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Vocabulary Instruction, Reading Comprehension, and Writing - Examining the effectiveness of an online intervention literacy programme for secondary students with dyslexia

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Abstract

As students with dyslexia develop their foundational literacy skills in reading and spelling, it is also imperative to ensure that they are being supported in managing their advanced literacy challenges in reading comprehension and writing given that these difficulties tend to persist or increase over their educational journey. Therefore, recognising the higher level of expectation, the sophistication of skills in literacy that are essential for students to acquire as they transition to secondary schools and beyond as well as the limited access to specialist programmes targeting the higher-order literacy skills, the English Language and Literacy Division (ELL) at the Dyslexia Association of Singapore (DAS) developed the iReaCH™ programme. iReaCH™ focuses primarily on equipping students with the necessary reading comprehension skills and strategies through an intentional and conscious emphasis on vocabulary instruction, a vital cornerstone in language and literacy development. During the course of the study, the programme was delivered online. This paper highlights not only the teaching pedagogies and approaches of iReaCH™ but also evaluates the relevance and effectiveness of the programme through the administration of formative and summative assessments, surveys and testimonials as well as an analysis of students' writing scripts. Overall, the results showed positive gains in the application of vocabulary knowledge, comprehension skills and writing techniques taught to secondary school students, with moderate to large effect sizes for vocabulary and reading comprehension within one year and six months of intervention respectively, albeit an online delivery. The results of this study have implications for wider use within Singapore and beyond to enhance the literacy skills of students with dyslexia.

Keywords: dyslexia, specific learning difficulty, vocabulary, reading comprehension, writing, independence, self-confidence, online learning

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INTRODUCTION

Dyslexia is a specific learning difference that persists throughout one's lifetime. (Ramus et al., 2003). While it is characterised by difficulties primarily with the phonological aspects of reading and spelling (Hulme & Snowling, 2013; Kemp, 2009), the secondary implications also include learning gaps in reading comprehension and writing. As reading comprehension and writing are one of the most important and highly emphasised academic skills taught in school (Curriculum Planning and Development Division, 2020), learners with dyslexia, arguably, may experience significant challenges as the demands and expectations increase substantially throughout their educational journey.

Additionally, strong correlation between reading comprehension and writing has been shown to grow through the primary school years (Bourke & Adam, 2010). In other words, learners with reading difficulties will likely demonstrate gaps in vocabulary acquisition and reading comprehension which includes interpreting and drawing inferences based on the information presented in the text (Mercer & Mercer, 1993) which consequently, impact their development of writing, thus resulting in a delayed writing profile and proficiency. Writing is also deemed as a more complex and sophisticated skill to gain mastery of as it involves both the production and processing of print.

Current Gap in Intervention

In Singapore, learners with dyslexia have access to intervention programmes offered by various providers. In government schools, they can attend the school-based dyslexia remediation programme if they are in primary school levels 3 to 4 (ages 9-10), while externally, they can look to organisations such as the Dyslexia Association of Singapore (DAS) for educational therapy. Most dyslexia remediation programmes in Singapore either primarily focus on building up a learner's functional literacy, or provide a holistic approach, addressing all aspects of literacy. However, this leaves the profile of learners who do not require functional literacy support without a programme that specifically targets their needs in higher order literacy such as reading comprehension and writing.

Singapore Education System

Until 2023, the Singapore education system differentiated secondary level students into three different streams of academic ability, Normal (Technical), Normal (Academic), and Express (Ministry of Education, Singapore, 2023). Each stream had a curriculum that was customised to ensure that the students could learn at their own pace (Ministry of Education, Singapore, 2023). At the tail-end of their secondary education, the students of each stream will sit for the Singapore-Cambridge General Certificate of Education examination (Singapore Examinations and Assessment Board, 2023). Students from the Express stream will take the Ordinary Level papers, Normal (Academic) will take the

Normal (Academic) papers, and Normal (Technical) will take the Normal (Technical) papers (Singapore Examinations and Assessment Board, 2023). While it is possible to take the annual examination as a private candidate, most students would go through 4 years of secondary school education before sitting for the respective examinations. From 2024, the system of streaming students into the three streams will be replaced with Full Subject Based Banding (Ministry of Education, Singapore, 2023) for students who enter secondary school that year. The new system allows greater flexibility for students to learn different subjects at their own pace and ability (Ministry of Education, Singapore, 2023).

The iReaCH™ Programme

The primary aim of iReaCH™ is to support learners in Reading Comprehension and Writing through the deliberate use of in-depth vocabulary instruction and educational technology. This allows them to be better able to apply the vocabulary they encounter in reading and writing texts, and also increase their engagement and participation in the lessons. The teaching principles emphasised in iReaCH™ adhere closely to the Orton-Gillingham (OG) principles to enable learners with dyslexia learn more efficiently and effectively. These include being direct and explicit, diagnostic and prescriptive, structured, sequential and cumulative (Gillingham & Stillman, 1997) in teaching instruction, the delivery of lessons as well as the development of the curriculum and teaching resources to promote greater student independence and agency. The programme also uses Marzano's six step process for vocabulary instruction. iReaCH™, therefore, has been purposefully developed to provide primary and secondary school students with not only the skills and content knowledge to cope with and excel in Reading Comprehension and Writing but also increase their confidence and preparedness during examinations.

REVIEW OF LITERATURE

Dyslexia

Dyslexia is a learning difference which learners with dyslexia have to navigate their entire lives (Ramus et al., 2003). This is due to dyslexia being neurobiological in nature, where regions of the brain that are associated with decoding and recognising words see lower activation than typical readers (Kearns et al., 2019). This manifests as deficits in functional literacy, where learners with dyslexia experience significant difficulties in reading and spelling words. However, the impact of dyslexia goes beyond the word level. It also affects reading comprehension and writing (Roitsch & Watson, 2019), which are considered the higher order literacy skills. As the literacy needs of learners with dyslexia differs with each individual (Maunsell, 2020), there would be those who require continued support in areas of functional literacy, and those who have acquired these skills readily and instead require more support in the higher order literacy skills. This could be despite both groups being at the same age or level in an education system.

Dyslexia and Vocabulary Instruction

Learners with dyslexia face difficulties in vocabulary acquisition and application. In terms of acquisition, Vizhi and Rathnasabapathy (2023) found that a majority of students in their study reported experiencing challenges in acquiring new vocabulary. In terms of application, Sumner et al. (2014) discovered that learners with dyslexia tend to use a more limited range of vocabulary in their writing as compared to their non-dyslexic peers. They attributed it to the lower spelling ability which increases the burden on their working memory, thus decreasing their mental capacity to focus on vocabulary generation (Sumner et al., 2014). It can be concluded that it is necessary to take into account the spelling difficulties that learners with dyslexia face when providing intervention in vocabulary instruction.

Furthermore, vocabulary instruction that utilises multimodal instruction and educational technology would be beneficial for learners with dyslexia (Vizhi and Rathnasabapathy, 2023). This is in line with the Orton-Gillingham Approach to reading instruction, where the focus is on using a multi-sensory approach to instruction (Orton, 1966). This multi-modality is also seen in Marzano's six-step process for vocabulary instruction.

Marzano (2004) described a six-step process that is useful for vocabulary instruction, the first three pertaining to introduction of the vocabulary term, while the remaining three steps focus on exposure via different mediums. The steps are briefly explained below:

- **Step 1: Explain** - Introduce the new vocabulary term in an accessible manner, using different methods such as stories, images, current events and pictorial representations to facilitate understanding of the term.

- **Step 2: Restate** - Get the students to use their own words to explain the vocabulary term, generate their own example sentences, which helps them to understand it from their own perspective.

- **Step 3: Show** - Direct the students to illustrate the vocabulary term in some form, such as a picture or a symbol. This encourages them to think of the term in a non-linguistic way, which can help reinforce the recall of the term.

- **Step 4: Discuss** - Involve the students in discussions of the vocabulary term, be it classifying or comparing similar or dissimilar terms, coming up with analogies and figurative language phrases.

- **Step 5: Refine and reflect:** Ask students to review their definition and illustrations of the vocabulary terms learnt, making edits and discussing with their peers about the vocabulary term. This deepens their understanding of the terms as they engage in discussions.

- **Step 6: Apply in Learning Games** - Allow students to review and reinforce their understanding of the vocabulary terms through interactive games that are conducted periodically.

These six steps are designed to help students understand and recall the vocabulary terms introduced, and would be especially useful for learners with dyslexia who benefit from multi-modal learning, and being exposed to a concept in various forms. The approach has been used in physical classrooms and found to be effective (Tan & Goh, 2020; Al-Husban & Alkhawaldeh, 2018; Suing, 2012). Research on its effectiveness when used in an online setting has not been conducted.

Dyslexia, Vocabulary and Reading Comprehension

Vocabulary knowledge is intrinsically linked to reading comprehension. To understand a text fully, readers must possess a comprehensive grasp of the vocabulary words employed within it. Consequently, an absence of vocabulary knowledge will result in poor comprehension of a text (Biemiller, 2013). This is exemplified in a study by Sidek and Rahim (2015), where participants cited their inability to comprehend texts in their native language and second language, attributing it to their inadequate vocabulary knowledge. Moreover, it is posited that readers need to possess knowledge of at least 95% of the vocabulary used in a text to be able to achieve sufficient comprehension (Laufer & Ravenhorst-Kalovski, 2010). Okkinga et al. (2023) also found that vocabulary knowledge is an important factor in reading comprehension intervention: students with poor vocabulary experience a higher cognitive load due to the simultaneous processing of the meaning of unfamiliar vocabulary and application of reading strategies, resulting in a lower effectiveness of the intervention.

In terms of vocabulary, instruction is found to be effective in helping students with literacy needs understand a text better (Elleman et. al., 2009). According to Benjamin (2002), vocabulary knowledge is targeted in more than 85% of reading comprehension questions in the GCE 'O' Levels English Paper 2. Explicit and implicit vocabulary instruction were also shown to be effective in helping students achieve better outcomes in reading comprehension due to an increase in their vocabulary knowledge (Al-Darayseh, 2014).

The frequency of vocabulary taught also played a significant factor in reading comprehension outcomes. In a study of English as a Foreign Language (EFL) learners, Masrai (2019) found that there needs to be intentional focus on teaching mid-frequency vocabulary to improve their reading comprehension. Learners with dyslexia showed improvements in reading comprehension after receiving focused vocabulary intervention (Kang et al., 2021).

Dyslexia, Vocabulary and Writing

While dyslexia is typically associated with reading challenges, both children and adults with dyslexia showed almost as many indicators of writing gaps as of reading when both reading and writing were evaluated (Berninger et al., 2001). Furthermore, adults with dyslexia reported that writing, not reading, is their major literacy challenge (Burden, 2005; Mortimore & Crozier, 2006). Moreover, writing is a complex process that involves an application of a wide range of skills that include a strong vocabulary, an understanding of the different genres, text structure and language features as well as organisational skills and self-monitoring behaviour (Kellogg & Raulerson, 2007). School tests and exams in Singapore also conventionally assess students largely based on written expressions and responses.

Drawing reference from the knowledge-telling model (Scardamalia & Bereiter, 1987), a model of developing writing skills as well as the link between long-term memory and vocabulary, there are two knowledge spaces namely, content knowledge and discourse knowledge. Content knowledge refers to subject matter information relating to the topic of the written text while discourse knowledge looks at procedural and genre awareness and understanding. Based on numerous studies, students who have a higher level of content and discourse knowledge are predicted to be more proficient in writing thereby, producing better quality text than those who lack this knowledge (Olinghouse & Graham, 2009; Benton et al., 1995). Vocabulary, is therefore, interwoven and implicated in each of these knowledge spheres.

Vocabulary thus communicates content knowledge since many topics and subject matters consist of specialised vocabulary (Harmon et al., 2005). Vocabulary has also been hypothesised to be a differentiating feature of the different genres of text (Biber, 1988; Halliday & Hasan, 1976).

The knowledge-telling model also suggests that vocabulary may contribute to the writing process through its role as a link between the knowledge stored in a student' long-term memory and his/her ability to apply and transfer that knowledge by selecting the most relevant and appropriate word based on a given context or scenario.

Dyslexia and Online Learning

The context of learning has evolved substantially especially during the period of pandemic when lessons had to be pivoted online, to minimise disruption and to allow continuity of learning to take place, making online delivery an integral component of school education. As a result, the process of teaching and learning is no longer confined to a conventional classroom environment. At the same time, the advent and affordances of electronic learning technologies (Pal & Vanijjam 2020) may have also accelerated the transition of learning to an online space.

With the ubiquitous use of online learning in education, more emphasis should be placed on enabling learners with dyslexia to maximise their learning from this mode of delivery. Therefore, the usability of the online platform and environment including access and engagement with course material, which has a significant impact on student learning (Kori et al., 2016) is critical in ensuring that students remain motivated and participative during the online lessons, resulting in a higher learning gain. In other words, the lack of usability of an online or e-learning system may have a negative effect on student motivation and the ability to retain the lesson materials taught as their focus may be on system functionality rather than content (Ardito et al., 2006).

In a study involving 86 students, Doggett (2008) found that online learning through video conferencing platforms did not significantly affect academic performance in comparison to face-to-face learning. Despite this, students preferred face-to-face instruction because they felt that the online medium did not facilitate interaction with the instructor. Doggett (2008) concluded that the lack of interaction stemmed from their attitude towards using the online medium to access lessons. This highlights the importance of students' attitudes towards the mode of learning being employed for their lessons.

Consequently, while online learning can benefit learners with dyslexia as this mode of delivery allows for self-paced learning and access to multimodal technologies, it is imperative to ensure that the online platform yields a high degree of usability for learners to achieve better engagement and satisfaction. Moreover, teacher and learner interaction and collaboration, through getting learners involved in critical discussions modelled and facilitated by the teachers and providing constructive and consistent feedback to learners on their progress (Gray & DiLoreto, 2016), plays an important role in achieving a more positive learning outcome.

PURPOSE OF STUDY

For the purpose of this study, 'online learning' refers to the delivery of the lessons using an online video communication platform, Google Meet, coupled with relevant and appropriate educational technologies, to increase student engagement and motivation as well as complement the content and learning materials.

This study aims to address the following research questions.

- **RQ1:** What is the effect of an online literacy programme on vocabulary acquisition for secondary students with learning differences?
- **RQ2:** What is the effect of an online literacy programme on the application of reading comprehension skills for secondary students with learning differences?
- **RQ3:** What is the effect of an online literacy programme on writing instruction for secondary students with learning differences?

METHODOLOGY

Participants

For the purpose of this study, only Secondary students who are in the Normal Academic (NA) and Express streams were selected. A total of 30 students were identified and their assessment scores were analysed. While the students selected to be part of the evaluation enrolled at different time points, all received the same intervention duration of 1 year. Some students who were identified also left the programme due to graduation or withdrawal, which resulted in a smaller pool of assessment scores to analyse, especially for the measure for a year of intervention. Furthermore, some data on reading comprehension assessments could not be used as the as the data were either lost or incomplete. The table below shows the number of students assessed on the various components after 6 months and 12 months of intervention respectively.

Table 1. Number of students analysed based on component

Component	After 6 months	After 12 months
Vocabulary	25 students	16 students
Reading Comprehension	18 students	4 students
Writing	3 Case Studies	

Table 2. Number of Students and their Academic Streams for English Subject taken in school

Normal (Academic)	20 students
Express	10 students

Table 3. Level and Student Demographic

Secondary 1	5 students
Secondary 2	12 students
Secondary 3	4 students
Secondary 4	8 students
Secondary 5	1 student

Instrumentation

iReaCH™ Progress Monitoring

Purpose

The purpose of iReaCH™ programme's progress monitoring tools is to measure and track the individual and collective progress of students. It is systematic and ongoing to evaluate the students growth and development by identifying their strengths and weaknesses. The data collected will be analysed to guide instructional decisions, measure effectiveness of the programme and inform future enhancements.

Types of Progress Monitoring

In iReaCH™, formative and summative assessments are conducted. A student will be assessed in three key areas: vocabulary, reading comprehension, and writing. The skills assessed are based on the curriculum that is covered on the programme.

Formative Assessment

Students are continually assessed on the concepts introduced in the lessons through online quizzes, guided work, and independent work. This informs the iReaCH™ Educational Therapists of the gaps in the students' knowledge, which can then be addressed in the following lesson through review and reinforcement of the concepts. One example is the use of Kahoot!, an online interactive quiz platform which allows students to answer questions as they compete for points.

Summative Assessment

Upon joining the programme, students sit for a pre-test, and following that, will sit for a post-test 6 months later and subsequently, the assessment will be administered at the end of every semester.

These assessments evaluate their overall progress and ability to apply the skills learnt throughout the semester.

- In vocabulary, students are given multiple-choice questions that test their vocabulary knowledge.
- In reading comprehension, students are tested on their understanding of a reading passage through a mix of multiple-choice and open ended questions. Some of the areas assessed include extracting information, interpretation of figurative language, and inference.

- In writing, students' ability to apply the writing concepts introduced throughout the lessons is assessed by examining their written work over the course of the term.

Surveys and Testimonials:

A survey will be conducted to gather feedback from the participating students on their experience with the programme. In addition, as most of the students may have other co-occurring learning challenges in addition to their dyslexia diagnosis, their progress may be varied and gradual. Therefore, testimonials and feedback provided by parents and Educational Therapists also form an important qualitative aspect in the evaluation of the students' overall progress as well as to triangulate the data.

Selection and Implementation:

Formative assessments are conducted during intervention. The observations are recorded by the educators.

The summative assessments are conducted online via Google Forms so that data can be recorded and analysed.

- For vocabulary, the items assessed are based on the vocabulary that has been identified from past year Cambridge examination papers that the local students will eventually sit for at the end of their secondary school education.
- For reading comprehension and writing, the questions or topics assessed are also based on the Cambridge examination.

These various components are crafted in consultation with our external curriculum consultant, Dr Isabelle Shanti Benjamin.

Data Analysis and Interpretation:

The data collected from the summative assessments is used to track students' progress on the programme, individually and as a whole. Individually, it informs the iReaCH™ Educational Therapists of what gaps need to be filled in the next semester. As a whole, the data provides insight into areas of improvement for the curriculum, such as the themes that need to be covered to meet the students' needs.

Test items that are Multiple Choice Questions (MCQs) are automatically marked by Google Forms, while marking rubrics or marking schemes are provided to the iReaCH™ Educational Therapists when they mark the open-ended questions or essay. This ensures the reliability of the data collected.

Quantitative data:

- Vocabulary Assessment (Summative)
- Reading Comprehension (Summative)
- Survey Forms- Parents and Students

Qualitative data:

- Writing Assessment (Summative)
- Testimonials- Parents and Educational Therapists

Intervention

The students who participated in this study were taught vocabulary using Marzano's six-step process. The worksheets they attempt are accompanied with a visual representation of the vocabulary word introduced, and opportunities are given to them to rephrase the word to their own understanding. To further reinforce the vocabulary items, group discussions about the word and its links to current affairs are carried out. Online interactive quizzes that gamify the lesson (e.g. Kahoot! and Blooket) are also used to review what has been taught.

The vocabulary items are grouped into themes and further split into categories for students to have focused and in-depth learning. These themes cover words that are identified to be useful and applicable to either reading comprehension and/or writing. For example, words that describe emotions, which helps students to answer reading comprehension questions that test on interpreting a character's feelings. In writing, words that describe situations and problems (e.g. deteriorate, degrade, aggravate, exacerbate) are among one of the themes introduced to students. This allows them to express their ideas better in essay topics where these words are applicable.

Educational technology is integrated into the lessons to facilitate the online delivery. The use of collaborative learning platforms such as Google Jamboard, Coggle, and Padlet, allow students to build on each other's contributions and learn collectively with mind mapping and group work.

RESULTS AND ANALYSIS

Vocabulary Assessment

The vocabulary assessment consists of 30 multiple-choice questions (MCQs) that test a variety of notable vocabulary words referenced from the national exam papers (O level and NA level). A majority of these vocabulary words are also included in the iReaCH™ vocabulary syllabus, while others are considered words that the students should have knowledge of, and are implicitly covered in the lessons. Students answer the questions on a Google Form.

Pre- and Post-test scores comparison for after 6 months of intervention

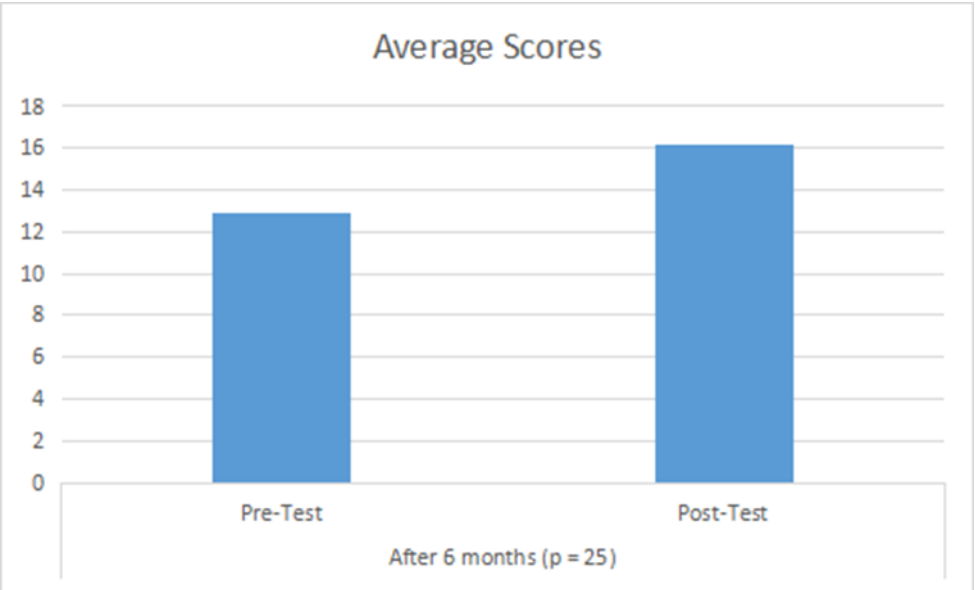

***Figure 1**: Comparison of average vocabulary assessment scores at pre and post-test after 6 months of intervention.*

Table 4. Pre and Post test scores after 6 months of intervention

	Sample Mean	Sample Size	Sample Standard Deviation
Pre-test	12.92	25	4.53
Post-test	16.16	25	4.52

Dependent t-test was conducted to measure the difference between the mean vocabulary scores in the pre-test and post-test after 6 months of intervention.

The results from the pre-test (M = 12.92, SD = 4.53) and post-test (M = 16.16, SD = 4.52) vocabulary task indicate that the intervention resulted in an improvement in vocabulary scores, $t(24) = 3.58$, $p = .0005$. The data also has a moderate effect size of 0.72.

Pre- and Post-test scores comparison for after 12 months of intervention

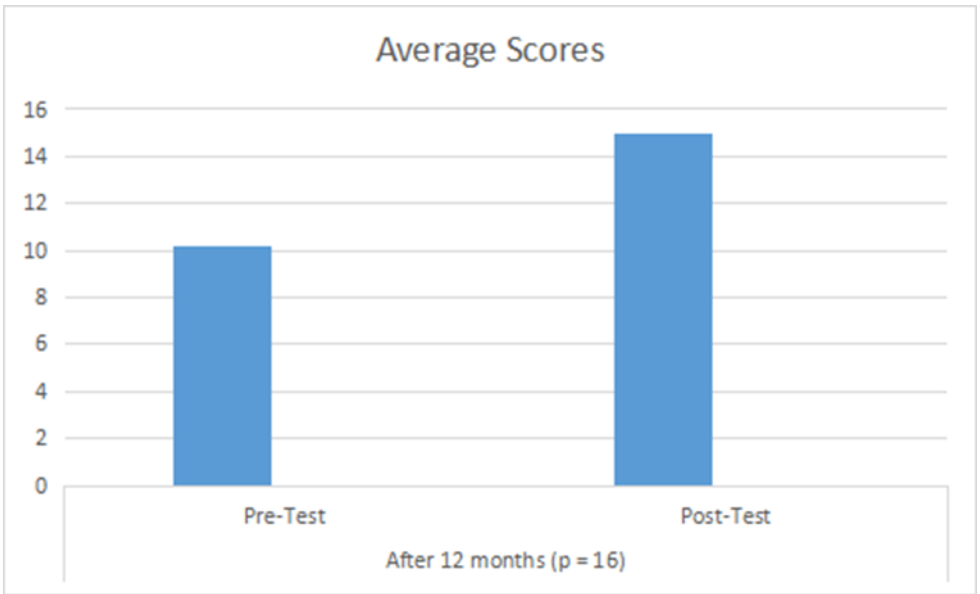

***Figure 2**: Comparison of average vocabulary assessment scores at pre and post-test after 12 months of intervention.*

Table 5. Pre and Post test scores after 12 months of intervention

	Sample Mean	**Sample Size**	**Sample Standard Deviation**
Pre-test	10.19	16	3.75
Post-test	15	16	4.62

The results from the pre-test (M = 10.19, SD = 3.75) and post-test (M = 15, SD = 4.62) vocabulary task indicate that the intervention resulted in an improvement in vocabulary scores, $t(15) = 3.58$, $p = .0001$. The data also has a large effect size of 1.05.

The results support the effectiveness of the intervention programme in helping students improve in their vocabulary knowledge after being on the programme as early as 6 months with an average increase of 3.24 marks, and even after 12 months with an average increase of 4.81 marks.

Reading Comprehension Assessment

The reading comprehension assessment consists of 10 or more open-ended questions that test a range of comprehension skills. The questions are designed to align closely to the questions that students will face in the national examinations. Two passages are selected, one for lower secondary, and another for upper secondary. Questions are then created for each stream (Express and Normal Academic). In order to mitigate the practice effect, some of the questions are changed in the second assessment. Before iReaCH™ transitioned to an online programme, the assessment was conducted through the pen and paper format. After being converted to an online programme, the assessment was converted to an online format administered through Google Forms.

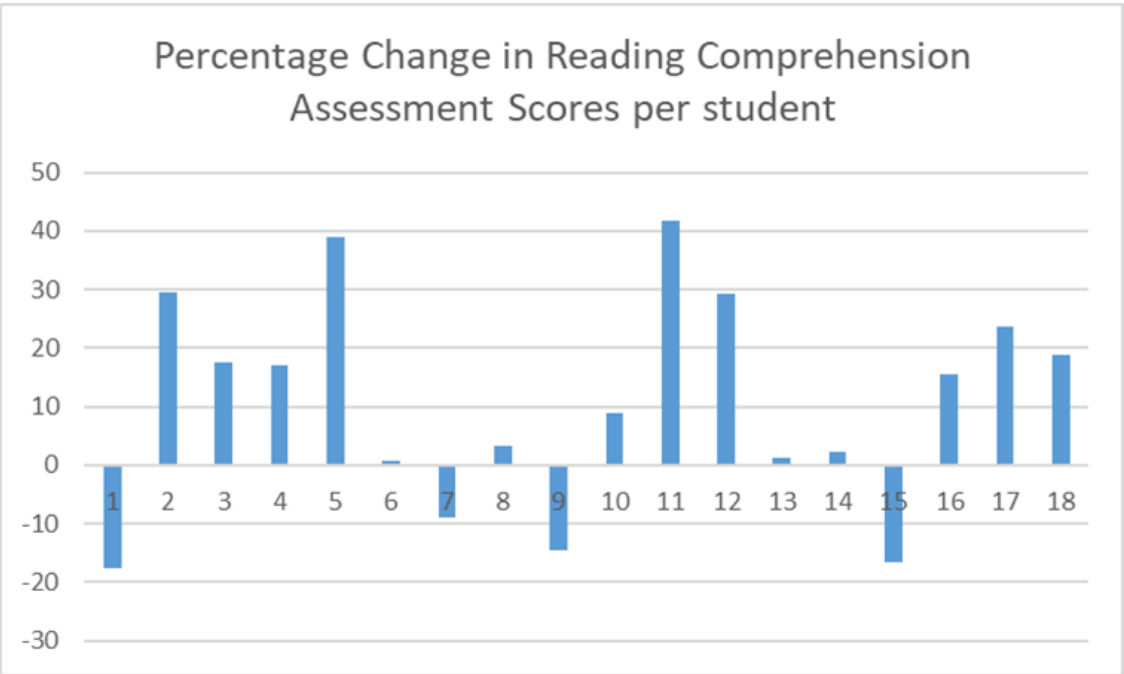

***Figure 3**: Percentage change in scores from pre and post-test after 6 months of intervention per student (n=18)*

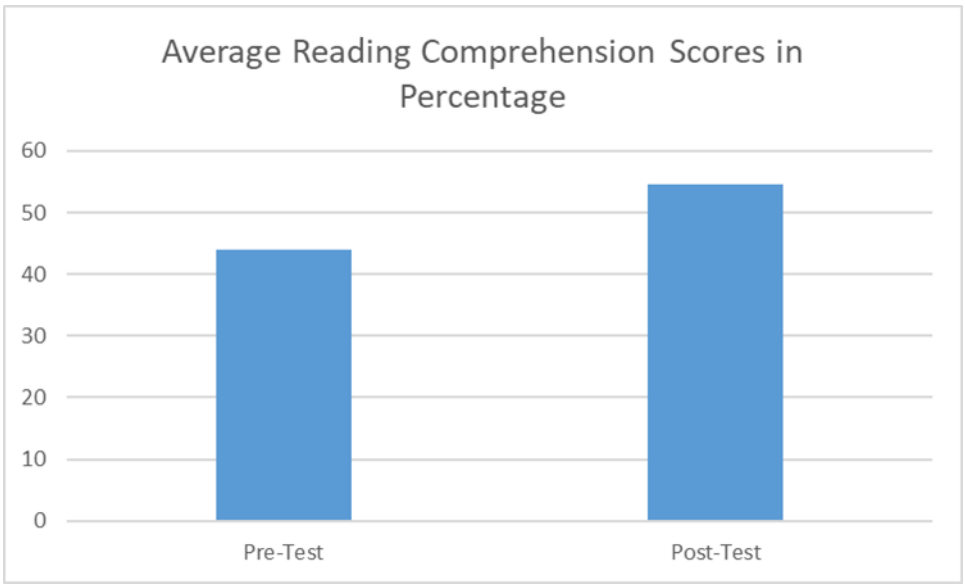

***Figure 4**: Average reading comprehension scores from pre and post-test after 6 months of intervention (n=18)*

Pre- and Post-test scores comparison for after 6 months of intervention

Dependent t-test was conducted to measure the difference between the mean reading comprehension scores in the pre-test and post-test after 6 months of intervention. The following details the values used for the test and the calculation.

Table 6. Pre and Post test scores after 6 months of intervention

	Sample Mean	**Sample Size**	**Sample Standard Deviation**
Pre-test	44.01	18	17.36
Post-test	54.58	18	19.83

The results from the pre-test (M = 44.01, SD = 17.36) and post-test (M = 54.58, SD = 19.83) reading comprehension task indicate that the intervention resulted in an improvement in reading comprehension scores, t (17) = 2.41, p = .025. The effect size, as measured by Cohen's d, was d = 0.53, indicating a moderate effect.

After 6 months of intervention, there was an average increase of 10.6% in the students' reading comprehension scores, from 44% to 54.6%.

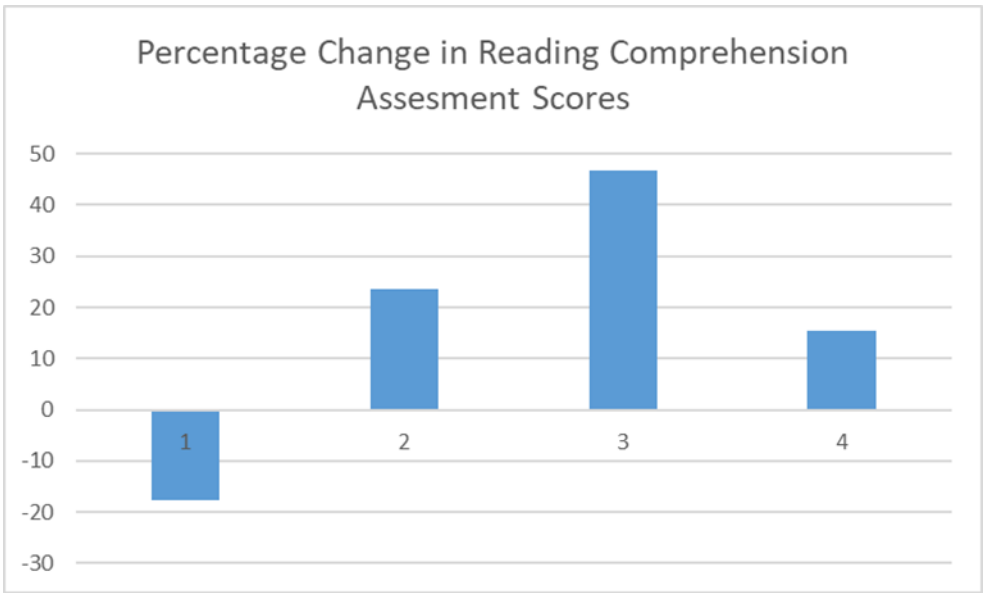

***Figure 5**: Percentage change in scores from pre and post-test after 12 months of intervention. (p=4)*

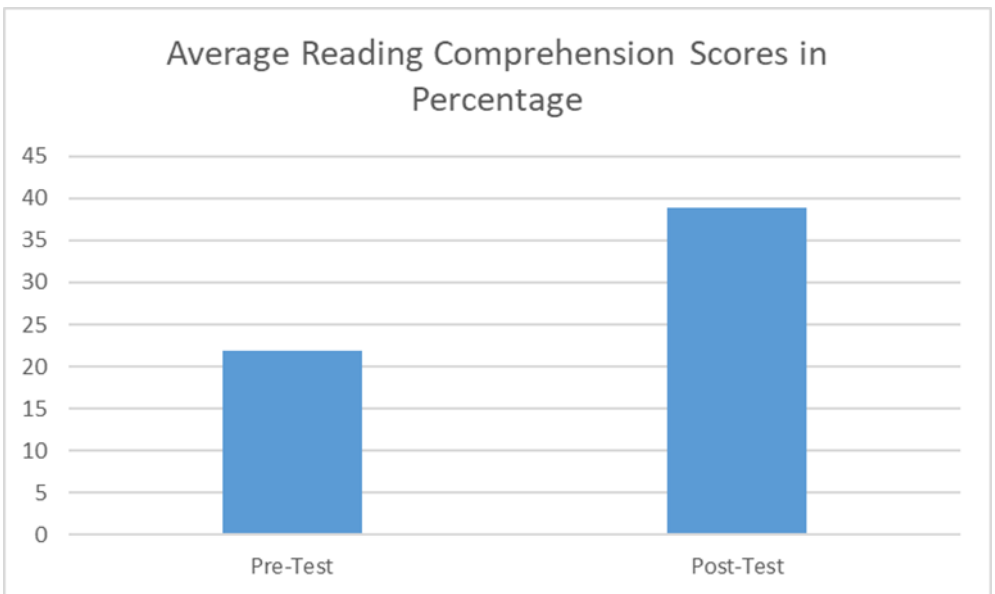

***Figure 6**: Average reading comprehension scores from pre and post-test after 12 months of intervention (p=4)*

Pre- and Post-test scores comparison for after 12 months of intervention

Table 7. Pre and Post test scores after 12 months of intervention

	Sample Mean	Sample Size	Sample Standard Deviation
Pre-test	21.95	4	19.43
Post-test	38.93	4	7.20

While the current data suggests that the students continue to show progress after 12 months of intervention, with an average increase of 16.9% in their scores, from 21.9% to 38.9%, the results from the pre-test ($M = 21.95$, $SD = 19.43$) and post-test ($M = 38.93$, $SD = 7.20$) reading comprehension task indicate that the intervention resulted in an improvement in reading comprehension scores, $t(3) = 2.41$, $p = .29$, is not significant. This is expected due to a loss of data during the height of the pandemic, coupled with the majority of secondary school students joining the programme less than a year before the study, which resulted in the amount of data collected to show the students' performance after 12 months to be low. However, the effect size as measured by Cohen's *d*, was $d = 1.05$, indicating a large effect.

Overall, the majority of students have been observed to benefit from the support in reading comprehension after a period of 6 months and 12 months. A small group of students (4) showed a regression in their scores after 6 months of intervention, and 1 after 12 months. This can be attributed to the change in level of the test, where they had to attempt the upper secondary assessment instead of the lower secondary assessment as they had progressed to upper secondary when it came to the post-test. The upper secondary assessment had a more challenging passage and set of questions.

Effect Sizes

The effect sizes of the vocabulary assessment ranged from moderate to large, which demonstrates that there has been a transference of skills taught to the students. According to the National Reading Panel, it is suggested that for vocabulary instruction to be effective, various instructional methods should be employed (National Reading Panel, 2000). This aligns with the vocabulary instruction method employed in this programme, the Marzano Approach.

Regarding reading comprehension, the effect sizes ranged from moderate to very large, based on Cohen's d, which identifies $d = 0.2$ as small, $d = 0.5$ as moderate and $d = 0.8$ as large. This shows that the intervention was likely to be effective in improving the students' reading comprehension skills. This may be attributed to the specific instruction in reading comprehension skills and question types covered in the programme,

employing the principles of the Orton-Gillingham approach to better support our learners.

Writing Evaluation

The tracking of writing progress was decided to be a continuous qualitative assessment, where students are assessed on their ability to apply the specific writing skills introduced in the term. The students' writing were analysed qualitatively at the start and at the end of the term.

Case Study:

This case study looks at the written work of secondary school students, who were being taught the structure and features of introduction paragraphs for expository essays for the term. At the beginning of the term, students were observed to start their essays by immediately answering the essay question instead of starting with a general statement which provides context to the essay. Some were also observed to not define the keywords in the essay question.

Student A:

Essay Question	**Students benefit from Co-Curricular Activities. Do you agree?**
Introduction Paragraph (Before)	**Yes I agree. During co-curricular hours students not only get to learn life-skills, they also get to learn character building and bonding with their CCA mates, and allows them to build teamwork.**
Essay Question	**Some people like to stand out from the crowd; others just want to be part of it. Which do you prefer and why?**
Introduction Paragraph (After)	**Some people like to stand out from the crowd while others would prefer to fit in. To stand out is to be different from everyone else and to fit in is to be the same. For me, I would personally sit on the fence. If I am in a situation where I am with people I don't like, I would prefer to stand out from the crowd out of spite.**

Legend
General Statement | **Definition of Keywords** | **Statement of Position** | **Points**

At the beginning of the term, Student A immediately answers the essay question and follows up with her points for her introduction paragraph. After a term of instruction, she was able to produce an introduction paragraph that provides context, defines the keywords, states her opinion, and lists her points, which is characteristic of what a typical introduction paragraph should be.

Student B:

Essay Question	**Students benefit from Co-Curricular Activities. Do you agree?**
Introduction Paragraph (Before)	**As a student, I agree that students benefit from co-curricular activities (CCA). Ever since primary 2 began, students were required to participate in a CCA that interested them.**
Essay Question	**Students benefit from Co-Curricular Activities. Do you agree?**
Introduction Paragraph (After)	**Co-curricular activities (CCAs) are often conducted on a weekly basis. Students are encouraged to take a skill to follow them throughout their school journey. I agree that students benefit from CCAs as time is allocated for students to master a skill, they can find themselves fostering communication skills, and self-growth.**

Legend
General Statement | **Definition of Keywords** | **Statement of Position** | **Points**

For Student B, she also initially immediately answered the essay question first, then provided context, but did not define the keywords. At the end of the term, she was able to write an introduction paragraph that also had the necessary components, which shows that she had a better grasp of the structure and features of the introduction paragraph.

Student C:

Essay Question	**Students benefit from Co-Curricular Activities. Do you agree?**
Introduction Paragraph (Before)	**I agree that students benefit from co-curricular activities. Co-curricular activities of CCA is important in a student's life as it contributes the most of the life of a student when he or she grows up to be an adult, such lessons include learning life-skills, character building and learning how to work as a team. Without co-curricular activities, students would grow up not knowing the importance of these lessons which can be detrimental to their lives when they start being part of the workforce.**

Essay Question	**Some parents say that teenagers' use of smartphones and other electronic gadgets is spoiling family life. What are your views?**
Introduction Paragraph (After)	**Smartphones and electronic gadgets have been around for more than 15 years becoming part of our daily lives. Electronic gadgets come in the form of handphones, tablets, laptops or desktops they are used in communication or entertainment this being a huge thing for teens. Although smartphones and electronic gadgets may be a need for most people some may think otherwise and find it a waste of one's life, degrading the use of these gadgets to merely playing games and nothing else. I find that using smartphones or electronic devices does not spoil family life, if used in moderation. Smartphones can be used to stay in touch with family members despite hectic schedules, not only that but can also increase social interaction online. Lastly, electronic devices can increase creative skills when used correctly for teens.**

Legend
General Statement | **Definition of Keywords** | **Statement of Position** | **Points**

At the beginning, Student C also showed the same tendency as Students A and B, to start by immediately answering the essay question. He then proceeded to list his points and explained them a little instead of giving the context and explaining the keywords in the question. At the end of the term, he was also able to follow the structure of an introduction paragraph and include the necessary components.

iReaCH™ Online- Progress and Feedback

iReaCH™ switched to a fully online programme with effect from Term 3, 2022 and this was also the period where the evaluation of the programme was conducted.

One of the main considerations for the programme to pivot online is to facilitate the placements of students into suitable classes in a timely and efficient manner, thereby, allowing more students to receive intervention sooner rather than later, without distance being a barrier. Secondly, online delivery has made the conduct of lessons more flexible and convenient for most students including those with hectic schedules or logistical constraints. Thirdly, the Educational Therapists and most of the students have experienced online delivery during the circuit breaker period. Some positive feedback was received with regard to the conduct of online classes.

In order to ensure a smooth transition to a fully online programme, support and implementation steps were put in place to assist the Educational Therapists, parents and students from Week 3 Term 1 till the end of Term 2, 2022. During this transition period, preparations and arrangements were made including converting resources and teaching materials to online format, sorting out administrative matters and requests for devices i.e. laptops.

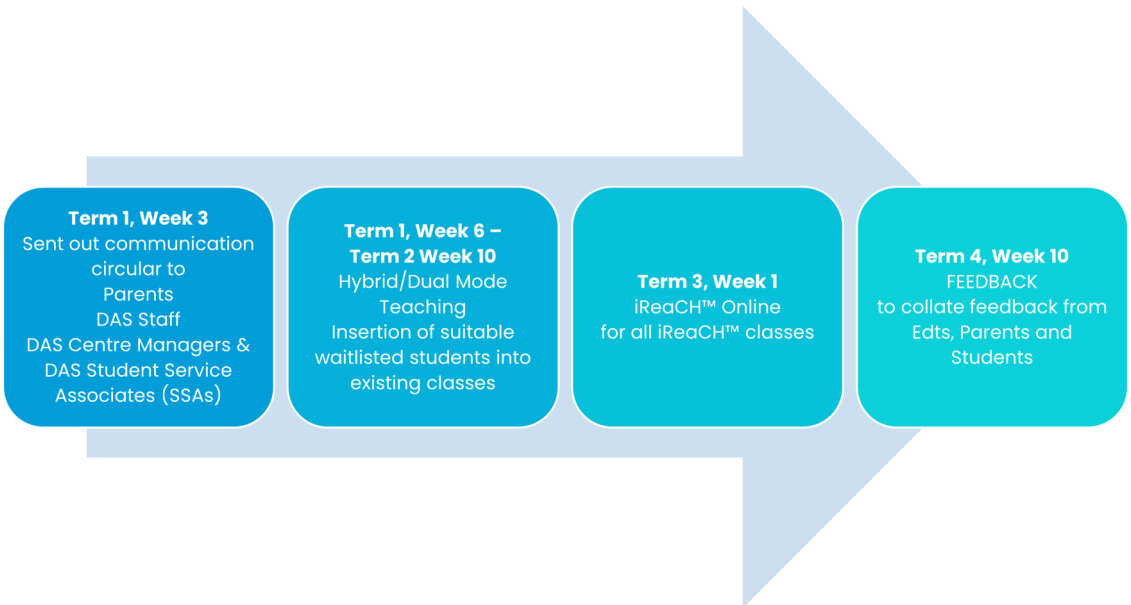

Figure 7: *Timeline of Implementation for iReaCH™ Online Delivery*

Positive feedback received for iReaCH™ online:

- Most parents and students find it convenient to access the lessons (no need to travel)
- The Educational Therapists feel they can focus more on higher order skills
- Insertion of students is much easier for placements or for unforeseen circumstances (e.g. hospitalisation leave (HL) of Educational Therapists), minimising disruption thereby, allowing for the continuity of lessons

Parent Survey on iReaCH™ - programme and online delivery

A detailed feedback is obtained through surveys that were rolled out to both parents and students to find out about their reception to the iReaCH™ programme and the online delivery mode. Parents and students alike were asked questions on their satisfaction levels with the programme, the switch to online delivery, what they liked about the programme, and their opinion on the effectiveness of the programme in building confidence in the English language, and the areas they felt they benefited from. Despite reminders, only a total of 5 parents responded to the online survey about the programme.

All parents surveyed were satisfied with the programme and the switch to online learning, with the majority being extremely satisfied.

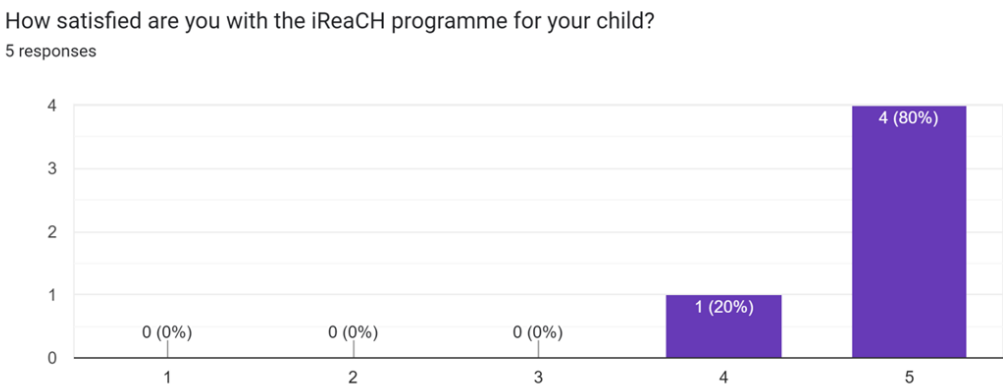

***Figure 8**: Parents' satisfaction levels with the programme (1 - Least satisfied, 5 - Most Satisfied). (n=5)*

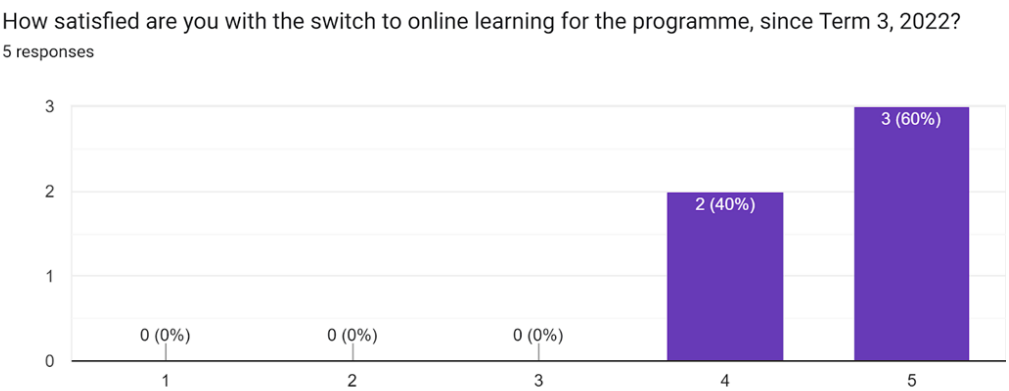

***Figure 9**: Parents' satisfaction levels with the switch to online learning (1 - Least satisfied, 5 - Most Satisfied). (n=5)*

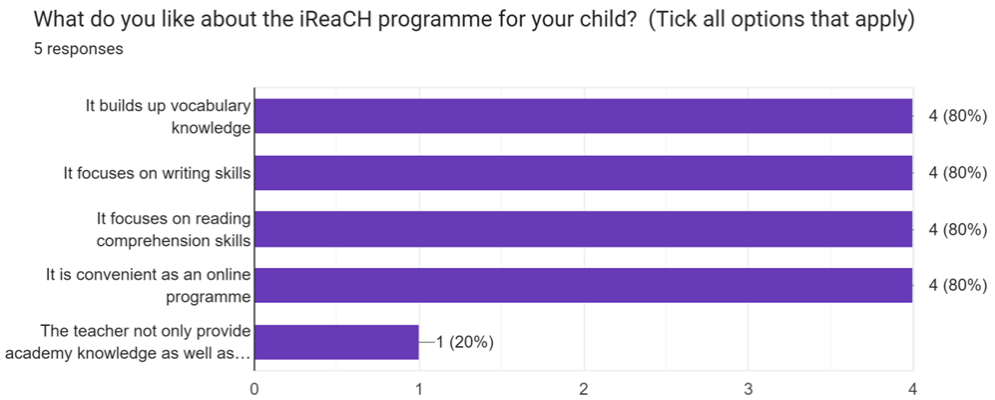

***Figure 10**: Characteristics of the programme that parents liked. (n=5)*

The parents surveyed like that the iReaCH™ programme focuses on the higher order skills of reading comprehension and writing, vocabulary building, and also it being an online programme, which is also reflected in their response in Figure 10. Additionally, one parent gave feedback that the teacher not only provided academic knowledge, but also guided their child in their future educational path.

Student Survey on iReaCH™ - programme and online delivery

Additionally, a survey was rolled out to students in Week 5, Term 4, 2022 to obtain their feedback on online delivery and the support received on iReaCH™. A total of 26 students completed the survey. The following graphs show the quantitative responses for 2 of the survey items rated by the students.

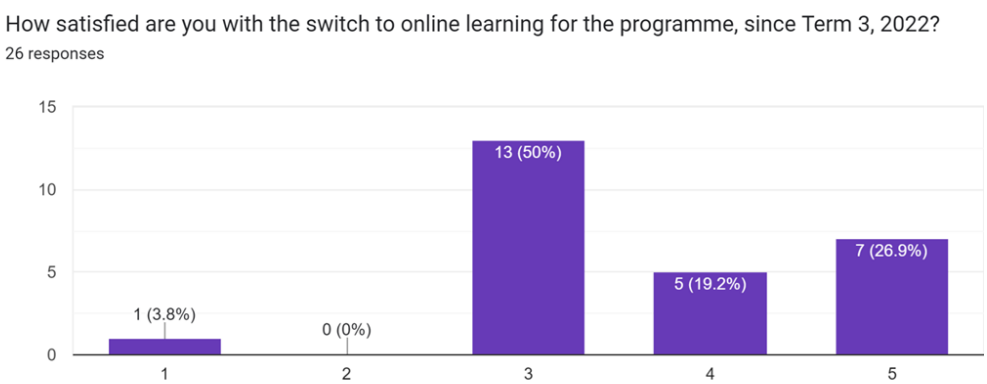

***Figure 11**: Students' satisfaction levels with the switch to online learning (1 - Least satisfied, 5 - Most Satisfied). (n=26)*

Almost all students had neutral (score of 3) or positive (scores 4 and 5) reactions to the switch from face-to-face classes to online learning. As an online programme, students benefit from the convenience of learning from home, eliminating the need to travel down to the learning centres. It is unavoidable that there would be some students who prefer face-to-face classes since each student has their preferred mode of learning, which explains the 1 student who was least satisfied (score of 1) of the change in the mode of delivery.

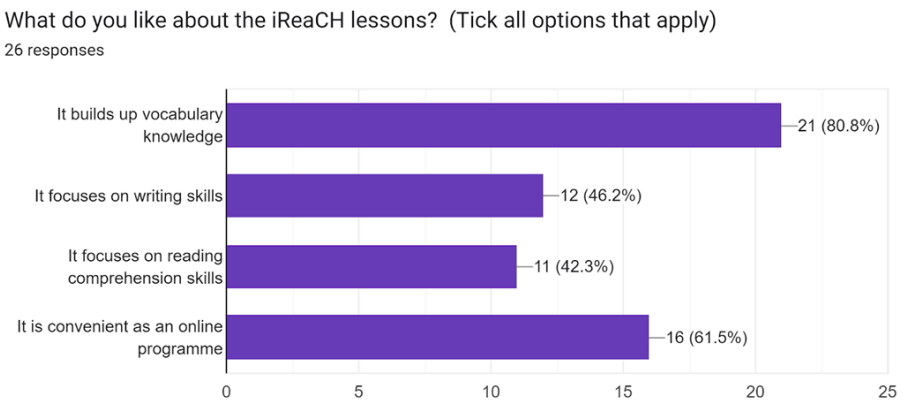

***Figure 12**: Characteristics of the programme that students liked. (n=26)*

Out of the 4 characteristics of the programme, (Figure 12) the students surveyed liked that it helped build up their vocabulary knowledge, followed by its convenience as an online programme, which is corroborated by the data in Figure 11, where almost all students were neutral or satisfied with the switch to the online mode of delivery.

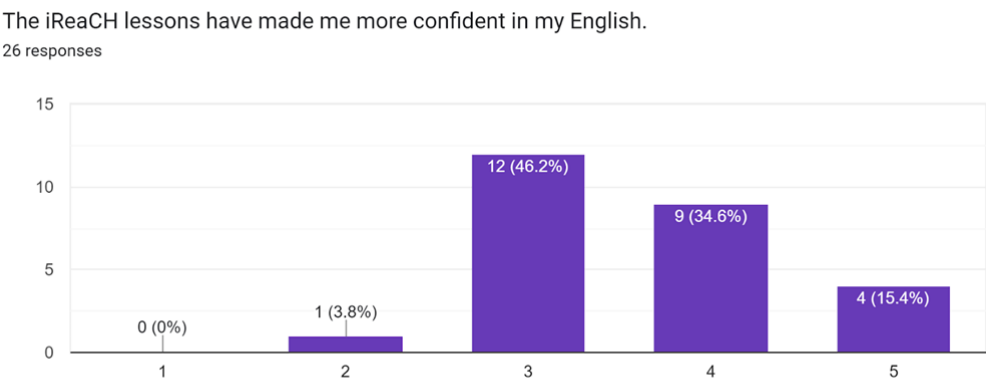

***Figure 13**: Students' opinion of their confidence level in English after attending the programme. (1 - Strongly Disagree, 5 - Strongly Agree). (n=26)*

Half of the students surveyed agreed (score of 4 or 5) that the iReaCH™ lessons have made them more confident in their use of the English language (Figure 13). 12 students had a neutral answer, with 1 student disagreeing.

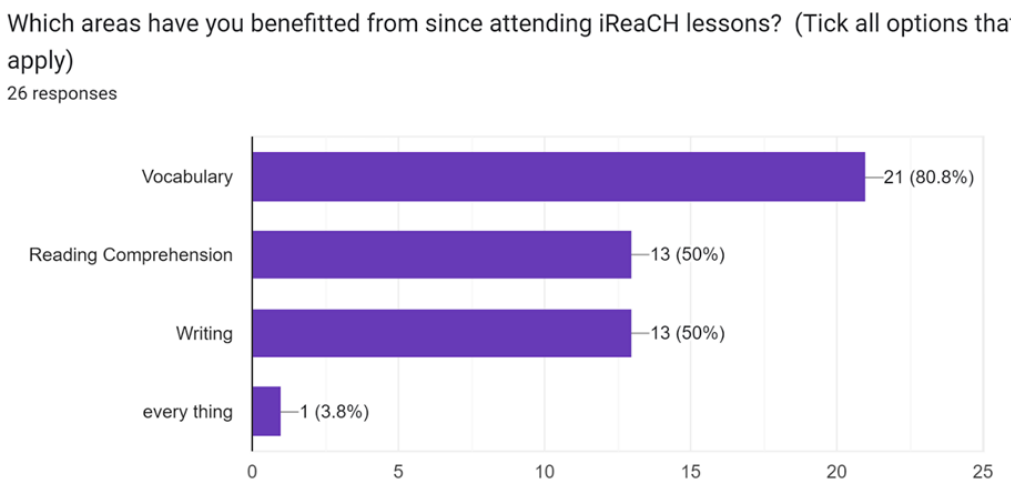

***Figure 14**: Areas where students felt they have benefitted in since attending the programme. Students can pick more than one option. (n=26)*

The survey shows that most students felt they benefited in vocabulary knowledge through the programme. This result corresponds well with the data in Figure 14, where the same number of students also indicated that they liked the vocabulary aspect of the programme. Both reading comprehension and writing shared equal weightage, and 1 student felt he benefited from the programme in all aspects.

Testimonial from Parents

> *Parent feels that the iReaCH™ [programme] has improved her child's vocabulary as she is being introduced to new words. Parent also feels that the child is being challenged every lesson, with tips and strategies to help with her writing skills.*
>
> *Parent shared that her child has made great improvement in school. She also received positive feedback from her Main Literacy Programme (MLP) Educational Therapist that she has improved in her writing behaviour, i.e. she is more keen on attempting writing tasks, as compared to before joining iReaCH™.*
>
> *All thanks to you and DAS for giving her help and confidence. She scored A2 for her English.*

Testimonials from iReaCH™ Educational Therapists

Student D is a very conscientious student who works independently and takes pride in his work. He focuses in class and willingly participates in group discussion. He also adds value to the lessons with his unique ideas and thoughts. Furthermore, he offers more direct responses to his reading experiences supported by reasons, examples, and details. He also shows tremendous improvements in grasping and applying the vocabulary learnt in lessons during his Reading Comprehension and writing tasks. Though he needed guidance occasionally, he is a very independent learner and is able to complete his work with confidence.

Student E has a good range of vocabulary. She is able to give definitions or explain the meaning of some words in her own words and is able to include the vocabulary taught in her writing. She is now also able to come up with synonyms and antonyms related to the vocabulary learnt and has a better understanding of word forms. With exposure to pre-writing activities such as brainstorming and discussions over articles and videos, she is able to generate more content into her writing, creating a cohesive and coherent piece. As for reading comprehension, she has shown improvements in identifying words with connotative meaning, personification and the use of literary devices. She is showing improvements in interpreting the meaning of these figurative languages in comprehension passages.

DISCUSSION

The findings are positive overall, with data from the National Panel (2000) indicating how difficult it can be to achieve significant results or positive effect sizes. The programme, which is delivered online and uses progress monitoring and educational technology to facilitate the lessons and cater to the individual needs of the students, is effective in helping students achieve better vocabulary, reading comprehension, and writing outcomes due to its focus on these skills.

In terms of the mode of delivery, while there are advantages to switching iReaCH™ to a fully online programme (ease of access to lessons and faster placement of students since location is not a factor), it also comes with some challenges:

- unsuitability for online delivery, especially students with more severe needs and/or attention issues.

- unfamiliarity with online lesson platforms: some students are unfamiliar with or take a longer time to use and be well acquainted with the online lesson platforms - e.g. Google Docs, Jamboard. The Educational Therapists would need to allocate more time and assist with familiarising their students over time.

- Students may experience online lesson fatigue by the 2nd hour.

- Some students access their lessons on their smartphones and/or tend to open multiple browser tabs despite the Educational Therapists' reminders to students and parents.

These challenges are reflective of the survey results on student satisfaction of the switch to online learning (Figure 11). As concluded by Doggett (2008), student attitudes towards online learning is crucial to their participation in the lessons. With the switch to online delivery, parental involvement and support is critical in ensuring that their child focuses and pays attention during their online lessons. The ease of use of the online lesson platform and engagement is also important to ensure participation in the online lessons (Kori et al., 2016), and this is achieved by using familiar online platforms (Google Meet) and quizzes (Kahoot!, Blooket) during lessons to constantly engage the students. The iReaCH™ team is also exploring ways to better support the Educational Therapists with online delivery as well as mitigate some of the issues experienced with online lessons. As for students who require intervention but are not suitable for online lessons, the team is exploring the idea of having face-to-face lessons as an option for students who are more suited to an in-person delivery.

Additionally, the study shows that even in an online setting, the use of Marzano's six step process to vocabulary instruction can be adopted and is effective in improving vocabulary knowledge outcomes of students.

CONCLUSION

The results showed that, despite the mode of delivery, the majority of students have not only shown gains in their vocabulary acquisition but also in applying the relevant skills taught to their reading comprehension and writing tasks over a duration of at least six months to one year on the programme. Moderate to large effect sizes in vocabulary and reading comprehension further highlight the positive impact of the intervention and also suggest that the teaching approaches and pedagogy used in the iReaCH™ programme have been effective in providing higher order literacy intervention to learners with dyslexia.

LIMITATIONS

This research is not without its limitations. The sample size is small, especially when analysing the reading comprehension scores of students over a period of 12 months. There was no statistical significance in the improvement of test scores for the reading comprehension task after 12 months of intervention, which could be attributed to the adjustment of the difficulty level of text as students progressed from lower secondary to upper secondary, and also the changing of some questions in the test in an attempt to reduce the practice effect. For writing, there was no summative assessment which meant that only a qualitative analysis of sample students' writing could be done to reflect their progress.

FUTURE RESEARCH

The evaluation yields some insights into future and further enhancement of the resources, assessment materials as well as teaching and learning pedagogy, to better facilitate online delivery and increase student engagement and participation. The resources will be enhanced to cover more breadth and depth for the various components, which will help students to be better equipped in tackling the academic challenges they face in schools. In terms of assessments, the separation between upper and lower secondary levels for reading comprehension will be streamlined so that the students will be assessed on the same reading level for the pre- and post- tests even when they progress from lower to upper secondary levels.

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