

# Overcoming difficulties with written expression

# **Full Report**

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# Overcoming difficulties with written expression

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## 1. Abstract

Many children on the autism spectrum have difficulty with the fine motor and perceptual demands of handwriting, and the conceptual and language demands of written composition. To overcome these challenges, an iPad application, 'Power Writer', was developed that supported students through peer video-modelling to use writing support software (*Text Help Read&Write*) and a writing instruction strategy, *Self-Regulated Strategy Development* (SRSD).

During Phase 1, 17 primary school-aged students (four on the spectrum and 13 not on the spectrum), four teachers, and two adults on the spectrum contributed to the co-design of Power Writer either by assisting with video production and/or accompanying music, or by providing feedback through focus groups and semi-structured interviews.

During Phase 2, the efficacy of Power Writer was measured using a series of single subject experimental design (ABAC) studies involving eight students on the spectrum to compare the quality and length of their persuasive writing composition when: (a) handwriting, (b) using writing support software alone, and (c) using SRSD scaffolded by the Power Writer app with a choice of handwriting or writing support software.

The attitudes of these students and their teachers toward the efficacy and social validity of the intervention were explored using semi-structured interviews, and student and teacher surveys. The writing support software significantly improved the writing quality of four students, and the word count of two students. Following SRSD training provided by Power Writer, the writing quality of one student significantly improved, and the word count of three students significantly improved. Students reported feeling more positive about writing, and teachers reported improvements in the quality and length of their written compositions and their willingness to write.

During Phase 3, the ecological relevance of the intervention was explored through focus groups involving nine teachers who used Power Writer with seven mainstream classes. Teachers perceived Power Writer to be suitable for whole-of-class mainstream classroom use and highly valuable in supporting struggling writers, while commenting on the need for further extension for competent writers. The peer-modelled instructional videos were perceived to be particularly motivating for students.

## 2. Introduction

The task of producing written compositions forms the basis of many classroom learning activities, as well as being a central element in much formal and informal assessment. However, for students on the autism spectrum, academic writing tasks can be particularly challenging. These students can experience difficulty with both the physical task of writing by hand (Green et al., 2002; Kushki, Chau, & Anagnostou, 2011), as well as the conceptual work involved in composing written texts (Harbinson & Alexander, 2009). Such difficulties not only have a negative impact on the length and quality of individual pieces of writing, but the continual requirement to produce written work may also affect the motivation of students on the spectrum and lead them to avoid writing where possible (Broun, 2009). Over time, this can have a detrimental effect on the academic performance of these students (Allen-Bronaugh, 2013; Feder & Majnemer, 2007).

Previous research indicates that assistive technology such as writing support software can help to overcome issues with the physical act of handwriting (Ashburner, Ziviani, & Pennington, 2012; Schneider, Codding, & Tryon, 2013) and can improve spelling ability and sentence construction of students with writing difficulties (Hetzroni & Shrieber, 2004). Self-Regulated Strategy Development (SRSD) has been shown to improve the quality of written compositions by scaffolding conceptual idea generation and sequencing (Asaro-Saddler & Bak, 2014). Video-modelling has been shown to be an effective way to support learning in students on the spectrum (Charlop-Christy, Le, & Freeman, 2000).

The overall objective of this research has been to support students on the spectrum to undertake writing tasks in mainstream classrooms. This project has involved the development and evaluation of an intervention package consisting of an iPad application, Power Writer and ancillary materials, which are able to be implemented by classroom teachers and used by all members of the class. Power Writer incorporated strategies that had previously been shown to be effective for students on the spectrum including the use of writing support software, SRSD and peer video-modelling.

In order to determine the relative contributions of these strategies, the quality and length of the written compositions of students on the spectrum was compared when handwriting, when using writing support software and when using assistive technology in combination with SRSD. Video-modelling was used to support the student's learning in the use of the writing support software and SRSD. This research investigated the potential of the Power Writer app to not

only improve the quantity and quality of written work produced by students on the spectrum, but also to enhance their motivation to engage with writing tasks.

#### 2.1 Handwriting challenges

Writing is a complex skill involving fine motor control as well as perceptual skills (Feder & Majnemer, 2007; Maeland, 1992). Children generally begin to develop handwriting skills in early childhood and, by around their second year of formal schooling, these skills have usually become somewhat automatic (Stevenson & Just, 2014). When students develop writing automaticity it allows them to focus more on the content of their writing (Jones & Christensen, 1999). It has, however, been observed that students on the spectrum have handwriting that is less legible than students not on the spectrum (Kushki et al., 2011), which may be related to difficulties with fine motor skills (Beversdorf et al., 2001; Johnson et al., 2013). One study of 56 eight-year-old students found that those on the spectrum differed from their neurotypical peers in the accuracy of their letter formation, and sacrificed legibility in order to write faster (Cartmill, Rodger, & Ziviani, 2009). Similarly, Grace, Gregory, Beth, Johnson, and Rinehart (2017) found that students on the spectrum had greater variability in the way they formed letters and the speed at which they wrote. Not only may these differences in handwriting ability entail a lack of automaticity, and less capacity to focus on writing content, but problems with legibility may also affect the way in which the academic ability of these students is perceived (Feder & Majnemer, 2007).

#### 2.2 Written composition

In addition to the challenge of handwriting, students on the spectrum can have difficulty with aspects of the conceptual work involved in writing composition. Compared to their peers not on the spectrum, students on the spectrum may produce writing that employs vague or unclear statements, has poorer textual coherence or is not well structured (Brown, Johnson, Smyth, & Cardy, 2014). Persuasive writing tasks may be particularly challenging as, in addition to generating ideas and structuring an argument, they require the ability to consider different points of view, to anticipate a reader's perspective and to present ideas in a way they will find convincing (Asaro-Saddler & Bak, 2014; Nippold, Ward-Lonergan, & Fanning, 2005). Writing persuasively is accorded great importance in the Australian curriculum (Australian Curriculum, Assessment and Reporting Authority [ACARA], n.d.). Australian students are regularly assessed on their persuasive writing through the National Assessment Program – Literacy and Numeracy (NAPLAN) and is a crucial skill for demonstrating learning and communicating ideas through secondary school and beyond.

## 2.3 Strategies employed

#### 2.3.1 Use of assistive technologies for written expression

Assistive technologies such as word processing, and speech recognition have been used to support students who experience difficulties with handwriting (Ashburner et al., 2012; Bouck, Meyer, Satsangi, Savage, & Hunley, 2015; Evmenova, Graff, Jerome, & Behrmann, 2010; Hasselbring & Glaser, 2000; Hetzroni & Shrieber, 2004; MacArthur, 2009; Schneider et al., 2013). Technology-based writing supports such as these have been shown to enhance the ability of students on the spectrum to produce written work (Dillon & Underwood, 2012; Evmenova et al., 2010). Additionally, while they may not lead to increases in writing speed for those still acquiring typing skills, the use of keyboards has been associated with improvements in the motivation of students on the spectrum to engage in writing tasks (Ashburner et al., 2012).

The use of technology to support writing is in alignment with the Australian curriculum which broadly defines writing as planning, composing, editing and producing text in either print or digital form (ACARA, n.d.). Many of the technologies used for writing are also well accepted socially and are used by a range of students in mainstream classrooms (Sessions, Kang, & Womack, 2016; Thomas & Muñoz, 2016).

Writing support software has been shown to assist with the expression of written language for students on the spectrum (Evmenova et al., 2010; Schneider et al., 2013). Word prediction can alleviate some of the physical demands on the writer by reducing the need to type some words in full (MacArthur, 2009). Writing support software also offers other functions including homophone detection and text-to-voice. These features can allow students to focus on content generation and revision rather than the mechanics of writing (Asaro-Saddler, 2016).

This project involved the use of writing support software called TextHelp Read&Write (2015) for iPad (hereafter referred to as Read&Write). This software offers students writing support features by overlaying them onto typical iPad use. Read&Write features that can assist students who have challenges with writing include: (a) speaking the words as they are typed (text to speech), (b) word prediction, (c) a dictionary to clarify words as they are typed, and (d) a vocabulary list that saves words and compiles the student's personal glossary.

## 2.3.2 Self-Regulated Strategy Development

Self-Regulated Strategy Development (SRSD) is an approach that has been shown to support students to plan, organise and sequence ideas, compose and then revise their work independently (Graham, Harris, MacArthur, & Schwartz, 1991; Harris, Graham, Friedlander, & Laud, 2013; Mason, Harris, & Graham, 2011). Research has demonstrated SRSD to be effective in improving the writing of students on the spectrum (Allen-Bronaugh, 2013; Asaro-Saddler, 2016; Asaro-Saddler & Bak, 2014) as well as students not on the spectrum (Glaser & Brunstein, 2007; Santangelo, Harris, & Graham, 2008; Tracy, Reid, & Graham, 2009). A systematic review by Asaro-Saddler (2016) indicated that these strategies have been shown to improve the written compositions of students including improving the quality and length of written compositions, the number of essay elements used, and the use of planning and self-monitoring when writing. The SRSD strategy used in this research was the POW+TREE strategy (Harris, Graham, & Mason, 2002). The POW+TREE writing strategy has been shown to be effective in improving the persuasive writing outcomes for students on the spectrum (Asaro-Saddler & Bak, 2012; Asaro-Saddler & Bak, 2014).

POW stands for:

- Pick my idea;
- Organise notes;
- Write and say more.

#### TREE stands for:

- Topic sentence;
- Reasons (three or more);
- Explain reasons;
- Ending and examine (Harris et al., 2002, p. 76).

In this project, the Power Writer software was designed to scaffold students in writing persuasive texts by prompting them to follow each of the POW+TREE steps.

#### 2.3.3 Universal Design for Learning

Class-wide "Universal Design for Learning" (UDL) strategies aim to support the inclusion of students with diverse learning needs (Denning & Moody, 2013). A UDL strategy "ensures that all environments and experiences are ready for all children" (Cologon, 2013, p. 6). The importance of having a class-wide strategy is that children are naturally diverse learners. Students bring a range of skills, needs, and interests to learning (Hitchcock & Stahl, 2003). As the range of available assistive technologies has increased, it makes sense to make these technologies available to the whole student population. The application of a UDL framework within every classroom is important because of the need to accept and plan for difference and make knowledge accessible to different ways of learning. In this project, the Power Writer software was designed to be used in a whole-of-class way, so that it would benefit all students in the class, including those with other additional learning needs.

#### 2.3.4 Video-modelling

Video-modelling is an intervention strategy that has been shown to be an effective way to support learning for students on the spectrum (Burton, Anderson, Prater, & Dyches, 2013; Charlop-Christy et al., 2000; Cihak, 2011; Nikopoulos & Keenan, 2004; Sherer et al., 2001). Videos present information in a predictable and systematic way, while gaining and keeping the attention of students on the spectrum (Charlop-Christy et al., 2000). In addition, videos are less socially demanding and are more intrinsically motivating (Charlop-Christy et al., 2000). Video modelling has also been shown to be an effective method for teaching students not on the spectrum (Kay, 2014; Robson, Blampied, & Walker, 2015; Schultz & Quinn, 2013; Shute et al., 2015) and therefore lends itself to be used as an inclusive teaching strategy. In this project, video-modelling was used as an engaging way to provide instruction to students on both the functionality of Text Help Read& Write software and the POW+TREE steps, and to provide examples of completion of NAPLAN-style persuasive writing tasks using the POW+TREE steps. The availability of video-models reduced the demand on teachers in teaching these approaches.

## 3. Overview of methodology and research design

This research was organised into three phases which are briefly described below, and then later in more detail in each of the three separate phases.

**Phase 1** involved the co-design of educational software and videos. Co-design involves the coconstruction of prototypes and relies on obtaining input from a variety of stakeholders to provide a broad perspective of the needs of the software to be developed (Scaife, Rogers, Aldrich, & Davies, 1997). A co-design (Scaife et al., 1997) development methodology was selected because it involves a repetitive process of engaging stakeholders. In this project, feedback on the initial prototype of the intervention was gathered through focus groups and semi-structured interviews from students on the spectrum and not on the spectrum, teachers and an adult on the spectrum.

During **Phase 2**, the efficacy of the intervention was explored using quantitative single subject experiment design (Horner et al., 2005; Zhan & Ottenbacher, 2001). Single subject design was selected for this phase due to the large range in abilities of students on the spectrum. In contrast to a randomised controlled trial with aggregated outcomes which was unlikely to accurately reflect the unique individual differences in student outcomes (Mesibov & Shea, 2011), in single subject research each participant acts as his or her own control. Participants are not compared with each other but rather their own performance is tracked over time under different conditions.

This research involved the use of a double baseline ABAC design, where A = handwriting, B = writing support software alone, and C = using Power Writer for SRSD instruction and then completing a writing task with a choice of handwriting or writing support software. The purpose of conducting a double baseline study was so that any potential learning curve could be factored into the analysis, and to determine the relative contributions of the writing support software and SRSD. If this study had only measured the impact of introducing both the writing support software and SRSD together, it would not have been possible to determine whether or not either or both strategies had impacted written expression. The first handwriting baseline ( $A^1$ ) was compared with the first intervention condition (B) while the second handwriting baseline ( $A^2$ ) was compared with the second intervention condition (C).

Qualitative feedback was also sought in **Phase 2** using (a) pre- and post- intervention semistructured interviews with the students, (b) post-intervention student surveys, and (c) postintervention teacher surveys. The pre- and post- intervention interview questions focused on student self-efficacy and attitude towards writing. At the start and the end of the intervention, students were asked questions around how they felt about themselves as writers, whether they enjoyed writing, whether they experienced any difficulties with writing and whether they used any strategies or tools to help them with their written expression. The purpose of the post-intervention student surveys was to evaluate how students felt about using the various writing techniques including handwriting, typing, Read&Write writing support software, and the POW+TREE writing strategy. The purpose of the post-intervention teacher survey was to look at changes in the students' approach to structured writing tasks in the classroom during the intervention phase.

**In Phase 3,** focus groups were run with teachers who had used the intervention on a whole-ofclass basis to assess the broader social validity of the intervention materials. The focus group questions explored the teacher's opinions of the Power Writer app as a tool for teaching purposes, the responses of students to the video-modelling strategies, and student preferences for Read&Write writing support software as compared to handwriting.

#### 3.1 Ethics

Ethical approval for this study was obtained from the University of Queensland human research ethics committee (approval number 2013001446), Queensland University of Technology (QUT; approval number 1400000223), the Queensland Department of Education, Training, and Employment (approval number 550/27/1415), and the Brisbane Catholic Education Research Committee (approval number 116).

#### 3.2 Research questions

The research questions were:

**RQ1:** How can a targeted yet inclusive intervention be designed for teaching and scaffolding SRSD instruction?

**RQ2**: What is the quality and length of written compositions of students on the spectrum when producing written text via: (A) handwriting, (B) writing support software supported by video-modelling, or (C) SRSD with either handwriting or writing support software supported by video-modelling?

**RQ3:** How effective is providing fully-scaffolded SRSD instruction through the co-designed Power Writer app in assisting students on the spectrum to overcome their difficulties in written expression?

**RQ4:** Is the Power Writer app perceived by students on the spectrum and teachers to be an effective and socially and ecologically relevant tool for inclusive class wide teaching and learning?

## 4. Phase 1: Co-design phase



#### Figure 1. Research flow diagram – Phase 1

Phase 1 addresses **Research Question 1:** *How can a targeted yet inclusive intervention be designed for teaching and scaffolding SRSD instruction?* The following facets of learning were considered in the initial design of the app.

## 4.1 The SETT*i* framework

To frame the requirements of an inclusive yet targeted training tool, a modified version of an assistive technology selection framework has been integrated into the design methodology of this research.

The SETT framework (Zabala, 2005) is an established set of criteria used by schools to assist the selection of assistive technologies (Cochrane, 2012). The SETT mnemonic stands for **S**tudent, **E**nvironment, **T**asks, **T**ools, and the framework poses questions around the needs of the student,

in their environment, the tasks that take place in that environment and the tools they need to participate fully. The SETT framework was modified for this research to include the aspect of inclusive class-wide use by adding an "*i*" for inclusion. The SETT*i* framework represents an instantiation of the SETT framework (Zabala, 1995) that considers students, the environment and the task as a basis for designing and developing inclusive learning tools.

As set out in Figure 2, the inclusive tool sits at the core of the framework. To develop an inclusive tool, student feelings of self-efficacy and the ability to self-regulate need to be considered in relation to the amount of scaffolding required to complete a task. The social validity of the tool in the environment, the degree to which the tool is targeted in supporting the specific needs of students and the application of the design principles of UDL are captured in the SETTi framework.



Figure 2. The SETTi assistive technology design framework

## 4.2 Scaffolding the self-regulation strategy

With the aim of scaffolding the students for success, six components of scaffolding set out by Wood et al. (1976) were incorporated in to the design of the app as shown in Table 1 (over page).

#### Table 1. Scaffolding the self-regulation strategy

Components of scaffolding (Wood et al., 1976)	Rationale	Strategy incorporated into the intervention
Development of learner interest in the task	Engaging interest of students on the spectrum who have difficulty with, and show little interest in writing	<ul> <li>Writing prompts developed to support students to make a choice about whether they agreed or disagreed with the persuasive writing stimulus.</li> <li>A series of example videos and prompt sheets on a variety of salient topics developed to maximise the chances of finding a topic of interest to students.</li> </ul>
Simplification of the task	To give students a sense of progress as they move through the task broken down into steps	<ul> <li>POW+TREE writing strategy broken down into steps to be completed one at a time.</li> <li>Once each step was complete student is required to tap "next".</li> </ul>
Provision of encouragement and direction	Students often poorly motivated and confused by writing task	<ul> <li>Two introductory peer-modeled videos developed to explain the writing task and the writing support software.</li> <li>Visual and auditory instructions incorporated for each step.</li> <li>Students given a token prize at the completion of each writing task.</li> </ul>
Provision of critical feedback	Real-time feedback about spelling	<ul> <li>Writing support software demonstrates correct spelling.</li> <li>Writing support software provides visual feedback by prompting the student to choose a word that they may be spelling from a list.</li> </ul>
Support to manage frustration	Some students on the spectrum experience high levels of frustration with writing	<ul> <li>Writing support software to overcome frustration with physical aspects of writing.</li> <li>Self-regulation writing strategy to overcome frustration with the conceptual aspects of writing.</li> <li>Peer modelling to encourage students to try the writing task.</li> </ul>
Modelling of a solution to the task	YouTube styled videos are quick to produce and socially valid	<ul> <li>Training video presented background skills and knowledge for the POW+TREE strategy and motivation behind its use.</li> <li>Series of example videos developed that applied POW+TREE strategy.</li> <li>Repetition of animated POW+TREE mnemonic at the beginning of each video.</li> <li>The app supports the writing strategy through scaffolded writing wizard.</li> <li>The app supports students to practice the strategy without the scaffold.</li> </ul>

The co-design of the app involved the following seven stages, as illustrated in Figure 3:

**Stage 1** involved an analysis of existing primary school educational apps. Many of the apps contained elements of video games, elements requiring user-creativity, rewards, levels and inviting interactive designs.

**Stage 2** involved the development of a low fidelity prototype. The researcher worked with a graphic designer to develop a series of interactive screenshots, which depicted a proposed POW+TREE learning activity. Elements of existing apps including game-like features and an interactive flow were included. The initial prototype was intentionally designed so that the desired functionality could be interpreted by potential users (primary school students in grades 4, 5 and 6).

**Stage 3** involved four co-design focus groups that included a total of 13 students not on the spectrum and four students on the spectrum, aged 8 to 11 years. In each focus group, sample videos, NAPLAN style stimulus sheets and the app prototype were presented. Students were asked about the look and feel of the prototype, the layout and the way that the POW+TREE mnemonic was incorporated. They were asked to comment on the video and whether it explained the POW+TREE mnemonic clearly. Each focus group was transcribed verbatim and a content analysis was used to explore themes emerging from the discussions. The results of the analysis indicated that students wanted more customisable and game features and ways to improve progression and flow of tasks.

**Stage 4** involved the employment of two experienced app developers to create a high-fidelity prototype that incorporated the feedback from the focus groups.

**Phase 5** involved the development of video models to teach students to use the POW+TREE writing strategy and the Read&Write software. Example videos across a range of categories were also developed. The researcher conducted collaborative design focus groups involving a student on the





spectrum and a student not on the spectrum to develop the video topics and scripts. Two adults on the spectrum from the Autism Queensland Studio G program assisted with the video production and the accompanying music.

**Stage 6** involved further prototype refinement based on feedback from semi-structured interviews with three primary school teachers, one school principal, one adult on the spectrum, an 11-year-old student not on the spectrum child and a 9-year-old child on the spectrum. The researcher asked interviewees to use the app. Interview data consisted of the researcher's observations and the participants' feedback, which was analysed through content analysis. Teachers expressed concerns about need for reliable Wi-Fi, a teacher administration page and a way to access and provide feedback on the student's work. The adult on the spectrum suggested simplifying the pages, reducing crowding and adding an audio button to read the text.

**Stage 7** involved final adjustments to prototype, based on participant feedback, including incorporating all feedback from the adult on the spectrum. Some of the teachers' issues such as the reliability of Wi-Fi and the addition of a teacher administration page could not be resolved.

An overview of the co-design process of the methodology, methods, data collection, analysis, participants, aim, and contribution are outlined in Table 2 overleaf.

Table 2. An overview of the co-design process

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7
	Analysis of educational applications	Low fidelity prototype	Co-design focus groups	Complete prototype development	Video development	Prototype refinement	Final adjustments to prototype
Procedure	Scoping study involving content analysis of existing apps	Application of SETTi to inform initial design	Focus groups of students to enable co- design of prototype	Integration of feedback from focus groups into design	Focus groups to enable collaborative design of videos	Interviews of teachers, adult on the spectrum and students to inform refinement of prototype	Integration of feedback from interviews into final prototype
Data Collection	Observational notes	n/a	Recordings, transcriptions	n/a	Researcher notes, audio and film	Researcher notes	n/a
Analysis	Content analysis to reveal common traits	n/a	Content analysis to reveal themes	n/a	Review of notes to develop scripts	Content analysis to reveal themes	n/a
Participants and professionals contributing to design	Researcher	Researcher, Graphic designer	16 primary school students, aged 8 to 11 years (12 not on the spectrum and 4 on the spectrum)	Researcher, Graphic designer, Software developers	Two males aged 9 and 11, one on the spectrum and one not on the spectrum, two adults on the spectrum	Two female year 5 classroom teachers, one female advisory visiting teacher, one male school principal, one female adult on the spectrum, one child not on the spectrum, aged 11, and one child on the spectrum, aged 9	Researcher, Software developers
Aim	To analyse existing apps used in schools	To develop a first prototype	To interpret functionality of the prototype and provide feedback	To develop a fully functional prototype	To develop salient topics for videos and to produce YouTube style instructional videos	To obtain feedback about the functionality, usability and perceived efficacy of the prototype	To integrate the themes from the interviews into the prototype
Contribution	To identify common design features	Tangible prototype	Feedback about the prototype to inform the next development stage	Functional prototype	Videos that teach the POW+TREE writing strategy	Feedback from a variety of stakeholders to refine the prototype	Final prototype

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## 5. Phase 2: Evaluation of writing support materials



#### Figure 4. Research flow diagram – Phase 2

The aim of Phase 2 of this project was to evaluate the writing support materials developed in Phase 1. This investigation was designed to address the project's second research question:

What is the quality and length of written compositions of students on the spectrum when producing written text via: (A) handwriting, (B) writing support software supported by video-modelling, or (C) SRSD with either handwriting or writing support software supported by video-modelling?

This phase has, however, also worked towards answering the third and fourth research questions by examining the effectiveness of providing fully-scaffolded SRSD instruction through the codesigned Power Writer app and investigating the views of both students and teachers regarding its usefulness, relevance and validity.

## 5.1 Method

## 5.1.1 Research design

As mentioned earlier, this phase consisted of single subject studies following a double baseline ABAC design. The baseline condition (A) was handwriting, the first intervention condition (B) saw the introduction of writing support software (Read&Write), and the second intervention condition (C) involved the implementation of Power Writer for SRSD with students having the choice of handwriting or using the writing support software. This design allowed any learning curve to be accounted for, while evaluating the key elements of the Power Writer app separately to determine their relative impact on students' written expression. Teachers were surveyed at the conclusion of the study, and students were interviewed both before and after the intervention, to ascertain impact of the writing support software and SRSD on student motivation and self-efficacy, as well as the social and environmental validity of the Power Writer app in an inclusive, mainstream setting.

The research design and data collection methods were tested during a pilot study involving one participant. Feedback from this student participant led to the second baseline being shortened to three handwriting sessions during the main study. As no other aspects of the research design were altered, the data from the pilot study is included in the main study analysis.

#### 5.1.2 Participants

The participants in Phase 2 of the project were eight students attending mainstream primary schools in years 4-6, and their teachers. The researcher worked with schools interested in taking part in the study to select potential student participants using a purposive sampling strategy (Palys, 2008). The students all had a primary diagnosis of an autism spectrum disorder, which was verified by the Queensland Department of Education, Training, and Employment, and were identified by their teachers as having difficulty with written expression. Student participants were also required to have the ability to communicate verbally, to have no intellectual impairment (this was confirmed using the Kaufman Brief Intelligence Test, 2nd Edition [KBIT-2]; Kaufman & Kaufman, 2004), a basic knowledge of word processing, and a typing speed over 10 words per minute (measured using a preliminary typing proficiency test; Langone & Levine, 1996; Schneider et al., 2013). Severe co-morbid conditions, or other impairments that would interfere with a student's ability to undertake the tasks involved in the study, were exclusionary criteria, however, no participants were excluded from the study.

Principals of the schools involved in the study, participating teachers, and parents/caregivers of potential student participants were all given detailed information about the study before providing signed consent to their further involvement. Student participants provided written assent at the start of the study and gave a verbal agreement to participate at the beginning of each session. Participants were free to withdraw consent/assent at any time.

Six of the eight student participants were male and two female. Their ages ranged from nine years and three months to eleven years and two months. Parents were asked to complete a brief questionnaire to provide demographic data and information about diagnoses. This participant information is set out in Table 3 below. Pseudonyms have been used to refer to participants throughout.

Student	Gender	Age at testing	Diagnosis	Age at diagnosis	Additional diagnosis	Medication	Language spoken at home	Grade
Luke	М	10 years 3 months	Asperger Disorder	7 years	-	Yes	English	5
Evan	Μ	9 years 8 months	PDD-NOS	4 years	ADHD/ Anxiety Disorder	Yes	English	4
Emma	F	9 years 7 months	Asperger Disorder	6 years	ADHD	Yes	English	4
Nate	М	10 years 1 month	ASD	6 years	-	No	English	4
Eric	М	9 years 10 months	ASD	7 years	-	No	English	5
Jack	М	10 years 8 months	ASD	8 years	ADHD	Yes	English	5
Nadia	F	9 years 3 months	Asperger Disorder	7 years	ADHD	No	English	4/5
John	М	11 years 2 months	ASD	6 years	ADHD	Yes	English	4/5

**Table 3. Student profiles** 

#### 5.1.3 Setting

The study took place in three metropolitan schools in Queensland. In each school, the research tasks were undertaken in a quiet room separate from the students' classroom, with all participants engaging in the tasks at the same time.

## 5.1.4 Materials

During the baseline conditions (A<sup>1</sup> and A<sup>2</sup>), the students used paper and pencil to complete the writing tasks. During the intervention conditions, each student was provided with an Apple iPad Air 2 on which were installed Read&Write writing support software and the Power Writer app. Wifi was required for both these programs.

Forty topic stimulus sheets to be used in each writing session were developed based on NAPLAN writing prompt instructional wording and in consultation with two qualified NAPLAN markers with input from two children (aged 8 and 11). The NAPLAN-style prompt sheets were created in MS Word by an adult on the spectrum and reviewed by NAPLAN markers and teachers to ensure suitability.

Videos modelling the SRSD process using same aged peers were used to introduce the Power Writer app and at the start of each session using SRSD.

## 5.1.5 Procedure

Pre-baseline assessments were conducted to ensure participants met the inclusion criteria, and to ascertain current levels of participants' ability in aspects of written expression. The assessments included:

- The Clinical Evaluation of Language Fundamentals Fourth Edition (CELF-4) (Semel, Wiig, & Secord, 2003).
- The Kaufman Brief Intelligence Test Second Edition (KBIT-2) (Kaufman & Kaufman, 2004).
- A handwriting speed test (Wallen, Bonney, & Lennox, 1996).
- A test of legible handwriting (Larsen & Hammill, 1989).
- A typing speed test (which included observations regarding whether the student used touchtyping or a "hunt and peck" approach to selecting letters on the keyboard; Ashburner et al., 2012)
- An oral reading fluency assessment (Hasbrouck & Tindal, 2006).
- An oral persuasive language assessment (which served to ensure that writing difficulties were not due to problems with oral language ability; Dockrell & Connelly, 2009).

The CELF-4 and KBIT-2 were administered by a qualified speech therapist and the other assessments were conducted by the principal researcher. Results of these assessments are provided in Table 4 below.

	CELF-4ª language score		-4 <sup>a</sup> IQ (KBIT <sup>b</sup> ) Ige e		Handwriting legibility (TOHL <sup>c</sup> )		Handwriting Speed Test <sup>d</sup>			Typing S	peed Test	Oral reading fluency		
	Rank %	Range	Rank %	Range	Rank %	Range	Characters per minute	Rank %	Range	Characters per minute	Description	Rank %	Support requirements	
Luke	5 <sup>th</sup>	Below average	32 <sup>nd</sup>	Average	4 <sup>th</sup>	Poor	54	37 <sup>th</sup>	Average	133	Touch type	10 <sup>th</sup>	Intensive support	
Evan	14 <sup>th</sup>	Below average	34 <sup>th</sup>	Average	2 <sup>nd</sup>	Very poor	50	37 <sup>th</sup>	Average	143	Touch type	27 <sup>th</sup>	Strategic support	
Emma	84 <sup>th</sup>	Normal	66 <sup>th</sup>	Average	<1 <sup>st</sup>	Very poor	50	25 <sup>th</sup>	Average	67	Touch type	94 <sup>th</sup>	Core	
Nate	5 <sup>th</sup>	Below average	23 <sup>rd</sup>	Below average	<1 <sup>st</sup>	Very poor	17	1 <sup>st</sup>	Significant impairment	28	Hunt and peck	1 <sup>st</sup>	Intensive support	
Eric	91 <sup>st</sup>	Above average	75 <sup>th</sup>	Average	37 <sup>th</sup>	Average	97	99 <sup>th</sup>	Superior	245	Touch type	83 <sup>rd</sup>	Core	
Jack	77 <sup>th</sup>	Normal	82 <sup>nd</sup>	Average	<1 <sup>st</sup>	Very poor	72	84 <sup>th</sup>	Average	241	Touch type	61 <sup>st</sup>	Core	
Nadia	77 <sup>th</sup>	Normal	91 <sup>st</sup>	Above average	5 <sup>th</sup>	Below average	44	16 <sup>th</sup>	Average	65	Hunt and peck	4 <sup>th</sup>	Intensive support	
John	77 <sup>th</sup>	Normal	94 <sup>th</sup>	Above average	37 <sup>th</sup>	Average	39	2 <sup>nd</sup>	Mild impairment	103	Touch type	2 <sup>nd</sup>	Intensive support	

a = Clinical Evaluation of Language Fundamentals - Fourth Edition (Semel, Wiig, & Secord, 2003) b = Kaufman Brief Intelligence Test – Second Edition (Kaufman & Kaufman, 2004). c = Test of Legible Handwriting: An Ecological Approach to Holistic Assessment (Larsen, 1989)

d = Handwriting speed test (Wallen, Bonney, & Lennox, 1996)

The first baseline (A<sup>1</sup>) consisted of five writing sessions in which students selected one of two NAPLAN-style prompt sheets. Students were given 15 minutes, using a timer, to complete their persuasive writing using paper and pencil.

In the first intervention condition (B) session students were introduced to the writing support software using video-modelling. All other sessions followed the same procedure as the first baseline with the exception that students composed their persuasive text in a textbox field within the Power Writer app using Read&Write. Students' work was then saved to a database for analysis. Five sessions were conducted in this way.

The second baseline condition (A<sup>2</sup>) followed the same procedure as the first, however, as mentioned earlier, the second baseline was limited to three sessions in response to student feedback. The student who participated in the pilot study, Luke, is the only one to have completed five sessions during the second baseline.

Students were given training in the use of the SRSD POW+TREE writing strategy using videomodelling and two worksheets. Students were given the choice to use the writing support software or continue handwriting. All students chose to use Read&Write and completed their work using the Power Writer app. Five sessions were conducted in this way. During the training sessions the writing task was not timed.

The second intervention condition (C) followed the same procedure as the training sessions. Students continued to be provided with the POW+TREE worksheets as a physical reminder of how to use the strategy. All students continued to use an iPad with the Power Writer app and Read&Write to compose their persuasive text and used a NAPLAN-style prompt sheet. The writing task was timed to be completed in 15 minutes for each of the five sessions and the finished work was saved to a database for later analysis.

#### **5.1.7 Data collection and analysis**

Student written responses to the NAPLAN-style prompt sheets were collected for all conditions. The written texts were analysed to ascertain any impact the writing support strategies may have had on two dependent variables: the quantity of writing each student produced and the quality of their compositions. The quantity of student work was calculated using a word count for each session. The quality was measured using the NAPLAN criteria by two experienced NAPLAN markers. NAPLAN assessment involves assigning a mark out of 48 by measuring against ten criteria: audience (the capacity of the writer to consider and persuade their audience); text

structure (the way the text is organized); ideas; persuasive devices; vocabulary; cohesion; paragraphing; sentence structure; punctuation; and spelling (ACARA, 2013). Where the two markers differed in their assessment of a text by more than three points the assessment was moderated through a process of remarking and, if there was still disagreement, consultation with the principal researcher.

During each session the researcher was supported by a research assistant who had been trained in data collection during the course of the pilot study. Both the principal researcher and research assistant made notes of their observations during the writing sessions, recording information about student behaviour and any external factors that might have impacted their ability to engage in the task.

The results of both the word count for each composition and the NAPLAN marking were analysed in two ways. Visual examination of the graphed data was used to identify apparent differences between conditions, and statistical analysis was used to ascertain the size and significance of any changes. The Tau-U method of statistical analysis was selected as this is recommended for small data sets and can be used to control for trends in baseline data (Parker, Vannest, Davis, & Sauber, 2011).

#### 5.1.8 Social validity

Students completed interviews and surveys both before and after the study, and teachers were interviewed at the end of the study, to investigate attitudes towards the intervention strategies and the acceptability of the Power Writer app for providing writing support in inclusive, mainstream classrooms. Student interviews included questions about their attitudes towards writing, their perceived self-efficacy, and whether they had found the writing support strategies useful. The questions were based on those used by Allen-Bronaugh (2013) and were the same for both interviews. Teachers were asked about their students' apparent motivation during writing tasks, their thoughts about the usefulness of the iPad with the Power Writer app and Read&Write, and whether or not they would be likely to continue to use the writing support strategies.

#### 5.2 Results

The NAPLAN scores given for each student's composition are presented in graph form below (Figures 5 and 6) and the number of words each student wrote at each session is graphed in Figures 7 and 8. Tau-U statistical analysis was used to compare the first baseline condition (A<sup>1</sup>) to the introduction of Read&Write writing support software (B), and the second baseline condition (A<sup>2</sup>)

to both the training phase and the use of SRSD and writing support software using the Power Writer app (C). In order to determine any difference between the effects of writing support alone and writing support with SRSD scaffolding, the first intervention condition (B) was also compared with both the training phase and the second intervention condition (C). Results of this statistical analysis are presented below in Table 5 and Table 6.



Figure 5. NAPLAN scores of students 1-4 when handwriting (A<sup>1</sup> and A<sup>2</sup>), using Writing Support software (B), using Writing support software plus SRSD (C) and during SRSD training



Figure 6. NAPLAN scores of students 5-8 when handwriting (A<sup>1</sup> and A<sup>2</sup>), using Writing Support software (B), using Writing support software plus SRSD (C) and during SRSD training



Figure 7. Number of words written by students 1-4 when handwriting (A<sup>1</sup> and A<sup>2</sup>), using Writing Support software (B), using Writing support software plus SRSD (C) and during SRSD training



Figure 8. Number of words written by students 5-8 when handwriting (A<sup>1</sup> and A<sup>2</sup>), using Writing Support software (B), using Writing support software plus SRSD (C) and during SRSD training

#### Table 5. Tau-U results for changes in NAPLAN scores across conditions for eight students

RESEARCH QUESTION:		L	UKE	EV	/AN	EN	МА	N	ATE	ER	RIC	JA	ACK	NA	DIA	JC	HN
What is quality of the student's written compositions when:	Comparison of conditions	Tau- U	p	Tau- U	p	Tau- U	p	Tau- U	p	Tau- U	р	Tau- U	p	Tau- U	р	Tau- U	р
(a) handwriting as compared to writing support software?	A <sup>1</sup> compared to B	1.04	0.007**	0.84	0.028*	1	0.009**	0.8	0.037*	08	0.835	6	0.117	600	0.117	0.52	0.175
(b) handwriting as compared to SRSD without scaffolding + writing software?	A <sup>2</sup> compared to C	1.08	0.048*	0.867	0.053	0.876	0.53	0.467	0.297	0.276	0.551	0.867	0.053	0.333	0.456	0.8	0.074
(c) handwriting as compared to fully scaffolded SRSD + writing software?	A <sup>2</sup> compared to training	1.32	<0.001**	1.067	0.017*	0.8	0.74	0.667	0.136	067	0.882	0.867	0.053	1	0.025*	0.8	0.74
(d) using writing software as compared to SRSD without scaffolding + writing software?	B compared to C	0.12	0.745	0.44	0.251	-0.44	0.251	0.88	0.022*	0.44	0.251	0.88	0.022*	0.840	0.028*	0.44	0.251
(e) using writing software as fully scaffolded SRSD + writing software?	B compared to training	0.64	0.095	0.44	0.251	0.04	0.917	1.08	0.005**	0.280	0.465	1.04	0.007**	0.960	0.012*	0.64	0.095

\*Significant at the P < 0.05 level in a positive direction \*\*Significant at the P < 0.01 level in a positive direction

Table 6. Tau-U results for changes in word count scores across conditions for eight students

RE QL	SEARCH IESTION:		LU	IKE	EV	'AN	E	MMA	NA	TE	ER	RIC	JA	ACK	NA	DIA	JC	OHN
What is word count of the student's written compositions when:		Comparison of conditions	Tau- U	p	Tau- U	р	Tau- U	р	Tau- U	р	Tau- U	р	Tau- U	Ρ	Tau- U	р	Tau- U	р
(a)	handwriting as compared to writing support software?	A <sup>1</sup> compared to B	0.44	0.251	0.28	0.465	1.280	0.001**	08	0.835	0.400	0.296	0.12	0.754	24	0.531	1.08	0.005**
(b)	handwriting as compared to SRSD without scaffolding + writing software?	A <sup>2</sup> compared to C	68	0.076	1.067	0.017*	0.667	0.136	0.4	0.37	0.400	0.371	1.067	0.017*	667	0.136	0.933	0.37*
(c)	handwriting as compared to fully scaffolded SRSD + writing software?	A <sup>2</sup> compared to training	0.52	0.175	0.733	0.101	0.8	0.74	0.933	0.037*	0.276	0.551	1.067	0.017*	0.667	0.136	0.8	0.74
(d)	using writing software as compared to SRSD without scaffolding + writing software?	B compared to C	32	0.403	0.6	0.117	84	0.028***	0.8	0.037*	0.120	0.745	1.16	0.003**	0.24	0.531	0.48	0.21
(e)	using writing software as fully scaffolded SRSD + writing software?	B compared to training	0.52	0.175	0.2	0.602	92	0.016***	0.96	0.012*	0.040	0.917	1.1	0.009**	0.64	0.095	0.416	0.676

\*Significant at the P < 0.05 level in a positive direction \*\*Significant at the P < 0.01 level in a positive direction \*\*\* Significant at the P < 0.05 level in a negative direction

#### 5.2.1 NAPLAN scores

Luke, Evan, Emma, and Nate all had significantly higher NAPLAN scores when using Read&Write writing support software (condition B) when compared to baseline (A<sup>1</sup>), and John's scores also increased. Eric, Jack, and Nadia had lower scores during the first intervention phase (see Table 5). The second intervention condition (C), in which SRSD and writing support were used, saw a significant positive change in Luke's scores when compared to the second baseline (A<sup>2</sup>). Five more students' results improved during condition C, and four of those saw improvements which approached significance. Eric and Nadia's scores in condition C were within the same range as their baseline scores (see Figure 6).

All students had higher NAPLAN scores when using SRSD and writing support (condition C) than they did with writing support alone (condition B). For Nadia, Nate, and Jack the difference was significant.

#### 5.2.2 Number of words written

As outlined in Table 6, both Emma and John increased the word length significantly with the use of the writing support software (condition B) when compared to baseline (A<sup>1</sup>). Luke, Evan, Eric and Jack also had increased word counts when using Read&Write, but these increases were not significant. Both Nadia and Nate had slightly lower word counts during condition B. Six of the eight students wrote more using SRSD and writing support software (condition C) when compared to the second baseline (A<sup>2</sup>). For three of these students (Evan, Jack, and John) the increases were significant. Luke and Nadia wrote fewer words during the second intervention phase.

When compared to writing support alone (condition B), six of the eight students wrote more when using SRSD in addition to writing support (condition C), and this increase was significant for two (Nate and Jack). Two students, Luke and Emma, produced less work during condition C when compared to condition B, and, in Emma's case, this decrease was significant.

## 5.3 Social validity

## 5.3.1 Students

In the initial student interviews, all eight students expressed negative feelings about writing tasks and their self-efficacy in completing them. Responses included describing writing tasks as hard, something that they were not good at, or something that took them longer to complete than their classmates. All of the

students reported having difficulty planning their work, preferring to skip that step, and difficulty with both the conceptual aspect of writing (n = 7) and the physical act of handwriting (n = 7) was reported. Seven of the eight students expressed a dislike for writing.

In the second round of interviews, six of the eight students expressed an improved sense of self-efficacy. Comments included:

*"I've gotten used to writing and I've gotten help writing stories. And I've gotten better at writing"* 

"I've actually started to write in class".

"That holiday story was really good. I was using persuasive words like, I mentioned that there was like this little cave..."

"I've wrote some more stories and I'm getting more confident."

"I think, the next time I am asked to do a persuasive text, I'll be much better at it."

"It was quite boring doing persuasive texts. I hated them before I did this."

Most of the students (n = 6) reported finding the scaffolding provided with SRSD useful in planning, and seven of the eight students expressed positive feelings about writing at the end of the study.

Students also completed a survey at the conclusion of the study which included indicating their responses to questions about handwriting, using Read&Write writing support, and having SRSD support using a Likerttype scale (see Table 7 below). The student survey included questions on their use of handwriting versus typing, and their confidence and preference for handwriting versus typing, and their experiences of using handwriting versus typing and SRSD. Seven of the students reported finding the writing support software of some use, and six found the SRSD support helpful.

## Table 7. Student survey responses (N = 8)

Question	Student responses								
Q1. How much do you usually like writing	I hate it	I don't like it much	It's not too bad, but not great	l like it a bit	l love it				
	1 (12.5%)	3 (37.5%)	2 (25%)	2 (25%)					
Q2. How confident are you at handwriting?	Not at all confident	A bit confident	ОК	Fairly confident	Really confident				
	1 (12.5%)	1 (12.5%)	4 (50%)	2 (25%)					
Q3. Do you prefer to write by hand or type your work at school?	Always prefer to handwrite	Mostly prefer to handwrite	About half of the time by hand and half by typing	Mostly prefer to type	Always prefer to type				
		1 (12.5%)	3 (37.5%)	1 (12.5%)	3 (37.5%)				
Q4. Do you find TextHelp Read&Write for iPad useful for writing	Not at all useful	A bit useful	ОК	Fairly useful	Really useful				
	1 (12.5%)	1 (12.5%)	1 (12.5%)	2 (25%)	3 (37.5%)				
Q6. Is it easy to use TextHelp Read&Write?	Not at all	A bit hard	ОК	Fairly easy	Really easy				
			1 (12.5%)	3 (37.5%)	4 (50%)				
Q11. How hard has it been to learn to use your iPad for writing?	3 (37.5%)	1 (12.5%)	4 (50%)						
Q7. How easy it is to understand how TextHelp Read&Write works?	It's very confusing	It's a bit confusing	I understand some of it but not all of it	Mostly easy to understan d	Very easy to understand				
	1 (12.5%)		1 (12.5%)	1 (12.5%)	5 (62.5%)				
08. If you have to write a story or a	Туре	Handwrite							
recount would you prefer to use a computer or write it by hand?	6 (75%)	2 (25%)							
Q15. You have been learning some new	No help	Not enough help	A little bit of help	Some help	Lots of help				
strategies to help you with writing, like this one: How helpful has it been?	1 (12.5%)	1 (12.5%)	1 (12.5%	1 (12.5%)	4 (50%)				
012 I would like more hole learning to use	Yes	No	Maybe						
my iPad.	3 (37.5%	3 (37.5%	2 (25%)						
Q13. I would like to learn more about how my iPad works.	4 (50%)	3 (37.5%	1 (12.5%)						
Q16. Do you think you will keep using this writing strategy?	2 (25%)	1 (12.5%)	5 (62.5%)						

The student survey also required the students to tick a box if a specified issue bothered them about handwriting. A range of potential issues about handwriting such as: *"it gives me a sore hand", "trouble spelling", "it makes me tired"*, and *"it's hard to keep up"* were provided in the survey. Similarly, the students were asked to tick a box if a specified issue bothered them about using technology, with a range of potential issues provided in the survey including *"I don't like the feel of it", "it doesn't work sometimes"*, *"I have to wait to use the printer", "the screen"*, and *"the sound"*. The number of students who indicated that these specified aspects of handwriting and using technology were problematic are provided in Table 8 below. Most of the students found numerous aspects of handwriting to be difficult but reported fewer challenges with the use of technology.

Challenges with handwriting	Students reported difficulty (n = 8)	Challenges with using technology	Students reported difficulty (n = 8)
Sore hand	7	It's embarrassing	0
Trouble spelling	6	I don't like the feel of it	0
Don't know what to write	3	It doesn't work sometimes	4
Hard work	7	I have to wait to put my work on the computer	3
Makes me tired	5	I have to wait to use the printer	0
No choice of pen/pencil	5	The screen	0
It stresses me	4	The sounds	0
Hard to keep up	6	Not having easy access to a computer	0
Feeling of hand on paper	4	Further comments: "I find it hard to find the letters on the keyboard" "It's slow sometimes" "I can't print from iPad at school but if I had one I would use it for my work in class." "I like the way that you can change the sound or screen brightness on an iPad"	
Feeling of pencil/pen	2		

#### Table 8. Student-reported challenges with handwriting and using technology

#### 5.3.2 Teachers

Six teachers completed a survey at the conclusion of the study. Their responses were mostly positive indicating that they found the writing support helpful for six of the eight students, and the SRSD component of the intervention very helpful for five of the eight students. All six teachers reported that they would recommend the use of writing support software to their colleagues, and five of the six teachers would recommend the SRSD method. Comments from teachers regarding the Power Writer components included:

*""I can get a lot more out of Luke if he is using his iPad. When I say more, his stamina is higher. When he has to use a pencil he just runs out of the will to write very quickly."* 

"It [an iPad with writing support software] just gives them that element. It takes the stress of using the hand writing and the fine motor skills out of it the equation and put what's actually in their head on the page."

"I would say that it [an iPad with writing support software] motivates them to get started and to continue working instead of dithering. Instead of getting that mindset..."

"I was saying that his focus has incrementally increased and for longer periods since you started this research."

"I would say that is helpful with completion of the story. He'd make a start previously, and then get distracted and then to come back to it ... This allows him ... Like I've read what he's written just recently and it's just flying. It's just the whole story's cohesive."

"I've got a couple of students who would really benefit [from using SRSD]. It's about organizing their thoughts and all sorts of things."

## **5.4 Summary and discussion**

The results of the Phase 2 evaluation of elements of the Power Writer app demonstrate the complexity of the challenges involved in supporting students on the spectrum to write. The individual characteristics of each of the student participants inevitably impacted the way in which the different intervention elements affected their writing performance. For example, Eric, who was already a proficient writer, did not have much room for improvement in his NAPLAN scores over the course of the study. Similarly, it is very likely that the typing skills of Nate and Nadia influenced

their ability to work with the Read&Write writing support software, impacting their word count scores and, possibly, their NAPLAN scores. Both Nate and Nadia increased their word counts and NAPLAN scores during the untimed training period.

The remaining six students all increased word counts with the use of the writing support software and all, except Luke and Nadia, improved in the amount they were writing when using SRSD and writing support. These results suggest that the Read&Write writing support software could be used to assist students on the spectrum to produce written work when the students have the skills to utilise the technology, and that this effect may be enhanced by the use of SRSD scaffolding. The quality of student work (as measured through the NAPLAN score) also improved for most students across the two intervention conditions. Five students saw improvements using the Read&Write writing support software, and six using both writing support and SRSD. The quality of work produced by Nate, Nadia and Jack was significantly increased during the second intervention condition, when compared to the first, and Emma was the only student whose NAPLAN scores were not improved between conditions B and C. This suggests that the two components together are more effective in helping students in the quality of their written expression than writing support alone.

The attitudes of both students and teachers towards the Power Writer app components was positive. All students chose to continue using the writing support on the iPad during condition C which may indicate that they were motivated to use the app. Also, most of the students reported more positive feelings about writing and greater self-efficacy after the study. Teachers reported the intervention being helpful for most of the students and were willing to recommend it to others. The third phase of this project explored the social and ecological validity of the Power Writer app in more detail.

## 6. Phase 3 Ecological relevance



#### Figure 9. Research flow diagram – Phase 3

This third phase of this research (see Figure 3) was designed to address RQ3, *is the Power Writer app perceived by students and teachers to be an effective and socially valid tool for inclusive class wide teaching and learning?* 

As indicated in Figure 10, the inclusive use of training materials with seven mainstream classes was observed and then the teachers were asked to comment on the suitability, usefulness and social and ecological validity of the training materials during focus groups.





## 6.1 Method

## 6.1.2 Part A: Observation of class use of the Power Writer app

## 6.1.2.1: Participants

Seven classes from three schools (one grade four, one grade four/five class, three grade five classes and two grade six classes) used the app as part of a lesson. At least one student on the spectrum was included in each class. Nine teachers (seven classroom teachers and two advisory visiting teachers) were involved in instructing the students and/or facilitating the activity.

## 6.1.2.2 Materials

In each lesson, students were provided with an iPad (at least one between two), two NAPLAN style prompt sheets and the two POW + TREE worksheets and were shown two instructional videos, *'What's this app about?*', (to explain Power Writer) and the *'TextHelp Read&Write instructional video*' (to explain the use of Read&Wrtie writing support). Each iPad had the Power Writer app with the Read&Write software loaded and was connected to the school's Wi-Fi.

## 6.1.2.3 Procedure

The two instructional videos were shown to the class using a projector. The students were then provided with iPads, the two POW + TREE worksheets and two NAPLAN prompt sheets. The students were asked to watch one or two of the example videos and then to start the writing task using one of the two NAPLAN prompt sheets. The researcher and a research assistant wrote observations of the class as a whole rather than individual students based on the following prompts:

- How are students working In groups? Individually?
- Are students on task? Is there interest in the activity? Issues with behaviour around staying on task?
- How is the app being used, is it being used as intended or in a different way?
- Do students appear to be engaged in the task?
- Questions/comments students ask/make about the app.

## 6.1.3 Part B - Teacher focus groups

## 6.1.3.1: Participants

The nine teachers (two male and seven female) who were involved in the lessons, participated in one of three focus groups, which were conducted after the lessons.

## 6.1.3.2 Procedure

The focus groups were semi-structured guided by questions and the teachers' responses were recorded.

- Did you find the POW+TREE app useful as a tool for teaching persuasive writing? *Probe questions* 
  - What do you think the students liked best about using the app?
  - What do you think the students didn't like about using the app?
  - What did you like about the app?
  - What didn't you like about using the app?
  - o Did the app always work as you expected it to?
  - $\circ$  Were there any specific problems that you encountered when you used the app?
  - $\circ$  Is there anything that you would suggest that would improve the app?
  - $\circ$  Is there any other feedback that you would like to give about the app?
  - How did your students' written compositions using the Power Writer app compare to their usual handwritten compositions?
  - Would you use the Power Writer app in the future? Would you recommend it to other teachers?
- Did the students like the video-modelling (of Read&Write and the POW+TREE writing strategies)?

Probe questions

- o Did you feel that the video-modelling helped to motivate your students?
- Would you use the video-models in your class in the future? Would you recommend them to other teachers?
- Did some of the students choose to use Read&Write rather than handwriting? *Probe question* 
  - If so, how did their written compositions using Read&Write compare to their usual handwritten compositions?

• Would you be happy to allow your students to use Read&Write regularly for their written work in class? Would you recommend it to other teachers?

#### 6.1.4 Data analysis

The focus group and observation notes were analysed using qualitative content analysis (Graneheim & Lundman, 2004; Stewart, Shamdasani, & Rook, 2007). Keywords and phrases were used to develop codes assigned to "*discrete objects, events and other phenomena*" (Graneheim & Lundman, 2004, p. 107). Categories were then created to group the codes around common descriptive ideas (Graneheim & Lundman, 2004). These categories were then used to identify sub-themes and themes, which are discussed in the following results section.

#### 6.2 Results

The themes that emerged from the teacher focus groups and researcher observations are presented below:

#### 6.2.1 Self-efficacy

Teachers reported that students who struggled with writing self-efficacy were more willing to persist with the Power Writer writing task with comments such as: "*I'm assuming it's from the app that he was a bit more confident to put his things down on paper*", and "*She's been more, not reluctant, more willing*". They also commented on the way that the app engaged students other than those on the spectrum: "It was good to see the other kids get to have a go at it yesterday and to see the engagement... how much it can actually help, not just those children with ASD. It could help all children and because you don't have to have ASD to be a reluctant writer".

#### 6.2.2 Self-regulation

The students were observed to explore the app and example videos and to begin the writing task without prompting, although some students who needed instruction on the way to access the writing scaffold after watching the videos. The structure of the Power Writer app and its ability to assist students with self-regulation and writing composition was mentioned by teachers at least twenty-five times. Their comments included: *"It gave them a very clear direction and structure, directions for moving, and structure through the areas where they could actually write their ideas", and "I think they could see if it made sense and having the structure there took the pressure off them trying to remember that. They could focus on exactly what they were writing".* 

#### 6.2.3 Task engagement

Students working in groups were observed to be engaged and on-task. They were observed to be discussing the NAPLAN prompt sheets and the points for or against the chosen topic. Teachers also reported high levels of engagement with comments such as, "*I found that one of mine in particular who his handwriting skills, his fine motor skills, are awful, very hard, difficult to read his writing and stuff; and I noticed he was quite engaged because he didn't have that barrier for him" and "if they didn't like it [the Power Writer app and videos], they'd have been silly and mucking around, so I think you could take it from that, that they were watching it, engaged".* 

#### 6.2.3 Video-modelling

Students were observed to be very engaged in the videos, as evidenced by their attention to the instructional videos. It was noted, however, that some students needed some help transitioning from the example videos into the writing task. Teachers reported that they liked the way the videos were peer modelled and that students who need information presented multiple times could watch the videos more than once. Comments included "*I thought the videos were awesome*", "*I think they could relate to it*". One teacher commented that having a video model enabled her to have more time to spend support other students "*I liked that it scaffolded them, also it took that role away from the teacher having to model it, because it was being modelled already, so then the teacher was freed up to go around and work one-on-one or with small groups*". Teachers also liked the relevance of the topics used in the videos: "*I think the other thing about was that there were topics that appealed to them, like the gaming one and the other topics that were offered were great*" and "*I think because of the samples that were given, the examples, some of them did some really outlandish topics that they were discussing. One group that I was with said, 'If we could all have flying cars' and they were, you know, rattling out all these ideas."* 

#### 6.2.5 Inclusive use

Power Writer app was observed to encourage collaboration amongst students, including students on the spectrum working with students not on the spectrum. Teachers observed that "*they* [students] *actually conversing with each other about it, so I thought that was a plus*". Although teachers praised the way in which the Power Writer app supported students, they perceived the app as a "*starting tool*" for reluctant writers and that competent writers needed more extension. Comments included: "[competent writers] *need that extension one, because they weren't pushed as much*".

#### 6.2.6 Writing support software

The teachers particularly liked the ability for students to make use of Read&Write, mentioning its usefulness 23 times. Comments included, "*My students liked, especially the ones that are reluctant writers and are not neat, found it* [Read&Write] *good because it was able to read back to them what they had typed in*" and "*I think TextHelp is great… My students who struggle with stamina, I think it gives them some tools to continue and help them with their writing even when it's difficult*". While Read&Write was considered to be a useful tool by all the teachers, they did note some limitations, including challenges with the assessment of spelling, the lack of personality in the voice and that the text-to-voice could be distracting when used in a class environment. Some teachers said that they would be reluctant to use Read&Write for English assessment: "You know, if they're using TextHelp all the time, there's never going be a spelling issue. So then how do you report on that?". Others were concerned about the misuse of the Read&Write software by capable students: "…it repeated back every word they were writing, and then when they realized that, a lot of them were touching all these random words and then it was saying like "Gibbly, gibbly".

#### 6.2.7 School environment

One of the most limiting factors associated with using an inclusive technology in the schools was the availability of the infrastructure required to run it. Challenges include (a) insufficient iPads for every student, (b) parents having to install the Power Writer app on personally owned iPads, and (c) lack of access to Wi-Fi in some schools. Although teachers were generally positive, they were challenged by the reliability of Wi-Fi, the lack of IT support and IT infrastructure: "Yeah, it's just the infrastructure, the technology". Teachers raised the issue of an iPad app not being suitable for schools that use other types of portable or desktop devices "It would be awesome if it was made into a website, just for us that don't have iPads, because we do have one-to-one laptops".

#### **6.2.8 Future improvements**

A number of aspects of the app that could be improved were suggested. Teachers described the need for greater access to the student work with comments such as "*I'd have liked to have access to what they're writing*". Teachers commented that the app should be able to incorporate teacher feedback: "*If the teacher can then put some feedback on there and then email it, that would be really useful*". Teachers also suggested that they would like statistics on student work "*like a little progress report*". An app with variable levels of scaffolding was also considered important to teachers and students. In particular, teachers suggested that the scaffolding in the Power Writer

app did not support high performing students, with comments such as "*It's great for starting students, but the ones that can do that …. need the extension and more flexibility maybe*". Both teachers and students remarked that the Power Writer app would be more engaging if it had more game features that included some kind of reward system and/or evaluative aspect. For example, one teacher commented "*I really love the idea of earning points, and someone suggested writing a sentence and people can vote. You could earn points and have like a competition of who's written the best sentence starter*".

## 6.3 Summary and discussion

Teachers commented favorably on the capacity of Power Writer to improve student self-efficacy, self-regulation, and engagement. They liked the way that Power Writer encouraged students to work together. The use of writing support software was perceived as advantageous for many students, although there were some concerns about its use for assessment tasks. Both teachers and students provided feedback on the need to create more game features and levels for more competent writers and the need for ways to mark and edit work. While teachers perceived that their struggling writers' self-efficacy and self-regulation improved during the Power Writer writing task, they described the need to provide more extension for competent writers. All teachers commented positively on the motivation provided by the peer-modelled instructional videos. Although they were generally supportive of the use of Power Writer app, a lack of technology infrastructure such as access to iPads and Wi-FI was perceived to be a potential barrier. Overall, the Power Writer app was considered to be a useful and ecologically relevant tool for students who were struggling with writing.

## 7. Discussion

The three phases of this project have facilitated the development and evaluation of the Power Writer app – a software package combining Read&Write writing support with SRSD scaffolding and supported by video-modelling. The aim of this project was to provide support for students on the spectrum to undertake persuasive writing tasks in mainstream classrooms. The objective was not only to develop an effective package of support strategies, but also to ensure that it adhered to principles of Universal Design and could be implemented by teachers in inclusive settings. For this reason, the development and evaluation focused not only on outcomes reflected in student writing, but also on the social and ecological validity of the Power Writer app.

Using the SETTi framework and a co-design process worked to produce an app with direct relevance to its intended users and the mainstream classroom setting. Structuring and documenting the development process through the first phase of this research may provide a useful reference for other researchers concerned with incorporating an inclusive, Universal Design approach to developing supports for students on the spectrum. The co-design process was an effective way to include the ideas and feedback of students, teachers, and individuals on the spectrum at a foundational level.

The second phase of the project demonstrated that the Power Writer app could be helpful in supporting students on the spectrum with their written expression. However, while most of the eight students in the evaluation study saw some improvement to the quality and length of their writing with the introduction of writing support and SRSD, a number of students saw no positive change in some areas. This inconsistency is likely to be associated with variations in ability in a number of areas.

In particular, differences in typing ability may have impacted on the capacity of students to benefit from the use of writing support software. For example, Nadia and Nate were "hunt and peck" typists. This was evident in the lack of change in their number of words from conditions A<sup>1</sup> (handwriting) to Condition B (writing support software) (see Figures 7 and 8). Nadia also wrote more words in condition A<sup>2</sup> Handwriting than in Condition B (writing support software), which suggests that she can currently produce better written compositions when handwriting than when typing. It is therefore recommended that students be given sufficient opportunity to practice typing and using technology, in order to maximise their capacity to take advantage of writing support software.

A second difference was the capacity of students to internalize the SRSD training. A review of NAPLAN scores in Figures 5 and 6, suggests that Luke and Nadia did not maintain the gains they made during training in condition C (writing support + SRSD). It is therefore recommended that additional training sessions be provided for some students to ensure that they have internalised the SRSD strategies.

A third difference was that the highest performing student Eric did not show improvements in either NAPLAN scores or word length. Eric's preliminary assessments indicated that he did not have writing difficulties in that (a) his handwriting legibility was in the average range, (b) his handwriting speed was in the superior range, and (c) he could touch type at a speed that was over 2.5 times the rate of his handwriting speed. He also had above average language ability and average range IQ (see Table 4). This suggests that the current version of Power Writer app may not be effective in extending the learning of high performing students. This finding was supported by the perceptions of teachers who participated in Phase 3, as these teachers described the need to provide more extension for competent writers. Wood, Bruner, and Ross (1976) identify feedback as one of the elements of effective scaffolding. Further refinement of the app to facilitate the provision of critical feedback and incorporate levelling to include more complex tasks could increase its utility among diverse groups of students. The results of the third phase of this research indicate that game elements would be a welcome way to implement these features.

Despite these issues, motivation to use the app was high among both the students in the double baseline study and those who trialed the app in the third phase of this project. Self-efficacy was shown to improve with the use of the Power Writer app, with students gaining confidence in their writing abilities, and teachers noting that their students were more willing to engage with writing tasks.

#### 7.1 Limitations

There are a number of limitations that are unavoidable when conducting research in school settings. Unpredictable events, absences, and time restrictions all impact the way in which research can be conducted. In this case, there were unavoidable restrictions on the length of the writing task and the number of training sessions the students received. In the study by Allen-Bronaugh (2013) which demonstrated the successful use of the POW+TREE writing strategy in supporting students on the spectrum, participants were trained until they achieved mastery. The shorter length of training students received in the current study may have resulted in lower scores when the training supports were removed. Additionally, although the NAPLAN marking criteria

provided an ecologically relevant measure for the writing tasks, it is designed to rate students with a very broad range of abilities. As a result, NAPLAN appeared to be insufficiently sensitive to detect small within-participant changes.

In the school environment, when trialed in mainstream classrooms, limitations due to resources and infrastructure were evident. In order to support individual writing expression, it is desirable that each student have access to a device with the Power Writer app installed. This was not achievable in every classroom with some students needing to share iPads to use the app. Difficulties in accessing a Wi-Fi internet connection consistently in some classrooms were also a limiting factor.

## 8. Conclusion

This research has shown that the use of writing support software in conjunction with SRSD scaffolding can have a positive impact on the amount and quality of writing completed by students on the spectrum who find written expression challenging. Furthermore, the implementation of these strategies using the Power Writer app has led to noticeable improvements in student motivation and self-efficacy. The continued refinement of the Power Writer app may build on this success by increasing its relevance to students with established writing skills. More broadly, by documenting a process of socially and ecologically valid intervention development and evaluation, this project serves as a contribution to a growing body of literature which may help future researchers to develop supports for students on the spectrum that can be used in inclusive settings.

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