at least 30 minutes long.” While teachers were generally offering balanced lessons, they were usually not doing this with the ABRA resources, but complementing the lesson with other materials. Teachers generally felt that ABRA selection of stories was limited, and tended to use other stories to support the lesson objectives.

**Program Differentiation**

ABRA and control teachers differed in their use of ability level differentiation in their literacy instruction. Control teachers tended to favour whole group over small group instruction, while the ABRA teachers used more small-group instruction and were therefore perhaps able to cater better to individual student needs. The mean score for differentiated instruction on the CLOS-R for the control teachers was 3.96, compared to the mean score of 4.34 for the ABRA teachers. ABRA, with its multiple levels and extensive array of activities, seemed to provide an easy platform for ABRA teachers to differentiate lessons according to student needs (Helmer et al., 2009). However, this score is considerably better than the 2009 mean score for program differentiation for both the ABRA and control teachers, where the mean
score for control teachers was 2.8, compared to the mean score of 3.13 for the ABRA teachers. Perhaps this is due to the RCT design where both groups only worked with 10-12 students at a time thus providing greater ease to work with small groups and individual students. In four of the six schools, teachers had to divide the students into small groups as there were not enough computers for each child which may have also provided the impetus to do more in terms of ability level differentiation.

Discussion
Implementation fidelity for the ABRA project was evaluated by examining adherence, exposure, quality of the delivery, and program differentiation. While adherence was good, with every teacher meeting and most teachers exceeding the minimum time requirement, some students, particularly Indigenous students, had less exposure. What remains unknown is how much ABRA exposure is required to effect a meaningful (e.g., standard deviation) gain in student literacy outcomes.

The quality of the delivery overall was very good, with all teachers scoring at the high end of the implementation quality measure. Overall ABRA delivery was stronger across all the measured benchmarks. Both researchers commented on the creativity and high quality lessons they regularly observed during their bi-weekly observations. This is attributed to the fact that each of these teachers was hired by CDU to deliver the ABRA lessons. They had no other school responsibilities that would demand of their time as did the teachers in the previous research. The training was also lengthened to run over one week allowing teachers more time to explore the ABRA resource, lesson plan and to reflect and ask questions about the previous day’s learning.
6. TEACHER TRAINING AND SUPPORT

The RCT teacher training and support strategy
The ABRA RCT training and support strategy was designed in accordance with the literature on best practices for professional development, including the provision of continuing expert support, which has been shown to be an essential component of all effective professional learning for teachers (Guskey, 2003; Hawley & Valli, 1999; Ingvarson & Meiers, 2005; Ingvarson, Meiers & Beavis, 2005).

The RCT teachers were trained in the use of ABRA, and their continued learning was encouraged and supported by pairing them with a researcher with early childhood literacy expertise, thus providing them with regular opportunities to reflect on their own learning needs the effect of their learning on student outcomes (Timperley et al. 2007). This supportive relationship was intended to build the teachers’ skills specifically in using ABRA to teach literacy, but also more broadly in the area of literacy instruction (Helmer, et al., 2011).

ABRA Training
All ABRA teachers attended a full week, half-day professional development (training) session at the university, held one week prior to school commencement in January 2010. In this way, the ABRA teachers were able to start in their respective schools at the beginning of the term, enabling them to establish positive relationships with the participating school they had been assigned. Once in the schools, ABRA teachers could attend to some of the logistical issues relating to the research such as obtaining consent forms and coordinating the pre-testing that would take place in Week 4 of the first semester. The training session was conducted by a university researcher in a university computer laboratory. The training included:

- An overview of the 2010 research design and their role as an ABRA teacher
- Review of the ABRA program, development and research
- Information on using a balanced literacy approach
- Background reading and examples for phonological and phonemic awareness instruction
- Effective classroom management
- Using ability level differentiation
- Description of the literacy assessment instruments
- Direct instruction on implementing ABRA
- Computer time to explore ABRA (time was provided each day)
- Teaching tips
- Group planning time
- A model lesson

The aim of the professional development session was to provide teachers with uninterrupted blocks of time to develop lesson plans, discuss their role in the research and to become more familiar with the ABRA website. The year three teacher training also focused on the integration of computer technology and literacy lessons in the context of a balanced literacy approach.
ABRA Support
The researchers provided the ABRA teachers with support throughout the research through bi-weekly on-site visits, phone calls and email. The on-site support included observing and providing constructive feedback on ABRA lessons, meeting with teachers to discuss their impressions of ABRA and offering pedagogical and technological support.

Data Sources
The quality and effectiveness of the training and support were evaluated through analysis of the following data sources:

1. A training evaluation survey completed at the end of the training session (See Appendix 6).
2. Researcher logbooks, which contained researchers’ notes on the ongoing support (See Appendix 2).
3. Teacher logbooks, which contained the teachers’ impressions of how the lesson went and which activities they had used (See Appendix 4).

Results

Training
Generally, the researcher/coaches recorded they were very satisfied that ABRA teachers were well prepared to begin teaching with ABRA after the initial professional development week. Most of the ABRA teachers came to the professional development having already viewed the ABRA software and the online manual, so they had a rudimentary understanding of what was offered on the ABRA website. As these teachers had been hired to be part of the ABRA team they were highly enthusiastic about their role in the research. However, due to varying levels of teaching experience, some came to the training session with a deeper level of understanding of teaching, literacy and early childhood development than others which necessitated more support during the initial stages of implementation.

Support
Over the previous two years of ABRA research, it was noted that on-site, in-person support was most effective when researchers were able to stay in the schools for extended periods (i.e., for half days rather than just immediately prior to and after ABRA lessons). This enabled the researchers to work around the ABRA teachers’ schedules, and organise meetings for when they had finished teaching. Compared with previous years of research, organising meetings with the RCT teachers was relatively straightforward, as it was not so necessary to fit the meetings around full teaching schedules and other planned and unplanned school activities. The 2010 ABRA teachers had the time to take full advantage of the support, to experiment with lesson delivery styles and to develop creative lesson plans that further complemented ABRA.

Teacher feedback about classroom visits
Following the ABRA data collection period, ABRA teachers were invited to write a paragraph highlighting their experiences during the RCT research. Three of the six teachers responded to this request. The teachers reported that the regular classroom visits were important to their effective use of ABRA. They welcomed the regular presence of a ‘critical friend’ to whom they could pose questions relating to program
implementation. They indicated that they believed regular contact is vital to establishing a professional and trusting relationship between the teacher and the researcher, where issues can be discussed openly and thoroughly and coaches can offer constructive feedback in confidence (Helmer et al., 2011). They also appreciated having someone to turn to in the case of technological problems.

“The regular feedback from the research team, and evaluation of lessons, helped to make my lessons as effective as possible” (ABRA Teacher (a), 2010).

“This programme has taught me many different ways of integrating literacy activities within the classroom through the use of technology. Having the support of the researcher/coach gave me a sounding board when I had questions and also provided valuable advice to improve my lesson delivery” (ABRA Teacher (b), 2010).

**Discussion**

**Implications for Training and Support**

The experience of the RCT research allowed the researchers to formulate a number of strategies and recommendations for enriching any future ABRA training. Notably, ABRA professional development should be conducted over an extended period of time whereby teachers receive information about ABRA to read prior to the formal training day. In this way teachers have an opportunity to familiarise themselves with the program and to come to the training day with some background knowledge of the ABRA software. The initial training should subsequently be attached to ongoing learning and support.

Instructional principles espoused in contemporary approaches to professional learning highlight the importance of an ongoing approach that is: embedded in teacher practice; organised around collaborative problem solving, involves reflection and feedback and is followed up with support from a range of experts (Guskey, 2003; Hawley & Valli, 1999; Ingvarson, Meiers & Beavis, 2005; Timperley et. al, 2007). The Literature Review above has already highlighted the need for literacy ICTs be implemented by well-trained teachers and aligned with existing approaches to literacy instruction, recognising the diversity of student needs.

For students to get the most out of ABRA, teachers must be supported during the initial stages of implementation. This is especially pertinent when the professional learning program involves substantial changes to teaching practices, beliefs, values and understandings (Timperley et al., 2007), as may be the case with the introduction of computer-based instruction in the classroom (Abbott, Lochs, & Williams, 2001).

**Implications for Research**

An area for future study that has been highlighted by the ABRA research is the need for teachers to receive training to learn how to more effectively embed the use of computer activities into their lessons rather than using computer software as an ‘add on’ activity. While injections of technology made by Federal, State and Territory Education Departments provide additional computers, electronic whiteboards and appropriate technologies to regions and schools, the issues of inadequate preparedness of pre-service teachers and lack of provision of quality professional development to experienced teachers can impact on the quality and soundness of

Additionally, it is a requirement to include Information Technology in pre-service education courses across the country, yet the amount of time and presentation varies considerably (MCEETYA, 2008). This training is not always sufficient to fully prepare novice teachers and ICT specific professional development activities are not always widely available or accessible (Lyons, Cooksey, Pianizzon, Parnell, & Pegg, 2006). Regular professional development is also a critical need for more mature teachers who may not be comfortable with the onslaught of various technologies. The crucial role of teachers highly adopting and implementing ICTs to delivery literacy instruction has also been highlighted in a recent literature review of ICTs integration challenges with teacher barriers identified as lack of confidence, ICT competence, and resistance to change (Bingimlas, 2009).

Students have a difficult time inferring what is happening in a computer game/learning activity if it is not connected to the broader ideas of the lesson (for example, after practising a blending activity then going back to the class and practising this skill while engaging in reading). ICTs alone cannot improve literacy. They must be integrated with other programmes that support and address the developmental needs of the learner (Kozma & Wagner, 2006). A survey completed in Australia and New Zealand by the Learning Federation has found that there is a generally low adoption of ICT. Reasons discussed were the “lack of alignment between curriculum, pedagogy, assessment of student’s performance and high stakes testing (Freebody, Reimann & Tiu, 2008).

Another area of research that may merit further investigation in the Australian context is the use of ABRA with students who have been identified with special learning needs. Macaruso, Hook and McCabe (2006) and Segers and Verhoeven (2005) reported gains in alphabetics for children at risk of reading disabilities and of ESL status. Although these results are encouraging and seem to suggest that the use of ICTs may be a beneficial resource to deliver literacy instruction, more research studying these populations and/or further sub-group analysis of studies including disadvantaged children in the sample is needed to understand whether these children in particular benefit and if so which factors contribute to their literacy gains.
7. TEACHER AND STUDENT PERCEPTIONS

Data Sources
Teacher perceptions were gathered from teacher logbooks. Teachers were also invited to compose a final evaluation of their experience as the ABRA RCT teacher. Three of the six teachers responded to this invitation. Student perceptions were collected via a structured interview conducted with a random sample of at least 3 students from each class.

Results

Teacher Perceptions
Notes from ABRA teacher logbooks and individual final evaluations represented ABRA positively. Teachers enjoyed being part of the ABRA research and felt both they and the students benefitted from using ABRA.

The teachers’ comments were categorised into three general statements about ABRA:

1. ABRA supports or complements regular instruction
2. ABRA helps students to self-regulate and extend their own learning
3. ABRA works best when students can focus on an activity at an age appropriate level.

*ABRA Supports Regular Instruction.* Using a web based tool provided enrichment to the regular literacy lesson. One ABRA teacher working at a Darwin school said, “The ABRACADABRA computer programme is a comprehensive literacy tool that I believe should be used in a complementary fashion when exploring new and developing concepts and sounds within class.”

Another teacher commented:

Each student has a different learning style, but captivating students’ interest and attention, as the Abracadabra program did, definitely helps to optimise the chances of students being able to learn and understand new concepts. It was also an excellent means of reinforcing skills learnt in class, enabling and ensuring that each child practised the skill independently, and encouraging the students to take responsibility for their own learning.

A third teacher added:

I found ABRACADABRA to be wide-ranging as it caters for students at different levels for example; (a) students that are still learning to extinguish between letters, (b) those students who needed practise on distinguishing the sounds of letters to (c) students that had mastered the basics and were extending their knowledge of phonetic spelling.

As a reinforcement tool, these teachers felt that ABRA’s mode of delivery provided an alternative learning platform for students that are sometimes more difficult to engage.
ABRA Supports Self-Regulation and Extension. An advantage of ABRA, according to the teachers, is in its ease of navigation. The ability to move quickly through the program, within and between activities, helped students to focus on the task at hand and facilitated their learning of the content material. This ease of navigation, coupled with clear instructions, meant students were provided opportunities to self-regulate and extend their learning. Teachers also noticed remarkable growth in these young students’ computer skills due to their frequent exposure to the technology. One ABRA teacher said:

I am so impressed with the students’ ability to independently log into the program. Also, their ability to use the mouse is so much better than when we initially started using ABRA. When I am occupied with another student if someone has a problem they can’t solve another student will often volunteer to try and fix it.

A teacher from another school stated:

It encouraged students to be independent learners. There was little opportunity to copy fellow students, so they really did have to do the activities by themselves. They also had to take responsibility for choosing a level and sometimes an activity that suited their needs/abilities.

ABRA Works Best When Students Focus on an Activity at an Age Appropriate Level. When teachers were asked to comment on how ABRA could be improved they most often mentioned an increase in the number of pre-literacy activities. At the beginning of the school year many of the Transition students have not yet learned the letters or the sounds. There were not many ABRA activities suited to their current level, so teachers found it necessary to enrich their learning with additional activities. ABRA teachers with Transition classes found ABRA somewhat limiting in this regard as most of the activities on ABRA assume students already have learned letter and sound recognition. Teachers felt ABRA would be stronger if it provided more opportunities to tailor the activities to individual needs as can be done in the “Word Families” game.

One teacher said:

Because many of my students were in Transition, I would have liked some activities that specifically helped students to learn their letter symbols and sounds, others that taught grapheme name and sound, and some to help with common blends such as “sh” and “ch” and “th”.

Another teacher commented:

The instructions were clear and easy to follow, and it was rare for students to not know what to do next.

A third teacher stated:

Being able to tailor more of the activities to suit your class’s needs would make the program far more appealing and user-friendly for
teachers, i.e., being able to choose your own words/vocab on “Speed”, “Vocabulary” and “Spelling words”. This would enable teachers to use the program when studying different texts, for theme work and to reinforce sight words.

Taken together with the above comments relating to ease of navigation and the potential for students to self-regulate and extend their learning, the teachers seemed to be saying that while ABRA is a comprehensive program with many positive features there are aspects that could be improved. For example, the bingo card in the game “I.D. Bingo” had 25 letters which children who had yet to master the alphabet found very frustrating. This activity could be improved by having several different levels starting with a card of only 6 letters, or designing it so teachers can choose which letters will be on a card. Another idea is providing the letter sound as well as the name of the letter, as students learn the sounds first. This could be added as a “Need Help” button.

**Student Perceptions**

A total of 46 students from 17 classrooms participated in structured interviews about ABRA. When asked to point to the face which conveyed how they feel when the teacher says they are doing ABRA, 44 said they feel happy, 1 was neutral and 1 was sad. Students most preferred using ABRA on individual computers (n=33), followed by doing other work that supported ABRA i.e. worksheets (n=8) and on the electronic whiteboard (n=5). Students who preferred the computer most often said they liked being able to work alone or with a friend at their own pace. One student said “I like using the computer because I don’t have to wait to get a turn like when the class uses the smart board.”

Students who preferred doing other activities related to ABRA appreciated the group interaction and time with the teacher. One student said, “I like doing the worksheets because we can colour and cut and paste. Sometimes we can play games that aren’t on the computer.” Another student said: “My favourite activity was when we planted beans after reading the ABRA story about how a bean grows.” These children seemed to enjoy ABRA as one activity among several done during the literacy block.

The students’ favourite characters were Julie (n=13), Leo (n=12), and Jeffrey the Dragon (n=10). Other characters mentioned were Colette the Whale (n=2) and Dolcie and Alphonse (n=2). The students’ favourite activities were Syllable Counting (n=9), Letter Sound Search (n=5), Letter Bingo (n=5), and Auditory Segmenting (n=5). Other activities that received a mention were Word Counting (n=3), Sequencing (n=2), Animated Alphabet (n=2), Same Word (n=2) and Word Changing (n=2).

The survey also asked about students’ knowledge of the ABRA program (e.g., to name the characters and icons). Introducing the characters within each activity was discussed during the teacher training. Getting to know the characters is believed to be a way of further engaging students with ABRA and thus adding to their overall experience while using it. Based on their responses it was evident that the children were very familiar with the main characters that were present in most activities. 80%
of the students could identify the Leo the cat and 84% could identify the little girl, Julie. Children that could not name the characters in several cases were also students who had no answer for several of the questions. It is possible they were shy, not confident speaking to the researcher, or irregular attendees who may not have had much overall time using ABRA.

One indication that ABRA was perceived by the students as engaging and fun is the large number students who referred to using ABRA as “play” (n=20) and the ABRA activities as “games” (n=39), and “fun” or “funny” (n=43). For example when one student was asked about a particular icon he said, “It goes to different games where you can play bingo and rhyming and fishing.” One ABRA teacher explained, “ABRA has such an interesting variety of games that really keep the children entertained and they are motivated to learn as they work their way through the activity.”

Discussion
Overall, teacher perceptions were favourable to using ABRA in the NT. Teacher support is vital to the success of any new instructional intervention (Timperley, Wilson, Barrar, & Fung, 2007; Darling-Hammond, 2000; Baylor & Ritchie, 2002; Fullan, 2001, 1993; Hall & Hord, 1987). In order for students to receive the full benefit of any initiative, teachers need to be enthusiastic about its possibilities to improve student outcomes (Fullan, 2007, Judson, 2006; Del Corso, 2005; Zhao & Cziko, 2001). Teachers are most supportive when an initiative seems teacher friendly and easy to integrate into the current program being used (Tondeur, van Keer, van Braak, & Valcke, 2008; Chen & Chang, 2006; Fouts, 2000). One teacher commented: “All students definitely enjoyed the activities as a whole. The characters are engaging, the graphics excellent, and the activities varied and interesting. Each activity has a “game” element that makes it appealing to students of this age.” This was further supported by student interviews which showed students felt ABRA was a ‘fun game.’

Teachers were very supportive of ABRA to the extent to which students seem to be engaged in and benefitted by the program. The teachers spoke positively about ABRA, felt that it assisted their students literacy learning and that students enjoyed using the program. Another teacher commented: “It encouraged students to “have a go” as there were no really negative responses if they got something incorrect – they just moved on, were given assistance, or could choose an easier level if need be.”

When asked how ABRA could be improved, teachers had a number of suggestions. Reflecting similar comments from teachers in previous years, a number of teachers in this study stated the view that while ABRA does have a comprehensive range of activities, there are not enough activities to support younger students who have not yet mastered all the letters and sounds. Teachers also expressed a desire to have more control over the words and sounds that are presented within each activity. A further expressed concern was the lack of quality literature in ABRA, which discouraged the teachers from reading many of the stories that were part of the ABRA resource.
Future Research

The three year ABRA research collected teacher and student (years two & three) feedback in order to make recommendations about the feasibility of using ABRA in the NT context. All three studies have indicated that using ABRA is very feasible provided that teachers are well-trained and supported and schools have the necessary technology (e.g., computers, headphones, reliable Internet access and interactive whiteboards). This feasibility finding is therefore contextualised within the structure and support of three research studies.

The question remains whether ABRA is a feasible tool in the absence of intensive teacher support, which is certain to be the case when teachers not in the study use ABRA. When teachers are not confident or have questions that there is no one to answer, they will stop using any new resource as it hasn’t become part of their regular teaching practice. We are unaware of anyone in the group of control teachers who is using ABRA on a regular basis. After a short training session if teachers have no support system they rarely make the extra effort to incorporate it into their literacy program. These findings support other research on professional development and affecting teacher change. Changing teacher behaviour is an ongoing process tied to teacher learning, student learning and what is known as effective instruction with the goal of developing teachers who are more reflective and meta-cognitive; who regularly ask themselves “What am I doing and how can I do it better?” (Kinnucan-Welsh & Grogan, 2006, p. 4). Teachers need to be confident in their knowledge of the teaching material and how students learn. Even for experienced teachers this can be challenging and requires continuous professional development with built in follow-up and expert support (Guskey, 2002; Ingvarson, 2005; Meiers & Ingvarson, 2005).
8. CASE STUDY

The ABRA case studies were set up with the aim of examining how teachers used and adapted ABRA in ‘naturalistic’ implementation conditions: that is, when receiving only minimal support from the research team as a reflection of the level of support that schools might ordinarily expect for their standard literacy programs. The studies also aimed to document how schools tackled the complexities of supporting teachers in new ways of teaching.

Research Questions
This case study was guided by two main research questions:

1. How are teachers and assistant teachers using ABRA?
2. What are the perceptions of teachers, assistant teachers, principals and students about programming for literacy (a) in inter-cultural contexts and (b) using ICTs?

Design
A multiple-case design (Yin, 2003) was employed to examine how well ABRA was being implemented, whether students were engaged with ABRA, and teachers’ perceptions of ABRA’s usefulness. Four schools served as case study sites and the findings across the case studies were collated, compared and contrasted to produce a compelling and robust analysis of how ABRA is used and how teachers and students perceive it.

Sites of study and participants
Six NT primary schools initially agreed to participate in the case study. These comprised two schools from each of three Australian Bureau of Statistics geographic classifications in the NT: two provincial schools (in Darwin, the NT capital, and Palmerston, a satellite town near Darwin), two remote schools (in the Katherine region), and two very remote schools (in the Gulf of Carpentaria and Arnhem Land).

Early in the study, both of the very remote schools were obliged to withdraw, highlighting the general difficulties facing very remote sites. In one case, the annual monsoon had caused flooding in the school and in the ensuing chaos of refitting classrooms and re-recruiting teachers, the school did not have the capacity to participate in the research. In the second instance, it was found that the literacy levels and technology confidence of the participating para-professional teachers (on whom implementation of ABRA would have depended) was not sufficient to enable ABRA to be deployed.

All of the four remaining schools serviced highly diverse populations, including many Indigenous, recent immigrant, low-income and welfare dependent families. The Indigenous students likewise hailed from diverse backgrounds: some were from remote and very remote regions of the NT, others were from ‘town camps’ (quasi-permanent Indigenous settlements existing on the periphery of major NT service centres and many remote area communities), while others were from housing
commission tenements surrounding the school. Many of the students spoke English as a second, third or even fourth language.

The teachers participating in the study taught a variety of year levels. In the Darwin school, ABRA was used by a Transition teacher, the special needs teacher and her assistant teacher. In the Palmerston school, ABRA was consistently used by two Transition-Year 1 teachers and one of the assistant teachers. In the larger of the remote schools, a number of teachers used ABRA; these teachers taught a Transition class, a Year 1-2 class and two Year 3-4 classes. In the smaller of the remote schools, ABRA was used by the teacher in charge of the composite Transition-Year 1-Year 2 class.

**Training and Support**

To establish the case study sites, researchers provided a full-day training session for participating teachers, both at the university campus (for the provincial teachers) and in schools (for the remote teachers). The training sessions for the case study teachers incorporated a review of ABRA’s development and the role of teachers in this research, guidance on effective classroom management, how to use ABRA to differentiate children’s ability levels and some time-saving tips for getting started. There were also discussions focusing on the elements of a balanced literacy approach (Rowe, 2005), with particular emphasis on explicit phonics and phonemic awareness instruction.

The teachers began using ABRA with their students in the week following the training session and continued to use ABRA over two school terms for a total delivery time of 15-16 weeks. The teachers were asked to use ABRA as part of their usual literacy instruction for a minimum of 30 minutes at least four times a week. ABRA was used mainly in early childhood classrooms (T-2), although in some sites it was also used as a remedial program with older students (Years 3 and 4). A researcher additionally provided teachers with minimal support by visiting once each term, observing lessons and providing feedback on the planning, structure and content of the ABRA lessons, with advice on dealing with the technology. Teachers were also offered assistance through phone conferences and email, but no teachers took up this offer.

The model of support offered to the participating case study schools was consistent with the level of support typically offered to teachers adopting a new literacy program in the NT. Characteristically, teachers in the NT are introduced to a new teaching approach through a one- or two-day seminar, organised by internal or external experts. Although there is an expectation that schools or groups of schools will organise support activities for new programs or interventions, these are rarely prescribed.

**Data sources**

*Teacher Log Books*

During the training session, teachers were asked to maintain log books of the amount of time they use ABRA each day, the number of students in the class, what was taught during that time, and their reflections about the lesson. However, teachers
found it difficult to find the time to maintain the log books, and they were ultimately discarded as a data source in this study.

Teacher Effectiveness Instrument and Researcher Log Book
Researchers observed ABRA lessons during site visits and used the ABRA Program Fidelity Observation Record (APFOR) (see Appendix 1) to document their observations.

Interviews with school staff
Semi-structured interviews (n. 12) were conducted with principals, teachers, assistant teachers and tutors to provide more in-depth information about how they perceived and used ABRA. Interviews were digitally recorded.

Student Interviews
Semi-structured interviews were also conducted with three students from each class at the end of the ABRA intervention to gather their perceptions of the ABRA software. They were asked what they liked about ABRA, what they did not like about ABRA, what they had learned using ABRA, and who were their most and least favourite characters. They were also asked to explain to the researcher how to use ABRA. Children were selected for the interviews on the advice of their teachers, and subject to agreement from their parents or guardians.

Ethnographic Field Notes
As it was not feasible to do prolonged ethnographic fieldwork in the schools, the researchers used rapid immersion techniques to gain quick familiarity with the schools’ routines. To do this, the researchers visited the school for day-long episodes of participant observation, focusing on the literacy and computer lessons. These observational records provided rich descriptive data on a snapshot basis.

Additional sources: published and unpublished literature
Data was supplemented by published and unpublished literature on the history of the participating schools and their demographic profiles, and available information about staffing profiles and student numbers.

Findings and discussion
Research question 1: How are teachers and assistant teachers using ABRA?

Two aspects of ABRA’s use are considered here: how teachers and assistant teachers adapted to the use of the ABRA technology; and how teachers integrated the use of ABRA into their overall literacy program.

Use of the ABRA technology. All of the case study schools were well equipped for implementing ABRA. Each of the participating teachers had an interactive whiteboard in her classroom, and four to six computers to which she could direct children on rotational basis. The Darwin and Palmerston schools additionally enjoyed dedicated computer laboratories, enabling all students to participate in ABRA activities at one time. All schools were overtly oriented to extending their use of ICTs in their classrooms, and teachers spoke positively about
the aim of increasing students’ familiarity with computers and the capacities of the Internet.

Nonetheless, lessons were frequently interrupted by technological problems. Teachers reported problems with the ABRA games freezing mid-lesson, or the sound not working on the interactive whiteboard or the computers. Sometimes the problems were trivial and avoidable—an older student might have activated the mute button on the computer, for example—but it could be enough to derail a lesson for a small child sitting at a computer, unsure of what kind of functionality to expect, and without the confidence to alert the teacher.

For the youngest students in particular, logging on was often frustrating, as they often needed a high level of help to enter password information accurately, and this could significantly disrupt a lesson. When children attended erratically, spending time finding new passwords or reminding children how to log on could also be disruptive to the whole class.

Managing children’s general behaviour while on the computers was a challenge for teachers who had little prior experience of ICT use in the classroom. Students were in many instances observed clicking from activity to activity, spending only a few seconds on something before losing interest and moving to something else.

How teachers dealt with technological problems depended largely on their confidence generally to cope with the technology while managing their classes. In interview, some teachers expressed the view that managing their students on computers was extremely difficult. In several cases, the children’s knowledge of how to navigate the program’s items was superior to that of the teacher, further undermining the teacher’s sense of being in control.

Many of these technological problems were, however, surmountable in the context of teachers’ regular practice; most of the teachers found ways to resolve these problems in some way, and did not see minor technical problems as a reason to abandon the program altogether. For instance, teachers dealt with the biggest technical problem—the games not working or freezing—by substituting new activities to fill the lesson time. Having a tutor or an assistant in the computer room to help the children with their individual problems assisted with the disruption caused by children still building their familiarity with the machines. As might be expected, as teacher and children’s skills and fluency grew over time, they found it easier to work with the ABRA resource.

*Integrating ABRA into the overall literacy program.* While some teachers were comfortable integrating ABRA into their regular literacy program, other teachers struggled to make connections between the ABRA activities and other aspects of their literacy learning. A number of teachers stated that they did not believe their training had adequately prepared them to teach children to read in the first instance. Further, despite the emphasis that had been placed on phonics and phonological awareness instruction during the teachers’ initial ABRA training, most of the case study teachers were still not confident in this area.
Some teachers treated ABRA as a benign babysitting tool (from one teacher) ‘because it fills the time’ and (from a second teacher) ‘it’s tempting to sit back because they look busy’. Teachers were observed using ABRA as a reward and as a diversion more often than they were observed integrating it into a coherent literacy plan. Teachers found this use of ABRA as an entertainment was particularly hard to avoid with children who were frequently absent from school, and who therefore had trouble engaging with the academic requirements of the lesson when they actually attended, but who could be kept happily occupied on ABRA’s brightly animated games without necessarily engaging with concepts that ABRA was designed to reinforce.

Of the four schools in this study, only one had mentoring arrangements in place that were embedded or consistent enough to provide continuing literacy support for teachers. The reason for this can perhaps be linked to high levels of staffing turnover in NT schools generally, which can make mentoring arrangements difficult to sustain. One other school occasionally organised teaching relief for teachers to be able to watch their colleagues teach, but while teachers aspired to do this more routinely, it was still an irregular occurrence.

In only one of the four schools was there any evidence of a shared approach to the pedagogy of early literacy, and in all of the schools there was little scope for teachers to be able to work collaboratively through their anxieties relating to the technology, or to source on-site help in planning lessons and in beginning to link their use of ABRA to other forms of learning.

Research question 2: What are the perceptions of teachers, assistant teachers, principals and students about programming for literacy (a) in inter-cultural contexts and (b) using ICTs?

This section includes discussions of: perceptions of ABRA’s ‘cultural appropriateness’; perceptions of ABRA’s place in the culture of the school; and perceptions about using ICTs generally and ABRA specifically.

Perceptions of ABRA’s ‘cultural appropriateness’. Many teachers had understandable misgivings when they first encountered ABRA; namely, that a Canadian resource would not be well suited to remote Australian contexts and that the technology itself would prove problematic. Concerns about ABRA’s Canadian provenance reflected an understandable broader concern in Indigenous education circles that materials used with Indigenous children should be ‘culturally appropriate’.

However, interviews with teachers and students suggested that once teachers started to use ABRA, on the whole they were untroubled by the Canadian voices or iconography. Teachers noted that children were not necessarily familiar with the kinds of characters in the games, but acknowledged that this in itself was an opportunity for learning. Teachers typically did not feel that the content was particularly unsuitable for Indigenous students.
Further, they did not consider the Canadian accents to be particularly problematic and several teachers reflected that the students were anyway well used to North American accents from television. This finding is consistent with the findings of the year 1 study that examined the feasibility of using ABRA in an Australian, Indigenous context.

**Perceptions of ABRA’s place in the culture of the school.** Teachers in all of the case study schools spoke in interview about the preponderance of difficulties – cognitive, emotional, linguistic and health-related - experienced by their students, which potentially impacted on their academic achievement. Further, some children in their first year of school were deemed by teachers difficult to teach because they had not attended preschool or were perceived as too young to receive academic instruction.

In the face of these kinds of difficulties, it was observed that teachers often prioritised behaviour management on the one hand, and the use of multiple individualised learning pathways on the other hand, at times with the assistance of other adults. The observed effect on teaching was that classes tended to be highly fragmented through the allocation of short spans of time on task, constant activity rotations and frequent changes in supervision amongst teachers and paraprofessional helpers. Lessons were fragmented into short rotational episodes, punctuated further by the withdrawal of children from regular class for various remedial interventions.

ABRA also had to compete with a crowded schedule in the case study schools, which all entertained multiple initiatives from sponsors keen to create a culture of attendance and enjoyable participation in poor performing schools. During the site visits for this study, for instance, the schools variously had visiting musicians creating songs with children, football stars or other celebrities visiting to exhort greater student engagement in school, or field excursions to share Indigenous bush tucker. It was observed that such activities were popular but caused disruption to programmed routines, and that, with so many competing initiatives and interventions, it was difficult for a literacy intervention such as ABRA to be genuinely prioritised.

Some teachers felt that adding ABRA to the mix of approaches they were already using simply compounded the children’s confusion. Teachers particularly worried that they would not have time to deal with ABRA adequately. In fact, ABRA seemed to add to their stress and workload because it seemed to be, as one teacher told us, “just another thing to be good at” when “we have so much to do”, rather than something that they could integrate easily into an already conceived literacy program.

**Perceptions about using ICTs.** The use of ICTs was considered important in all of the schools. However, the acquisition of new hardware seemed to take priority over supporting teachers to use the ICTs. For example, one principal talked at length in interview about the various packages that were being introduced into the school and about imaginative ways of manipulating funding formulae to allow the school to
invest in greater levels of computer technology. At the same time the principal rejected the suggestion that the school could find ways to invest in extra staff for mentoring teachers, insisting, ‘The funding formulae will never allow that’.

Most teachers nonetheless explicitly valued in-school support and spoke about the frustration of being sent to professional development sessions without collegial support or follow-up. A number of teachers emphasised their frustration at the inherent difficulty of sustaining knowhow when knowledgeable colleagues simply ‘disappear’ in the churn of constant teacher turnover. Further, one school leader attributed expert knowledge of how to use ABRA to one individual teacher, and took the fatalistic position that the knowledge would inevitably be lost if that teacher were to leave: ‘If she was to leave our school tomorrow I’d say ABRA would fall apart, you know, because she’s the one that carries that knowledge. That’s often the nature of schools isn’t it?’

The fact that teachers had almost no continuing in-school support to build their skill levels in relation to ABRA (or any new approach) left many of them with a fairly blasé attitude to the tool, irrespective of its reported success in other contexts. Well aware that programs do not just magically ‘work’, they were generally cynical about the idea that any program could address their particular teaching challenges and the permanent social imprint of student and community disadvantage. This was expressed in their wariness generally towards new approaches, and their sentiment that so many pedagogical fads and unrealistic policy expectations are pushed upon them that this is ‘just another thing that comes in and then it’s gone again’. How indigenous students are taught can thus be difficult to shift in pedagogical terms.

**Conclusion**

While most teachers in the case study schools were positive about using ABRA, and several teachers were successfully integrating it into their overall literacy program, much of implementation of ABRA was less than ideal.

Despite the fact that all of the case study schools were technologically well equipped to extend their use of ICTs in their classrooms, and the use of ICTs was considered important, lessons were frequently interrupted by technological problems. Managing children’s general behaviour while on the computers was also a challenge for many of the teachers, although teachers reported gaining confidence over time.

Many of the teachers struggled to make connections between the ABRA activities and other aspects of their literacy program, despite the emphasis that had been placed on phonics and phonological awareness instruction during the teachers’ initial ABRA training. Instead of integrating ABRA into a coherent literacy program, some teachers used ABRA more as a babysitting tool or as a reward and diversion, particularly with infrequently attending children who found it difficult to engage with more academic demands. Further, despite the value that teachers placed on in-school support, mentoring arrangements in most of the schools were inadequate for supporting teachers to plan ABRA lessons or link ABRA to the broader curriculum.
Teachers did not voice major concerns about the Canadian provenance of ABRA: they did not find the Canadian accents to be problematic, nor did they feel that the images were inappropriate for Indigenous children, reflecting rather that the foreign origin of the resource provided rich learning opportunities. On the other hand, it was clear that ABRA was competing with a mix of teaching approaches within an already crowded schedule, making it difficult for teachers to prioritise their own skill development. As a result teachers were reluctant to embrace wholeheartedly yet another approach, particularly in cases where they felt overwhelmed by the task of working with children that were firmly identified as difficult to teach.
9. KEY FINDINGS, FUTURE RESEARCH DIRECTIONS AND RECOMMENDATIONS

Key Findings
ABRA is feasible and effective across the NT context, provided that:

• teachers are well-trained and supported professionally to use ABRA to greatest effect
• it is integrated into the overall literacy program
• it has high levels of technical support
• it is accepted by the teachers and the wider school community (a high level of support for ICTs in the classroom)
• the school is properly equipped to deliver ABRA (interactive electronic whiteboards, a sufficient number of computers for classes).

The evidence showed that ABRA use improves students’ phonological awareness and phoneme-grapheme correspondence to a greater extent than other programs in use. It also showed that ABRA is effective even with students who have less than ideal attendance and who are from Indigenous or ESL (‘disadvantaged’) backgrounds.

Despite a positive response from teachers in the case study schools, many of whom had integrated ABRA into their overall literacy programs, outside of supported implementation conditions, the deployment of ABRA was less than ideal. Among the issues impeding its effectiveness were:

• technological problems, including interrupted connectivity in the more remote areas
• managing behaviour while children were using the computers for the program
• teachers using ABRA as either a reward or a diversion
• teacher reluctance to take on yet another new approach and a consequent inability to integrate ABRA into literacy programs
• lack of continuing in-school support and a collegial approach to professional development
• teacher turnover, which is a perennial problem of the jurisdiction, robbing schools of expertise in using ABRA
• competition within schools for a place on an overcrowded schedule and a consequent fragmentation of the ABRA effort.

Despite some apprehension, ABRA’s Canadian provenance was not problematic.

The findings from the ABRA project are broadly consistent with several key factors in the success of ICTs in classroom literacy programs, which emerged during the course of the Literature Review for the project. Specifically, these include teacher training and level of qualifications, the alignment of the ICT with existing approaches to literacy teaching, adequate technical support and acceptance by school communities. Challenges identified in the literature include teachers’ lack of confidence in and competence with the technology; teachers’ resistance to change; and providing an appropriate level of communications infrastructure and support. In
the Australian setting, intermittent or permanent hearing loss is likely to have an impact on the speech and language development of Indigenous children and particularly on their ability to develop literacy skills.

**Future Research Directions**

- While ABRA has demonstrated its feasibility in the NT context, closer investigation needs to be made into how it compares with other literacy resources and whether its impact would be magnified by a systemic scale-up. A longitudinal study would help assess the impact on later reading outcomes. It would be appropriate to question whether ABRA students had learnt to read more quickly or with greater skill that their non-ABRA peers.
- The case studies documented in the report suggested that conventional practice in disadvantaged schools is structured to work against the effective introduction of new ways of teaching. Without systematic mentoring and follow-up of professional development, teachers struggle to incorporate new practices into their literacy program. There needs to be research into what constitutes the optimal conditions for teachers to integrate an innovation like ABRA into a balanced literacy program. Among these conditions for investigation are the nature and extent of training, continuing professional development and support, and the nature of the classroom dialogue through which teachers frame literacy.
- It remains to be seen whether ABRA is of particular benefit to students who have been identified as having special learning needs. The literature reports gains for children at risk of reading disabilities or of ESL status, which suggests that ICTs may be an effective resource for delivering literacy instruction. More research into ICTs being used with special needs and other at risk sub-groups, including Indigenous children with hearing loss or deficiency, would help in understanding whether the use of ICTs was in fact effective and, if they were, what factors contribute to literacy gains.
- Questions related to the above, but involving additional investigation, include how teachers could more effectively embed technology into everyday teaching practice, rather than using it as an add-on activity; and whether students would benefit from teachers using ABRA more broadly than they have in this study, in which they have focused mainly on ABRA alphabets activities.
- During the course of this research, the project team noted that a number of students from the intervention group either left the school or were absent during testing periods. These students need to be tracked to assess the impact, if any, ABRA may have had on their literacy development.
- The GRADE K and PIPS-BLA findings for phonics were inconsistent. The project team was inclined to conclude that PIPS-BLA may be a less valid measure of phonics than the GRADE assessment, based on its more recent introduction (2009). The project team eliminated the phonics section of the PIPS-BLA from the analysis because of problems with its reliability. Further research could examine its reliability and validity.
• Research should also evaluate whether ABRA works more effectively to improve specific types of phonics skills.
• Finally, given teachers’ understandable wariness in the face of a seemingly endless round of new practices they are asked - or expected - to adopt, it is important that future research address the question of how best to disseminate research findings to teachers as well as to policy-makers and throughout the research community.

Recommendations
On the basis of this study, the project team recommends that:
• ABRA be used by teachers to support phonological awareness and letter sound knowledge
• it be used at least twice a week for continuity and familiarity, for 30-40 minutes per day, for a total of between 20 and 30 hours over the year
• teachers using ABRA be adequately trained, with at least one full day’s in-service professional development, and supported intensively with bi-weekly visits during the first three months of using ABRA
• regular professional development sessions would make their use of ABRA more effective
• teachers should receive additional training in the use of the Literacy Tool Kit as an effective class monitoring tool
• the kind of systematic research used to evaluate ABRA is feasible in regional and remote settings and should continue
• interventions in other areas of learning (e.g. maths and science particularly) should be similarly studied
• research transfer is a critical element in the adoption of resources like ABRA.
• the use of ICT-based literacy interventions in comparable international Indigenous contexts should be studied, with a view to better understanding broader issues of implementation.
10. REFERENCES


11. APPENDICES

Appendix 1: ABRA Implementation Fidelity Instrument and Researcher Log

Appendix 2: ABRA Literacy Lesson Observation Instrument

Appendix 3: ABRA Raw Score Analysis

Appendix 4: RCT ABRA Literacy Lesson

Appendix 5: ABRA Student Interview

Appendix 6: ABRA Teacher Training Survey
Appendix 1: Implementation Fidelity Instrument and Researcher Log

Improving Literacy through Technology

ABRACADABRA
Program fidelity observation record
(APFOR)
[version 2-21 Nov 2009]

Please check the activities you observe during the lesson. (Only check it if the student has completed what the teacher has instructed or been on the activity for at least 3-5 minutes).
### Observation Probes

#### Evaluator comments – Technology

Did the teacher experience any technical difficulties? How was this handled? How much time was taken to resolve the difficulties?

<table>
<thead>
<tr>
<th>Comment</th>
<th>Comment</th>
<th>Comment</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Evaluator comments – introduction:

Did the teacher introduce the lesson? What did the teacher do during the introduction? Were children engaged? Was the introduction effective?

<table>
<thead>
<tr>
<th>Comment</th>
<th>Comment</th>
<th>Comment</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Evaluator comments - lesson:

How do you feel the ABRA lesson progressed today? (Were all the children engaged? What aspects were you particularly pleased / displeased with?)

<table>
<thead>
<tr>
<th>Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What is the teacher’s comfort level with the ABRA program and activities that were being used during this session? Did the teacher appear prepared?

<table>
<thead>
<tr>
<th>Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Evaluator comments - conclusion:

Did the teacher conclude the lesson? What did the teacher do during the conclusion? Were children engaged? Was the conclusion effective?

<table>
<thead>
<tr>
<th>Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Evaluator comments - overall:

Please share any other observations you may have had regarding both the teacher and the children in regards to using ABRA, i.e. class management, organization, teaching style, unforeseen interruptions, ability level differentiation.

Evaluator comments - General
ABRACADABRA lesson fidelity measures

**Key**

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Applicable</td>
<td>Strongly disagree</td>
<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
<td>Strongly agree</td>
</tr>
</tbody>
</table>

**Dates of observations**

| Teacher is familiar with the ABRA program / lesson content |
| Lesson has clear goals and objectives |
| Lesson is planned ahead of time |
| Lesson content is balanced (i.e. Alphabets, Word and Text level activities) |
| Lesson includes a mix of whole group, small group and individual activities |
| Lesson includes an introduction |
| Lesson includes a demonstration / revision of navigation |
| Teacher monitors students’ navigation of the program |
| Lesson includes a whole class conclusion |
| Lesson includes a mix of ABRA computer and non computer based ABRA resources |
| Lesson includes non ABRA resources |
| Teacher has effective classroom management. Student behaviour doesn’t interfere with learning. |
| Teacher uses ability level differentiation when appropriate. |
| Teacher prepares learning environment prior to the lesson (i.e. all computers are on; smart board is set up, other resources are prepared beforehand) |
| Teacher assistant takes an active role in the lesson |
| Lesson is at least 30 minutes long |
| Teacher reflects on lesson planning and implementation and modifies future lessons accordingly |
Appendix 2: Literacy Lesson Observation Instrument

Improving Literacy through Technology

Classroom literacy teaching practices observation record

Teacher: __________________________________________

School: _________________________________________

Year level: ______________ Date/s: _______________

ObObserver: _____________________________________
<table>
<thead>
<tr>
<th>Particpation</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention</td>
<td>Not Applicable</td>
<td>1</td>
<td>strongly disagree</td>
<td>2</td>
<td>disagree</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>neutral</td>
<td>4</td>
<td>agree</td>
<td>5</td>
<td>strongly agree</td>
<td></td>
</tr>
<tr>
<td>Engagement</td>
<td>All students are focused on literacy learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stimulation</td>
<td>Students are deeply absorbed in the literacy lesson / task</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pleasure</td>
<td>The teacher motivates interest in literacy tasks, concepts and learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consistency</td>
<td>Strong literacy routines are recognised and understood by the students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td>Literate physical environment is used as a teaching resource</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purpose</td>
<td>Students’ responses indicate tacit or explicit understanding of the purpose of the literacy task</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Substance</td>
<td>The lesson / task leads to substantial literacy engagement, not busy-work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explanations</td>
<td>Explanations of literacy concepts are clear and at an age appropriate level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modelling</td>
<td>Demonstrations of literacy tasks include metacognitive explanations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metalanguage</td>
<td>Students are provided with a language for talking about literacy concepts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awareness</td>
<td>The teacher has a high level of awareness of literacy activities and participation by students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structure</td>
<td>The environment is predictable and orderly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexibility</td>
<td>The teacher responds to learning opportunities that arise in the flow of literacy lessons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pace</td>
<td>The teacher provides strong forward momentum in literacy lessons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transition</td>
<td>Minimum time is spent in transitions or there is productive use of transitions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assessment</td>
<td>Fine-grained knowledge of students’ literacy performance is used in planning and teaching</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scaffolding</td>
<td>The teacher extends the students’ literacy learning through modelling, modifying and correcting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedback</td>
<td>The teacher gives explicit literacy feedback to students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Responsiveness | The teacher shares and builds on students’ literacy contributions
---|---
Explicitness | Text level – The teacher makes explicit specific attributes of a text
Explicitness | Word level – The teacher directs students’ attention to explicit word and sound strategies
Persistence | The teacher provides many opportunities to practise and master new literacy learning
Challenge | The teacher extends and promotes higher order thinking in literacy learning
Differentiation | Differentiated literacy instruction recognises individual differences
Inclusion | The teacher facilitates inclusion of all students in the literacy lessons
Variation | Literacy teaching is structured around groups or individuals
Connection | Connections are made between class and community literacy-related knowledge
Warmth | Welcoming, positive and inviting classroom is focused on literacy learning
Rapport | Relationships with students support tactful literacy interventions
Credibility | Respect for the teacher enables her to overcome any challenges to order and lesson flow
Citizenship | Equality, tolerance, inclusivity and awareness of the needs of others are promoted
Independence | Students take some responsibility for their own literacy skills


**Observation Probes**

These probes are only to be used when observing a control class.

1. What literacy program is being used?
2. What types of activities did you observe?
3. Any other observations?
Appendix 3: Raw Score Analyses

Table A.1
GRADE K and PIPS-BLA Mean Raw Pre-test, Post-test Scores, Standard Deviations, and Analysis of Variance (ANCOVA) Results for Intervention as a Function of School Controlling for Pre-test Raw Score

<table>
<thead>
<tr>
<th></th>
<th>Intervention</th>
<th>Control</th>
<th>ANOVA F, Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Pre M (SD)</td>
<td>Post M (SD)</td>
</tr>
<tr>
<td><strong>Primary Outcome</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRADE K Phonological Awareness and Reading</td>
<td>163</td>
<td>9.57 (4.15)</td>
<td>11.84 (3.85)</td>
</tr>
<tr>
<td><strong>Secondary Outcomes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRADE K Phonological Awareness</td>
<td>163</td>
<td>14.08 (6.24)</td>
<td>17.16 (5.73)</td>
</tr>
<tr>
<td>GRADE K Word Reading</td>
<td>163</td>
<td>5.06 (3.09)</td>
<td>6.52 (2.78)</td>
</tr>
<tr>
<td>PIPS-BLA Phonics</td>
<td>156</td>
<td>10.74 (7.19)</td>
<td>17.65 (8.58)</td>
</tr>
<tr>
<td>PIPS-BLA Reading</td>
<td>156</td>
<td>66.21 (42.80)</td>
<td>97.72 (45.90)</td>
</tr>
</tbody>
</table>

α Effect size (d) calculated using adjusted means: X’i-X’c/MSE 5
*p<.05
**p<.01

Table A.2
GRADE K Early Literacy Skills and Phoneme-Grapheme Correspondence Pre-test 75th Percentile Raw Scores, Percent Above Pre-test 75th Percentile at Post-test and Logistic Regression Results for Intervention as a Function of School Controlling for Pre-test Raw Scores

<table>
<thead>
<tr>
<th></th>
<th>Intervention (n=163)</th>
<th>Control (n=145)</th>
<th>Logistic Regression Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre 75th Percentile Value</td>
<td>Percent above Pre-test 75th Percentile</td>
<td>Percent above Pre-test 75th Percentile</td>
</tr>
<tr>
<td>Secondary Outcomes</td>
<td>PRE</td>
<td>POST</td>
<td>PRE</td>
</tr>
<tr>
<td>GRADE K Early Literacy Skills</td>
<td>23</td>
<td>21.5%</td>
<td>57.1%</td>
</tr>
<tr>
<td>GRADE K Phoneme-Grapheme Correspondence</td>
<td>16</td>
<td>27.0%</td>
<td>40.5%</td>
</tr>
</tbody>
</table>

*p<.05  
**p<.01
Appendix 4: RCT ABRA Literacy Lesson

Teacher Log
(Please record in this log everyday.)

<table>
<thead>
<tr>
<th>Date:</th>
<th>Class / Year:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teacher:</th>
<th>School:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location of lesson:</th>
<th>Length of the lesson:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What instructional format did you use for this ABRA lesson? (Check all that apply)

- Whole Class  - Small Groups  - Individual Student

What types of technology did you use to support this lesson?

- None  - Computers  - Smartboard  - Projector  - Other

If Other, please describe.

___________________________________________________
___________________________________________________
___________________________________________________

How much time was spent reviewing how to navigate the program?

- 1-5 mins.  - 6-10 mins.  - 11-15 mins.  - more than 15 mins.

How much time did you spend on the introduction?

- 1-5 mins.  - 6-10 mins.  - 11-15 mins.  - more than 15 mins.

How much time did children spend practicing ABRA independently or with a partner?

- 1-5 mins.  - 6-10 mins.  - 11-15 mins.  - more than 15 mins.

How much time did you spend on the conclusion?

- 1-5 mins.  - 6-10 mins.  - 11-15 mins.  - more than 15 mins.

Did you develop / use any other resources to support your lesson?

- Yes  - No
If yes, please describe.
___________________________________________________

___________________________________________________

___________________________________________________

___________________________________________________

Did anything interfere with your delivery of this lesson?
☐ Tech Problems  ☐ Unforeseen interruptions  ☐ Behavioural Issues  ☐ Other
Please describe.
___________________________________________________

___________________________________________________

___________________________________________________

Please check the activities you used during the lesson. (Only check if the student has completed what the teacher has instructed or been on the activity for at least 3-5 minutes).

Please reflect and rank yourself on the following items for this lesson

Key

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Applicable</td>
<td>Strongly disagree</td>
<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
<td>Strongly agree</td>
</tr>
</tbody>
</table>

· I was familiar with the ABRA program / lesson content
· The lesson had clear goals and objectives
· The lesson was planned ahead of time
· The lesson content was balanced (i.e. Alphabets, Word and Text level activities)
· This lesson included a mix of whole group, small group and individual activities
· The lesson included an introduction
· The lesson included a demonstration / revision of navigation
· I monitored students’ navigation of the program
- The lesson included a whole class conclusion
- The lesson included a mix of ABRA computer and non-computer based ABRA resources
- The lesson included non-ABRA resources
- I had effective classroom management. Student behaviour did not interfere with learning.
- I prepared the learning environment prior to the lesson (i.e. all computers were on; smart board was set up, other resources prepared beforehand)
- The teacher assistant took an active role in the lesson
- The lesson was at least 30 minutes long
- I reflected on my lesson planning and implementation and have modified future lessons accordingly
Appendix 5: ABRA Student Interview

1. Does your teacher ever use the ABRACADABRA program?
   Yes                                               No

2. When my teacher says it’s time for ABRA I feel……

   [Emojis]

3. I like doing ABRA best on the:
   Computer                        Smartboard                          Worksheets

4. I like the:
   Games
   Stories
   Games and Stories

5. What happens when you click on the A?
   ________________________________________________

6. What is your favourite activity to use?
   ________________________________________________
Why?
___________________________________________________
___________________________________________________
___________________________________________________

7. Who is your favourite character?
___________________________________________________
___________________________________________________

Why?
___________________________________________________
___________________________________________________

8. What is the cat’s name? ____________________________

9. What is the girl’s name? ____________________________

10. What other things do you do in the ABRA besides working on the computer?
___________________________________________________
___________________________________________________
___________________________________________________

Student is:
Male                        Female
Indigenous                  Non-indigenous
Age __________
ESL: Yes                   No
Year Level: __________
Appendix 6: ABRA Teacher Training Survey

<table>
<thead>
<tr>
<th>I. Did the training sufficiently…</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>…explain the background of ABRA?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>…explain the research activities?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>…provide time for you to explore ABRA?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>…give you ideas for using ABRA?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>…give you ideas for way to incorporate ABRA with your literacy teaching</td>
<td></td>
<td></td>
</tr>
<tr>
<td>…give you ideas for ABRA lesson plans?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments:

2. Did the training help you feel prepared to begin using ABRA in your classroom? Why or why not?

3. What concerns/struggles do you foresee encountering when using ABRA in your classroom?
4. What questions do you have that were not addressed during the training?

5. What suggestions do you have for future ABRA training sessions?