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Assistive Technology Implementation in the Mainstream Classroom to Support Students with Learning Difficulties

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ABSTRACT

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The current redevelopment of the Irish primary curriculum supports the principles of the Universal Design for Learning, facilitating accessibility, and equal opportunities for engagement and expression for all students. Universal Design for Learning is about leveraging technology in the curriculum to foster a truly inclusive learning environment. A lack of AT implementation and utilisation in mainstream schools has been identified in Ireland. A teacher survey identified the lack of assistive technology utilisation in a primary school in Ireland. This study aims to determine how assistive technology can be implemented in this mainstream classroom to support students with learning difficulties. Specifically, it explores the training, planning and utilisation of assistive technology for students with literacy needs. It aims to analyse these aspects of implementation, as well as the benefits, challenges and barriers to implementation to support this school in implementing an action plan for assistive technology for students with special educational needs.

An action research was carried out in this mainstream primary school, where 10 students with learning difficulties and their 5 class teachers were involved in an assistive technology implementation trial. The teacher-researcher practiced autoethnography by reflecting on the assistive technology training and observations in the classrooms. Semi-structured interviews were conducted with the 5 teachers and surveys were administered to the 10 students, using thematic and cross-tabulation analyses.

The results suggest that assistive technology can be implemented in the mainstream classroom to benefit students with learning difficulties when relevant student and teacher training is given on the utilisation and planning of assistive technology. The study indicates the importance of teacher and student reflection in identifying the challenges and barriers of implementation. The study concludes with the significance of addressing and communicating educators' and students' feelings and recommendations about assistive technology for effective implementation.

Confidential information in relation to the school, staff and students has been removed from this thesis.

Key words: assistive technology, learning difficulties, education

CONTENTS

ABBREVIATIONS

AT	Assistive Technology
LD	Learning Difficulties
SEN	Special Educational Needs
UDL	Universal Design for Learning

1 INTRODUCTION

If you were hosting a dinner party, would you prepare and serve chicken enchiladas to your dinner guests, who have various nutritional preferences and allergies? Enchiladas are a Mexican dish, made up of flour tortillas filled with meat and topped with cheese. One guest is on a dairy-free diet, therefore, they would be unable to eat the cheese, the other is a vegetarian, therefore, they would be unable to eat the chicken and the other has a gluten intolerance, therefore, they would be unable to eat the wheat wraps.

Novak (2014) cleverly compares preparing and hosting a dinner party to the planning and teaching of a lesson in the classroom. Novak (2014) suggests that if we were to serve dinner like this, we would more than likely end up running around the kitchen trying to make something that each guest could eat, or possibly finding our guests eating around what they could eat. Novak (2014) explains that in this situation, not all guests would get the same wholesome meal, and experience. It would be more time-effective and favourable for a host to plan a meal which all guests can take from it what they need, like a “make your own” tortillas, where you would have a variety of fillings and toppings, and types of wraps to suit all. If we would not serve our guest who is vegetarian meat, that she is unable to eat, why would we give a student with a learning difficulty an assignment that s/he is unable to digest?

We would not leave our dinner guests starving for their dinner, so why are we leaving our students starving for their education?

1.1 Background

There was an inclusion movement in the Irish education, which was described as the “one size fits all” curriculum (Reynor, 2020). This movement focused on the ‘integration’ of students with special needs into the mainstream classroom. Pupils regardless of their additional needs were expected to ‘fit in’, subjecting students to the same teaching styles and evaluation methods. In the 1980s, the discourse of social justice and human rights brought a change in the Irish education system; an emphasis on making the student ‘fit’ into the environment, changed to changing the environment to fit the needs of the student. Reynor (2020) argues that

Ireland is slow to restructure the curriculum, and the needs of students with special educational needs (SEN) are not being met in mainstream schools. A consistent inclusive model for all mainstream schools in Ireland has yet to be achieved in the Irish education system, resulting in the inability of schools to wholly foster inclusive learning environments for their students.

The National Council for Curriculum and Assessment (2020), states that the redevelopment of the Irish primary curriculum will support schools with the creation of inclusive teaching and learning environments, using the Universal Design for Learning principles (CAST, 2018), which supports students in curriculum accessibility, and opportunities for engagement and expression.

This study will take place in a mainstream Irish primary school, where both students with and without special educational needs (SEN) are in attendance and are subjected to this "one size fits all" curriculum.

1.2 Research Question

With the need for a change of environment to fit students' needs, this thesis evaluates the efficacy of Assistive Technology (AT) for children with learning difficulties (LD) in mainstream education in Ireland. The research question is "*How can AT be implemented in the mainstream classroom to support the needs of students with LD*?"

1.3 Terms

This study will use the term 'Assistive technology'. The National Council for Special Education (NCSE) in Ireland, describes Assistive Technology (AT) as "any device or system that helps to improve the functional capability of people with disabilities". The NSCE also states how broad AT is, ranging from 'low-tech' to 'high-tech' (2021).

This thesis will focus on 'high-tech' AT, in particular, the iPad; its features, accessibility features, and applications. The AT will give students with LD the opportunity to use text-to-speech, speech-to-text, screen readers, word processing, and word prediction; all of which are defined as 'high-tech' AT (SDDL, 2008). Taylor, Lohmann and Kappel (2020) state that high-tech assistive technology is

computer-based, and needs technical knowledge to efficiently train the users to adequately access the device.
AT is different from instructional technology, as instructional design focuses on the design and delivery of instructions for students, whereas AT can enable students to access the curriculum and participate in classroom activities (Atanga et al., 2020).

This research will also use the term ‘Learning Difficulties’. It will be focusing on students with learning difficulties and who have challenges with their literacy. These students are considered as ‘high incidence special needs’. High incidence special needs are additional needs that frequently occur in the broad population, such as borderline general disability and dyslexia (Flood, 2013). Dyslexia is a learning difficulty that affects the learner’s fluency and accuracy in reading and spelling (Dyslexia Association of Ireland, 2019). GoodTherapy (2021) explains that learning difficulties do not indicate the intelligence level of students; they actually indicate the need for alternative teaching and learning methods and are a result of cultural and environmental disadvantages. GoodTherapy (2021) also states that Learning difficulties are very different from intellectual disabilities. The World Health Organisation (WHO) (2021) defines an intellectual disability as, “a significantly reduced ability to understand new or complex information and to learn and apply new skills (impaired intelligence)”.Students with literacy learning difficulties have challenges with word decoding, reading accuracy, reading fluency, reading comprehension, spelling, handwriting, organisation of written work, and self-confidence (NCSE, 2021).

1.4 Purpose of Study

There has been research conducted worldwide on AT utilisation for students with LD. Research has been carried out in various countries, including Ireland on AT implementation, the effectiveness of AT, AT benefits, the challenges of AT, and the barriers of AT implementation. A study by the National Council for Special Education in Ireland drew on the knowledge, experiences from AT experts in Ireland and various countries around the world; the United States, the United Kingdom, Denmark, Norway, Italy, and New Zealand. This study by Wynne et al. (2016) compiled an evidence summary for the best AT practice in Ireland and

internationally. Although the compilation of these guidelines and principles is very informative and useful, there is a considerable gap in the Irish educational system for more research on using AT for children with LD in the mainstream classroom. The process of school self-evaluation is encouraged in Irish schools, it motivates both pupils and teachers to become active participants and learners in advancing a culture of improvement and innovation in learning and teaching (Department of Education and Skills, 2016).

The school where this research is being carried out is one of the many schools in Ireland that has yet to implement the use of AT for students with LD. In the school where the study takes place, 76 students have learning difficulties, with 35 of these students presenting with severe literacy learning difficulties. Although these students are withdrawn from their classrooms for literacy support on a daily basis for half-hour slots by the special education team, the majority of their day is spent in the mainstream classroom. These students struggle to participate in the classroom due to their academic limitations and suffer from low self-esteem from recurring failures due to their lack of control of their learning environment (Pandy, 2012).

In Ireland, there is little use of AT in mainstream schools, resulting in this student suffering. Students struggle with their literacy, therefore they find accessing and participating in all subject areas difficult. The Department of Education and Skills (2011-2020) states the importance of literacy skills in a person's life as we use basic literacy skills throughout our daily lives. The Department of Education and Skills expresses that without literacy skills, a young person or adult is isolated from many aspects of life in and out of the classroom.

Atanga et al. (2020) also state the importance of literacy, explaining how literacy skills enable a person to actively participate in his/her environment. AT is the tool and resource that gives students with learning disabilities the opportunity to participate in literacy tasks, both in and out of the classroom. The lack of AT implementation in Irish education is the cause of absent AT school guidelines which would address the eligibility criteria, school responsibilities, and the training and monitoring of AT (Cullen et al., 2012).

Cullen et al. (2012) encourage educators with an interest in AT to share their knowledge, and experience of AT to raise awareness of AT in the mainstream classroom. The purpose of this thesis is to help raise this awareness of AT use with children with LD in mainstream schools in Ireland, through sharing the knowledge, experiences, results, and recommendations from this study. The goal of this thesis is to find out if and how AT can be successfully implemented into the mainstream primary classroom to support literacy for children with LD.

The Education Act 1998 is one of the pieces of legislation in Ireland that supports the actions of provision for assistive technology (Cullen et al., 2012). In Section 21 (2), this act states that schools should have objectives and show their action plan in ensuring equality of access to and participation in the school environment by students with learning difficulties (Cullen et al., 2012).

At present, no objectives or an action plan have been devised for this school. The objective of the present research will inform this action plan in relation to training, planning, and identifying the challenges and barriers of AT implementation in this school. The study will also communicate the participants' reservations and optimisms of AT, and identify the recommendations for future studies in AT implementation in this school. There was a widespread agreement that assessment of AT should include a trial period of AT usage that observes students with and without AT. These AT trials are needed in Irish schools to collect data on AT provision (Wynne et al., 2016). This study not only informs and supports AT implementation in this school, but it could also support the National Council for Curriculum and Assessment, and the Department of Education with the planning of the renewed Irish primary curriculum, and the development of teaching training programmes.

1.5 Structure of Thesis

This thesis contains 5 chapters. Chapter one introduces the topic of AT utilisation for students with LD, outlines the thesis questions, and explains terms, the context, and purpose of the research along with the methods chosen. In Chapter 2, the Theoretical Framework discusses the many areas around the topic of AT: Irish and international legislation, implementation, best practice, principles, and

guidelines for AT utilisation from Ireland and countries around the world, the benefits of AT, and the barriers of AT. Chapter 2 will also discuss the Universal Design for Learning (UDL) framework, Gardner's theory on Multiple Intelligences, Bruner's theory on Discovery Learning, and Vygotsky's Constructivist theory and Zone of Proximal Development with AT implementation, along with the Active Learning Approach.

Chapter 3 introduces the methodology and clarifies data collection using quantitative and qualitative research methods. Chapter 4 will present the results. The thesis will conclude in the fifth chapter, discuss findings and provide recommendations for the school. Chapter 5 will also state the limitations of the study, as well as suggestions for further research.

2 LITERATURE REVIEW

The theoretical framework will discuss the history of SEN in Ireland, the Universal Design for Learning framework, learning theories related to AT implementation, and various researches conducted worldwide on AT implementation, which shows several structures for AT implementation, the challenges and barriers of implementation, as well as the benefits of AT.

2.1 History of Special Educational Needs

According to Kenny, McCoy and Mitiut (2020), Ireland has had a complex history in relation to special educational needs and inclusive education. Ireland has only recently enacted Irish legislation for SEN and inclusive education in the late 1990s, therefore Ireland is actually quite new to the inclusion of students with SEN, in comparison to other countries (Reynor, 2020). There has been a vital policy shift in the last two decades, and Ireland is slowly transitioning from the use of special schools and special classes to the use of the inclusive school model (Reynor, 2020).

The Education Act 1998, The Education Persons with Special Educational Needs Act 2004 (EPSEN), the Equal Status Act 2000-2018, and the Disability Act 2005 are the most pertinent pieces of legislation where the actions in the provision of assistive technology in education are supported (Cullen et al., 2012). The Education Act 1998 states in section 6 (c) that Irish schools must “promote equality of access to and participation in education” (Education Act, 1998). The EPSEN (2004), clearly states, “A child with special educational needs shall be educated in an inclusive environment with children who do not have such needs”. The Equal Status Act 2000-2018, proclaims that all educational establishments must provide services that accommodate students with learning disabilities. This act allows for positive action to be taken to promote equality of educational opportunities and to cater for students with SEN by implementing any necessary services, resources, arrangements, or assistance (The Irish Human Rights and Equality Commission, 2018). The United Nations Educational, Scientific and Cultural Organisation’s (UNESCO), Salamanca Statement and Framework for Special Educational Needs was extremely influential internationally. This framework

encouraged many countries worldwide to recognise and react to the diverse needs of their people, and to consider inclusive education for students with disabilities (Reynor, 2020). On account of national and international legislation, Ireland has seen greater numbers of students with SEN in attendance in mainstream schools. This rise of numbers of students with learning disabilities means that Irish schools now have to progress from the integration of students with SEN to truly inclusive learning environments (Reynor, 2020), and as a result, the National Council for Curriculum and Assessment are currently reviewing the Irish school curriculum and planning around the principles of the Universal Design for Learning Framework (NCCA, 2020).

2.2 The Universal Design for Learning (UDL)

UDL is a set of principles for curriculum design that guides educators in creating equal opportunities for students with LD (AHEAD, 2017). UDL came from the architectural idea of universal design by Ron Mace, an architect, product designer, and educator. He promoted designs of environments and the products within these environments that would meet the diverse needs of people. Due to the work of Ron Mace, many educational institutions embraced educational inclusion by encouraging the physical access to environments and resources for all students, regardless of their disability. However, physical access alone did not guarantee inclusive environments, therefore in 1984, Center for Applied Special Technology (CAST) was founded and they created UDL. CAST is known for its work on innovative technology-based strategies and resources. CAST created the UDL framework based on the concept of universal design, and the work of Lev Vygotsky, his prerequisites for learning; affective network, recognition network, and strategic network. In general, human brains share these network operations, however, individual brains have alternative ways of receiving and processing information (Ocali, n.d.). UDL promotes the following principles during lesson planning; multiple means of engagement, multiple means of representation, and multiple means of action/expression to encourage the accommodation of various needs (AHEAD, 2017).

2.3 Learning Theories

Lev Vygotsky, a constructivist theorist explains that a student is motivated to learn when s/he has control over their learning and constructs their own unique learning environment, and AT is what motivates and allows students with LD to construct their own learning (Merrill, 2007). In order for the student to develop autonomy, the teacher must take on the role of the scaffolder, and scaffold the students towards independence (Masouleh & Jooneghani, 2012). Instructional scaffolding is an effective teaching strategy in students work with the teacher to reach their goals.

Vygotsky's social constructivist theory emphasises the importance of co-construction of knowledge in improving educational outcomes. Vygotsky states that children realise their full potential with the support of adults (Davis, 2011). Vygotsky proposed the zone of proximal development (ZPD), where learning takes place for a child with support from an adult. The ZPD is between what a student cannot do and what a student can do independently. Vygotsky's concept of scaffolding is divided into three areas; the child cannot do, the child can do with teacher assistance, the child can do independently (Davis, 2011). Davis (2011) states the many barriers students with LD face on a daily basis; cognitive, physical, and communication limitations. AT integration is needed for these students, particularly participation with AT in literacy activities. Educators must encourage active participation from students by encouraging and giving opportunities for multiple attempts of AT utilisation, giving demonstrations of AT use to improve students' use of AT and practice scaffolding by a gradual release of supports to ensure the independent use of AT (Davis, 2011).

Active learning is an important teaching strategy in education as knowledge is the amassing of experiences constructed by students through learning experiences (Pardjono, 2016). As implied in Vygotsky's ZPD, and in the active learning approach, regardless of the amount of assistance a student needs, educators must encourage active participation in AT utilisation in the learning environment to support students with LD with engagement in lesson tasks (Davis, 2011). Research by Freund (1990), concluded that children who engage in guided active learning

with ZPD with an adult-led to greater comprehension and performance in a task than working alone (McLeod, 2020).

FIGURE 1. Zone of Proximal Development and scaffolding

Gardner's theory of Multiple Intelligences guides the UDL learning principles. Howard Gardner's theory acknowledges that we all learn differently; that each learner has his/her strengths and challenges. Gardner was influential in presenting the role of intelligence in learning. The multiple intelligences include linguistic, logical-mathematical, bodily-kinesthetic, interpersonal, intrapersonal, visual/spatial, musical, and naturalist, and AT is an appreciable tool and resource to present and show learning in various ways that meet the needs of all types of learners (Nicol, 2014). Gardner's role of intelligence in learning principles is that learners should be supported in using their preferred intelligence in learning, learning should interest all intelligences and numerous methods of assessment should be encouraged (Merrill, 2007). Constructivism includes the multiple intelligences theory. When a student with LD uses AT, barriers to learning are removed, and the student is given an alternative way to learn and present their learning, which ultimately gives them control over their assignments, and empowers them to construct their own learning (Harwood, 2007). Harwood (2007), states that there is an evident parallel between Constructivist paradigms and AT utilisation in the

mainstream classroom by students with LD. In a constructivist classroom, a teacher must become the facilitator in the students' learning, organising the learning environment, the AT and to ensure student engagement and exploration in their learning (Harwood, 2007).

Jerome Bruner's theory, Discovery Learning, is also connected to AT utilisation, as students learn by discovering information in environments set up by educators. Bruner's principles are that instruction must involve active experience and be contextual as this motivates students to learn (Merrill, 2007). AT utilisation results in student motivation and ability to learn.

2.4 Implementation Steps of Assistive Technology

The Iris Center (2021) have researched AT implementation and encourage the use of the following steps to successfully implement AT in the classroom:

1. **Considering AT Planning**

   The school's special educational team (SET) should review a child's individual educational plan/Student support file, their needs, and targets, to determine whether the child requires AT and/or to choose appropriate AT for the student.

   The students' needs must be assessed by the SET. One person on the SET must be knowledgeable about AT and trained in various types of AT devices, software and applications. The creation of the IEP/Student support file (SSF) and its AT targets is a collaborative task, which includes the SET, class teacher, parents, and any outside agencies, ie. educational psychologist to ensure the organisation of appropriate school environments and the delivery of effective interventions (NCSE, 2006).

2. **Implementing AT**

   When the type of AT for the student is decided, a plan to help guide the AT and delivery of AT is needed. This plan is drawn up by the AT implementation team in a school. The AT implementation team is a sub-group of the SET team. An AT implementation plan should contain the following; Member roles and responsibilities, AT devices and services which will be

utilised, classroom and home implementation, and training on AT for teachers, students, and parents.

When the AT plan is completed, the student and teacher should receive training in AT devices. The student should use the device for academic content which s/he is familiar with, as learning new content and new AT concurrently can be challenging (The IRIS Center, 2021). The analysis suggests that it is important to start small with the implementation training content (Depiereux, 2018).

3. **Evaluating the effectiveness of AT**

   When the AT is implemented the AT implementation team should gather information from the teachers to realise the effectiveness of the AT. This information should be collected from teachers through teacher observation, student feedback, and data performance. This will inform the AT implementation team and teacher if the student is able to use the AT, is engaged in the learning process, is enjoying the learning experience, and is completing the tasks given. The AT outcomes should show the child's ability to complete an assignment using the AT (The IRIS Center, 2021).

4. **Ongoing monitoring of AT**

   Ongoing monitoring of the AT is crucial in understanding if it will have long-term benefits for the student. Observations, student assessments and data collection should be collected periodically to determine the efficacy of the AT, and to identify areas in need of improvement and further research. (The IRIS Center, 2021)

Wynne et al. (2016) in their study communicated various ways in which the AT provision could be improved in Ireland. To enhance AT in Irish, Ireland needs the following:

- School guidelines outlining school responsibility and AT eligibility criteria
- A clear service pathway for acquiring AT
- Monitoring of AT implementation
- Sufficient student training
- A focus on students with high incidence profiles
- Collaborative learning with other educators

- An AT support system for parents and schools, and professional development

In order to enhance AT provision, regional, sub-national, national AT policies need to be urgently developed and enacted (MacLachlan et al., 2018).

The National Council for Special Education (NCSE) states that the Universal Design for Learning (UDL) is an acceptable method in creating inclusive educational environments, and AT is a vital component in this creation (Wynne et al., 2016). The NCSE discusses how a UDL approach could respond to the overlapping of classroom ICT and AT. The NSCE advises that the 8 steps AT acquisition should be reviewed and updated with the guidance of the UDL framework, resulting in a more proactive approach to AT implementation. The UDL enables educators to plan and create inclusive learning environments by using multiple methods of content presentation, methods of student action, expression, and engagement in the UDL guidelines; meeting the needs of many all types of learners. The UDL framework views the environment as the problem, not the differences a learner with LD has (Wynne et al., 2016). The UDL framework celebrates the social model of disability, which argues that it is the environment that disables people, not because of his/her impairment (Goering, 2015). UDL is a framework that strives to tackle learning barriers for students which LD which are the cause of the “one size fits all" curriculum. AT responds to the diverse learning needs and styles of students, breaking these barriers (Wynne et al., 2016).

2.5 Assistive Technology Implementation Benefits

The National Council for Special Education in Ireland (NCSE) carried out research, “Assistive technology/Equipment in Supporting the Education of Children with Special Needs-What works best?” (Wynne et al., 2016). This study was granted by the Department of Education in Ireland and examined 100 pupils acquiring and using AT. The AT met the needs of 70% of the students. Educators found that AT increased students' access to the curriculum, and improved class participation, and academic outcomes. The research found that the main benefit of AT use was the positive impact it had on literacy in the classroom, as software,

such as text-to-speech allowed students to read their school books and comprehend the content. The other main benefits from this study were improved engagement and interest in learning, access to resources, and student preparation and organisation. Teachers found that students were less stressed during the school day (Wynne et al., 2016).

The National Council for Special Education in Ireland (NCSE) carried out research, “Assistive technology/Equipment in Supporting the Education of Children with Special Needs-What works best?” (Wynne et al., 2016) and reviewed AT provision in other countries worldwide. This study viewed AT provision through an international lens, examining AT in the United Kingdom, The Netherlands, Denmark, Norway, Italy, and New Zealand, and in reviewing Irish and international guidelines and principles. Wynne et al. (2016) concluded the best practice for AT provision:

- AT needs to be observed from an inclusive education perspective
- AT can play an important role in UDL
- AT provision must be supported to ensure effective use of the tool in the physical environment and in curriculum assessment
- It is vital that curriculum and instructional technologies do not generate barriers in the use of AT by learners with LD
- AT use and learning and teaching should be linked and coordinated with educators
- Communication with parents and students is crucial during the needs assessment process and AT selection
- Assessment professionals play a key role to play in choosing appropriate AT for students
- A phased approach to identifying the appropriate technology to the needs of the student is crucial
- Ensuring that the student is cognitively able to use the AT independently and appropriately
- AT provision is part of the individual educational planning
- Positive attitudes to AT should be promoted among all stakeholders involved with the AT provision of the student
- Consistent AT maintenance is an essential practice in the AT process.

Students with high-incidence disabilities, such as LD experience better academic outcomes when they are given access to AT devices (The IRIS Center, 2021). The IRIS Center (2021), a national center in the United States, dedicated to improve learning outcomes for students with LD, states the importance of planning and implementing AT in the classroom.

The World Health Organisation (WHO) defines AT as a vital environmental facilitator (Wynne et al., 2016). Atanga et al. (2020), discuss how AT makes the learning environment more inclusive, bridging the gap between elementary and middle school students with learning disabilities, and their classmates without learning disabilities. Bouck and Long (2020) states how AT allows a child to select his/her own pace of learning. Atanga et al. (2020) state that children with LD who have the opportunity to work at their own pace with AT, feel less pressure, and consequently improve in areas, such as communication, attention, and behaviour. Bouck and Long (2020) also confirm how AT promotes independent learning. Masouleh and Jooneghani (2012) describes autonomous learning, also known as independent learning, as the learner's ability to take control of their own learning. Masouleh and Jooneghani (2012) state that a student change becomes an autonomous learner through teacher instructional scaffolding.

Panesi, Bocconi and Ferlino (2020) discuss the role and impact that technology has on student well-being and inclusion in school. Positive student well-being and inclusion are related to AT utilisation, helping students with LD to integrate into their educational environment. Panesi et al. (2020) highlights that a number of researches, in particular the research, "Is school participation good for children?" by de Róiste et al. (2012), show that the active involvement for a student in school in positive social and emotional well-being.

Reading and writing AT tools help students to become independent learners through the various range of facilities, such as text-to-speech, speech-to-text, word recognition, word prediction, and spelling correction (AHEAD, 2021). Atanga et al. (2020) speak of a study on AT carried out by Cullen et al. (2008) on the use of talking word processors in conjunction with word prediction software,

and found that 70 percent of students with learning disabilities in the study showed improved quantity and quality in their written work.

The use of text-to-speech AT on a tablet results in progression in shared reading, guided reading, and independent reading. Text-to-speech software reads words aloud, as well as highlights them for the reader; this familiarises students with written text (Atanga et al., 2020).

Marsh et al. (2021) explain how children with LD acquire literacy skills slower than students who do not have LD, and that AT can be one of the appropriate strategies to developing literacy needs in students with LD. Flewitt, Messer and Kucirkova (2015) explain how the iPad encourages learning opportunities, and promoted motivation, concentration, expression, and independent learning.

2.6 Assistive Technology Challenges

Flewitt et al. (2015) discuss the disadvantages of AT in the classroom, in particular the iPad. They found that teachers were spending a lot of personal time planning for AT and choosing applications to meet the needs of their students, which ultimately leads to teacher stress. Time factors are one of the causes of teacher stress and burn-out; spending out of school hours on schoolwork because of the lack of time for planning or resource accumulation during school hours (Brown & Ralph, 2002).

Another disadvantage of AT in the classroom was technical issues, which teachers found interrupted the flow of lessons (Flewitt et al., 2015). A teacher's concern with AT is the student's ability to use the device efficiently, but not grasp the lesson concept. Keany explains Laura Northrop and Erin Killeen's framework for using iPads to build early literacy skills. Northop and Killeen (2013) clarify that the lesson concept must be taught to the student without the iPad before introducing the iPad.

Between 20-30% of the pupils reported the ineffective use of AT. Students found that the correct AT was not matched with their needs. Some students also felt that their AT was suitable but found it challenging to include the AT in their school

day. The implementation of AT is not solely about choosing suitable AT for a child. A student's learning environment, as well as their relationship with it has changed, therefore professionals who implement the AT must work with the students on their transition from no AT use to AT use (Wynne et al., 2016). The work by Edutopia (2007) explains how the AT implementation is a continuous process after the tools have been introduced into the classroom in that an educator must question the technological how these can be Other barriers of AT included lack of student opinion during AT selection, lack of teacher training and knowledge on device maintenance, ineffectual AT resources, and lack of motivation (Wynne et al., 2016).

2.7 Barriers to Assistive Technology Implementation

Ahmed (2018) lists some of the barriers to the use of AT; time constraints, obtaining and managing AT devices, inadequate assessment and planning, lack of funding, insufficient training, and negative teacher attitudes. Teachers are given limited or no AT training in teacher training colleges, therefore are unprepared for their responsibilities in AT which are assessing student needs, providing AT recommendations for IEP/SSF, AT implementation and monitoring, and evaluation. In this study by Ahmed (2018), 96% of students shared that AT made a significant difference to their learning, as AT helped these students to overcome their daily challenges. However, when answering another question, 14% of students voiced that they thought the students with LD using AT was unfair to the other students without LD. Reading Rockets (2019) highlight the question about whether using an iPad is cheating or not, and does it give some students an unfair advantage. This negative outlook and attitude to AT is a disadvantage in the classroom.

Wynne et al. (2016), in the NCSE report, identifies the barriers to the implementation of AT in Irish schools. The barriers reported were general lack of resources, negative attitudes of educators towards AT, lack of training, the inability or support to find the relevant and suitable equipment, the inconsistencies of systems, and the challenge of keeping informed on AT, which is constantly changing. Sullivan (2019) states that teachers are hesitant to use AT due to the misconception that AT is more work for the teachers.

In looking back on the history of SEN, Ireland in recent years has made major changes in the education of students with LD. With the introduction of legislation and the progression towards a truly inclusive environment in using the UDL framework, educators can encourage constructivist classrooms, where students are active participants in their own learning. In exercising the UDL principles, applying learning theories, and observing and reflecting AT practices worldwide, educators can be informed on AT implementation.

3 METHODOLOGY

3.1 Introduction

The researcher of this study has identified a problem in the school that she works in, which is the lack of use of AT for children with LD in the school environment. The main research question is, *How can AT be implemented in the mainstream classroom to support the needs of students with LD*? The objective of this study is to inform training, planning, and to identify the challenges and barriers of AT implementation in this school. The study will also communicate the participants' reservations and optimisms of AT, and identify the recommendations for future research in AT implementation in this school. The study will be part of a solution to permanently have AT successfully implemented in this school.

3.2 Methodological Approach

Action research was chosen for this study as it has been suggested to work in harmony with social constructivism, in developing inclusive education through educators' research (Armstrong, 2019). Armstrong (2019) states that action research is a "powerful approach to transformation in teaching and learning" (p.1). Action research promotes a constructivist learning environment, where the teacher is the facilitator and provides experience for the students to construct their own learning. The researcher is the facilitator of the research where both students and teachers construct their own learning.

Action research encourages teachers to be active participants and critical spectators in their own educational process to achieve change in their practice and positively impact the learning of their students. It can make teachers aware of classroom issues and develops teacher confidence in solving these problems (Aldridge et al., 2004).

3.3 The Methods

The researcher chose to focus on the planning and implementation of AT to support students with LD in the mainstream classroom. The researcher used both

qualitative and quantitative methods in the action research. Mixed methods empower the researcher, giving the person conducting the study the flexibility to answer the research question in the most efficacious way (Tashakkori & Teddlie, 2013).

AR uses a variety of methods. Surveys were used in the quantitative data collection phase. The qualitative research methods used by the researcher were a survey, interviews, reviewing existing documents and records, and observation and reflective teaching. The researcher used autoethnography, an approach where the researcher describes and analyses her personal experiences in the AT training and classroom setting to understand the experiences of teachers and students in relation to the AT implementation (Ellis, Adams & Bochner, 2011).

3.3.1 Qualitative Research Methods

Qualitative research methods collect data that are narrative (Mertler, 2017). Unstructured observations were carried out in the classrooms by the researcher and class teachers. Unstructured observations allow the practitioner to observe while attending to other activities in the classroom (Mertler, 2017). There are many advantages to teacher observation, such as the opportunity to gather data on the actual behaviour and performance of the students, and report events that students may be unaware of or unable to express their feelings or perceptions (Mertler, 2017). When conducting research through observation, the teachers and researcher need to be mindful of the limitations and that the students' behaviours may change due to their knowledge of the teacher undertaking observation notes (Mertler, 2017). In this study, teachers and the researcher were mindful of this limitation and discreetly wrote down observations. Observation notes were recorded by the researcher in the form of field notes, writing down what she saw during training sessions and in the classrooms. The researcher divided her field notes into two sections to ensure that she wrote down exactly what she witnessed, as well as her interpretations of the observations (Mertler, 2017). The type of unstructured observation used was naturalistic observation as the researcher observed the students and teachers in their natural environment, the classroom (Tenzek, 2018).

Semi-structured interviews were chosen for this study as the format is more flexible than structured interviews and allows the researcher to clarify answers and ask follow-up questions to collect richer data. “Base” questions (See Appendix 1 for base questions) were created for the semi-structured interviews (Mertler, 2017).

Reflective teaching is a process used by educators to examine their own teaching (Harrison, 2008). When engaging in reflective teaching an educator must factor in three aspects; the actual lesson, the recollection of the lesson, reviewing and responding to the actual occurrence during the lesson (Mertler, 2017). For this study, the researcher used self-evaluations during both teacher and student training and factored in the three aspects to ensure effective reflection.

In relation to the existing documents and records, the school’s Information and Communications Technology (ICT) and Special Education policies were evaluated. The school’s Support Register and Individual Student Support Files (SSFs) were reviewed. The school policies are public documents and therefore were readily available In relation to the Support Register and SSFs, the researcher has access to these documents in her role as a learning support teacher in the school. The procedures approved by the school were followed when accessing the documents (Mertler, 2017).

3.3.2 Quantitative Research Methods

Quantitative methods gather data that are numerical. Quantitative data allow collecting and organising ratings of participants’ attitudes, feelings, and insights on a numerical scale (Mertler, 2017). Mertler (2017) defines surveys as a collective group of quantitative method data collection. They are questions that are administered to participants by the researcher. Written surveys, where participants answer questions and return their answers to the researcher are known as questionnaires (Mertler, 2017). In this study, two questionnaires were created and distributed to both teachers and students. The teachers’ survey contained 10 closed-ended questions (See Appendix 1 for teacher survey questions), whereas the students’ survey included 16 questions, 15 closed-ended questions, and 1 open-ended question (See Appendix 2 for student survey questions). Closed-ended

questions were used as they were easier and quicker for the teachers to answer, promising more responses to the questionnaire (Hyman and Sierra, 2016). The other advantage of closed-ended questions is making the questionnaire more accessible for students with literacy difficulties (Hyman and Sierra, 2016). Open-ended questions allow for participants to give their own answers, whereas closed-ended questions prompt the participants to choose a response (Hyman and Sierra, 2016).

3.4 Research Context

The action research took place in a senior primary mainstream primary school in Ireland. The school has 330 pupils, ranging from 7 years old to 13 years old, second class to sixth class. The school has 13 mainstream classrooms and 3 special education rooms with 4 special education teachers. In Ireland, students with special educational needs (SEN), attend special schools, special units in mainstream schools, or learning support classes in mainstream schools for literacy, numeracy, or social/emotional support. In schools with learning support, the Department of Education has set out a Continuum Support of Framework to aid schools with identifying and supporting the needs of students (NSCE, 2021). The school in this study has identified the students' needs based on this framework. The support is given to students who are in the 4 categories:

1. ‘Students in Whole-School & Classroom Support’, ‘School Support’, and ‘School Support Plus’.
2. Students who are below average in literacy and numeracy
3. Students who have an educational psychological assessment report
4. Students who have social/emotional needs

In ‘School Support Plus’, and Individual Educational Student Support Files are written up for these students; where student targets and reviews are documented (O’ Loughlin, 2019). In this school, 78 students are in ‘School Support Plus’ in 2021, 45 percent have literacy learning difficulties, 46 percent have numeracy learning difficulties, and 9 percent have other special needs, such as Autistic Spectrum Disorder (ASD), motor and social/emotional needs.

This research is focusing on students with literacy learning difficulties in 'Student Support Plus'.

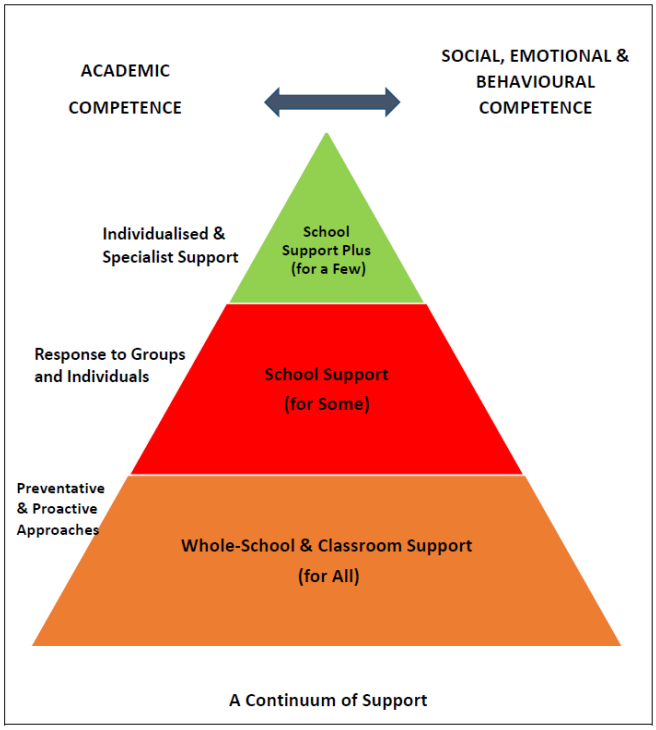

FIGURE 2. The Continuum of Support (Primary) (NCSE, 2021)

3.5 Population and Sampling

The population of this study was 17 teachers (13 mainstream teachers and 4 Special Education teachers) and 35 students with literacy difficulties in the Student Support Plus group. The students are Irish and female and range from 7 years to 13 years old. All teachers are Irish and are predominantly female, with 91% of the mainstream teachers being female, and 9% male.

For this study, purposive sampling was chosen as the researcher wanted to discover as much information about one specific case (Tashakkori & Teddlie, 2013). A survey was distributed to the teaching staff of this school and to 10 students from the 35 students with literacy difficulties. The researcher also chose the 5 classroom teachers to interview. These teachers were selected as they were the teachers of the classes with the 10 students. Two students from each of the 5 classes from second to sixth class, ages 8 years to 12 years, were chosen to use the AT. In using purposive sampling, the researcher was able to identify the problem in the school, the needs of the teachers and students in relation to AT, and

trial the use of AT in mainstream classrooms. There are different types of strategies in purposive sampling. In this study, the strategy sampling to achieve representativeness was used (Tashakkori & Teddlie, 2013). The teachers represent themselves, as well as the future teaching staff of the school. The students represent the group of students with literacy learning difficulties. These students also represent future students in the future.

3.6 Action Research

A key feature of Action Research (AR) is that it is concerned with "bringing about a change of some kind" in an educator's own context (Armstrong, 2019, p. 5). Regularly, educators will notice a problem in the teaching and learning practices in their school, this could be an issue in their own classroom, or a whole school problem. Action research allows teachers to examine their educational environment, identify the problem and explore solutions to improve the teaching and learning in school (Mertler, 2017). An action research methodology follows the following 6 steps: Identify and describe the problem, Generate and analyse data, Plan intervention, Introduce and monitor intervention, Analyse evaluative data, and Review Process. (See Figure 3).

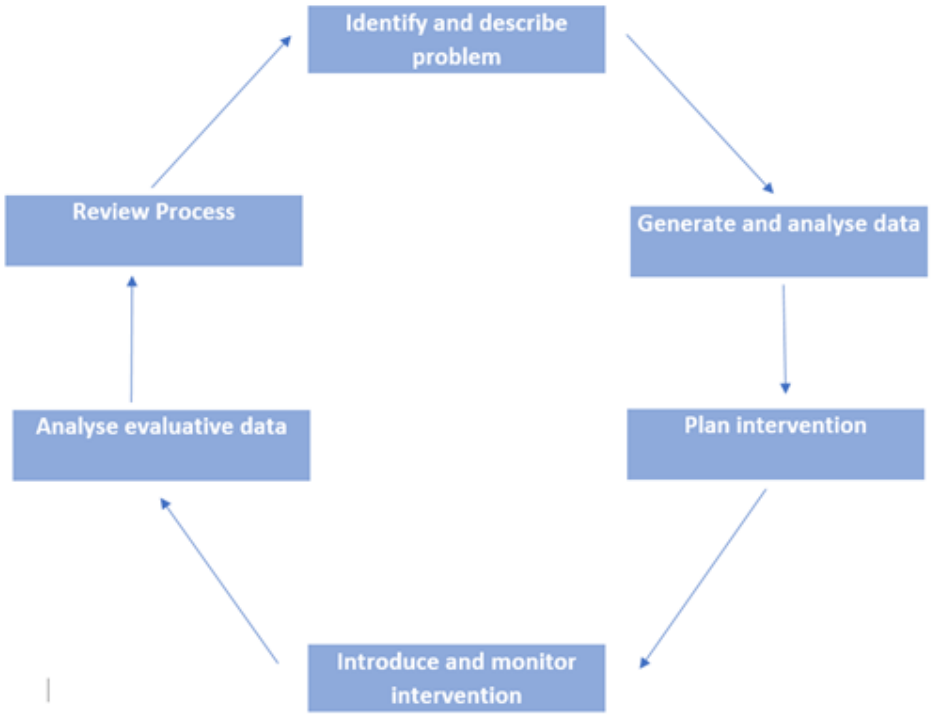

FIGURE 3. The Action Research Cycle

Teaching and learning are continuously evolving practices, with schools facing both human and technological changes, therefore action research is an appropriate type of research to use. Action research requires educators to critically reflect on their practice to ensure that the most effective teaching and learning methods are utilised (Woodall, 2017). The researcher used these 6 steps of action research in the study to identify and attempt to solve a problem in the teaching and learning within the school that she works in. The process is described in more detail in the following.

3.6.1 6 steps of Action Research

Step 1: Identifying and solving the problem

The researcher has worked within the special education team in the school as a learning support teacher. A learning support teacher in Irish schools is responsible for supporting students with both academic and social needs in one-to-one, small group, or whole class settings. In relation to the role of the researcher, the researcher's contribution can be positive and useful. As the primary data collector in the research, it is required to identify the personal values of the researcher, as well as the assumptions and biases (Creswell, 2009). It is important to acknowledge the researcher's special education role in the school, her interest in special education, and the welfare of students with LD.

The researcher observed students with special educational needs in small learning support settings, as well as in the mainstream class during in-class support. During her first year in learning support, the researcher observed challenges for students with literacy needs in the mainstream classroom, students were unable to learn at the same rate as their peers. The reasons for this were their inability to read the exercises given to them, as well as respond to the exercise. Students approached this issue differently, some students continually asked the learning support or class teacher for help, others asked their peers to assist them, and others did not ask for any help. The researcher identified a problem: students were unable to access the curriculum, or express themselves. Students were observed having low self-esteem due to the lack of control over their learning. What

initiated this study was that the researcher wanted to better support these students. In the initial literature review AT was identified to have many benefits for students with LD.

After identifying the problem, the researcher enrolled in and completed two courses in AT. Continuing Professional Development (CPD) for educators is vital for causing education reform (Ford, 2016). She finished a course “Assistive Technology in Primary Education” with Enable Ireland, Disabilities Service, and a course “Assistive Technology for the Classroom-Mastering your laptop or iPad” with UrAbility, a service for teachers to learn how to support their students with LD using AT. UrAbility trusts that technology can bring learning to life for children with LD (UrAbility, 2021). The course with Enable Ireland was a one-day course, and the course with UrAbility was 15 days long. Enable Ireland’s vision for AT for people with LD is that they have access to up-to-date and appropriate AT for their needs to support people exercising their human rights to independence, freedom, and participation in society (Enable Ireland, 2016). The AT courses confirmed the possible benefits of AT for students with LD.

Step 2: Generate and analyse data

After identifying the topic, the researcher gathered preliminary information to find out the teachers’ perceptions of the researcher’s proposed research (Mertler, 2017). The researcher created an online survey, “The Use of Assistive Technology for Children with Learning Difficulties” through SurveyMonkey. The anonymous survey was created and was sent to the management team in the school to be authorised. A survey pre-test was carried out by 3 trainee teachers in the school. These trainee teachers are not part of the school staff but were completing their teaching practice in the school. The survey pre-test was conducted to ensure that the participants would understand the questions (SoSci, 2021). The survey contained 10 closed-ended questions and was distributed to the staff through email, requesting the 17 teaching staff to complete it. The purpose of the survey was to get the teaching staff’s perspective on the need for AT for students with LD, their current use of AT, and their knowledge and training of AT.

3.7 Results from the teachers' survey

The results of the survey showed that 88% of mainstream teachers do not use any form of AT in the classroom, 94% think that AT would support students with LD in their classrooms, 94% of teachers in this school do not have any AT training, 88% have no iPad training, 82% are unaware of the iPad accessibility features, 100% of teachers would like their students with LD to be trained in suitable AT, as well as 100% of teachers wanting AT training themselves. The results present the problem in the school: students struggle due to the lack of suitable learning resources. These results illustrate the lack of AT knowledge, training, and want for AT implementation and utilization to support students with LD in the classroom.

The literature review chapter presents a broad outline of AT planning, implementation and utilisation. This collection of literature helped the researcher to make informed decisions when creating and implementing an AT plan for her school (Mertler, 2017). The researcher also analysed the school policies, the ICT and SEN policies. These two school policies did not involve AT use and needed reviewing and revision at the end of the first cycle of the study.

Step 3: Plan Intervention

When the school policies and teacher survey data were collected from reading school policies and surveying the teachers, the problem identified by the researcher was confirmed, as well as the need and desire for AT in the mainstream classrooms for children with LD. The researcher took a leadership role and created an AT implementation plan using the AT research and the completed AT courses. Leadership roles can be taken on by teachers. The change in school responsibility of procedure and policy revision should not solely rest on the school management team (Harris & Muijs, 2003). In order to access the population, a meeting was organised with the school management, and the plan for this action research was presented to the management. When the plan was authorised, the plan was presented to the teaching staff. The plan contained the following:

1. The objectives of the action research

- identify the students
- identify the needs of the students with LD
- find the appropriate AT for the students' needs
- teach the teachers how to use the AT
- train the students in the AT
- implement iPads into the classrooms to support the needs of students with literacy LD
- identify the benefits, barriers, and areas for improvement in using the AT
- Identify areas for future studies in AT implementation

2. The timeframe for the project

The timeframe for this project was the first term of the school year, Sept and October 2021.

3. The suggested targeted students

The school's support register was reviewed and 10 students were chosen from the register, 2 students from each class level, second class to sixth class. The students chosen have severe literacy difficulties. The researcher is aware of the students' needs through the review of the student.

In order to choose the correct AT for these students, the researcher reviewed the student support files. The students' main needs are literacy difficulties, which impact on their reading and writing pace, spelling, phonological awareness, word decoding, and handwriting.

The researcher had to get permission from the parents/guardians of these students. A permission form was created, authorised by management, and emailed to the parents of the students. The permission letter explained the objectives for the research and outlined the research plan. All parents emailed back their permission (See Appendix 1).

4. The suggested AT

The AT devices that were chosen were the school iPads. The applications chosen were Natural Reader, a text-to-speech application, and Touch-Type Read and Spell (TTRS), a typing programme application. The iPad accessibility features

and iPad notes were also used. Natural Reader allows the user to take photographs of text and have it read to you, this application uses the Dyslexia font and students can complete their written work here. As the iPad accessibility features are turned on, users can use predictive text, have the predictions read to them, have their work read back to them, and also use speech to text, where they can use their voice to express themselves and complete written assignments. The users copied their work and shared it with 'Notes' on the iPad for teacher correction. A profile for each student for TTRS was created in order for children to practice their typing skills in a multi-sensory typing course. The fifth and sixth class students in the sample were given the responsibility to deliver and collect the iPads during this trial.

5. Teacher AT training

The researcher carried out training over a week with the 5 class teachers, explaining how to use the AT. The students also showed the teachers how to use the AT.

6. Student AT training

The researcher carried out AT training over a week with students. The students were given training in pairs. The researcher engaged in reflective teaching during training with both students and teachers.

7. Logistics of AT

An email was sent to the teaching staff to explain that 10 iPads were being used for the research. The researcher turned the accessibility features on and downloaded the applications for all 10 iPads. Students were asked to bring in headphones of choice. The researcher ensured the delivery and collection of iPads to classrooms each day. The researcher ensured that the iPads would be stored safely, charged, and cleaned regularly to ensure COVID-19 cleaning guidelines were followed. The researcher must ensure that any invoices will be given to the school office. The TTRS cost to set up an account for 10 students for the term.

8. The evaluation (interviews and survey)

Interviews with the 5 class teachers were conducted and the 10 students answered an anonymous survey to find out how the AT implementation went, what worked, what were the barriers, and what improvements were needed.

9. The recommendations

Feedback from the interviews and surveys will inform the next steps for AT for implementation and utilisation. This feedback will support the reviewing and revision of the ICT and SEN policies to include the use of AT for children with LD.

Step 4: Introduce and monitor intervention

The plan was implemented in the classrooms. The researcher explained to the teachers and students to begin using the AT for English lessons and then use the AT whenever they felt was necessary outside of English. The researcher was the facilitator, encouraging a constructivist approach in the classroom, allowing the teachers and students to construct their own knowledge through their individual experiences with the AT in the classroom (Bhattacharjee, 2015). The researcher explained to the 5 teachers and 10 students that she was there as a support for them if there were any challenges regarding the implementation or utilisation of the iPads. The teachers monitored the use through teacher observation on a daily basis. The researcher had the opportunity to observe the 10 students over the course of the implementation. The researcher went in and out of the classrooms when her timetable allowed her to.

The researcher gave the 10 students a survey consisting of 9 closed-ended questions and 1 open-ended question. The survey was given to the students on Natural Reader. The survey was presented in the dyslexia font, and students had the opportunity to have the questions read to them. The surveys were shared in their notes for the researcher to access.

A pre-test survey was carried out with 3 students who were part of the population of 35 students with literacy difficulties but are not a part of the sample of 10.

Semi-structured individual interviews were conducted at the end of the term with the 5 class teachers. The interviews were audio-recorded on a school iPad and manually transcribed by the researcher. The researcher chose audio-recording as it gave her the opportunity to actively listen and focus on the conversation, without having to concentrate on note-taking (Bloor & Wood, 2006).

Step 5: Analyse evaluative data

The two types of data collected were numerical and textual and the two types of data analysis used were statistical and thematic (Tashakkori & Teddlie, 2013).

3.8 Quantitative Data Analysis: Cross-tabulation

To analyse the closed-ended questions in both surveys, descriptive statistics were used to quantitatively describe and summarise the information collected from both surveys (Mertler, 2017). . The surveys' data were presented in percentages (value/total value X 100%). Cross-tabulation was used to analyse and present some of the data from the students' survey. The researcher chose to use cross-tabulation as she has surveyed 5 class levels. Cross-tabulation shows the relationship between variables and identifies patterns from the data. Cross-tabulation reduces confusion when analysing data, allows for insights, and encourages action for decision-making in an institution (Alchemer, 2018). The researcher found both the row percentages (cell/row marginal) and column percentages (cell/column marginal) to clearly show findings within each class level, as well as within the whole group sample. The students' survey data is presented in the Results chapter.

3.9 Thematic Analysis for Qualitative Data

To analyse the qualitative data, the observation notes, the researcher used an inductive thematic analysis. The thematic analysis focuses on identifying patterns and themes in the data (Braun & Clarke, 2006). When reducing the data in the qualitative inductive data, the researcher was careful not to distort, minimise or misinterpret the data, as this can sometimes occur in this type of analysis (Mertler, 2017). The researcher followed the following steps of thematic analysis to analyse the interview transcripts, observation notes, and open-ended questions in her survey (Braun & Clarke, 2006):

1. **Familiarisation with the data**

   The researcher read the data thoroughly to become familiar the data content

2. **Coding**

   A coding scheme was used to categorise the data based on similarities (Mertler, 2017). For the initial codes, the researcher chose words and colour-coordinated these words, which can be seen in Figure number 4 Codes identify important pieces of the data that could answer the research question (Braun & Clarke, 2006).

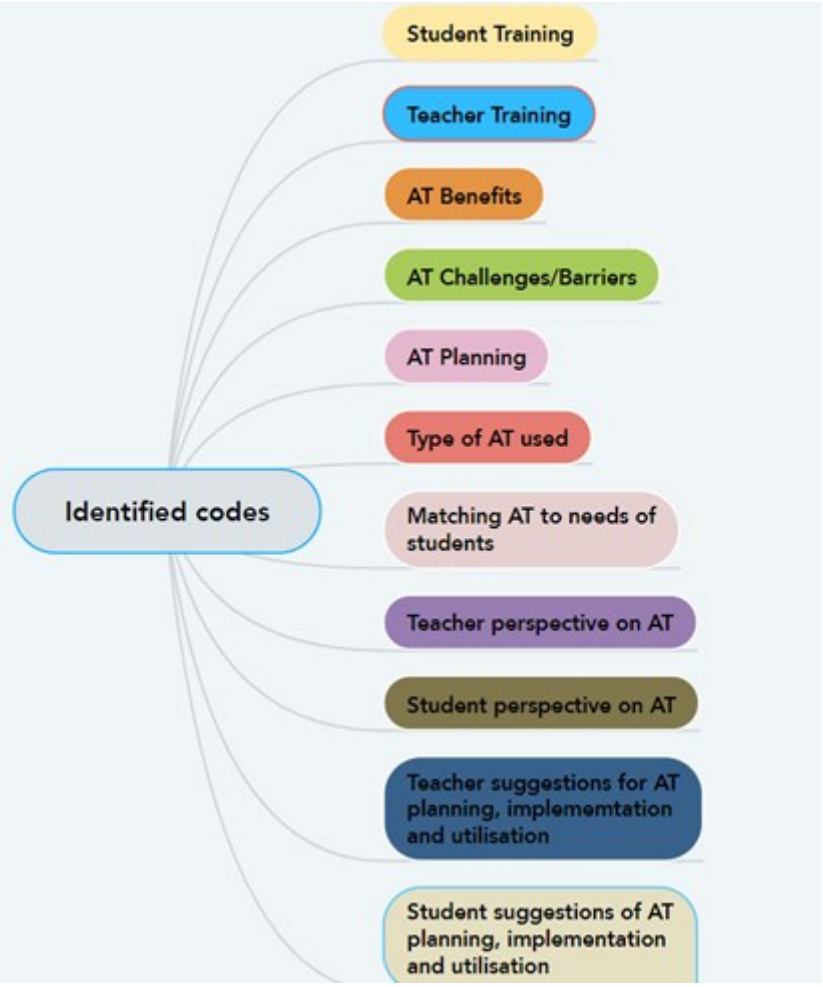

FIGURE 4. Codes

3. **Generating initial themes**

   The codes were examined and potential themes were identified in the data. Data was collected for each theme.

4. **Reviewing themes**
   The themes were checked against the collection of data to discover if they answer the research question, and were refined.
5. **Defining and naming themes**
   Five themes were identified and named. These themes can be found in Figure 4.

Colour-coding was used in Google Drive after the observation notes and open-ended survey answers were typed up, and the interviews manually transcribed. The themes will be presented in the following Results chapter. The transcribed interviews, observation notes, and open-ended survey replies were transferred to a word processor document and color-coded. The analysed data supported the researcher in devising an action plan to inform the next cycle of action research for AT planning and implementation.

In the next stage, the teachers can continue to use instructional scaffolding, building on the students' experiences and knowledge from this project. This promotes further AT skills, enhancing learning, and the mastery of AT skills (Iris Center, 2021). The action research results will be shared with the management team, teaching staff, and parents in the researcher's school. A presentation of the findings will be created by the researcher and shared with the management team and teaching staff in a staff meeting in January 2022. Sharing the findings of action research with other educators is extremely important as they are continuously trying to find ways to better their practice (Merlter, 2008). Another presentation sharing the results will be given to parents over Zoom in January 2022 by the researcher. The researcher would hope that school policies for ICT and special education could be amended after these presentations.

Step 6: Review Process

The teacher-researcher engaged in reflection at the end of the action research cycle. She reviewed the research process, determining its effectiveness, and considered revisions for future planning and implementation of AT in the mainstream classroom to support the needs of students with LD (Mertler, 2017). This review could also inform and support the other teachers who would like to join the AT implementation team in the school.

3.10 Ethical Considerations

The researcher is aware of the major ethical issues in research, such as informed consent, respect for anonymity, confidentiality, and privacy (Fouka & Mantzorou, 2021). The researcher has aimed to follow ethical guidelines while conducting this study. In order to achieve this, the researcher has also consulted the management for research ethics and authorisation of this study.

3.10.1 Informed consent

The researcher gave the parents a detailed description of the research in the consent form (See Appendix 3 for student consent form) which was emailed to the parents.

The researcher also gave a detailed description of the research, in a consent form to the participating teachers (See Appendix 4 for teacher consent form), in order for them to also make an informed decision whether to give consent to their participation (Mertler, 2017).

The parents of the students, as well as the teachers, were assured anonymity, confidentiality, and privacy during the surveys and interviews. Their rights to anonymity, confidentiality, and privacy were communicated to them in writing (Mertler, 2017). Both parents and teachers gave written consent. In addition, the researcher has complied with the General Data Protection Regulation (GDPR).

4 RESEARCH FINDINGS

In this section, the results from both the quantitative and qualitative data are presented. The results of the quantitative section of the research are presented first, followed by the qualitative research results. The presentation of the quantitative results is structured with the closed-ended student survey questions. The presentation of the qualitative results is structured with the qualitative data collection methods, 1) researcher's reflection on the AT training, 2) mainstream classroom observation and 3) interviews with the mainstream classroom teachers. The results of the qualitative data are structured by and presented under the following 6 themes that emerged from the qualitative data:

1. Importance of high quality and relevant AT training
2. Identifying and evaluating the benefits of AT implementation and utilisation
3. Identifying the challenges of AT utilisation and barriers of AT implementation
4. Importance of high quality and well-considered planning of AT
5. Recognising the users' and facilitators' optimisms and reservations of AT
6. Acknowledging the users' and facilitators' suggestions for future planning and implementation

These 6 themes and their connections to the 11 codes (See Figure 5).

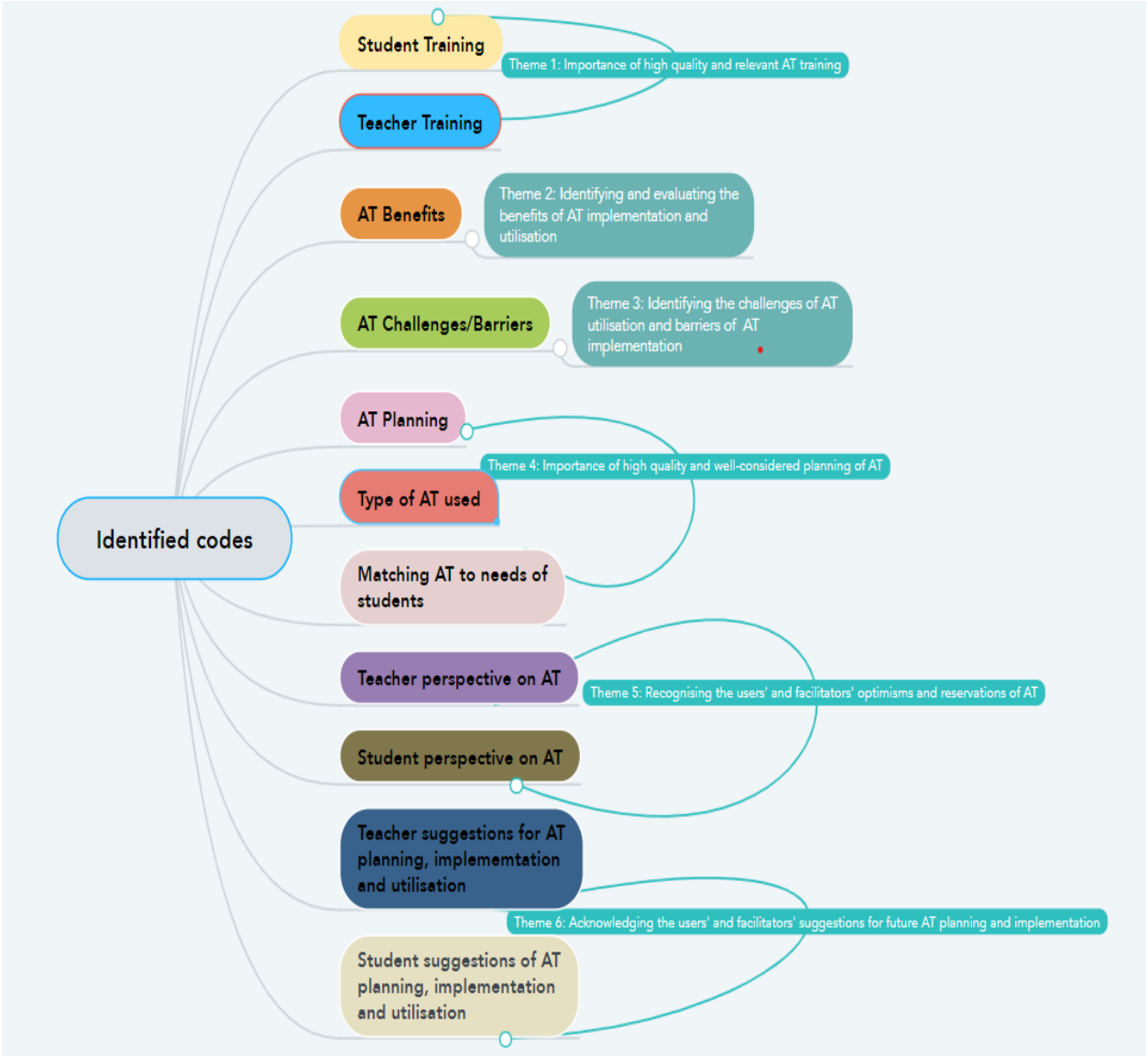

FIGURE 5. The identified themes and their connection to the codes

4.1 Quantitative Data Findings

4.1.1 Tables

	2nd 8 years	3rd 9 years	4th 10 years	5th 11 years	6th 12 Years	
Yes	2	2	1	0	0	5
Row %	20%	20%	10%	0%	0%	50%
No	0	0	1	2	2	5
Row %	0%	0%	10%	20%	20%	50%
Total Number of Students	2	2	2	2	2	10
Column %	100%	100%	50%	0%	0%	

Table A: Responses to the question, *Do you think you need more training on the AT that you used this term?*

The responses to the question, *Do you think you need more training on the AT that you used this term?*, show that 50% of the ten students need more training in the AT that they used during the iPad trial. The 50% who said they needed more training are the younger students, 20 % in 2nd class aged 8 years, 20% in 3rd class aged 9 years and 10 % in 4th class aged 10 years. The other 50% of the pupils who said they were confident in the use of the AT that they were trained in were from the senior end of the primary school, 10% from 4th class aged 10, 20% from 5th class aged 11 and 20% from 6th class aged 12.

	2nd 8 years	3rd 9 years	4th 10 years	5th 11 years	6th 12 years	
Yes	0	1	2	2	2	7
Row %	0%	10%	20%	20%	20%	70%
No	2	1	0	0	0	3
Row %	20%	10%	0%	0%	0%	30%
Total Number of Students	2	2	2	2	2	10
Column %	0%	50%	100%	100%	100%	

Table B: Responses to the question, *Were you confident using iPad Notes?*

The responses to the question, *Were you confident using iPad Notes?* show that 70% of the students were confident in using the iPad Notes. 100% of students from 4th Class to 6th, 10 years to 12 years were confident in using this feature. 30% of students were not confident using iPad Notes. These students were from the junior end of the school in 2nd and 3rd class, with 20% from 2nd class and 10 % from 3rd class.

	2nd 8 years	3rd 9 years	4th 10 years	5th 11 years	6th 12 years	
Yes	0	1	2	2	2	6
Row %	0%	10%	20%	20%	20%	70%
No	2	2	0	0	0	4
Row %	20%	10%	0%	0%	0%	30%
Total Number of Students	2	2	2	2	2	10
Column %	0%	50%	100%	100%	100%	

Table C: Responses to the question, *Were you confident in using Natural Reader?*

The responses to the question *Were you confident in using Natural Reader?* show that 70% of the students were confident in using Natural Reader. 100% of students from 4th Class to 6th, 10 years to 12 years were confident in using this feature. 30% of students were not confident using Natural Reader. These students were from the junior end of the school in 2nd and 3rd class, with 20% from 2nd class and 10% from 3rd class.

	2nd 8 years	3rd 9 years	4th 10 years	5th 11 years	6th 12 years	
Yes	0	1	2	2	2	7
Row %	0%	10%	20%	20%	20%	70%
No	2	1	0	0	0	3
Row %	20%	10%	0%	0%	0%	30%
Total Number of Students	2	2	2	2	2	10
Column %	0%	50%	100%	100%	100%	

Table D: Responses to the question, *Did you enjoy the experience of using the iPads throughout your school day?*

The responses to the question, *Did you enjoy the experience of using the iPads throughout your school day?* show that 70% of the students enjoyed the experience of using the AT in the classroom. The 70% are made up of 10% from 3rd class, 20% from 4th class, 20% from 5th class and 20% from 6th class. 30% of students express that they did not enjoy the experience. These students were from the junior end of the school in 2nd and 3rd class, with 20% from 2nd class and 10% from 3rd class.

	2nd 8 years	3rd 9 years	4th 10 years	5th 11 years	6th 12 years	
Yes	0	1	2	2	2	7
Row %	0%	10%	20%	20%	20%	70%
No	2	1	0	0	0	3
Row %	20%	10%	0%	0%	0%	30%
Total Number of Students	2	2	2	2	2	10
Column %	0%	50%	100%	100%	100%	

Table E: Responses to the question, *Do you think the iPads helped you to do your reading in class?*

The responses to the question, *Do you think the iPads helped you to do your reading in class?* show that 70% of the students said that the AT helped them with their literacy work in the classroom. The 70% are made up of 10% from 3rd class, 20% from 4th class, 20% from 5th class and 20% from 6th class. 30% of students answered no, that the AT did not help them with their written work. These students were from the junior end of the school in 2nd and 3rd class, with 20% from 2nd class and 10% from 3rd class.

	2nd 8 years	3rd 9 years	4th 10 years	5th 11 years	6th 12 years	
Yes	0	1	2	2	2	7
Row %	0%	10%	20%	20%	20%	70%
No	2	1	0	0	0	3
Row %	20%	10%	0%	0%	0%	30%
Total Number of Students	2	2	2	2	2	10
Column %	0%	50%	100%	100%	100%	

Table F: Response to the question, *Do you think the iPads helped you to do your written work in class?*

The responses to the question, *Do you think the iPads helped you to do your written work in class?* show that 70% of the students said that the AT helped them with their literacy work in the classroom. The 70% are made up of 10% from 3rd class, 20% from 4th class, 20% from 5th class and 20% from 6th class. 30% of students answered no, that the AT did not help them with their written work. These students were from the junior end of the school in 2nd and 3rd class, with 20% from 2nd class and 10% from 3rd class.

	2nd 8 years	3rd 9 years	4th 10 years	5th 11 years	6th 12 years	
Yes	0	1	2	2	2	7
Row %	0%	10%	20%	20%	20%	70%
No	2	1	0	0	0	3
Row %	20%	10%	0%	0%	0%	30%
Total Number of Students	2	2	2	2	2	10
Column %	0%	50%	100%	100%	100%	

Table G: Responses to the question, *Do you think the iPads made you be a more independent learner?*

The responses to the question show that the AT made them more of an independent learner. The 70% are from 3rd class up to 6th class, 50 % of 3rd class students and 100% of 4th, 5th and 6th class students. 30% of students express that the AT did not make them more independent in the classroom. These students were from the junior end of the school in 2nd and 3rd class, with 20% from 2nd class and 10% from 3rd class.

	2nd 8 years	3rd 9 years	4th 10 years	5th 11 years	6th 12 years	
Yes	0	1	2	2	2	7
Row %	0%	10%	20%	20%	20%	70%
No	2	1	0	0	0	3
Row %	20%	10%	0%	0%	0%	30%
Total Number of Students	2	2	2	2	2	10
Column %	0%	50%	100%	100%	100%	

Table H: Responses to the question, *Do you think the iPads made you feel more confident in the classroom?*

The responses to the question, *Do you think the iPads made you feel more confident in the classroom?* show that 70% of the students said that the AT made them feel more confident in the classroom. The 70% are from 3rd class up to 6th class, 50 % of 3rd class students and 100% of 4th, 5th and 6th class students. 30% of students express that the AT did not make them feel more confident. These students were from the junior end of the school in 2nd and 3rd class, 20% from 2nd class and 10% from 3rd class.

	2nd 8 years	3rd 9 years	4th 10 years	5th 11 years	6th 12 years	
Yes	0	0	0	1	2	2
Row %	0%	0%	0%	10%	10%	20%
No	2	2	2	1	1	8
Row %	20%	20%	20%	10%	20%	80%
Total Number of Students	2	2	2	2	2	10
Column %	0%	0%	0%	50%	100%	

Table I: Responses to the question, *Other than English lessons, were you confident in when and how to use the iPads in the classroom?*

The responses to the question, *Other than English lessons, were you confident in when and how to use the iPads in the classroom?* show that only 30% of the students were confident in how and when to use the AT outside of English lessons. The 30% were from the senior end of the school, 10% in 5th class and 20% in 6th class. 70% of students expressed that they were not confident in when and how to use the iPads outside of English lessons. The 70% is made up of students from all levels. 0% of students from 2nd to 4th were confident, only half of 5th and 100% of 6th class students said they were confident.

Subject	English	Maths	History	Geography	Science	Drama	Visual Art	Music
Amount of students	10	2	3	3	3	1	0	0
% of students	100%	20%	30%	30%	30%	10%	0%	0%

Table J: Responses to the question, *What subjects did you use the iPads for?*

The responses to the question, *What subjects did you use the iPads for?* show that 100% of the 10 students used the AT in English lessons. The next three popular subjects where the AT was used were History, Science, and Geography, with 30% of the students using the AT for these subjects. 20% of the students used the AT for Maths, 10% of the students used the AT for Drama and no students used the AT for Visual Art and Music.

Subject	English	Maths	History	Geography	Science	Drama	Art	Music
Amount of students	7	0	1	1	1	0	0	0
% of students	70%	0%	10%	10%	10%	0%	0%	0%

Table K: Responses to the question, *What was the main subject you use the iPad in?*

The responses to the question, *What was the main subject you use the iPad in?* show that 70% of the 10 students used the AT in English lessons. The next three popular subjects where the AT was used were History, Science, and Geography, with 30% of the students using the AT for these subjects. The results for table K are presented on Chart A below:

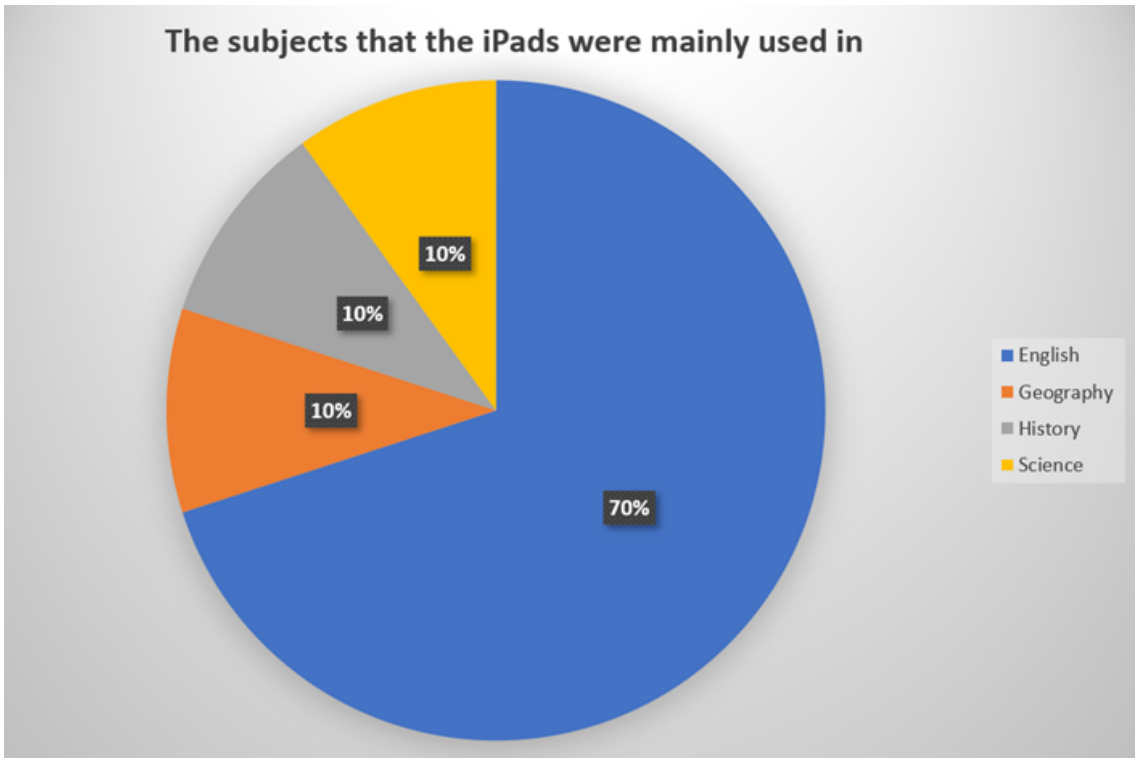

Chart A: The subjects that the AT was mainly used in

Chart A shows that of the students answered yes to the following questions: *Would you like to use the ipads in the classroom every day?* 100% of the students answered 'yes', *Did you enjoy the typing programme (TTRS)?* 100% of the students answered 'yes', *Do you think your typing has improved since you started using the typing programme (TTRS)?* 100% of the students answered 'yes'. *Do you think the ipads suited your learning needs?* 100% yes

4.2 Qualitative Data Findings

4.2.1 Students' Survey Findings

The ten students were asked the following open-ended question, *Do you have any comments to make or ideas for the iPads after using them in your classroom?* The students used the iPads to answer this question, some using speech to text and others typed using the prediction feature. The findings from this open-ended question will be presented under the 6 identified themes.

Theme 1: Importance of high quality and relevant AT training

The students were aware of the importance of training in order to use the AT in the classroom effectively and efficiently, and they expressed their need for more time for AT training. The students explained that they needed more training to support their literacy school work, develop their confidence, and to advance their typing skills. The following responses exemplify the students' need for more AT training:

> *I need more time to learn about how to use the iPads.*
>
> *I want more practice using the iPad notes and Natural Reader.*
>
> *I would feel more confident if I had more time to practice using the iPad and apps.*
>
> *I think the apps were good for my needs like helping me with my reading and writing. But it was hard to tell because I found the iPad and the apps confusing sometimes. I need more time to learn how to use the iPad I think.*
>
> *I need more practice with my typing skills to type up my work.*
>
> *I liked TTRS and would love more time on it so that I could type my work better.*

Theme 2: Identifying and evaluating the benefits of AT implementation and utilisation

The students communicated the benefits of the AT in the mainstream classroom by explaining how the AT supported their literacy work, helping them to read challenging words, as well as communicate their learning. The AT improved their pace of learning as students expressed their ability to work at the same pace as their peers. The pupils also voiced how the AT enabled independent learning, as they turned to the iPad for support, instead of their teacher or colleagues. This independence reduced feeling self-consciousness and uneasiness in the classroom. The following responses represent the benefits for the students:

> *The iPads were great for subjects where you had to do a lot of reading and writing.*
>
> *The iPads helped me with big words in English, Science, Geography and History.*
>
> *The iPads helped me to keep up with my friends in my class.*
>
> *The iPads made me enjoy my schoolwork and not worry about it because it helped me to read and write.*
>
> *When I have the iPad I am not embarrassed in class. I didn't need to ask my teachers or friends for help as much. I could do the work on my own.*
>
> *I got a lot more work done on the iPad because it was easier and more fun.*

Theme 3: Identifying the challenges of AT utilisation and barriers of AT implementation

The students explained how they found it difficult to transition from a learning environment without AT to an environment with AT. Some students shared their confusion about where and when the AT should be used throughout the school

day in a variety of subjects. Other pupils communicated their inability to use the AT across the curriculum, mainly using it for English lessons. The following responses present the AT challenges and barriers:

> *I used the iPad for the subjects where I had to read a lot but I didn't use it for art or anything like that because I didn't know how to.*

> *I didn't know when to use it sometimes because I found it strange going from no iPad to using one.*

Theme 4: Importance of high quality and well-considered planning of AT

There is an evident connection between the challenges and barriers of AT and the classroom planning of AT. The students were aware of the importance of planning to use the AT effectively. The students voiced their lack of understanding on when to use the AT in the classroom and their need for some guidance and structure to use the iPads successfully in all subject areas of the curriculum. The following responses show these AT planning issues and need:

> *I would like the teacher to tell me when to use the iPad in the classroom. I felt like there was no real plan so it was kind of confusing sometimes.*

> *I would like to know how to use it in my learning for lots of subjects. Not just English lessons.*

> *I always used the iPad for English but was confused sometimes because I didn't know what other subjects I could use it for.*

Theme 5: Recognising the users' and facilitators' optimisms and reservations of AT

The students voice their optimisms and reservations. Two students stated how they were nervous before starting the iPad trial, they were worried about lacking in the skills needed for AT utilisation. Other students expressed their admiration

for the AT, expressing how the AT supported their learning. The following responses epitomise the students' optimisms and reservations:

It was easier to use than I thought it was going to be. I was nervous at the start of training.

I was a bit worried about if I would be able to use the iPads properly in class.

I love the iPads so don't get rid of them.

I don't want the iPad to go. I will miss it because it really helped me do my work in the classroom.

Theme 6: Acknowledging the users' and facilitators' suggestions for future planning and implementation

Under each theme, the students' comments and ideas inform future AT planning and implementation. The direct suggestions given by the students were the desire for learning games and an iPad timetable. The following responses show these suggestions:

More learning games would be fun.

An iPad timetable for the classroom.

4.2.2 Researcher's Reflection

The researcher's reflections will be presented next. She did two weekly reflections and asked the following questions after each week of AT training with the teachers and the students:

- *What worked during the training?*
- *What did not work and could have been more effective? What was missing or needed?*
- *What is important for me to do in future training?*

The researcher's two weekly reflections informed Theme 1, Importance of high quality and relevant AT training.

The Researcher's Reflection for AT Teacher Training

The researcher asked the reflection question, *What worked during the training?* She communicated that there was a sufficient amount of content in the AT training for the teachers, and that it was completed in the week. The AT that was in the training was the iPads accessibility features, two applications and one program. This was evident as the teachers clearly understood the training and could use the AT after the training. The researcher also explained their confidence and ability in training her colleagues after completing two AT courses. Parts of the researcher's reflection that show what worked during the AT training are represented below:

> *The training was completed in the allocated time.*
>
> *I think there was a perfect amount of content in the training plan.*
>
> *I was happy that I chose one application and one program for training and implementation. I have big ideas and plans but I think it is important to start small.*
>
> *After the training, I asked the teachers to show me how to use the iPad features, applications and the program and they were all able to use the AT.*
>
> *As I completed two courses on Assistive Technology, I was confident and capable of giving the training to my colleagues. I found that I could answer their questions too. It was definitely important to get professional training, instead of self-teaching.*

The researcher asked the questions, *What did not work and could have been more effective? What was missing or needed?* She explained that the introduction to the training was not successful as the teachers were nervous at the beginning of the training. The researcher explained that a group discussion on AT was

needed before starting the AT training. The researcher's reflection shows this below:

> *The teachers seemed quite nervous on the first day of the training. Some of them explained that they were anxious about the AT training as they had gotten little or no training in college.*
>
> *I think I should have started the training with a short check-in with the teacher, asking them how they were feeling, about their worries or reservation about AT training and implementation. I believe that this would have started the training off on a more positive note and relaxed the teachers before starting the training. I think it would have helped the teachers to listen to others' worries.*

The researcher expressed that the use of a presentation for the training was missing:

> *At times the teachers asked for information that was given during the training and I wished I had a presentation to refer to. I think it would have been more effective if I had a presentation for the teacher AT training so that teachers could look over the content of the training as I was doing the training,and after the training in case something was forgotten or confusing during the session.*

The researcher voiced that her training was focused on how to use the AT, and that there was not enough on how the teachers should plan for and incorporate the AT in the classroom:

> *Although the teachers were confident in the use of the AT at the end of the training, I think I should have included more about how to plan for the AT in the mainstream classroom.*

The researcher asked the reflection question, *What is important for me to do in future training?* She identified the areas for improvement in the AT teacher training; creating a training presentation, encouraging conversation between teachers

about AT and including more about planning for AT to support the teachers' transition from the classroom environment without AT utilisation to the classroom AT utilisation. The reflective notes below show these.

> *For future training, I would prepare a training presentation that could be emailed to teachers for future reference.*
>
> *I would begin the teacher AT training addressing worries, concerns, and reservations about AT training and implementation.*
>
> *One teacher asked me what subjects she should be using the AT for. I encouraged the use of AT for any literacy exercises throughout the curriculum. This was not enough information and I should have included more information about the planning of AT to support the teachers.*

The Researcher's Reflection for AT Student Training

The researcher asked the reflective question, *What worked during the training?* She communicated that the majority of students were capable of using the features, applications and program after the training. The reflection notes show the majority of students AT capabilities:

> *The majority of students were able to use the AT after the week as they were capable of demonstrating the iPad features, applications and program for their class teachers.*

The students were excited and positive about the opportunity to use the iPads for learning. The notes from the reflection show this enthusiasm:

> *The students were extremely optimistic about the AT training and implementation. When they were practicing using the speech-to-text, text-to-speech, and prediction features, they were so excited and voiced how the features would help them with their reading and writing in class.*

The researcher asked the reflection questions, *What did not work and could have been more effective? What was missing or needed?* She emphasised that the younger students needed more than 1 week AT training. This identification of the need for more AT training for the younger classes is seen in the reflection notes below:

> *I found that the younger students, the 2nd and 3rd class students found it more challenging to grasp than the older students in the time given for training. Although they could demonstrate the AT for their teachers, they needed constant reminders from me and may need the support from the class teachers during this trial.*

The researcher asked the reflection question, *What is important for me to do in future training?* She communicated that she would give the younger students, those at the junior end of the school more training. The section from the researcher's reflection notes below reveals this:

> *For future student AT training, I would plan for more training time for the 2nd and 3rd class students.*

The researcher explains how she would change the future AT training by including more about how to integrate the AT into lessons. The reflection notes below show his:

> *During the training, some students asked me when they should use the AT throughout the school day. At the time of the training, I encouraged them to use the AT for literacy lessons throughout the curriculum. I should have given more guidance to the students on this. The training I created focused too much on equipping the students to use the AT and not enough information on when and how to integrate the AT into their school day.*

The researcher states that video demonstrations would be useful for students' learning and skill building, and would create and use these in future AT training. This idea is shown in the reflection notes below:

I found that some students had forgotten features that were taught to them and needs revision in the following days. I should have created video demonstrations for the features, applications, and program so that the students had these resources to remind them of the features, applications and the program.

4.3 Observations

During the observations of the 10 students, the researcher recorded the descriptive and reflective information. Descriptive notes are defined as objective, whereas the reflective are more subjective (Allen, 2017). The descriptive information explained the settings, roles of participants, social environments and how they interacted with the setting, and direct comments from participants (USC, 2021). The reflective observation notes from the 5 observations will be presented under the identified themes. The researcher's summary of her descriptive observation notes for the 5 observations are presented next.

4.3.1 Summaries of Descriptive Observation Notes for Observations 1-5

Observation 1:

This observation was in term 1 in 2nd Class in the school. I observed the two students who were using the AT and the 2nd Class teacher. The 2nd class students were using the iPads in an English lesson. For the English lesson, they had to read a short story and answer 10 questions. The students used Natural Reader and Notes for the lesson. They had difficulty using Natural Reader and had to ask the teacher to explain to them how to use it. The teacher was able to explain it to them clearly. The students were confident in using it independently after the teacher's explanation. When they were comfortable with it, they used Natural Reader to read the short story for them, using their headphones. When the story was being read to one student, she said "This makes English so much easier". They used Natural Reader to type up their answers to the questions. When One student got 4 typed up and the other got 5 typed up. When they were typing up their answers, one student said "I need to practice my typing. I am so slow". The teachers took up the iPads for correction.

Observation 2:

This observation was in term 1 in 3rd Class in the school. I observed the two students who were using the AT and the 3rd Class teacher in an English lesson. For the English lesson, the students were creating Halloween acrostic poems. One student was very confident in using the iPad, and the other had some difficulty. The confident student supported the unconfident one in using Natural Reader by explaining how to use it. One child said “I love the iPad. I wouldn’t have done that whole poem if I was writing”. Both students completed the poem and read it to the class using the text-to-speech feature.

Observation 3:

The observation was in term 1 in 4th Class in the school. I observed the two students who were using the AT and the 4th Class teacher in a Science lesson. For the Science lesson, the students were learning about the skeleton. The iPads were not used much in this lesson. The students were unsure when to use the iPad. One student asked the teacher, “Do we use the iPad to read the labels on the skeleton?”. The other student said “It is easy to use the iPads for English lessons”. The teacher was unsure of how to answer. The students were labelling a worksheet of a skeleton and wanted to use the iPad but did not know how to do this on the iPad and the teacher was unable to support them.

Observation 4:

The observation was in term 1 in 5th Class in the school. I observed the two students who were using the AT and the 4th Class teacher in a History lesson. For the History lesson, the students were doing project work on WW1. The students typed up many facts using the prediction tool. They were really confident and worked at the same pace as their peers in their project groups. When the facts were collected, the teacher did not take up the iPads for corrections. The students were told that they would get their copies at the end of the school day in order so that they could continue the project at home. The students using the AT were unable to take the iPads home.

Observation 5:

The observation was in term 1 in 6th Class in the school. I observed the two students who were using the AT and the 6th Class teacher in a Geography lesson. For the Geography lesson, the students were learning about mountains in Ireland. The students used Natural Reader to help them read difficult words in the lesson. The students worked independently and at a great pace. During the lesson, one student asked the teacher why the two students were using the iPad to do school work and why she did not have one.

4.3.2 Reflections from Observation Notes for Observations 1-5

Theme 1: Importance of high quality and relevant AT training

I identified that the younger students need more training on the use of the iPad features and applications, as well as more practice on developing their typing skills. I observed that the teachers and older students are competent in using the AT and can work collaboratively and independently. I need to prepare students for a variety of literacy lessons as the AT did not suit certain lesson plans.

The following reflective observation notes represent the insights on AT training:

> *I think the 2nd class students need more training in the AT.*
> *Do the 2nd class need more typing experience/use of TTRS before they are encouraged to type up their work?*
>
> *The teacher is well-trained and can support and facilitate the learning on the iPads.*
>
> *The older students are extremely capable of using the AT that was taught to them in the training.*
>
> *Well trained students can help their peers which is wonderful to see.*
>
> *The iPad training that I gave to teachers and students didn't prepare them for all types of literacy exercises, eg. filling in worksheets.*

Theme 2: Identifying and evaluating the benefits of AT implementation and utilisation

I outlined the benefits of using AT for the participants; curriculum accessibility, opportunities for expression, improved working pace, independent learning, students' confidence in their literacy abilities, and opportunities for teachers to support other students without LD. These are seen in the following observation notes:

> *Students are capable of keeping up with their peers.*
>
> *The students successfully use the text-to-speech feature to help them with their reading comprehension.*
>
> *The students successfully use the speech-to-text and prediction features to complete their written work.*
>
> *The students are working independently.*
>
> *The teacher has the opportunity to work with other students, not only those with LD.*
>
> *The students are confident in their ability to complete exercises.*

Theme 3: Identifying the challenges of AT utilisation and barriers of AT implementation

I identified a lack of connection between school and home for students with LD, difficulties for the teachers in accessing and assessing students' work, teacher and student frustration due to technology malfunction, lack of training in teacher

planning of AT, and a lack of understanding of AT and LD in the classrooms. These challenges are barriers are shown in the following observation notes:

The students are unable to continue their work at home.

The teachers are finding it challenging to correct the students' work.

When the AT doesn't work, the teachers and students become frustrated and uncomfortable.

The teachers and students are unsure of how or when to use the ipads when the lesson is not just a straightforward reading comprehension lesson.

The students' peers are confused as to why certain students get to use AT. What can I or a teacher do to help them understand?

Theme 4: Importance of high quality and well-considered planning of AT

I recognised that Notes is not a sufficient way to store students' work. I will question the plan for another system that will be more beneficial for students and teachers. This question of planning is seen in the following observation notes:

The Notes application is not working for keeping the students' work. Maybe the students should be using Google Drive? Google Drive would allow the students to continue their work at home. Teachers might find it easier to correct the students' work on GoogleDrive?

I acknowledged that the AT implementation plan should include an opportunity for students with LD to present to their peers about how they learn and express themselves using AT. This realisation is seen in the observation notes:

Should the students have the opportunity to explain the AT and why they use it to their classmates? Some students may want to do this and others might not.

I expressed the need for more teacher training on planning for AT in the classroom:

> *More training is needed for teachers on how to plan for the AT in the classroom. It is a challenge going from a learning environment without AT to one with AT.*

4.4 Interview Findings

The interviews conducted with the 5 mainstream classroom teachers will be presented under the 6 identified themes (See Appendix 5 for base questions)

Theme 1: Importance of high quality and relevant AT training

The researcher discovered that the AT training was successful for the senior students from 4th to 6th class as they were proficient in the use of the AT after the iPad training. The students were able to competently demonstrate the AT to their teacher. The senior students used the iPads independently and confidently, and did not need support from their teacher. The following responses show the success of the AT training and the students' AT expertise:

> *The children in my 4th class showed me how to use the iPad. They had a great understanding of how the programme worked and how they were supposed to use the ipads. They were able to clearly demonstrate each aspect of the programme which showed they understood what they were doing.*

> *The girls are in 6th Class so were able to show me how to use the AT. They had a great knowledge of the AT and explained it to me very well felt that they didn't need any extra training as it was explained to me so well by the students.*

> *The children did know how to use the iPad and the programmes that they were using. They seemed to have a very good knowledge of the apps to be used and how to use them. They did not need teacher support at all and were well capable of working with the iPads independently. I think they were both very confident using it as they told me.*

The responses showed that the younger students needed more AT training as they experienced difficulties in using the AT. The following responses exemplify the need for more training:

> *I think that my 2nd class girls could benefit further from more training and continued instruction.*

> *One of my 3rd class pupils had difficulties at times in using some of the assistive technology. I think they both could have done with longer training though.*

The responses typified that more teacher training was needed to support the teachers with their planning and incorporating the AT into their lessons, and across the curriculum. It was found that the AT was successfully implemented in English, however, the teachers found it challenging to implement it into other curricular areas. There is also a need for more training resources to support the teachers during and after the AT training. The following responses show the needs for teacher AT training:

> *I would have liked it if the researcher used a presentation during the training because I think teachers could use something like this after the training is finished like a revision of the training if you understand what I'm saying. I need more training especially to be able to help and support the children in all areas of the curriculum.*

> *I think teachers could use more training to know how to incorporate it into more lessons other than English or so they could include it in their plans.*

> *I feel teachers definitely would need more training as I do feel these could be a great resource in the classroom if we knew more about the various apps and how they can be used and integrated across the curriculum.*

Theme 2: Identifying and evaluating the benefits of AT implementation and utilisation

The responses showed that the benefits of the AT in the classrooms during the AT trial allowed opportunities for engagement, representation and expression (AHEAD, 2017). In relation to engagement, the students were motivated, enthusiastic and confident in their ability when using the AT. The students wanted to show the teachers their work which showed how proud they were of themselves. The students engaged with school work that they previously would have been reluctant to engage with. The following responses show the students willingness to engage in their learning:

> *I noticed a notable boost in both students' self-confidence. In both students, I'd previously noticed a reluctance and unease with having to read and understand a whole page of writing.*

> *They would look forward to practicing their typing and were eager to give things a go with minimal input from me. This enabled them to feel more comfortable in their own abilities, which resulted in them producing a higher standard of work.*

> *I noticed the girls become more enthusiastic about and confident in their work. Their ability to work independently increased and they were better able to express thoughts.*

> *I found they were much more willing to complete tasks than they would have been before. They were also very eager to show me their work and were very proud of it. Previously they would feel insecure about their work due to spelling errors, writing and so on and comparing their written work to others in the class.*

> *They became willing to engage with lessons that they would have previously been nervous to attempt. They were very enthusiastic about working on the programme.*

Regarding representation, the students were able to access their schoolwork as it was presented in a variety of ways that suited their needs. The text-to-speech feature supported the students with their challenges in reading and permitted access to the curriculum.

> *The students could read independently using the text-to-speech functions in the Natural Reader. Like they didn't need me to read out words or didn't ask their friends to either. They just put their earphones in and could do it on their own.*
> *The students used the iPad to help them read the class novel. Normally I would read it to them but they listened to the book and could reiterate what they had listened to.*

The AT enabled the students to express their learning. The responses show that students used the applications to complete their written work using text-to-speech and the prediction features. One teacher explained how it was so beneficial for planning and editing their writing. The AT helped them to complete their work, with independence and at a quicker pace, similar to the pace of their peers. The AT also supported student self-assessment. The following responses show how the AT supported the students in expressing their learning and ideas:

> *The students were definitely able to express themselves more using the iPads. They used a mixture of speech-to-text and prediction. The iPad accessibility features read out words for them or their whole piece of writing.*

> *The girls used it for written exercises. They also used it when planning their creative writing, drafting it and editing it. I found that it worked best with English. The children were able to type up their work and it informed them of any errors which helped them edit their own work. It also read their writing back to them which allowed them to identify any misspellings. They would have found these tasks quite difficult when writing in their copies.*

> *It also enabled the girls to complete work at a much quicker pace than before.*

> *It positively affected class time because the children were able to finish at the same time as the rest of the class.*

The students engaged well immediately and I felt more comfortable in leaving them to work independently. This both allowed them to further improve upon their self-confidence in working independently and gave me an opportunity to further support other students.

Theme 3: Identifying the challenges of AT utilisation and barriers of AT implementation

The challenges of AT utilisation that were identified was lack of technology skills that the younger students had. One teacher explained that her students did not benefit from the AT as they lacked typing skills. Other teachers explained the difficulty in accessing students' work for correction. The responses also showed that the students interrupted the class quite often to ask if and when they could use the AT. The following responses highlight the challenges of AT:

I don't believe that the full benefit was gotten from the notes element, as my students found typing to be a sometimes longer and more concentrated effort.

A challenge that I was faced with was looking at and correcting the students' work. Although I knew how to access their work and would check in regularly throughout a lesson, I didn't often find myself checking their completed work as I would other students.

It affected class time as the children often interrupted class time, asking when they would get to use the iPads.

They also asked frequently throughout the day when was it time to use the iPads which interrupted each lesson.

The barriers of AT implementation identified by the class teachers was the lack of support and training in the planning of AT across the curriculum. Some teachers voiced their inability to integrate the iPads into subjects other than English. These responses from the teachers state the barriers:

I wasn’t sure on how to use the programme for subjects other than English.

I didn't know what other curricular areas to use it in other than English. They wanted to use the programmes for other lessons but I wasn't sure how I could achieve this. I would like more knowledge/training in order to incorporate the programmes in other curricular areas.

I did feel like I had to try to integrate them more into my day and found this difficult as I didn't fully know how I could use them to help the children in other subjects.

Theme 4: Importance of high quality and well-considered planning of AT

In relation to the planning, and matching the AT to the learning, the teachers expressed how the iPads suited the needs of the students. The students used the iPads to support their learning in the areas that they have difficulty with, such as reading comprehension, written work and spelling. The application, Natural Reader was identified as being quite dependable and successful in supporting the students with checking spellings, word recognition, and comprehending their own written work. The responses show that the AT supported the children in completing their exercises, and at a quicker pace and more independently.

The responses below show these findings:

The AT matched the needs of the students entirely. It helped them in areas they struggle most with. I found the natural reader element of the programme great for the children. They were able to use it to identify and correct their own spelling errors. It also aided their comprehension of written pieces. They were able to listen through the headphones and identify more words than if they read it themselves. I found this quite helpful for texts which had difficult or subject-specific vocabulary. It enabled the children to work on certain tasks individually which previously they would have required a lot of help with.

The iPad really helped the girls in this subject as spelling and writing speed was the main issue that held the girls back. Using the AT improved their writing speed impeccably.

Yes, I do think that the AT matched the needs of the student. The student found the speech to text and spell check extremely beneficial.

Theme 5: Recognising the users' and facilitators' optimisms and reservations of AT

The teachers had many reservations about the AT before beginning this AT trail. The teachers felt anxious, nervous and worried. The main reasons for their reservations were the lack of knowledge, training and experience of AT. Many of the teachers voice the lack of AT training in Irish teacher training colleges. One reservation that was evident in the responses was the worry of spending a lot of teaching time on supporting students who used AT. Responses below display the negative emotions that the teachers had towards AT implementation and utilisation:

I was also anxious to recall the minimal amount we had learned in college about AT, but I did not find what I had learned then to be useful in this situation.

I also did not get any training in college regarding these programmes so was unsure how they would work.

I was quite nervous at the start because I had only ever used technology on a whole class level. I was unsure how it would affect the dynamics of the classroom because the other children didn't have access to the iPads.

I was quite worried that the children would have no idea how to use them and that I would have to spend more time explaining them which would take up time in my day.

Before this pilot I was nervous about the iPads because I did not have much training in them myself. I was worried that I would have to put in a lot of time learning about it myself and then put in a lot of time teaching it to the children.

The teachers voiced how they felt after they experienced the AT in their classrooms. Many teachers said that they felt more confident in their AT ability, and

others expressed that they were surprised at how little they had to support the students when using the AT. The following responses support this finding:

> *I am not less frightened of the thought of AT in my classroom. I guess it was just me being afraid of the unknown.*

> *I couldn't believe how well the students mastered the iPads, like they not only didn't ask me for help with it, they were able to do their work more independently.*

> *My students did not need much support when using the iPads. They only asked for me when they needed something corrected.*

Theme 6: Acknowledging the users' and facilitators' suggestions for future planning and implementation

The teachers' suggestions for future AT planning and implementation are, the teachers will need more training and support in implementing the iPads across the curriculum.

> *I was also unsure on how I could best integrate this technology into subjects outside of English and maths, so maybe more training is needed for the planning of AT in all subjects in the curriculum.*

Another suggestion given by a teacher was to incorporate a presentation given by students with LD, and in it they could explain how they learn, and demonstrate their AT for their peers. The teacher believes that this could support students' understanding of LD and AT, and further develop student self-confidence, and self-assessment. The response from this teacher is below:

> *At some point throughout their use, I think that it would be of benefit for the students to demonstrate to students in their class what they use the iPads for and how others can use them too. Not only does this give them the chance to show off their expertise and competence in this area, it also helps to foster an understanding amongst other students of what way it is used. I feel that sometimes why students receive additional support can be kept*

very 'hush hush'. I think it's of undeniable benefit for students to understand how others' brains and thought processes work differently. In the pupils sharing what they've learned to a new audience, this will also serve as a mode of assessing what they know well and are unsure of.

The teachers want the work to be saved in another way. The teachers suggested GoogleDrive as teachers can access the work after iPads are stored in the office, teachers can leave corrections on the work, students can continue work from home and parents have access to their child's school work to monitor difficulties and progress. One teacher stated how Google documents allow the students to see the corrections that the teacher has made, which is not a feature of iPad notes. The responses that show these suggestions are:

I would also like to explore different programmes rather than notes that could be used as I found it difficult when the iPads were being collected each day to have the children's work corrected before the iPads were collected.

I think it would be very beneficial for the children to be working on Google Docs as opposed to notes. Then a record could be kept of all the work and I could access the work after the student went home.

I would like to know more about how to assess the work of students using iPads.Like maybe Google Drive would work better and we used this during school closures so students and parents are used to it.

Maybe have a feature that allows the children to see the corrections the teacher made rather than just changing the work for them. Corrections are seen on GoogleDrive.

Have it attached to Google docs so that teachers could access it at all times not just when the iPads are in the classroom. As sometimes I didn't get around to correct them before they had to be left back to the office to charge.

The teachers were asked if they would join an AT team in the school if one was set up in the future and 80% of the teachers said they would be interested. The teachers expressed that a great amount of training, organisation and planning would be needed in order to set an AT implementation team up, but the 80% of

teachers were enthusiastic about the workload after seeing the benefits of AT during the trial. This finding is clear in the following responses:

> *I would absolutely love to support the implementation of AT within our school if this were to happen. Although I have little training on this myself, I believe that there is a world of possibilities within AT that could help us to even further support so many of our students. I understand that this would require greater time to train, implement and maintain, but I think that the benefit of this pilot far outweighs the challenges.*
>
> *Yes I would like to be part of the AT team. Maybe we dedicate an evening in the week to stay back after school perhaps?*
>
> *Yes I would love to. I have seen the benefits of it and I would love for other students to engage in the programme in my class and other classes also*
>
> *I would be interested in joining the AT team however I feel I would definitely need more experience and training before doing so and I am not sure when this could take place as we are quite busy already, but I do think we could make it work and it would be a great programme to have in our school as it is a great opportunity for those with learning difficulties.*

The findings indicate that AT can be implemented in the mainstream classroom with the appropriate teacher and student training. The results highlight that teachers and students need coaching in how to plan for and integrate the new resource into their school day, as well as support in the transition from a learning environment without AT to one with AT. The results outline the many challenges and barriers in AT implementation, however, if the trainers and teachers are aware of these and plans rigorously, a positive AT implementation experience in a mainstream classroom should be possible to attain. The findings show that the benefits for students and teachers undoubtedly outweigh the heavy workload in AT planning, implementation, and evaluation.

5 DISCUSSION

5.1 Interpretations and Implications

The researcher identified a problem in the school that she is working in. She observed the lack of AT utilisation for students with LD in the mainstream classroom. When investigating the problem, she found that the teaching staff had minimal AT knowledge and training, and barely any experience with AT in the classroom. The researcher has a role in special education in the school and recognised the need for AT implementation in the mainstream classrooms to help students with severe literacy needs who struggle in accessing and participating in the curriculum. This study supports the research by the Irish Department of Education and Skills (2016) in that "Teachers have to be at the heart of any effort to improve learning" (p. 5). As a practitioner, she asked the question, "*How can AT be implemented in the mainstream classroom to support the needs of students with LD*?" with the aim of fostering a more inclusive school environment. The study shows that AT can be implemented in the mainstream classroom to support the needs of students with LD if teachers and students work collaboratively and mindfully in the implementation of AT. Armstrong (2014) communicates that in order to achieve inclusive education, both teachers and pupils must collaborate and reflect on practices. The outcomes of this thesis support this study by Armstrong (2014), as it clearly shows the importance of student and teacher collaboration and reflection in educational reform. The reflective feedback from the researcher, students, and teachers about their experience of this AT trial has informed AT implementation in this school.

There are evidently many patterns and relationships among the quantitative and qualitative data that inform the school on how to implement AT in a mainstream classroom. The research brings attention to training and planning, as well as the benefits, challenges, and barriers of AT implementation. This study also identifies and voices student and teacher ideas around AT for future AT implementation.

5.1.1 Student and Teacher Assistive Technology Training

The findings from the data collected from the participants of this study give insights into the training for AT implementation in the mainstream classroom. For

this study, the researcher started by training the students in a small amount of AT and found that it was a sufficient amount of content to train pupils over a school week. This finding supports the research of Depiereux (2018) who stated the importance of starting small for AT implementation. The AT training was predominantly successful as the researcher acted as the scaffolder in this training, guiding the students through the process of ZPD and scaffolding them towards independent AT utilisation. This approach to training underpins the research by Masouleh and Jooneghani (2012) on Vygotsky's ZPD theory. Although the majority of the students mastered the AT, the younger students needed more training in the AT. As well as needing more training in AT, they lacked experience in some technological skills, compared to the senior students. In this case, a need was identified for early intervention for technological upskilling for typing, to support the implementation of the AT (Hilkemeijer, 2021). The analysis confirms the work of Wynne et al. (2016), in that AT must be carefully considered for individual needs to ensure appropriate AT utilisation. Although student literacy needs were taken into consideration when choosing AT, it was found that it is crucial to question the technological skills of students and to dismiss the myth of 'digital natives', where we assume that students have the appropriate technological skills (McBride, 2018). This finding also supports the work of Edutopia (2007) in encouraging educators to question the type of skills students need in order to use the AT appropriately.

The results show that more information and support needed to be given to students in relation to how to integrate the AT into their learning environments. Although all children could incorporate the AT into English lessons, most students voiced their uncertainty and lack of confidence in AT implementation in other curricular areas. This resulted in the insufficient implementation of AT in these subjects. This finding supports the work of the IRIS Center (2021) in that students find it easier to utilise AT in subjects that have repeated structure and that they would engage with regularly, such as English reading comprehension or writing lessons. Other subjects would have less structure to them and the lesson layout and content would change regularly, such as Social, Environmental, and Scientific Education (SESE).

Regarding the teachers' AT training, all five teachers could successfully use the AT after the training, which reveals that there was an adequate amount of content

in the training. The teachers were capable of facilitating and guiding the students to independent AT utilisation in their learning. This data is in line with Vygotsky's theories of ZPD and the importance of the role of the teacher as a facilitator in the constructivist classrooms (Merrill, 2007). Teachers voiced that they would have benefited more from the AT training if they had a presentation to review or revert to after the completed training sessions. This finding supports the study by Wynne et al. (2016), in that barriers to implementation, occur when required resources are absent. This discovery shows the importance of communication between the AT coordinator and educators to ensure required resources are arranged. The findings also showed that teachers needed more information and support in utilising AT across the curriculum. They were capable of implementing it in English, however, found it more challenging to facilitate it in other subjects. This finding indicates that teachers find it uncomplicated to implement and facilitate AT in academic subjects with which they are familiar. English lessons are taught using repeated frameworks, whereas the teaching methodologies and strategies vary a lot more in subjects, such as those in SESE. This could be the cause for the lack of AT implementation in these subjects (The Iris Center, 2021).

5.1.2 Planning of Assistive Technology

The findings from the data collected from the students and teachers give insights into the planning for AT implementation in the mainstream classroom. Firstly, the study is in line with the work of Wynne et al. (2016) in showing the importance of having a member of staff educated in AT for the whole school AT planning. 70% of students and all teachers were competent in the use of the AT. The study by Wynne et al. (2016) states the significance of taking a phased approach to AT implementation to ensure that the appropriate AT is chosen to meet students' needs. This research shows that a phased approach does not necessarily need to be used, as this study did not used a phased approach and 100% of students said that the AT suited their needs, and instead the researcher chose AT based on the needs identified in each student's SSF file. Consulting SSFs to choose the relevant AT supports the work of the IRIS Center (2021), that states the importance of using the SSFs to decide on suitable AT. English was the subject where AT was utilised the most, and 80% of students expressed their lack of

understanding and confidence in using the AT outside of English. This finding suggests that there was more focus on the ability to understand and use the AT, and not enough attention or time given to the integration of it. This datum reinforces the work of Davis (2011) on the importance of spending ample time on active integration of AT, after a sufficient amount of training is given for AT utilisation. Teachers must be trained in how to plan for AT utilisation in all curricular areas, especially in subjects that they would be less familiar with teaching. Research by the IRIS Center (2021) suggests that without explicit planning of AT for each lesson, AT implementation may not occur. In order to successfully implement AT, the teacher needs to be aware of the many challenges and barriers to AT implementation.

5.1.3 Challenges and Barriers of Assistive Technology

There were many challenges and barriers found in the implementation of AT, such as insufficient AT training and planning, unavailable or ineffectual resources, negative attitudes to AT, and a lack of awareness of AT in the school community. These data concur with the research of Ahmed (2018) on the barriers and challenges of AT.

One of the main challenges found was the difficulty of transitioning from a learning environment without AT to one with the integration of AT. This finding suggests a need for more training on AT planning for the incorporation of AT. The data supports the work of Wynne et al. (2016) in that the implementation of AT is not solely about choosing suitable AT for the pupils, but supporting them with the change in their learning environment, transitioning from no AT to AT utilisation. Some teachers voiced that this lack of planning caused regular disruptions in the classroom with the students asking when they could use the AT. These interruptions not only reduce the time for AT implementation but also take away from the overall learning time.

The lack of AT resources after training sessions caused barriers to implementation as students and teachers did not have resources to consult when AT issues arose. This supports the research of Wynne et al. (2016) on barriers arising due to ineffective AT resources. All participants agreed that another type of resource

for storing the school work must be sourced as it caused barriers in the AT implementation. The main barrier was the disconnect between schoolwork and homework. The iPad 'Notes' disallowed the students to continue their work at home. This also interrupted the communication between school and home and possibly distanced the parents/guardians from their children's schoolwork. This supports the research by the IRIS Center, which states the importance of AT utilisation in both the school and home for AT implementation to be successful (2021). The teachers voiced that access was limited to the students' schoolwork using 'Notes' as the iPads were stored in the school office at the end of each school day. This barrier is in line with the research of Ahmed (2018) on AT utilisation causing inadequate student assessment.

The researcher and one teacher identified a possible challenge and barrier in AT implementation, that is the lack of understanding of AT that students without LD have. They both witnessed students questioning the AT and the need for it. This unawareness that students have of AT and LD could cause discriminative bullying during AT implementation as incomprehension and suspicion between people in relation to disability is the cause of this type of bullying (Elamé, 2013). It is imperative that teachers and students reflect on the challenges and barriers of AT implementation to inform the next cycle of action research in this school (Harrison, 2008).

5.1.4 Benefits of Assistive Technology

This study shows that AT can be successfully implemented and be of benefit for students with LD if the teachers are guided by the principles of the UDL educational framework. These principles encourage multiple methods of engagement, representation, action, and expression (AHEAD, 2017). The benefits of this AT trial allowed the staff to instil the principles of UDL. In using the AT, the teachers facilitated a learning environment where students of multiple intelligences had the opportunity to learn and show their learning. This finding underpins the theories of Gardner's Multiple intelligences (Nicol, 2014) and the research of Wynne et al. (2016) in how AT supports diverse learners.

The results of this study show how students are able to engage in the classroom by using AT. The majority of the teachers communicated how the students improved in classroom engagement, how they had a more positive attitude to learning and were motivated to learn. The data show how AT empowers independent learning. This is in concurrence with studies by Bouke and Long (2020) and Masouleh and Jooneghani (2012) which show how AT supports autonomy as it gives students the opportunity to take control over their learning. It has been identified in research by Pandy (2012) students who have control over their learning, have more positive self-esteem. This finding is in agreement with Panesi et al. (2020) on how AT promotes positive well-being in school for children with LD. The data show that AT enabled students with LD to attain the same pace of learning as their peers which is in line with work carried out by Atanga et al. (2020) on how AT bridges the gap between students with LD and their peers without LD. This trial showed that AT allows for students to engage in active learning by representing the content in various ways to allow for meaning. Participants expressed opportunities for text-to-speech which assist students with literacy difficulties. The data underpins the theory of active learning as students benefited from actively participating in their own learning (Pardjono, 2016). Regarding action and expression, the participants used prediction and speech-to-text which gave them the opportunity to demonstrate and present their learning, as well as self-assess. This finding shows how students learn by discovering their own learning which supports Bruner's theory on discovery learning (Merrill, 2007).

5.1.5 Reservations

This study highlights the importance of identifying the reservations that both students and teachers have with the introduction of a new initiative in the school. One significant finding from this research was the teachers' apparent anxieties about AT before the training due to their lack of training and experience with AT. The data support the studies by Ahmed (2018) and Wynne et al. (2016) as these researchers express the negative attitudes that teachers have to AT before experiencing AT implementation. Sullivan (2019) expresses how these negative attitudes stem from misconceptions of AT. This finding stresses the importance of promoting conversation about AT amongst teachers in schools to reduce this fear of AT and develop positive attitudes towards AT, consequently encouraging AT

implementation. This study also found that some students had worries about AT. These worries could potentially negatively impact AT implementation in schools if students have these feelings about AT. These findings show the significance of fostering a school culture that encourages open and effective communication around AT (Wynne et al., 2016).

5.1.6 Optimisms

This study shows that student and teacher reservations were transformed into positive attitudes through experiencing the AT in the classroom. This supports the ideas of Sullivan (2019), that through experiencing AT, people can re-evaluate their relationships with AT. Even the younger students who had difficulty with the AT, were optimistic for their future use of AT if given the opportunity for more AT training. This finding is in line with the work of Flewitt et al. (2015) in their discussion on how iPads excite students and motivate utilisation. Most of the teachers voiced their interest in becoming part of an AT implementation team which is suggested in research by the IRIS Center (2021). Teachers state that they are aware of the workload, but after experiencing this trial believe that the workload is worth the benefits that ensue for students with LD, and how it promotes an inclusive school community.

5.1.7 Suggestions

This study shows the value in encouraging participants to reflect on their experiences of AT as they can inform, build on and refine AT implementation to enhance teaching and learning. From participating in the AT trial in the school, both the teachers and students could reflect on their experiences (IRIS Centre, 2021) and voice suggestions for how AT implementation can take place. The discovery of the importance of reflection supports Harrison's (2008) work on the crucial act of teacher reflection. One significant suggestion for AT implementation from a teacher was the idea of encouraging students with LD to communicate to their peers about how they learn and how the AT supports their learning. This could encourage positive conservations and attitudes towards AT. As discussed, teachers and students have suggested more support for the planning of AT and have requested another programme for storing school work, with the desire of bridging the connection between school and home.

As the Irish curriculum is changing, with an aim of incorporating the UDL principles to encourage truly inclusive educations in Ireland, research on AT implementation in Irish schools is crucial. The results of this study are important as they inform how AT can be implemented in this Irish mainstream primary school. The data informs the staff of this school how to implement AT, as well as being a resource for informing the next cycle of the action research for AT implementation in this school. In the NCSE research by Wynne et al. (2016), "Assistive technology/Equipment in Supporting the Education of Children with Special Needs-What works best?", the authors present how AT implementation in Ireland is lacking compared to other countries, and NCSE states the need for progression in the area of AT utilisation in schools. The study by Wynne et al. (2016) draws on ways of improvement from researching AT in other countries. The data from this research in an Irish primary school contributes to a clearer understanding of AT implementation in an Irish primary school. This study agrees with the worldwide list of best practices collected by Wynne et al. (2016) in that the following aspects of implementation are crucial: collaboration between all stakeholders, utilising students SSFs, ensuring the students and teachers are competent in the AT, and the promotion of a positive attitude to AT. This study provides insight into the transition of learning environments for students with LD and their teachers with the introduction of new technologies. It emphasises the importance of supporting the students' and teachers' well-being and the significance of planning for this transition. The research also gives insight into the use of AT for select students in a mainstream classroom where students with LD and without LD learn in close proximity.

5.2 Limitations

There are a number of limitations to this study. The generalisability of the results is limited by gender, nationality, age, and needs of the participants. The researcher, the 10 students, and the 5 classroom teachers are all female and of Irish Nationality. The students in this study ranged from 8 to 12 years. This is an all-girls school and all staff is Irish. There are students of many nationalities, students aged 7 to 13 and male teachers on the staff, therefore these results do not represent AT implementation for all students and teachers in this school. The study does not represent the students aged 7 years or 13 years, the students with

various nationalities who do not have English as their first language, and male teachers. This generalisability of the results is also limited by the needs of the students. All students in the sample have severe literacy difficulties, however, there are many students with literacy needs that present as less severe. The results do not represent these students. They also do not represent all students with LD in the school as the LD varies in types and severity.

The AT training lacked in preparing teachers and students to implement AT across the curriculum. Due to the lack of data on AT implementation in subjects other than English, Geography, History, and Science, the results cannot confirm how AT can be implemented in the other subjects of the Irish curriculum. The majority of the data showed the implementation of AT in English lessons. Within these limitations, the results can still give valuable insights into AT implementation to support students with LD in the mainstream classroom.

6 Conclusion and Recommendations

In Ireland, there is insufficient AT utilisation in mainstream primary schools. There is a need for teachers to engage in action research under the UDL principles in this area to promote and inform the use of AT in Irish schools (Wynne et al., 2016). This research aimed to answer the question, "*How can AT be implemented in the mainstream classroom to support the needs of students with LD*?" The researcher observed the lack of AT utilisation in her school and the need for it to support students with learning difficulties. In order for the researcher to answer this question, she began with the literature review, outlining the main studies around SEN and AT implementation in the classrooms for students with LD. The study employed action research methodology with mixed methods data collection and analysis. The quantitative data were analysed by using cross-tabulation and the qualitative data with thematic analysis.

Collaboration and participants' reflections were found to be enlightening in AT implementation. The analysis showed findings in five main areas of implementation: training and planning, benefits, challenges, and barriers of implementation, as well teacher and student perceptions of AT. The findings showed that AT implementation can occur when the appropriate teacher and student training takes place, and when relevant AT and class planning occur. The data from this study inform the school of the benefits of AT for students with LD, as well as the possibilities of AT in fostering a commitment to inclusion, equality of opportunity, and the holistic development of all students (Department of Education and Skills, 2016).

With the evolving education system in Ireland, the staff were enthusiastic and acknowledged the importance of AT implementation in ensuring that "all students are provided with learning opportunities that recognise and celebrate their uniqueness and develop their full potential" (Citizens Information, 2021). The action research encouraged the participants to reflect on their experiences of the AT trial in the school and consider further research and studies for AT implementation.

6.1 Future Research

The findings from this study will inform the next cycle of action research for AT implementation in the school, and highlight the issues and areas where further research is needed. Based on the conclusions of the study, the teacher-researcher and teachers of this school should consider further research on the planning of AT across the curriculum, and carry out individual research on each subject. Further research is required to establish how to support both students and teachers in the transition from a learning environment without AT to a classroom where AT is utilised. Additional research should revise the AT training to better understand its approach, content, and resources for pre-training and post-training. Further studies should take the younger students' ICT skills into consideration and carry out research on early intervention for ICT skills before. Teachers could benefit from conducting research on addressing the anxieties of students and teachers to promote positive well-being and attitudes towards AT before implementing it. Another topic that is in need of research in this school is addressing peer curiosity on LD and AT. A final suggestion for a future study is to determine alternative programmes or applications for storing schoolwork, and to identify the significance of these resources on student assessment and on the communication between school and home. All of these studies would build on and enrich the results of the present study on AT in facilitating the redevelopment of the Irish primary curriculum in the school.

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APPENDICES

Appendix 1. Teachers' Survey Questions

1.Do you have any assistive technology training?

- ☐ Yes
- ☐ No

2. Do you have any iPad training?

- ○ Yes
- ○ No

3. Do you know how to use the accessibility features on the iPad?

- ○ Yes
- ○ No

4. Have you ever used text-to-speech and/or speech-to-text applications/software?

- ○ No, neither.
- ○ Yes, both.
- ○ Only text-to-speech
- ○ Only speech-to-text

5. Have you ever ran a typing program in your classroom?

- ○ Yes
- ○ No

6. Do any of your students with learning difficulties use an iPad or any form of assistive technology in the classroom to access the curriculum?

- ○ Yes
- ○ No

7. Do you think your students with learning difficulties would benefit from using assistive technology in the classroom, eg. iPad?

- ○ Yes
- ○ No

8. Do you think your students would benefit from iPad training?

- ○ Yes
- ○ No

9. How confident are you in using the school iPads?, 1 being very unconfident and 5 being very confident.

- ○ 1
- ○ 2
- ○ 3
- ○ 4

- 5

10. Would you like some training in classroom assistive technology, eg. iPads?

- Yes
- No

Appendix 2. Students' Survey Questions

Student Survey Questions

1. *Do you think you need more training on the AT that you used this term?*
2. *Were you confident using iPad Notes?*
3. *Were you confident in using Natural Reader?*
4. *Did you enjoy the experience of using the iPads throughout your school day?*
5. *Do you think the iPads helped you to do your reading in class?*
6. *Do you think the iPads helped you to do your written work in class?*
7. *Do you think the iPads made you be a more independent learner?*
8. *Do you think the iPads made you feel more confident in the classroom?*
9. *Other than English lessons, were you confident in when and how to use the iPads in the classroom?*
10. *What subjects did you use the iPads for?*
11. *What was the main subject you use the iPad in?*
12. *Would you like to use the iPad in the classroom every day?*
13. *Did you enjoy the typing programme (TTRS)?*
14. *Do you think your typing has improved since you started using the typing programme (TTRS)?*
15. *Do you think the iPad suited your learning needs?*
16. *Do you have any comments to make or ideas for the iPads after using them in your classroom?*

Appendix 3. Student Consent Form

Thesis Title: Assistive Technology Implementation in the Mainstream Classroom to Support Children with Learning Difficulties

Dear Parents,

I, Alexandra Corr, am currently undertaking a Master's Degree in Educational Leadership in Tampere University of Applied Sciences. This Master's Degree Programme is a unique collaborative distance-learning programme. Before the COVID-19 outbreak, I had the opportunity to visit my university on a couple of occasions to observe the teaching and learning in Finnish primary schools. These visits, alongside numerous course modules over the past two years have encouraged me to question current and new practices in teaching and learning in special education. For my thesis, I will be carrying out an action research project in the school, which will explore if, and how the use of Assistive Technology can be implemented into the mainstream classroom to support students with their learning. Assistive Technology is a term used for an assistive device for people with learning difficulties. In this case, the assistive technology is an iPad.

The purpose of this form is to provide you (as the parent of a prospective research study participant) information that may affect your decision as to whether or not to let your child participate in this research study. I will describe the study to you and answer all your questions. Read the information below and ask any questions you might have before deciding whether or not to give your permission for your child to take part. If you decide to let your child be involved in this study, this form and your consent through email will be used to record your permission.

Purpose of the Study

If you agree, you will be asked to participate in a research study, which will explore assistive technology implementation for children who have literacy difficulties in a mainstream classroom. The purpose of this study is to find out how assistive technology can be implemented in the mainstream classroom

for students with literacy difficulties. The study will question the effectiveness, as well as the logistics of the implementation of this type of assistive technology into a mainstream classroom, and the role of the school, teacher and student.

What is my child going to be asked to do?

If you allow your child to participate in this study, they will be asked to take part in iPad training and will use the following features and applications in the classroom:

- iPad accessibility features
- iPad 'Notes'
- Natural Reader
- TTRS (Touch, Type, Read & Spell).

Your child will use the iPad in the classroom in the first term of the school year 2021. In using the above iPad features and applications, your child will have the opportunity to use the following:

- Text-to-speech
- Speech-to-text
- Word prediction
- Typing skills practice

Your child will also be asked to answer an anonymous survey about the AT implementation at the end of the trial.

The class teachers have been trained in; in case your child has any issues or questions with the assistive technology. I will be available to support both students and teachers during the assistive technology implementation trial.

In order to create the training for the students and teachers, I completed two courses on Assistive Technology in the summer; one with Enable Ireland and the other with UrAbility, in addition to trialing and testing various features and applications.

The action research will take place from September to November 2021. There will be nine other students taking part in this study; two students from each class level.

By the end of this research, the class teachers will have had the opportunity to observe these students in the classroom without and with the assistive technology.

The class teachers will be interviewed at the end of the trial about their observations of the use of the assistive technology in the mainstream classroom.

I will be writing up assistive technology recommendations for the school from my findings, and will share these with all parents.

What are the risks involved in this study?

NOTE: If risks are minimal include the statement: There are no foreseeable risks to participating in this study.

What are the possible benefits of this study?

The possible benefits of participation are:

- Training in the iPad accessibility features and applications stated above.
- Developing ICT (Information Communication Technology) skills.
- Use of the iPad as a tool and resource in the classroom to access the curriculum.
- Becoming a more independent learner.

Does my child have to participate?

No, your child's participation in this study is voluntary. Your child may decline to participate or to withdraw from participation at any time.

This research study will take place during regular classroom activities.

How will your child's privacy and confidentiality be protected if she participates in this research study?

Your child's privacy and the confidentiality of his/her data will be protected as the data will contain no identifying information that could associate it with your child, or with your child's participation in the study.

Whom to contact with questions about the study?

Prior, during or after your participation you can contact the researcher Alexandra Corr by sending an email to XXX for any questions. This study has been reviewed and approved by Tampere University of Applied Sciences.

Please read this document carefully and send me an email in response if you agree to allow your child take part in this research. Please state the following in the email:

'I, **full name** have read the consent form and give my child, **name** permission to take part in the research study conducted by Alexandra Corr.

Signature: **name or initials**'

Your privacy and your child's privacy again will be protected and no identifying data from your response email will be shared.

Response email stating your permission to allow your child to participate in the study

You are making a decision about allowing your child to participate in this study. Your below indicates that you have read the information provided above and have decided to allow them to participate in the study. If you later decide that you wish to withdraw your permission for your child to participate in the study you may discontinue her participation at any time.

Appendix 4. Teacher Consent Form

Teacher Consent Form for Participation in Research

Thesis Title: Assistive Technology Implementation in the Mainstream Classroom to Support Children with Learning Difficulties

Dear Teachers,

I, Alexandra Corr, am currently undertaking a Master's Degree in Educational Leadership in Tampere University of Applied Sciences. This Master's Degree Programme is a unique collaborative distance-learning programme. Before the COVID-19 outbreak, I had the opportunity to visit my university on a couple of occasions to observe the teaching and learning in Finnish primary schools. These visits, alongside numerous course modules over the past two years have encouraged me to question current and new practices in teaching and learning in special education. For my thesis, I will be carrying out an action research project in the school, which will explore if, and how the use of Assistive Technology can be implemented into the mainstream classroom to support students with their learning. Assistive Technology is a term used for an assistive device for people with learning difficulties. In this case, the assistive technology is an iPad.

The purpose of this form is to provide you (a prospective research study participant) information that may affect your decision as to whether or not to participate in this research study. I will describe the study to you and answer all your questions. Read the information below and ask any questions you might have before deciding whether or not to give your permission. If you decide to participate in this study, this form and your consent through email will be used to record your agreement.

Purpose of the Study

If you agree, you will be asked to participate in a research study, which will explore assistive technology implementation for children who have literacy difficulties in a mainstream classroom. The purpose of this study is to find out how assistive technology can be implemented in the mainstream classroom

for students with literacy difficulties. The study will question the effectiveness, as well as the logistics of the implementation of this type of assistive technology into a mainstream classroom, and the role of the school, teacher and student.

What will I be asked to do?

If you agree to participate in the study, you will be asked to take part in iPad training and will facilitate your students in using the following features and applications in the classroom:

- iPad accessibility features
- iPad 'Notes'
- Natural Reader
- TTRS (Touch, Type, Read & Spell).

Your students will use the iPad in the classroom in the first term of the school year 2021. In using the above iPad features and applications:

- Text-to-speech
- Speech-to-text
- Word prediction
- Typing skills practice

I will be available to support both you and your students during the assistive technology implementation trial.

In order to create the training for the students and teachers, I completed two courses on Assistive Technology in the summer; one with Enable Ireland and the other with UrAbility, in addition to trialing and testing various features and applications.

The action research will take place from September to November 2021. There will be ten students taking part in this study; two students from each class level.

Class teachers will be interviewed at the end of the trial about their observations of the use of the assistive technology in the mainstream classroom.

I will be writing up assistive technology recommendations for the school from my findings, and will share these with all members of the school community.

What are the risks involved in this study?

NOTE: If risks are minimal include the statement: There are no foreseeable risks to participating in this study.

What are the possible benefits of this study?

The possible benefits of participation are:

- Training in the iPad accessibility features and applications stated above.
- Developing ICT (Information Communication Technology) skills.
- Use of the iPad as a tool and resource in the classroom to access the curriculum.

How will my privacy and confidentiality be protected if I participate in this research study?

Your privacy and the confidentiality of your data will be protected as the data will contain no identifying information that could associate it with you or with your participation in the study.

Whom to contact with questions about the study?

Prior, during or after your participation you can contact the researcher Alexandra Corr by sending an email to XXX for any questions. This study has been reviewed and approved by Tampere University of Applied Sciences.

Please read this document carefully and send me an email in response if you agree to take part in this research. Please state the following in the email:

'I, **full name** have read the consent form and agree to take part in the research study conducted by Alexandra Corr.

Signature: **name or initials**’

Your privacy will be protected and no identifying data from your response email will be shared.

Response email stating your agreement to participate in the study

You are making a decision about participating in this study. Your below indicates that you have read the information provided above and have decided to allow them to participate in the study. If you later decide that you wish to withdraw your agreement of participation in the study you may discontinue your participation at any time.

Appendix 5. Interview Base Questions

Interview Base Questions

1. *Please describe your experience of the pilot programme in your classroom.*
2. *Did the students know how to use the AT that they were trained in?*
3. *Did you observe any benefits from using the iPads in the classroom for the students with learning difficulties in the mainstream classroom?*
4. *Did you observe any barriers from using the iPads in the classroom for the students with learning difficulties in the mainstream classroom?*
5. *How did you feel about assistive technology utilisation in the classroom before this pilot? And how do you feel now about AT use in the classroom?*
6. *Do you think the AT matched the needs of the students?*
7. *After having the AT pilot project in your class, please give recommendations for planning, implementation, and evaluation of AT.*
8. *Would you be interested in joining the AT implementation team in our school if we were to start one?*