Science and Mathematics Education Centre

Understanding the Number Sense Competence of High School Students with Borderline, Mild and Moderate Intellectual Disabilities

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DECLARATION

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university. The research presented and reported in this thesis was conducted in accordance with the National Health and Medical Research Council National Statement on Ethical Conduct in Human Research (2007) – updated March 2014. The proposed research study received human research ethics approval from the Curtin University Human Research Ethics Committee (EC00262), Approval Number HR188/2013.

Signature: …………………………………………

Date: 24th May 2017

ABSTRACT

The study investigated selected elements of teacher-related factors, including the mathematics teaching efficacy beliefs of teachers towards students with intellectual disabilities (ID). It also examined student-related factors such as IQ, age, gender, anxiety and self-efficacy in order to understand their influence on the mathematics achievements of students with Borderline, Mild and Moderate ID. The relationship between students' achievements and two different instructional approaches, as well as the suitability of four assessment tools for students with ID, were also evaluated. Students' mathematics achievements were compared at the pre- and post-intervention phases of the study over a six-month period using four assessment tools.

Data for this study were gathered from a specialist school dedicated to the education of students with ID. Twenty-four students with diagnoses of ID ranging from Full Scale IQ Scores of 40 to 79 along with sixteen staff, consisting of five teachers and 11 education assistants, participated in this study. The IQ assessments were carried out by a qualified school psychologist in collaboration with a lead/senior school psychologist, both employed by an Australian Department of Education.

A mixed (qualitative and quantitative) methodology was used for this action research study, with a variety of procedures used for data collection. These included interviews, questionnaires (administered at both the pre- and post-intervention phases of the study), observational data (examining every piece of work completed by each student during the study), audio recordings and the school's biographical records of student participants. The efficacy beliefs of the teachers were measured using the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) authored by Enochs, Smith and Huinker (2000). Each teacher completed the MTEBI at the beginning of the study (pre-instruction) and six months after (post-instruction). The Mathematics self-efficacy instrument used in this study was an adaptation of the instrument described by Joet, Bressoux and Usher (2011). It was modified to make it relevant and more appropriate for students with ID. Statistical analyses were undertaken with *Minitab 17 Software* (Minitab Inc, 2010) and ConstructMap (Wilson, 2005). The self-efficacy instrument was administered orally to students twice at six months

intervals, and clarifications were provided where necessary to ensure the participants understood the questions.

Among the outcomes of this study is the finding that all five teachers demonstrated high outcome expectancy and self-efficacy beliefs in their ability to teach mathematics to students with ID. On the relationship between IQ and students' achievements in Mathematics, the study showed that on the average, students with higher cognitive ability did better than their lower IQ counterparts, however IQ did not have an absolute bearing on individual students' mathematics achievements in the tests. There were many instances where some students outperformed others with IQ scores ranked above them. There was overwhelming evidence from the study that age and gender are not factors that influence the mathematics achievements of students with ID. With regard to the mathematics self-efficacy of students, the study found no strong correlation between the mathematics self-efficacy of students with ID and their achievements in Mathematics or with the categories of ID.

The various scenarios that emerged from the study include students with low mathematics self-efficacy who achieved high scores in the tests, students with high mathematics self-efficacy who achieved low scores in the tests, students with high mathematics self-efficacy who achieved high scores in the tests and students with low mathematics self-efficacy who achieved low scores in the tests. These results further reinforced the importance of individualised mathematics education for students with ID. In the main, the findings have demonstrated that no singular factor accounted for the mathematics achievements of students with borderline, mild and moderate ID. Instead, it was the interplay of several factors, thus pointing strongly to students' individuality. The IMPELS instrument (Individualised Mathematics Planning and Evaluation of Learning for Students with ID), which was developed as part of this study, was ranked higher than the other three tools as the most preferred tool for students with ID.

DEDICATION

This thesis is dedicated to:

My mother

Vero Igbinigiesu Enoma

My late father

Napoleon Osawaru Enoma

who taught me at a tender age to appreciate the joy in reading and writing.

To my wife

Endurance Enoma

A jewel of inestimable value and an anchor who has stayed
by me through thick and thin.

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I wish to express my profound gratitude to my parents for stimulating my interest in learning at a tender age and for denying themselves tremendously that I may have knowledge and an income. Finally, I wish to express my gratitude effusively to my beloved wife and 3 children for enduring many countless days and nights without me and for showing great understanding on those numerous occasions during which I made the library my home.

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LIST OF ABBREVIATIONS AND GLOSSARY OF TERMS

Term	Definition
AAC	Alternative or Augmentative Communication
AAIDD	American Association on Intellectual and Developmental Disability
ABAS II	Adaptive Behaviour Assessment
ABLES	Abilities Based Learning and Education Support
ABS	Australian Bureau of Statistics
ACARA	Australian Curriculum, Assessment and Reporting Authority
ADHD	Attention Deficit Hyperactivity Disorder
AITSL	Australian Institute for Teaching and School Leadership
APA	American Psychiatric Association
AR	Action Research
ASDAN	Award Scheme Development and Accreditation Network
Boardmaker	Boardmaker is a software used in many special education schools to create visuals or symbols adapted curriculum materials to support the learning needs of students with disability.
BSP	Behaviour Support Plan
COAG	Council of Australian Governments
Constructivist Paradigm	That people construct their own knowledge and meaning (understanding) of the world from their experiences. It involves an active, contextualized process of constructing knowledge in contrast to acquiring knowledge.
CPFS	Department of Child Protection and Family Services (CPFS)
CRA	Concrete-Representational Abstract
DDA	Disability Discrimination Act

DEEWR	Australian Government Department of Education, Employment and Workplace Relations
DETWA	Department of Education & Training of Western Australia
DSE	Disability Standards for Education
EAP	Education Adjustment Plan
ER	Experience Recorded
ESC	Education Support Centre
FASD	Foetal Alcohol Spectrum Disorder
GH	Gestural Help
HREC	Human Research Ethics Committee
Human Functioning	Refers to all body functions, activities and participation (WHO, 2002).
IBP	Individual Behaviour Plan
ICF	International Classification of Functioning, Disability and Health
ID	Intellectual Disability
IEP	Individual Education Plan
IMPELS	Individualised Mathematics Planning and Evaluation of Learning Tool for Students with Intellectual Disability.
Interpretivist Paradigm	The world view that knowledge is socially constructed and reality is ultimately subjective.
IPS	Independent Public Schools
ITP	Individual Transition Plan
IQ	Intelligence Quotient
Mastery Experience	Past experiences with success leads to greater beliefs in one's ability.
MCEECDYA	Ministerial Council for Education, Early Childhood Development and Youth Affairs Australia
Min Counting	Counting-on by starting from the larger number.
MSSD	More Support for Students with Disabilities
MTEBI	Mathematics Teaching Efficacy Belief Instrument

MTOE	Mathematics Teaching Outcome Expectancy
Numeracy	The aggregation of skills, knowledge, behaviours and disposition that people need to effectively use mathematics in a wide range of situations including home, work and the community.
PD	Performance Descriptions
PH	Physical Help
PLP	Personalised Learning Plan
NAPLAN	National Assessment Program — Literacy and Numeracy
NCCD	Nationally Consistent Collection of Data on Students with Disability
NDIA	National Disability Insurance Agency
NDIS	National Disability Insurance Scheme
NH	No Help
NHMRC	National Health and Medical Research Council
Number Sense	Refers to the fluidity and flexibility with numbers that arise from a person's general comprehension of number and operations together with the ability and disposition to employ this understanding in a variety of ways to make mathematical judgements and to acquire valuable strategies for manipulating numbers and operations
OECD	Organisation for Economic Cooperation and Development
Paradigm	A paradigm is a philosophical or an ideological position held by a researcher. It is a system of beliefs about the nature of the world, an assumptive base from which new information or knowledge is discovered. It is characterised by **ontology** (What is reality?), **epistemology** (How do you know something?) and **methodology** (How do go about finding out?) (Guba & Lincoln 1994, p. 107).

Physiological states	Stress, moods, emotions, and physical reactions that may impact on personal abilities.
Positivist Paradigm	The belief that reality is fixed and that objective knowledge can be produced through rigorous methodology.
RMP	Risk Management Plan
PMTE	Personal Mathematics Teaching Efficacy
SE	Sensory Experience
Self-Efficacy	The belief in one's capabilities to organise and execute the courses of action required to manage prospective situations (Bandura 1995, p. 2)
SENAT	Special Education Needs Assessment Tool
SH	Spoken/Signed Help
SMART	Specific, Measurable, Achievable, Realistic and Relevant as well as Time-limited
Social Persuasions	Believing in one's capability due the encouragement and motivation received from others.
Sum Counting	Counting both addends starting from 1 — counting-all approach
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNICEF	United Nations Children's Fund
VABS	Vineland Adaptive Behavior Scale
Vicarious Experience	Observing other people carrying out a task helps one to undertake similar tasks by imitation.
WAESPAA	Western Australian Education Support Principals and Administrators Association
WHO	World Health Organisation
WISC-IV	Wechsler Intelligence Scale for Children Fourth Edition
Writing with Symbols	Writing with Symbols is a software used in many special education schools to create visuals or

	symbols adapted curriculum materials to support the learning needs of students with disability.

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Chapter 1

INTRODUCTION

1.1 Introduction to this Study

The primary focus of this research study was to determine if improved mathematics instruction for students with intellectual disabilities (ID) could be achieved by implementing the outcomes of the study.

In the past, educating individuals with ID was seen as an exercise in futility (Chomba, Mukuria, Kariuki, Tumuti & Bunyasi, 2014) because of the generally held notion that they were not capable of making progress. ACARA (2010) has acknowledged that “many students with special education needs are able to achieve educational standards commensurate with their peers, provided the necessary adjustments are made to instructional processes and to the means through which they demonstrate their learning” (p. 5). As a subset of special education, this observation recognises the fact some students with ID are capable of making educational improvements depending on the quality of teaching at their disposal. Quality, equity and inclusive education have been acknowledged as the determinants of performing education systems for schools of the 21st century and beyond (Organisation for Economic Cooperation and Development − OECD, 2012; United Nations Educational, Scientific and Cultural Organisation − UNESCO 2013; United Nations Children Fund — UNICEF, 2000).

In many parts of the world today, schools (including special education schools) are under intense pressure from their governments and relevant authorities to provide quality, equitable and inclusive education for their students (Frieden, 2004; Teicher, 2007; Adjacent Open Access, 2015). It is increasingly becoming obvious that high enrolment and regular school attendance figures alone are not sufficient to achieve improved educational outcomes for students, particularly in the light of the findings that “despite increased enrolments, an estimated 250 million children cannot read, write, or count well, whether they have been to school or not” (UNESCO, 2013, p. 2). It has also been observed that “across the world, 200 million young people leave school without the skills they need to thrive, plus an estimated 775 million adults" (UNESCO, 2013, p. 2). The Australian federal government has adopted a number of strategies in recent years aimed at improving the quality of education of all Australians, and to keep the Australian educational system at par with other developed nations and with renowned educational systems such as those in the United States, the United Kingdom and Canada.

This introductory chapter provides a synopsis of my study in the following order:

Section 1.2	Improving the Quality of Education in Australia
Section 1.3	Improving the Quality of Education for Students with Intellectual Disabilities in Australia
Section 1.4	Rationale of the Study
Section 1.5	Objectives of the Research
Section 1.6	Research Questions
Section 1.7	Significance of the Study
Section 1.8	Overview of the Thesis

1.2 Improving the Quality of Education in Australia

The recent educational reforms aimed at improving the quality of education in Australia are as elaborated upon below:

1.2.1 Improving teacher quality – Australian Professional Standards for Teachers. Teacher quality has been acknowledged as the singular most important factor influencing student achievement and engagement (Queensland Department of Education and Training, n.d. p. 1; Australian Institute for Teaching and School Leadership − AITSL, 2011a, p. 1; Council of Australian Governments – COAG, 2008; COAG, n.d.). The Commonwealth government of Australia (through the Council of Australian Governments) has taken a leading role to effect a systemic change aimed at improving the quality of teaching and leadership in Australian schools. One important outcome of a COAG-initiated effort to improve quality is the development of the *Australian Professional Standards for Teachers* which was introduced in 2011 (AITSL, 2011a). The standard consists of specific skills and knowledge areas which AITSL has described as ‘the key elements of quality teaching’ that teachers must demonstrate while progressing through the career stages of Graduate, Proficient, Highly Accomplished and Lead Teacher (AITSL, 2011a, p. 1). These skill areas are organised into the three sub-headings of professional knowledge, practice and engagement. The skills under the professional knowledge domain include an expectation for teachers to have the knowledge of their students and their learning styles as well as to possess a sound knowledge of the learning areas they teach and how to teach it. Under the professional practice domain, The Australian Professional Standards for Teachers is used widely in schools for the management of a teacher’s performance and also by the Teachers Registration Boards of the various states and territories for the registration and accreditation of teachers and by professional association.

1.2.2 Improving the quality of school leadership – Australian Professional Standards for Principals. Educational leadership is among the key factors impacting on successful school improvement (Mulford, Silins & Leithwood, 2004). This view point was supported by the Australian Institute for Teaching and School Leadership (2011b), acknowledging that school leaders have a crucial role to play in establishing high standard of performance for schools and improving the educational achievements of their students. The Australian Institute for Teaching and School Leadership has developed a national framework which describes the roles of principals and the quality school leadership styles that improve learning outcomes for students. This document is called the *Australian Professional Standards for Principals* or known simply as *The Standard*. According to the AITSL (2011b), the “standard sets out what principals are expected to know, understand and do to achieve excellence in their work” (p. 2). It consists of three requirements and five key professional practices expected of school leaders. The requirements include (1) vision and values, (2) knowledge and understanding and (3) personal qualities and social and interpersonal skills, while the professional practices include (1) leading teaching and learning, (2) developing self and others, (3) leading improvement, innovation and change, (4) leading the management of the school and (5) engaging and working with the community.

All Australian schools and education systems are mandated to employ The Standard to guide the provision of professional learning for school leaders, as the basis for self-reflection and as a tool that informs the management of self and other staff. Since 2011, The Standard has been used widely in Australian educational institutions and systems for a number of purposes. These include using it for the formulation of selection criteria for assessing the suitability of individuals seeking leadership positions in Australian schools as well as the performance management of school leaders.

1.2.3 Provision of greater autonomy for schools – Independent Public Schools. While this study focuses on improving mathematics instruction for students with ID, this goal cannot be achieved without giving schools the authority to run their own affairs. The Australian government recognises that the educational context of every Australian school is different and thus, has to be managed differently to realise improved educational outcomes for students. As a result, the federal government has embarked on the decentralization of the educational system and the provision of greater autonomy in decision-making to schools under its Independent Public Schools (IPS) initiative. The government has committed $70 million to support government schools in all states and territories achieve IPS status by 2017 (Australian Government Department of Education and Training, 2016; Good Schools Guide, 2016). Currently, there are 180 independent public schools in Queensland (Queensland Department of Education, 2015) and 445 independent public schools in Western Australia (Department of Education of Western Australia, 2016a). Over 48% of education support schools owned by the government of Western Australia have attained the status of independent public schools (Department of Education and Training of Western Australia, n.d.). The United States operates an educational initiative under the name of 'Charter Schools' which is similar to the Australian IPS (Buckingham, 2015).

1.2.4 Implementation of the National Assessment Program – Literacy and Numeracy (NAPLAN). The National Assessment Program – Literacy and Numeracy, otherwise known as NAPLAN, is a yearly assessment conducted Australia-wide since May 2008 for all students in Years 3, 5, 7 and 9 (Commonwealth of Australia, 2014; Gavrielatos, 2013). According to the Australian

Curriculum, Assessment and Reporting Authority (ACARA) 2016, "NAPLAN is the measure through which governments, education authorities, schools, teachers and parents can determine whether or not young Australians are meeting important educational outcomes in literacy and numeracy" (p. 1). Specifically, the objectives for the introduction of NAPLAN include better and targeted allocation of resources, identification of the strengths and needs of individual students, to measure the performance of individual students against a national average and to compare the performance of a school against other schools in identical or socio-economic circumstances (Commonwealth of Australia, 2014).

1.2.5 The Australian Curriculum. The goals of achieving global competitiveness, inclusivity and the retention of high standards of learning in all Australian schools have been the principal driving forces behind the development of a single Australian Curriculum (White, 2015). The First Phase of the Australian Curriculum comprising Mathematics, English, Science and History was completed in 2010 and scheduled for implementation by the majority of schools at the commencement of the 2013 school year. Ideas about having one Australian Curriculum for the entire Commonwealth of Australia, to replace the eight separate Curriculum Frameworks implemented by the different Australian states and territories, have been crystallising for several decades. These ideas assumed national significance in 1989 when the ministers of education in all states and territories of the Commonwealth came together and unanimously agreed to 10 goals for a future Australian Curriculum under the Hobart Declaration on Schooling (Ministerial Council for Education, Early Childhood Development and Youth Affairs Australia − MCEECDYA, 1999a). Apart from laying the foundation for subsequent declarations, the Hobart Declaration holds special significance for offering the opportunity for one of the most comprehensive and intellectual discussions on the Australian Curriculum. The 10 goals that emerged from the Hobart Declaration were subjected to further deliberations and articulation to reflect the contemporary socio-economic and cultural needs of Australia in 1999 under the Adelaide Declaration on National Goals for Schooling in the Twenty-First Century (MCEECDYA, 1999b) which superseded the Hobart Declaration. The final declaration and precursor of the Australian Curriculum is the Melbourne Declaration on Educational Goals for Young Australians (MCEECDYA, 2008) which superseded the Adelaide Declaration. While the Melbourne Declaration (MCEECDYA, 2008) reflected the national goals of Australian education, it laid bare Australia's adoption of the Salamanca Statement on Principles, Policy and Practice in Special Needs Education (UNESCO, 1994) and the Universal Declaration of Human Rights (1948) (United Nations — UN, 1948). Australia's commitment to these international standards is evident from the two goals of the Melbourne Declaration (MCEECDYA, 2008) and an acknowledgement that these goals are relevant to the comprehension of the Australian Curriculum:

Goal 1: Australian governments, in collaboration with all school sectors, commit to promoting equity and excellence in Australian schooling. This goal encompasses the following among others:

- The provision of access to high-quality education to every Australian student that is devoid of discrimination on the grounds of gender, language, sexual orientation, pregnancy, culture, ethnicity, religion, health or disability, socioeconomic background or geographic location.
- Ensuring that socioeconomic status does not pose any barrier to the educational achievements of students; ensuring that students are not disadvantaged by virtue of their disability, homelessness, refugee status and remoteness; the provision of individualised education in harmony with the diverse abilities of Australian students.
- To sustain a culture of excellence in Australian schools through the provision of 'challenging and stimulating learning experiences' that facilitate inquiry, independence and build on their prior knowledge and ability.
- To strengthen the collaboration between schools, parents, carers, families, and the broader community in building a culture of high expectation for students.
- To promote an Australian society that is socially cohesive by respecting the increasingly cultural, social and religious diversity of modern Australia.

Goal 2: Australian governments commit to working in collaboration with all school sectors to support all young Australians to become successful learners, confident and creative individuals, and active and informed citizens. This goal has several dimensions and components and some of them are as outlined below:

- To support young Australians to become confident and creative individuals (developing self-worth, self-awareness and identity that allows them to manage their emotional, mental, spiritual and physical wellbeing).
- To support Australian citizens to become active and informed citizens that conduct themselves with moral and ethical integrity.
- To develop students' appreciation of Australia's social, cultural, linguistic and religious diversity.

The above goals are in harmony with the focus of this study — to improve mathematics instruction for students with ID. The Australian Curriculum, Assessment and Reporting Authority (ACARA, 2010) and the Federal Government (Commonwealth of Australia, 2009) have insisted on one curriculum for all Australians.

1.3 Improving the quality of education for students with intellectual disabilities in Australia.

The Commonwealth, state and territory governments have adopted a multi-dimensional approach towards improving the standard and quality of their education as discussed below:

1.3.1 More Support for Students with Disabilities (MSSD). The More Support for Students with Disabilities (MSSD) initiative is a Federal Government of Australia special funding arrangement that has been put in place primarily to build the capacity of schools to deliver quality education for the over 164,000 students with disabilities in Australian schools nationwide (Targeted News Service, 2011). As the name implies, MSSD is designed to meet any additional costs in educating students with disabilities that are otherwise not covered under existing budget for schools. Under MSSD funding, the Australian government has dispensed $300 million to government, Catholic and independent (non-government) educational institutions in each state and territory over the 2012-2014 school years of its implementation (Australian Government Department of Education and Training, 2015).

An evaluation of the MSSD initiative over 3 years (2012-2014) of its implementation indicates that it has spent substantial amount of money on a number of areas aimed at improving the education of students with disabilities as indicated by Figure 1.1:

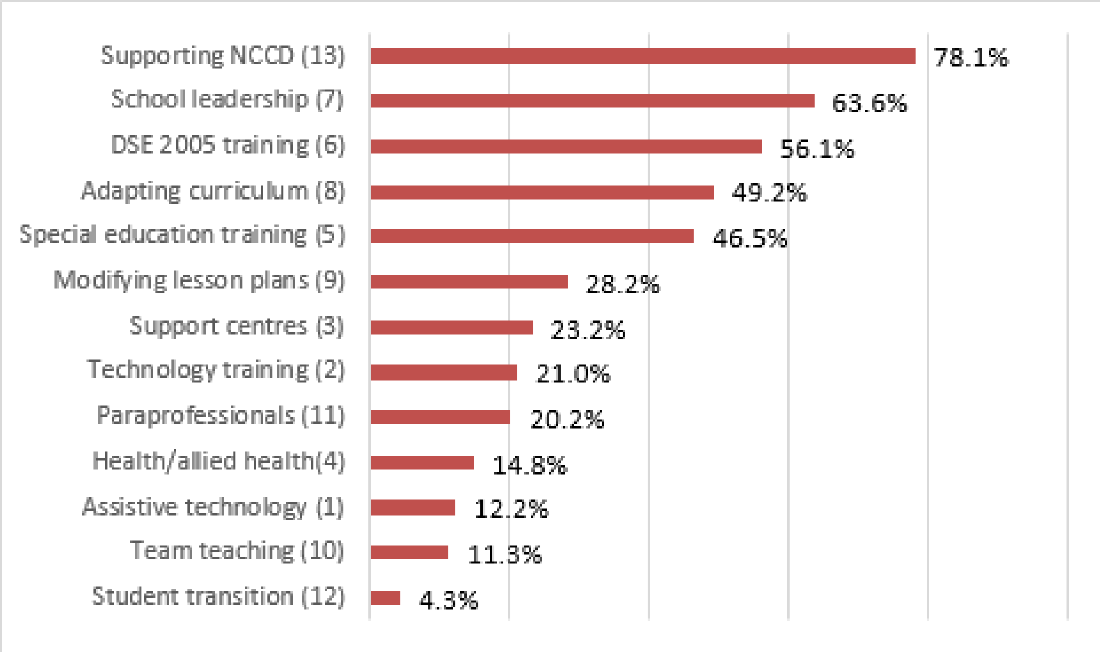

Figure 1.1: Proportion of Australian schools supported under MSSD (extracted from the Australian Government Department of Education and Training, 2015; p. 56).

According to a report compiled by the Australian Government Department of Education and Training (2015; pp. 56 & 57), the MSSD has made significant contributions to the education of students with disability including:

• supporting 6000 schools (63% of Australian schools) to build the capacity of their teachers through the offering of scholarships for further studies in special education and other relevant training.

• Offering training to 12,559 school leaders in inclusive practices.

• Training 78,150 teachers in the Disability Standards for Education (DSE) 2005 that accounted for 5,264 schools (56%).

• Provision of additional support to 7,346 schools to provide 65,619 teachers with understanding and implementing the Nationally Consistent Collection of Data on Students with Disability (NCCD).

- Provision of specialist training (including online, post-graduate studies and face-to-face) in disability to 36,261 teachers involving 4364 schools (47% of Australian schools).
- Provision of training to 821 teachers across 4,624 schools (49.2%) in assessment and how to adapt the curriculum to meet the needs of students with disability.
- Provision of specialist advice and training to 12,752 teachers across 2,646 schools (28.2%) to support them on how to develop and modify lesson plans.
- Provision of benefits, under the MSSD initiative, to 1,389 schools and more than 4000 teachers through the services of Health and allied health professionals.
- Offering scholarships to 27,000 education assistants in 1,897 schools (20%) to undergo additional training (such as Certificate 3) and other courses
- Provision of support, under the MSSD initiative, to 3408 students with disability in 407 schools with their transition needs (school to work, furthering their education and as they move through stages of schooling.
- Provision of support under the MSSD initiative, to 24,286 students with disability in 2,177 schools (23%) with special schools and support centres.
- Provision of support under the MSSD initiative, to 1,143 schools with 14,157 teachers through a wide range of over 8,000 assistive technology items, and prior training was offered to them on how to use the assistive technology items.

1.3.2 National Disability Insurance Scheme (NDIS). The Cerebral Palsy Guide (2016) has acknowledged that about two-thirds of individuals with cerebral palsy (a life-long/permanent condition) also have intellectual disability. Cerebral palsy impacts on students learning of mathematics in manifold ways including short attention span, motor planning difficulties and perceptual difficulties (CPL, 2015). One organisation that has been set up in Australia to offer support to people living with life-long conditions is the National Disability Insurance Scheme (NDIS). The NDIS was set up in July 2013 by the Australian federal government (NDIS, n.d. — a, b, & c) The scheme was implemented in two phases consisting of the trial and full scheme periods (NDIS, n.d.). Being relatively new, the scheme has recently completed its trial phase in selected locations across all states and territories except in Western Australia where the trial phase has been expanded to more areas and extended to 30 June 2017 (NDIS, n.d. — a, b, & c). The roll-out of the full scheme in all states and territories (except Western Australia) is scheduled to commence progressively in 2016 (NDIS, (NDIS, n.d. — a, b, & c). NDIS adopts a lifetime and insurance-based approach to funding support services to the 460,000 Australians below 65 years of age with permanent and significant disability (National Disability Insurance Agency, 2014). The scheme is operated by the National Disability Insurance Agency (NDIA) under the guidelines of the *National Disability Insurance Scheme 2013 (No. 20)* (Australian Government, 2013). The key objectives for the setting up of the NDIS, as outlined in the National Disability Insurance Scheme Act 2013 (No. 20), are to:

(i) support the independence and social and economic participation of people with disability; and

(ii) provide reasonable and necessary supports, including early intervention supports, for participants in the National Disability Insurance Scheme launch; and

(iii) enable people with disability to exercise choice and control in the pursuit of their goals and the planning and delivery of their supports; and

(iv) facilitate the development of a nationally consistent approach to the access to, and the planning and funding of, supports for people with disability; and

(v) promote the provision of high quality and innovative supports that enable people with disability to maximise independent lifestyles and full inclusion in the community; and

(vi) raise community awareness of the issues that affect the social and economic participation of people with disability, and facilitate greater community inclusion of people with disability (Australian Government, 2013, p. 8).

To be eligible for NDIS, an individual must have a condition or impairment that is likely to be lifelong (permanent) and as a result of the impairment, the individual is unable to undertake tasks without support from other people or assistive technology. Additionally, the impairment must be of a nature that diminishes individuals' social and economic participation and as such are likely to be dependent on NDIS support throughout their life (NDIS, n.d. — a, b, & c). This scheme will facilitate the implementation of inclusive learning environment in schools, and particularly for those students with lifelong impairments, such as those with permanent vision loss, and permanent loss of movements in their body.

The NDIS discussion is a recognition of other factors outside the curriculum and instructional approaches that could impact on students' learning. Students with ID often have comorbid conditions (Gautam, Bhatia & Rathi, 2014) that may have adverse effects on their comfort and concentration at school.

1.3.3 Special Education Needs Assessment Tool (SENAT). The Special Education Needs Assessment Tool (popularly known as SENAT) was introduced to Western Australian specialist schools and education support centres in 2011 at the annual conference of Western Australian Education Support Principals and Administrators Association (WAESPAA) (Department of Education of Western Australia, 2011a). The SENAT is a combination of an adaptation of the United Kingdom P-Scales (UK Department of Education, 2014) to the Western Australian context and the Australian Curriculum.

SENAT was developed as an effort to address the difficulty that has been encountered frequently by teachers working with students with ID — the regular curriculum levels have been set too high for these students (Stobbs, 2016). It has been observed that a significant number of students with ID who are eligible to attend specialist schools in Western Australia are performing below Foundation (the lowest level in the Australian Curriculum). SENAT was developed to accommodate those students that are performing below the Foundation level. It is a work in progress, and has currently (2016) been completed for selected learning areas including English, Mathematics, Science, History and Physical and Health Education. SENAT is not a curriculum and does not replace the Australian Curriculum, though its strong point is that it is closely aligned to the Australian Curriculum. SENAT performance descriptions (PD) are employed as supplementary resources to assess progress in the curriculum and provide a ladder that connects those students that are performing below Foundation level. There are ten levels or performance descriptions (PD) that are catered for under SENAT. According to the Department of Education of Western Australia (2011b), performance descriptions 1 to 3 describe the earliest levels of achievement and are not learning area specific (they are common to all learning areas), performance descriptions 4 to 8 describe the emergence of skills, knowledge and understanding across the different learning areas, while PD 8 to 10 align with Foundation, Year 1 and Year 2 respectively of the Australian Curriculum (Department of Education of Western Australia, 2011b).

Tools such as SENAT that enable students who are achieving below their peers are of tremendous importance in locating where these students are in their learning. Having such knowledge provides teachers with a sense of direction in setting new learning goals and for describing and measuring progress (Stobbs, 2016).

1.3.4 Abilities Based Learning and Education Support (ABLES). The Abilities Based Learning and Education Support (ABLES) program is another recent effort targeted at meeting the instructional and learning needs of students with disabilities and additional needs (Victoria State Government Department of Education and Training, 2016a; 2016b). ABLES is described as a tool for assessing, monitoring and responding to individual students learning needs of students by:

1. Accurately identifying and setting learning goals for students with disabilities and additional learning needs.
2. Tracking a student's progress against their individual learning plan over time, and providing new information to parents on their child's learning and development.
3. Identifying the optimal resources that are known to improve learning, which can be adjusted as the learning needs of students change over time. (Victoria State Government Department of Education and Training, 2016a, p.1)

The research that informed the development of ABLES was undertaken in 2007 under the collaboration between the University of Melbourne and the Victorian Department of Education and Training. Data collection centred on the English learning area (Speaking and Listening; Reading and Writing) and Personal and Social Capability (Victoria State Government Department of Education and Training, 2015a). It involved 700 teachers across 77 Victorian government schools and 1,700 students (Victoria State Government Department of Education and Training, 2015b). The author describes ABLES as

> a suite of curriculum, pedagogy, assessment and reporting resources that

> assist teachers in recognising and responding to the diverse learning needs of all students, and in assessing and reporting student learning, monitoring student progress and providing accurate intervention advice (Victoria State Government Department of Education and Training, 2016, p. 1).

1.3.5 Award Scheme Development and Accreditation Network (ASDAN). Central to the improvement of the quality of learning (and Mathematics in particular) for students with ID (focus of this study) are curriculum adjustments and appropriate assessment methods. The Award Scheme Development and Accreditation Network (Queensland Curriculum and Assessment Authority — QCAA, 2012) otherwise known as ASDAN (ASDAN, n.d.a) have addressed both. ASDAN is a UK-based charity organisation. It offers a diverse range of curriculum programs under their "Preparing for Adulthood Programme" for students with moderate, severe, complex, profound or multiple learning difficulties (ASDAN, n.d.a p. 1). These programs adopt a real-life context for students' development of personal, social, independent, ICT and work-related skills for those students working below the Foundation level of the Australian Curriculum. The development of the programs was informed by the research conducted by the University of the West of England in the 1980s and established as an educational charity (ASDAN) in 1991 (ASDAN, n.d.b). The levels of support employed in assessing and reporting students' achievements include:

NH *No Help* (work undertaken independently by the student)

SH *Spoken/Signed Help* (the student receives signed or spoken suggestions from teachers/paraprofessionals

GH *Gestural Help* (the student is a recipient of support using hand signals or other forms of gestural prompts.

PH *Physical Help* (The student is held or helped to ambulate in order to undertake the task).

SE *Sensory Experience* (the student is accorded the opportunity to be a participant in the learning activity through sensory experience such as hearing, touch, sight or taste)

ER *Experience Recorded* (while the learning experience is made available to the student, if he/she is unable to participate).

ASDAN has four Preparing for Adulthood programs targeted at meeting the needs of students with special needs. They include:

New Horizons: for students with special educational needs within the 9 to 13 years old age bracket.

Transition Challenge: targeted at 14 to 16 years old students with severe and/or profound learning difficulties

Towards Independence: targeted at students over 14 years of age and adults with moderate, severe, and profound and multiple learning difficulties

Workright: targeted at students over 14 years of age and adults that are undertaking a work-based programme of study.

The full range of curriculum programs that ASDAN offers to students with moderate, severe, complex, profound or multiple learning difficulties under their "Preparing for Adulthood Programme" is as detailed on ASDAN official website (ASDAN, n.d.a).

1.4 Rationale of the Study

My roles as a special education teacher and as principal of a public school for High School students with borderline, mild, moderate and severe intellectual disabilities (Years 7 to 12), have offered me the opportunity to meet many students with number sense difficulties. I have been frustrated by the lack of tangible progress in these students. It has been noted that a significant number of Australian students (including students with ID) experiencing mathematics difficulty are underachieving in this learning area (Graham, Bellert & Pegg, 2007). Booker (2004) has observed that some of these difficulties have "been brought about by the teaching program the students have experienced rather than any innate mathematical learning difficulty" (p. 129). The author's observation has strengthened my belief that schools can improve the number sense skills of these students if effective instructional approaches are put in place. Berch (2005) reiterated this position by acknowledging that number sense is a skill that is teachable. Thus, it is important to gain a deeper understanding of these students' number sense in order to be able to put in place an effective intervention program. Number sense is a core part of the maths skills that individuals (including people with ID) need to function independently in the community (Ginsburg, Manly & Schmitt, 2006).

I have searched the literature for studies on the number sense difficulties of high school students with intellectual disabilities and found that no study of this nature appears to exist. Previous studies on number sense have focused on Preschool children prior to school entry (Howell & Kemp, 2010), kindergarten children (Dyson, Jordan & Glutting, 2011; Ivrendi, 2011), primary 1 to primary 3 children (Dunphy, 2006; Sasanguie, Gobel, Moll, Smets, & Reynvoet, 2013; Reys, Lindquist, Lambdin & Smith 2004), primary 6 students (Yang & Hsu 2009). Past research efforts on number sense have therefore not catered for students beyond the primary years of education and neither have they provided for high school students with borderline, mild, moderate and severe intellectual disabilities. The lack of researched data on number sense for this group of students is hampering effort to prepare them adequately for a life of independence after secondary education. It has also limited their life chances and choices as they are disadvantaged while competing for employment or seeking to further their education. Among the favoured instructional approaches in the literature for teaching mathematics to students with learning disabilities are the constructivist-based approach (Cobb, Yackel, & Wood, 1992; Schifter, & Simon, 1992) and explicit teaching/learning strategies (Witzel, Mercer, & Miller, 2003; Doabler, & Fien, 2013). The effectiveness of these strategies in relation to High School students with intellectual disabilities has not been investigated. Towards this end, I also undertook a *comparative study of the effectiveness of both approaches* as will be observed in research question 3.

1.4.1 My previous education in special education. I hold a Master Degree in Special Education and graduated with distinction from the University of Newcastle (Australia). I completed the following courses as part of my Master Degree in Special Education:

1. Teaching Students with Autism Spectrum Disorder
2. Educating Children with Special Needs
3. Instructional Strategies for Learning Difficulties
4. Behaviour Management and Social Skills Instruction.
5. Policy and Administration in Special Education
6. Communication Interventions in Special Education
7. Critical Reflection in Special Educational Settings

8. Current Issues in Special Education

1.4.2 My classroom experience teaching students with intellectual disabilities. I have had 16 years of experience teaching, assessing and reporting on the achievements of students with ID in Australian schools. As a special needs teacher, I have had ample experience developing individualised learning programs in the forms of IEP (individual education plan), PLP (personalised learning program) or EAP (education adjustment program) in collaboration with parents and external agencies (e.g. school psychologist, physiotherapist, occupational therapist, audiologist, school nurse, Department of Child Protection and Family Services and son as needed). The curriculum for these students are typically differentiated, modified or accommodated to meet the individual needs of the students. My assessment approach encompassed the collection of baseline data to ascertain individual students' prior knowledge and their learning needs, and the use of these data as a reference point for future assessments relevant to monitoring the progress of the students in the course of the school year.

I employ a wide range of instructional approaches including explicit instruction (Modelling -“I do” phase), Guided practice - “we do” phase) and independent work - “you do” phase) (Miller & Hudson, 2006), 'Chunking' (breaking activities into small achievable sections), checking for learning by having the students repeat back what they have done, or explain what they have learnt, giving one instruction at a time, providing breaks in between tasks as needed, acknowledging students’ effort no matter how small, fading away as students gradually gain confidence with the task, breaking work into small manageable steps, clarifying tasks using pictorial or visual clues, teaching to the students’ level prior to extension, and increasing the font size on worksheets as well as enlarging activities from A4 to A3 worksheets to make them easier for students to read among other strategies.

I also use a wide range of resources including *Boardmaker* (to create visual schedules, timetables and flashcards), *Writing with Symbols* software (an additional resource for supporting students with ID), Alternative or Augmentative Communication (AAC) techniques such as picture board, ipad, computer-assisted devices or/and communication boards with pictures to support the diversity of students' needs in my classroom.

1.4.3 My experience as a principal of a high school for students with intellectual disabilities. I was the principal of a specialist high school for students with ID in Australia for 5 years (2010, 2011, 2012, 2013, 2014). The school catered for Years 8 to 12 students with mild, moderate and severe intellectual disability as well as those with multiple disabilities and a comorbidity of other conditions. As Principal, I was responsible for the day-to-day running of the school, the development of inclusion policies and the implementation of an inclusive school environment; building the capacity of staff and facilitating their on-going professional growth in the area of special education through performance management; the deployment of resources and ensuring that reasonable adjustments were made to learning programs in accordance with the individual needs of students. I was also responsible for facilitating the use of evidence-based instructional approaches that met the teaching and learning needs of students with ID, ensuring compliance with relevant legislations, departmental policies and procedures related to the education of students with disabilities and ensuring that school practices met departmental standards and obligations. I fostered the development of a responsive and inclusive school-based curriculum that catered for the social, emotional and academic developments of all students. Additionally, I delivered numerous professional development activities for staff ongoing professional growth among other roles and responsibilities.

1.4.4 My role as a Disability and Early Childhood Intervention Advisor. From June 2014 to March 2015, I worked for the Northern Territory Government as a Disability and Early Childhood Intervention Advisor. Under this role, I travelled to Secondary and Primary schools within an educational region of the Northern Territory to encourage and promote the development and implementation of inclusive school cultures through (1) the provision of expert support, advice and strategies to schools and families of students diagnosed with learning and other forms of disability, (2) assistance to schools with the process of identifying children with disabilities and special needs and applied for government funding, (3) assistance to schools and families to make appropriate and informed decisions about interventions and educational options for students with disabilities, (4) suggestions and modelling of appropriate teaching and learning strategies to help with classroom management and the delivery of the curriculum, (5) support to schools with the writing of individual education plans whose learning goals were specific, measurable, achievable, relevant and that could be measured within a given time frame, (6) the observation and assessment of students who were identified as needing assistance and reported their findings to various stakeholders, (7) the provision of assistance with the development of transition plans as students moved from one year level to the other and graduated from school to the community, (8) the provision of professional learning opportunities to special education teachers and support staff on disability specific topics and programs such as current policies, Student Services Division protocols and procedures, (9) planning and facilitating Special Education forums, (10) the provision of online training on special education to teachers and principals and (11) liaising with service providers and external agencies such as the National Disability Insurance Scheme, Disability Services Commission, Psychologists, Physiotherapists and Occupational Therapists.

These experiences have familiarised me with the gaps and difficulties that are frustrating current efforts to improve the teaching of Mathematics to students with ID. I have been motivated to undertake this study to gain better understanding of the degree of influence exerted by various student- and teacher-oriented factors, on the teaching and learning of Mathematics, with the intention of using the outcomes of the study to make improvements.

1.5 Objectives of the Research

The chief aim of this study was to determine if improvement in the quality of teaching and learning for students with ID could occur by implementing the outcomes of the study. The specific objectives of this study include the following:

1. To evaluate the number sense competence of high school students with borderline, mild and moderate intellectual disabilities
2. To improve the instruction of number sense among high school students with borderline, mild and moderate intellectual disabilities

3. To understand the effects of age, gender, student and teacher factors on the number sense achievements of high school students with intellectual disability
4. To compare the effectiveness of the explicit approach and a strategy based on the philosophy of constructivism to teaching high school students with intellectual disability
5. To develop an assessment tool in numeracy that is appropriate for students with ID – an assessment tool whose development and conditions of administration are considerate of the learning characteristics of individuals with intellectual disability.

1.6 Research Questions

1. Do students with borderline, mild and moderate intellectual disabilities possess specific number sense skills that distinguish members of one group from the other?
2. What are the effects of age, gender, student and teacher factors on the number Sense achievements of students with borderline, mild and moderate intellectual disabilities?
3. What are the effects of explicit instruction and a strategy based on the philosophy of constructivism on the development of number sense among high school students with borderline, mild and moderate intellectual disabilities?
4. What numeracy assessment tool among those examined in the study is most appropriate for students with ID?

1.7 Significance of the Study

The outcomes of this study will provide better insight into the teaching of number sense to students with ID in schools. The knowledge gathered should enable teachers to devise instructional approaches that are evidence-based and effective for students with ID as well as trigger further research in this important area that has been neglected for so long.

1.8 Overview of the Thesis

This thesis provides a report on a study whose primary focus was to enhance the quality of teaching and learning of mathematics for students with ID and severe mathematics difficulty. A comprehensive approach comprising various elements of teacher and student factors, such as the impacts of students 'age, gender, self-efficacy, anxiety and social-emotional state as well as teachers' mathematics teaching efficacy beliefs in relation to students with ID, were investigated as part of this study. In recognition of the tremendous importance of teaching strategy to students' educational outcomes, the parameter of this student was extended to investigating the effects of explicit instruction and an explicit-constructivist-based approach on the development of number sense among high school students with ID. The development of a number sense assessment tool that considers the learning characteristics of students with ID in its development and implementation was also an essential component of this study.

Chapter 1: The introductory chapter set the stage for this study through the provision of condensed information on recent efforts to improve the quality of mathematics education in Australia and particularly for students with disabilities. This chapter outlines the research questions whose quest for answers provided the impetus for this study. The significance of the study, and relevant government regulations that mandate inclusion and making reasonable adjustments to the curriculum for students with disabilities were among the contents covered in this chapter.

Chapter 2: This chapter is dedicated to reviewing the literature pertinent to this study. The chapter opens with the definitions of the terms 'number sense' and 'intellectual disability' as well as describes the various types of intellectual disability. It also covers the different categories of severity of ID and how to utilise such information to provide quality learning to the students through the differentiation, modification and accommodation of the curriculum. Other information covered in this chapter include the policies and guidelines relevant to the education of students with ID, instructional approaches, the learning environment-student factor-teacher faction impacts on students' learning among others.

Chapter 3: This chapter details the research framework, background of the school where data collection was executed, including the demography of the students that participated in the study, the research design and methods as well as the sampling procedure employed at both the pre- and post- phases of the study. Additionally, the chapter describes the range of instrumentation used in the study, including three number sense assessment tools and IMPELS (an assessment tool developed as part of this study (Enoma & Malone, 2015b) as well as the mathematics teaching efficacy belief instrument (MTEBI). Others included the administration of the self-efficacy and sources of mathematics self-efficacy of students as well as the students' anxiety factor questionnaire among others. This chapter also explains how matters of objectivity, validity and reliability were accommodated in the study.

Chapter 4: This chapter gives a detail account of the results and analyses of the data collected using the different instruments at both the pre-intervention and post-intervention phases of the study. The data generated were aimed at answering my four research questions namely,

1. Do students with borderline, mild and moderate intellectual disabilities possess specific number sense skills that distinguish members of one group from the other?
2. What are the effects of age, gender, student and teacher factors on the number sense achievements of students with borderline, mild and moderate intellectual disabilities?
3. What are the effects of explicit instruction and a strategy based on the philosophy of constructivism on the development of number sense among high school students with borderline, mild and moderate intellectual disabilities?
4. What numeracy assessment tool among those examined in the study is most appropriate for students with ID?

Chapter 5: This chapter provides a summary and discussion of the salient findings of this study. The chapter gives an account of the significance and implications of the research and indicates the constraints and limitations experienced in this study. By way of conclusion, the chapter discusses the suggestions and recommendations offered for future research into understanding the mathematics competence of students with borderline, mild and moderate intellectual disabilities.

Chapter 2

LITERATURE REVIEW

2.1 Introduction and Overview

The purpose of this introductory part of the literature review is to shed some light on how people with ID have historically been considered to lag behind the rest of the population in the three main domains of life identified by the United Nations (2016). These include the: (1) availability of opportunities (such as the unequal access to education, health care and other basic services), (2) access to employment and income and (3) participation in political and civic life. It has been acknowledged that it is impossible to fully comprehend ID without examining the society, culture and history within which it has existed (Sarason, 1985). The inhuman, discriminatory, and exclusionary treatments accorded individuals with ID date back to the Egyptian, Greek, Roman and Chinese civilizations and the early Christian period (Nesbit & Philpott, 2008). The earliest documented reference to intellectual disability could be traced back to the Egyptian Papyrus of Thebes in 1552 B.C. (Harris, 2006). The ancient Romans and Greeks saw the birth of a child with ID as a taboo and had the misconception that children born with ID were cursed − the consequence of an angry god (Harbour & Maulik, 2010). Such children were abandoned and left to die. The inequities and exclusions that confront individuals with ID today (Naaldenberg, Banks, Lennox, Ouellette-Kunz, Meijer & Lantman-de Valk, 2014) could be traced back to these times. The main difference was that the discriminatory treatment of people with ID was more severe in the past and accepted as a normal way of life than it is today. Nesbit and Philpott sum up the plight of persons with ID nicely:

> The social and educational treatment of individuals with cognitive challenges can be described as a gradual positive evolution, with better treatment in the 21st century than during earlier times – but history has not always been kind. Individuals described as being cognitively challenged have been perceived as “burdens to society", thrown to wild beasts, and at various points in history, have been utilized as fools and court jesters and described as “village idiots". They were viewed paradoxically at one point both as “demon possessed” and

> as “les enfants du bon Dieu” (God’s children). Progress has been slow, difficult and not without interruption. (2008, p. 2)

The advent of Christianity brought with it the teaching that all human beings regardless of their disability were created by God (Nesbit & Philpott, 2008) and that the weak and disadvantaged in our society should be loved and cared for. These teachings over time have been one of the positive influences that shifted people’s perception of individuals with ID and cause them to be seen in more favourable light.

The birth of renaissance in the 15th and 16th centuries which encouraged the philosophy of humanism was another factor that has helped to shift society’s view of individuals with ID. Beirne-Smith, Patton and Kim reiterated this fact in their observation that

> renaissance thinking encouraged the philosophy of humanism, principally concerned with people’s worth as human beings and their freedom to develop. The idea that all were created equal and had inalienable rights to life, liberty, and the pursuit of happiness was popular. (2006, p. 6)

The first planned and methodical intervention for ID that is documented in the literature was implemented in 1799 in France by Jean-Marc Itard (a medical doctor) who is regarded by some as the founder of special education (Harbour & Maulik, 2010; Nesbit & Philpott, 2008). He developed his program for a person with ID who he referred to as ‘Victor’’ (Harbour & Maulik, 2010).

In the early times, there was optimism that individuals with ID could be rehabilitated, trained and reintegrated into normal life. With the dawn of the industrialization and urbanization era in the mid-1800s came an escalation of social problems such as poverty, illness, and crime. People with ID were mostly blamed for the spike in these social issues and this situation gave birth to the institutionalization of people with ID.

The above paints a vivid picture of a culture of exclusive practices by the mainstream society against persons with ID and other forms of disability dating back to time immemorial. These discriminatory practices have not completely gone away as evidences of the stereotypes, biases, inequality and inequity against people with disability still abound and linger in our society today (including the education sector) (Anwyll, 2013). Expressing similar sentiments, Jitendra, Rodriguez, Kanive, Huang, Church, Conrroy and Zaslofsky (2013) have acknowledged that students with mathematics difficulties lag significantly behind their peers. The observation has been made that a large number of students in Australia (including students with ID) who encounter mathematics difficulty are underachieving in this learning area (Graham, Bellert & Pegg, 2007). Booker (2004, p. 129) has noted that, some of this situation has "been brought about by the teaching program the students have experienced rather than any innate mathematical learning difficulty". Students with ID require adjustments to the curriculum, provision of more time, repetition, support, structure, sequential and explicit instruction to make improvements which are often not provided (Enoma & Malone, 2015a). According to Ignacio Estrada (as cited by Waters, 2015, p. 1), "if a child can't learn the way we teach, maybe we should teach the way they learn". Sayeski and Paulsen (2010) have acknowledged that without intensive instruction and targeted intervention efforts, the gap will continue to grow wider. Students with ID encounter difficulty with learning mathematics more by the instructional practices of teachers than by the limitations imposed upon them by their cognitive ability (Booker, 2004).

This study, which focuses on the improvement of mathematics instruction for students with ID is an endeavour in the broader picture of creating a more inclusive society (UNESCO, 2015) and better quality of life for people with ID. The link between maths and quality of life has been laid bare by the finding that mathematics/functional numeracy has pronounced influence on the life chances and life choices of the citizenry (Dvorsky, 2016). That every person needs maths (regardless of disability) for the enjoyment of everyday life was reiterated by Schleicher (|Director for the Directorate of Education and Skills for the Organization for Economic Cooperation and Development – OECD) who observed that "Good Numeracy is the best protection against unemployment, low wages and poor health" (National Numeracy, 2015, p. 1).

This chapter reviews the literature that are relevant to how students with ID and others with mathematics difficulty learn Mathematics as well as how to improve the teaching and learning of these students using the following organisation:

2.2 Number Sense

An area of mathematics that is of special significance to individuals with ID is number sense because it relates to the application of numbers in authentic life situations. Number sense is the foundation to the acquisition of mathematics knowledge and skills including gaining an understanding of numbers, different representations of numbers, relationship between numbers and number systems, an understanding of number operations and their relationships to each other as well as the ability to make reasonable estimates (National Council of Teachers of Mathematics, 2000). The point has also been made that, to be successful in mathematics students must have a good sense of numbers early in their school life, as failure to do so may lead to long-term difficulty in the learning area (Riccomini & Witzel, 2010). These include career choice, paying bills, prudent financial management (e.g; predicting expenditures) and calculating mileage (Witzel, Ferguson and Mink (2012). The authors identified the use of concrete experiences, teaching to proficiency and connecting language to maths as the three ways to supporting students with mathematics difficulty to improve upon their number sense.

The term 'number sense' has been defined differently in the literature. In its basic form, number sense has been defined as "the ability to immediately identify the numerical value associated with small quantities (e.g; 3 pennies), a facility with basic counting skills, and a proficiency in approximating the magnitudes of small numbers of objects and simple numerical operations" (National Mathematics Advisory Panel, 2008, p. 27). At a more advanced level, number sense has been defined as the fluidity and flexibility with numbers that arise from a person's general comprehension of number and operations together with the ability and disposition to employ this understanding in a variety of ways to make mathematical judgements and to acquire valuable strategies for manipulating numbers and operations (Mcintosh, Reys & Reys, 1992, Muir, 2012). Similarly, Gersten and Chard (1999) have defined number sense as "an emerging construct (Berch, 1998) that refers to a child's fluidity and flexibility with numbers, the sense of what numbers mean, and an ability to perform mental mathematics and to look at the world and make comparisons" (pp. 19 & 20). This encompasses a:

> principled understanding of place value, of how whole numbers can be composed and decomposed, and of the meaning of the basic arithmetic operations of addition, subtraction, multiplication, and division. It also requires understanding the commutative, associative, and distributive properties and knowing how to apply these principles to solve problems.
> This more highly developed form of number sense should extend to numbers written in fraction, decimal, percent, and exponential forms. (National Mathematics Advisory Panel, 2008, p. 27)

There is also no unanimity among researchers about the components of number sense. Lymen and Duatepe-Paksu (2015) have identified the components of number sense as equivalent expression, number estimation, number value, operation effect and using benchmark. The National Council of Teachers (cited by Way, 2011) has described the number sense components as number meaning, number relationships, number magnitude, operations involving numbers and referents (things in the authentic world that can be understood through numbers) as well as referents for numbers and quantities. Faulkner (2009), named the components of number sense as: (a) quantity/magnitude (the idea that maths is not about numbers but quantity), (b) numeration (the idea of grouping numbers at the rate of 10 in our numeration system), (c) Equality (e.g; X=Y represents two things that are not the same but equal in value), (d) Base Ten (e.g; the idea that 600 is 6x10x10 and not 'add two zeros'), (e) Forms of a number (e.g; "●●●●" is another way of representing 4), (f)

Proportional Reasoning (the comparison of numbers within and between quantities and (g) Algebraic and Geometric Thinking (e.g; X = Y). The lack of agreement on the elements of number sense is a reflection of the interplay between the many domains that make up mathematics (including number sense) and the interest of the different researchers. My view of the components of number sense is a synthesis of the work of several authors because of their operational significance. They include oral counting, number identification, quantity discrimination, missing number measure (Clarke & Shinn, 2004), number writing (including one-to-one correspondence) (Reys, Lindquist, Lambdin & Smith, 2009) and knowledge of number operations (National Council of Teachers of Mathematics, 2008).

Number sense is of fundamental importance to the success of every student in mathematics and students with mathematics difficulty often have problem with number sense (Shumway, 2011; Jordan, 2010). Number sense is a core component of the functional numeracy that is covered at education support schools/centres, providing students with mild, moderate and severe intellectual disabilities with the "essential knowledge, skills, and understanding that will enable them to operate confidently, effectively and independently in life and at work" (Department for Education and Skills, 2007, p. 21). All around us, there are everyday examples of mathematics impacting on our lives including shopping, using the phone, transport, money, cooking and many others (Gouba, 2008).

Early number sense provides a strong indicator of later success in school mathematics (Dyson, Jordan & Glutting 2011). According to Witzel (2013) children that are number sense competent display the characteristics outlined in Table 2.1

Table: 2.1

Some characteristics of children with number sense competence.

1. Develops *meaning* for numbers and operations.
Developing meaning of numbers and operations related to real life contexts is crucial for the subsequent three categories. Since children are exposed to meaning of numbers very early through daily living activities, it is important for formal mathematics instruction to continue to develop quantity, associations between and within the four operations as well as recognizing and generating differing

representations of numbers. This category forms the foundation of future number sense development.

2. ***Looks for relationships among numbers and operations.***

In this category, formal knowledge of numbers and operations begins to take shape by extending the meaning developed initially. Students are able to decompose numbers in varying forms (2 + 6 = 8; 2 + 4 + 2 = 8; 8 - 6 = 2) and begin to recognize how numbers and operations are interconnected. The interconnectedness of mathematics is essential for the correct application of strategies and procedures.

2. ***Understands computation strategies and uses them appropriately and efficiently.***

In this category, students begin to apply formal rules and procedures with an understanding of why a specific procedure or algorithm is appropriate. Students pay more attention to accuracy and precision in their answers as well as demonstrating flexibility with various strategies based on the context of the problem. Estimation becomes a crucial piece in the development of the understanding of efficient and correct strategies.

3. ***Makes sense of numerical and quantitative situations.***

In this category, students begin to develop and seek out calculations and relationships that make sense in the context of real life problems. The "making sense" of mathematics in this category is based on the execution of strategies and algorithms resulting in precise answers that are context dependent. Students' development with the ability to make sense of answers in the real world is the cornerstone of the application of mathematics, the ultimate goal of mathematics teaching.

One approach that has been employed to assess the number sense needs among mainstream students with mathematics difficulty is the model of mathematics development described by Geary, Hoard and Hamson (1999). The model consists of the following:

(1) Number production and Comprehension

This component assesses the student's ability to transcode numbers from verbal to Arabic and vice versa.

(2) **Counting Knowledge**

This component is made up of one-one correspondence (only one word tag such as 'one' or 'two' is allocated to each object that is counted); the stable order principle (the order of the word tags does not change across the group of objects being counted); the cardinality principle (the value of the final word tag defines the quantity of items in the group); the abstraction principle (objects of different kinds can be gathered together and counted) and the order-irrelevance principle (objects within a given group can be tagged in any order or sequence).

(3) Arithmetic

This encompasses the lowest form of problem-solving such as the finger-counting strategy, or verbal counting strategy (without using the fingers) to undertake basic addition task such "4 + 3". The two main strategies used in counting by students are the min approach (counting-on by starting from the larger number) and the sum or counting-all approach (counting both addends starting from 1). With increased competence, the student shifts from reliance on the sum procedure to constant use of min counting. The student may progress to using the decomposition approach (e.g; 5 + 4 = 4 + 4 + 1).

(4) **Working Memory**

Children with mathematics difficulties struggle to retain information in their working memory while participating in other processes and might take longer time undertaking processes that support working memory.

(5) **Long-Term Memory Retrieval**

This is assessed by comparing children participating in tasks involving the articulation of familiar words (e.g' numbers) and unfamiliar nonwords. The differences in the speed of articulating familiar and unfamiliar nonwords provide an indication of any difficulty with retrieving information from long-term memory.

2.3 Human Functioning

Intellectual disability is a social construct that is better understood within the broader perspectives of human functioning and disability (World Health Organisation, n.d). According to the World Health Organization (2002), human functioning "refers to all body functions, activities and participation" (p. 2). The connection between human functioning and disability has been made by Buntinx and Schalock (2010) who defined disability as the "expression of limitations in individual functioning within a social context that represent a substantial disadvantage to the individual" (p. 284). This definition is in alignment with the World Health Organization's (2002), description of disability as an umbrella term, covering "impairments, activity limitations, and participation restrictions" (p. 2) and observing that "Disability is thus not just a health problem. It is a complex phenomenon, reflecting the interaction between features of a person's body and features of the society in which he or she lives" (p. 1). The various environmental factors that interact with the three main components of disability have been summarized by the World Health Organization (2002) under the *International Classification of Functioning, Disability and Health* (popularly known as ICF) (Figure 2.1).

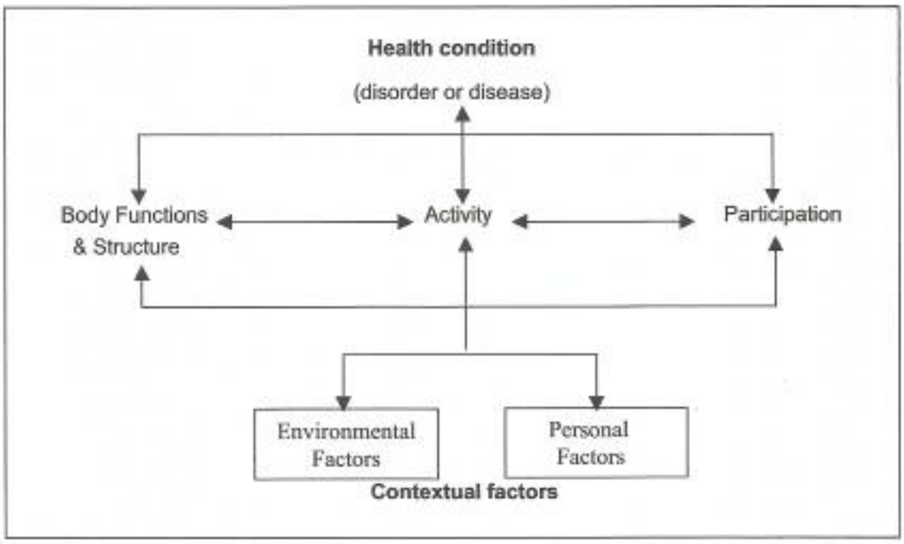

Figure 2.1: World Health Organization (WHO) Model of human functioning and Disability.

Another model of human functioning has been proposed by the American Association on Intellectual and Developmental Disabilities (2010, p. 14). It adopts a multidimensional approach to describing human functioning as consisting of five elements including intellectual abilities, adaptive behaviour, health, participation and context (Figure 2.2).

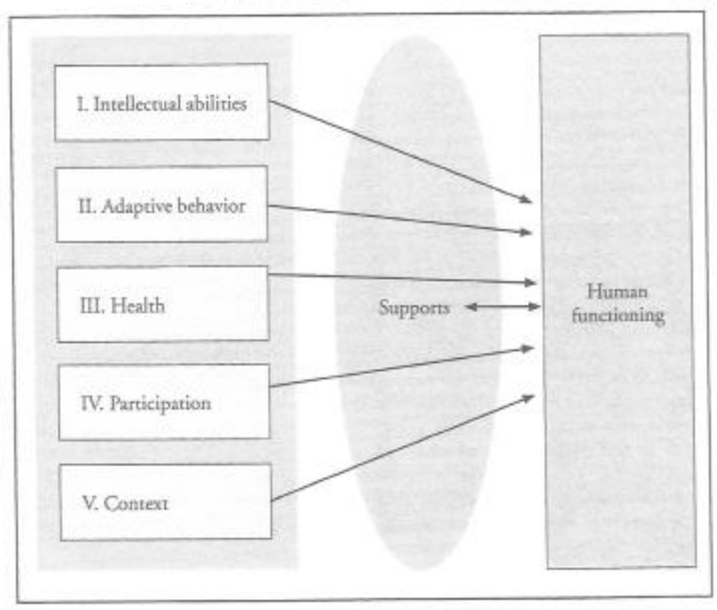

Figure 2.2: American Association on Intellectual and Developmental Disability (AAIDD) Conceptual framework of human functioning.

The American Association on Intellectual and Developmental Disabilities (2010) conceptual framework of human functioning acknowledges "that the manifestation of Intellectual Disability involves the dynamic, reciprocal engagement among intellectual disability, adaptive behaviour, health, participation, context, and individualized supports" (p. 15).

In order to fully comprehend the locus of ID among other forms of disability, it is important to consider the definition of disability under Australian law. According to the Disability Discrimination Act (1992), the term 'disability' when applied to people refers to:

(a) total or partial loss of a person's bodily or mental functions, or
(b) total or partial loss of a part of the body, or
(c) the presence in the body of organisms causing disease or illness, or
(d) the presence in the body of organisms capable of causing disease or illness, or
(e) the malfunction, malformation or disfigurement of a part of the person's body, or

(f) a disorder or malfunction that results in the person learning differently from a person without the disorder or malfunction, or
(g) a disorder, illness or disease that affects a person's thought processes, perception of reality, emotions or judgment, or that results in disturbed behaviour; and includes disability that:
(h) presently exists, or (i) previously existed but no longer exists, or
(j) may exist in the future, or
(k) is imputed to a person (Australian Government, n.d.).

The above definition of disability is very broad and covers a wide range of disabilities including physical disability, disability associated with mental health conditions and so on. This study focuses only on individuals with "a disorder or malfunction that results in the person learning differently from a person without the disorder or malfunction" (Australian Government, n.d; p. 1).

2.4 Intellectual Disability

2.4.1 Definition. The definition of intellectual disability and the characteristics of individuals with intellectual disability are well documented in the literature (Harris, 2006). The definition of intellectual disability (ID) and its levels of severity have undergone many revisions over the years in response to emerging research outcomes which have changed how ID is perceived. There is a shift in thinking from a deficiency model which suggests the problem resides in the individual with ID to the environment or support/needs model that focuses on what adjustments are needed to be made to support people with ID. The term 'intellectual disability' (ID) (previously known as mental retardation) has been used interchangeably in the literature for 'intellectual developmental disorder' (American Psychiatric Association - APA, 2013, p.33) and 'intellectual impairment' (Wen, 1997, p. 2). According to the APA (2013, p. 33), ID is a disorder that is characterised by (A) deficits in intellectual functioning, (B) deficits in adaptive functioning, and (C) intellectual and adaptive deficits occurring during the developmental period. One of the most popular and all-encompassing definition of ID has been given by the (American Association on Intellectual and Developmental Disabilities - AAIDD, 2010; AAIDD, 2017). The AAIDD (2010) and AAIDD (2017) define ID as "significant limitations both in intellectual functioning and in adaptive behavior as expressed in conceptual, social, and practical adaptive skills. This disability originates before age 18" (p. 1). Intellectual disability may also be defined as individuals with IQ score of about 70 and below who display concurrent deficits in at least 2 out of the 10 elements of adaptive functioning and display learning difficulty during their childhood or during their teenage years (American Association on Intellectual and Developmental Disabilities, 2010; Bray 2003). Indispensable to the application of this definition are the following five assumptions recommended by the American Association on Intellectual and Developmental Disabilities (2010; 2017):

1. Limitations in present functioning must be considered within the context of community environments typical of the individual's age, peers and culture.
2. Valid assessment considers cultural and linguistic diversity as well as differences in communication, sensory, motor, and behavioral factors.
3. Within an individual, limitations often coexist with strengths.
4. An important purpose of describing limitations is to develop a profile of needed supports.
5. With appropriate personalized supports over a sustained period, the life functioning of the person with intellectual disability generally will improve (p. 1).

There is no guarantee that all these five conditions will be fulfilled in every diagnosis of intellectual disability. The Wechsler Intelligence Scale for Children Fourth Edition (WISC IV) is the most widely used tool worldwide to ascertain the IQ component in the diagnosis of intellectual disability (Sherman, Brooks, Fay-McClymont, & MacAllister, 2012; Baron, 2005). The validity and interpretation of WISC IV IQ scores are a function of the education and experience of the Psychologist administering the assessment (Community-University Partnership for the Study of Children, Youth, and Families, 2011). Therefore, the diagnosis of intellectual disability is at best, an approximation, a social construction, an informed guess that is not immune to human errors. Biklen (2000) reiterated this view point by acknowledging that

> the objection to the social construction of mental retardation was not that it is a social construction but that it was so often and so universally taken up as

> real and immutable and that, in the main, its reification is dangerous to people so labelled (p. 454).

It is common error among people to view intelligence scores as an indication of the magnitude of intelligence that an individual possesses. Wechsler intelligence scales are not designed to measure the quantity of an individual's intelligence but developed to measure an individual's intellectual performance. There are two reasons for Wechsler's performance approach to intelligence. One reason is the view that the quantity of intelligence is of little or no significance and that what is important, is how well people use their intelligence (performance). A second reason is that the intellectual ability of an individual is not a concrete object whose existence and size can be verified or measured reliably. How well people use their intelligence (performance) is measurable and therefore, the focus of the Wechsler's intelligence scales. One of the most detrimental consequences of special education labels such as 'intellectual disability' and its subclasses of 'mild', 'moderate', 'severe' and 'profound' is that it lowers teachers' expectations of their students (Algozzine & Sutherland 1977, p. 292)

For several decades, IQ scores have been employed widely in describing the levels of severity of ID including borderline (IQ 84 to 71), mild (IQ 70 to 55), moderate (IQ 54 to 35), severe (IQ 34 to 20) and profound (IQ below 20) (Wen 1997, p. 4). This IQ-based classification is being phased out and to be replaced by needs-based severity codes. The APA (2013, pp. 33-36) has introduced needs-based severity codes that consist of mild, moderate, severe and profound ID. This categorization is based on adaptive functioning rather than IQ scores and with functional limitations evaluated across conceptual, social and practical skills domains as detailed in the *Diagnostic and Statistical Manual of Mental Disorders (Fifth Edition)*. The AAIDD (2010) has also introduced its own support-based severity codes of ID consisting of intermittent support, limited support, extensive support and pervasive support which are based on the intensity of support needed by the individual with ID. A summary description of these codes as provided by Reynolds, Zupanick, and Dombeck (2013, pp. 33-34) includes (1) Intermittent support (equivalent to mild ID under APA standards) – "they may only require additional supports during times of transition, uncertainty, or stress", (2) Limited support (equivalent to moderate ID under APA standards) – "with additional training, they can increase their conceptual skills, social skills, and practical skills. However, they can still require additional support to navigate everyday situations", (3) Extensive support (equivalent to severe ID under APA standards) – "… they will usually require daily support" and (4) Pervasive support (equivalent to profound ID under APA standards) – "daily interventions are necessary to help the individual function. Supervision is necessary to ensure their health and safety. This lifelong support applies to nearly every aspect of the individual's routine". The IQ-based classification was used in this study as that was the practice in place at the commencement of this study 4 years ago at the school where this study was conducted.

2.4.2 Diagnosis of intellectual disability. The diagnosis of intellectual disability encompasses a comprehensive assessment that includes elaborate medical examination, genetic and neurological assessments, familial and social history, educational history, psychological assessment to assess intellectual functioning, adaptive functioning assessment, interviews with primary caregivers, interviews with teachers, social and behavioral observations of the child in natural environments and so on (King, Toth, Hodapp & Dykens 2009; Reynolds, Zupanick & Dombeck 2013). The diagnosis process is based on the two defining characteristics of intellectual disability including (1) limitation in intellectual functioning and (2) limitation in adaptive behaviour or life skills.

The examinee's intellectual functioning is measured using the WISC-IV and assessment is conducted across four composite scores in the areas of Verbal Comprehension Index, Perceptual Reasoning Index, Working Memory Index and the Processing Speed Index. A Full-Scale IQ score is derived from these scores. IQ assessment measures reasoning, problem solving, abstract thinking, judgment, academic learning and experiential learning (Reynolds, Zupanick & Dombeck 2013). In the past, a Full-Scale IQ score of 70 and below was the cut off mark for the diagnosis of intellectual disability, but the American Psychiatric Association (2013) in its publication of its fifth Diagnostic and Manual of Mental Disorders has recommended that the level of adaptive functioning be used instead.

Several assessment tools have been developed to measure the adaptive behaviour component of intellectual disability. These include version 2 of the Adaptive Behaviour Assessment (ABAS II) (Harrison & Oakland, 2003a & 2003b), Woodcock-Johnson Scales of Independent Behavior (Bruininks, Woodcock, Weatherman & Hill, 1984), Vineland Adaptive Behavior Scale (VABS) (Sparrow, Cicchetti & Balla, 2005) and The Diagnostic Adaptive Behavior Scale (Schalock, Tasse & Balboni, 2015).

2.4.3 Limitations of individuals with ID and implications for learning. People with ID typically demonstrate limitations in intellectual functioning and adaptive behaviour (APA, 2013; AAIDD, 2010). Limitations in intellectual functioning affect their acquisition of language and academic skills and generally learn at a slower pace than typical students (Rosenberg, Westing & McLeskey, 2013). Intellectual functioning is exhibited in a wide range of areas including difficulties recalling previously learnt information (poor memory recall), inability to generalise skills knowledge, tasks and information, displaying learned helplessness and low motivation (Texas Council for Developmental Disabilities, 2013). This study attempted to address the students' difficulties with recalling previously learnt information by ensuring that (1) previous lessons are reviewed at the introductory phase of each lesson, (2) transition between lessons are sequential from the previous to the introduction of new contents. In the main, students with ID demonstrate deficits in three major areas of intellectual functioning including attention, memory and generalization (Rosenberg, Westing & McLeskey, 2013).

Attention

It has been acknowledged that students with ID expressed three types of attention-related difficulties. These include orienting to a task attention (looking in the direction of the teacher or the learning activities being demonstrated), selective attention (paying attention to what is important and ignoring what is not) and sustaining attention (persisting on a given task) (Rosenberg, Westing & McLeskey, 2013). The attentional difficulties of students with ID have a wide range of implications for classroom practice. To adequately support students with attentional difficulties in the classroom or at school, Rosenberg, Westing and McLeskey (2013), have offered the following recommendations:

1. present initial stimuli that vary in only a few dimensions,
2. direct the individual's attention to these critical dimensions,
3. initially remove extraneous stimuli that may distract the individual from Attending,
4. increase the difficulty of the task over time, and
5. teach the student decision-making rules for discriminating relevant from irrelevant stimuli (p. 1).

Memory

Students with ID have been found to encounter difficulties retaining information. According to Rosenberg, Westing and McLeskey (2013), these students "remember this information one day, they may forget it the next" (p. 1). To facilitate students' retention of memory, it is important to redirect students to the task whenever they lose focus and teach them strategies known to facilitate the retention of information such as rehearsal, clustering information and using mnemonic devices (Smith, Polloway, Patton, & Dowdy, 2015).

Generalization

As indicated earlier, Individuals with ID encounter difficulties with the transfer of knowledge from one setting to another. To improve the students' capacity to generalize skills/information and knowledge, it has been recommended that teachers provide positive reinforcements to students for transferring/generalizing across materials and settings, provide frequent reminders to apply what they have learnt across different settings and for the teacher to teach information in relevant and multiple contexts (Smith, Polloway, Patton, & Dowdy, 2015).

Limitations in adaptive functioning are often expressed through deficits in conceptual, social and practical skills including poor problem-solving skills, inability to make good choices and set goals (Texas Council for Developmental Disabilities, 2013). The limitations that characterise students with ID have manifold implications in the classroom as discussed above. Overall, both the curriculum and instructional approaches must be modified and accommodated to meet the learning needs of individual students.

It must be noted that there is a strong link between difficulties associated with the cognitive deficits of students with ID and their degree of social competence. For example, delayed language development and/or low cognitive development may impact on how the students understand what is expected of them or comprehend and respond to what is going on around them.

2.4.4 Severity categorisation of intellectual disability - Levels of intellectual disability. According to the Diagnostic and Manual of Mental Disorders Fifth Edition (American Psychiatric Association, 2013), there are four levels of severity of intellectual disability including mild, moderate, severe and profound intellectual disability. It has been acknowledged that, the various levels of severity of intellectual disability "are defined on the basis of adaptive functioning, and not IQ scores, because it is adaptive functioning that determines the level of supports required Edition (American Psychiatric Association, 2013, p.33). A second reason for using the adaptive functioning of students to determine their levels of severity of intellectual disability is the fact that IQ scores are less reliable in the lower end of the IQ range Edition (American Psychiatric Association, 2013).

2.4.4.1 Mild intellectual disability. According to the Diagnostic and Statistical Manual of Mental Disorders – Fifth Edition (American Psychiatric Association, 2013, p. 34), individuals with ID operating at the mild level of adaptive functioning display the following characteristics across conceptual, social and practical domains:
Conceptual domain: They exhibit difficulties in academic skills such as reading, writing, arithmetic, time or money. Support must be provided in one or more of these areas to perform at the level expected of persons of their age. Problems with abstract thinking, executive function (i.e., planning, strategizing, priority setting, and cognitive flexibility), and short-term memory, as well as functional use of academic skills (e.g., reading, money management), are manifested even as adults. They are

inclined to using somewhat concrete approach to problems and solutions compared with age-mates.

Social domain: They manifest evidences of social incompetence − difficulties with reading social cues in comparison to typically developing age-mates, social judgment is below what is expected of people of their age (gullible) and show limited awareness of risk in social situations. Display immaturity or disposition for more concrete strategies in their communication, conversation, and language use than expected of persons of similar age. They may have difficulty controlling their emotions and behaviour as expected of persons of their age.

Practical domain: People with mild ID may be able to undertake personal care independently but require some support with undertaking complex daily living tasks compared with individuals of the same age. These may include support with grocery shopping, transportation, home and child-care organizing, nutritious food preparation, and banking and money management. They generally need support on matters related to health, making legal decisions and raising a family. They are capable of holding jobs that make relatively minimal demands on their conceptual skills. Recreational skills are age-appropriate but judgement pertaining to organisation, safety and wellbeing in relation to recreation requires support.

***2.4.4.2 Moderate intellectual disability*.** The characteristics of persons with ID operating at the moderate level of adaptive functioning show the following characteristics across conceptual, social and practical domains (Diagnostic and Statistical Manual of Mental Disorders – Fifth Edition (American Psychiatric Association, 2013, p. 35):

Conceptual domain: They generally lag behind peers in their conceptual skills throughout life. For school-age children, the development of academic skills in areas such as reading, writing, mathematics, and understanding of time and money occurs at a slow pace across the school years and is significantly below persons of similar age. Adults with moderate ID whose academic skills are at an elementary level may be dependent on support to apply academic skills in work and personal life. For some individuals at the moderate level of adaptive functioning, they require continuous support daily to undertake conceptual tasks of day-to-day living while full take-over of these responsibilities is the only option for the others.

Social domain: They exhibit social and communication skills that are markedly inferior to their age-mates across development. Significant social and communicative support is required to undertake work successfully. Spoken language is the main tool for social communication and relatively less complex in comparison to peers. While individuals may have the capacity to form relationships with families and friends, they often do not have the capacity to interpret social cues correctly. They have limited social judgment and decision making abilities and as a result carers must support them in making life decisions.

Practical domain: They may have the ability to care for personal needs independently as adults after the provision of extensive instruction and reminders in these areas have taken place. Examples of these needs include eating, dressing, elimination, and hygiene. Adults with ID that are operating at the moderate level of adaptive functioning are able to undertake household tasks. However, they will continue to rely on ongoing support to achieve performance that is commensurate with the standard expected of an adult. They are able to take up paid employment that involves limited conceptual and communication skills as long as ongoing support is maintained to manage social expectations. They also need assistance with undertaking ancillary responsibilities including scheduling, transportation, health benefits, and financial management. Some display social problems associated with maladaptive behaviour.

2.4.4.3 Severe intellectual disability. The characteristics of individuals with ID who exhibit severe level of adaptive functioning as detailed in the Diagnostic and Statistical Manual of Mental Disorders – Fifth Edition (American Psychiatric Association, 2013, p. 36) include:

Conceptual domain: Individuals with ID who exhibit severe level of adaptive functioning have little understanding of written language or concepts of numbers, quantity, time, and money. As a result, they are dependent on extensive life-long assistance in problem solving.

Social domain: Comprehend speech and gestural communication. Spoken language is characterised by single words or phrases and very limited use of vocabulary and grammar. Speech and communication may be supplemented by augmentative means/technology and focused on the present within everyday events. Individuals derive pleasure and support from members of family and familiar others.
Practical domain: Individuals with ID who exhibit severe level of adaptive functioning require assistance with all activities of daily living such as meals, dressing, bathing, and elimination. They require constant supervision as they are more likely to make decisions that will compromise their wellbeing or the safety of others. Some display self-injurious behaviours.

2.4.4.4 Profound intellectual disability. The characteristics of persons with ID operating at the profound level of adaptive functioning show the following characteristics across conceptual, social and practical domains (Diagnostic and Statistical Manual of Mental Disorders – Fifth Edition (American Psychiatric Association, 2013, p. 36):

Conceptual domain: The skills at this level often involve the physical world rather than symbolic processes. They employ objects in goal-directed fashion for self-care, work, and recreation. They may also display certain visuospatial skills, including matching and sorting that are related to physical characteristics. However, the functional use of objects may be hindered by the co-occurrence of motor and sensory impairments (American Psychiatric Association, 2013, p. 36).

Social domain: People with profound ID are characterised by social limitations such as very limited understanding of symbolic communication in speech or gesture. They may comprehend some simple instructions or gestures but communicate their emotions and desires mostly through nonverbal, non-symbolic communication. They are more comfortable in relationships involving people who are familiar to them including close family members, and carers. Gestural and emotional cues are the main methods of initiating and responding to social interactions. Participation in social activities may be restricted by co-occurring sensory and physical impairments (American Psychiatric Association, 2013, p. 36).

Practical domain: People with ID who exhibit profound level of adaptive functioning depend on others for all aspects of daily physical care, health, and safety, but may be able to participate in some of these activities. Those without severe physical impairments may be able to carry out limited daily chores such as carrying dishes to the table. They require on-going support to engage in vocational activities, using simple actions with objects. With the support of carers, they are able to participate in recreational activities, including listening to music, watching movies, going out for walks, or participating in water activities. Participation in home, recreational, and vocational activities are often restricted by co-occurring sensory and physical impairments (American Psychiatric Association, 2013, p. 36).

2.4.5 Risk factors/causes of intellectual disability. The Australian Bureau of Statistics (ABS — 2014a) has identified the causes of ID in Australia to be genetic conditions (such as Down syndrome), problems at the time of pregnancy (Foetal Alcohol Spectrum Disorder — FASD), birth of a child, health issues in childhood and dementia in later life. Others include accidents that involve health injury, stroke, and other forms of brain damage. For many individuals with ID, the causes are not known (ABS, 2014a).

Some authors have categorised these causes into four groups, namely, brain damage, medical conditions, genetic conditions and psychiatric conditions (Reynolds, Zupanick & Dombeck 2013).

Brain damage – These include (1) traumatic brain injury (e.g. auto accident, a blow to the head, or a fall, when infants are violently shaken or dropped), (2) congenital brain damage, and (3) progressive brain damage (e.g. spinal muscular atrophy and Batten disease)

Medical conditions – Foetal Alcohol Syndrome – alcohol and drugs use or abuse during pregnancy and after the birth of a child and exposure to toxins (e.g. lead, mercury or radiation) and some infections can adversely affect brain development. Some infection that have been found to cause intellectual disability include Toxoplasma infection (toxoplasmosis), Hepatitis B, syphilis, and the virus herpes zoster, that causes chicken pox, Rubella, cytomegalovirus and Herpes simplex II.

Researchers working in the medical field/profession have made significant contributions to our understanding of the causes of ID. As an example, studies by Ordonez, M.A. Rosety, Camacho, I. Rosety, Diaz, Forniedes, Garcia and Rosety-Rodriguez (2014) have indicated that obesity is a significant health problem among people with ID and that aerobic training improved low-grade inflammation in obese women with ID. As a consequence of this finding, carers and other service providers for individuals with ID implement aerobic training for obese women with low grade inflammation as part of their care plan.

Genetic conditions **–** Studies undertaken by Nakano-Kobayashi, Tai, Kasri and Aest (2014) have established a genetic connection to ID. The authors have found that an X-linked ID protein OPHN1 interacts with Homer 1b/c to control spine endocytic zone positioning and expression of synaptic potentiation. Other conditions of genetic etiology that have been associated with ID include Down syndrome (Piek, 2006), Fragile X syndrome (Bailey & Nelson, 1995), Williams Syndrome (Dhareshwar, Patel & Ambani, 1981), Angelman syndrome (Scheiffele & Beg, 2010; Margolis, Sell, Zbinden & Bird, 2015), Bardet-Biedl Syndrome (Forsythe & Beales, 2012) and Laurence-Moon-Biedl syndrome (Janati, ALGhasab, Haq, Abdullah & Osman, 2015). They also include Cockayne Syndrome Disease (Kitsera, Gastelger, Luhnsdorf, Allgayer, Epe, Carell & Khobta, 2014), Cri du Chat Syndrome (Cuming, Diamond, Amirfeyz & Gargan, 2010), Cornelia De Lange Syndrome (Boyle, Jespersgaard, Brondum-Nielsen, Bisgaard & Tumer, 2015), Rubinstein-Taybi Syndrome (Stevens, Pouncey & Knowles, 2011), Tay-Sachs disease (Filho & Shapiro, 2004), Prader-Willi Syndrome (Cassidy, Schwartz, Miller & Driscoll, 2011) and Tourette Syndrome (Byler, Chan, Lehman, Brown, Ahmad & Berlin, 2015).

Psychiatric conditions – Children and adolescents with ID have been found to be at a higher risk for mental disorders than the general population (Neece, Baker, Blacher & Crnic, 2011). This observation corroborates the findings that many people with ID have comorbidities of other psychiatric conditions such as Attention Deficit Hyperactivity Disorder (ADHD) and the risk of ADHD increases with increasing severity of ID (Ahuja, Martin, Langley & Thapar, 2013).

While the main criterion for enrolment at the special school where this study was conducted was a diagnosis of ID, many of the students had a comorbidity of many other conditions related to medical, genetic and psychiatric factors. These included ADHD, cerebral palsy, depression, foetal alcohol syndrome disorder and severe self-injurious behaviours among others.

The American Association on Intellectual and Developmental Disabilities (2010, p. 60) has described the causes of intellectual disability under the umbrella of risk factors and has identified four categories of risk factors. They include biomedical (e.g. genetic and nutritional disorders), social (e.g. social and family interaction – stimulation and adult responsiveness), behavioural (e.g. engaging in injurious behaviours or activities such as substance abuse and educational (access to educational opportunities or supports that enhance cognitive development and facilitate the development of adaptive skills (Table 2.2).

Table 2.2

Timing	Biomedical	Social	Behavioral	Educational
Prenatal	1. Chromosomal disorders 2. Single-gene disorders 3. Syndromes 4. Metabolic disorders 5. Cerebral dysgenesis 6. Maternal illnesses 7. Parental age	1. Poverty 2. Maternal malnutrition 3. Domestic violence 4. Lack of access to prenatal care	1. Parental drug use 2. Parental alcohol use 3. Parental smoking 4. Parental immaturity	1. Parental cognitive disability without supports 2. Lack of preparation for parenthood
Perinatal	1. Prematurity 2. Birth injury 3. Neonatal disorders	1. Lack of access to prenatal care	1. Parental rejection of caretaking 2. Parental abandonment of child	1. Lack of medical referral for intervention services at discharge
Postnatal	1. Traumatic brain injury 2. Malnutrition 3. Meningoencephalitis 4. Seizure disorders 5. Degenerative disorders	1. Impaired child-caregiver interaction 2. Lack of adequate stimulation 3. Family poverty 4. Chronic illness in the family 5. Institutionalization	1. Child abuse and neglect 2. Domestic violence 3. Inadequate safety measures 4. Social deprivation 5. Difficult child behaviors	1. Impaired parenting 2. Delayed diagnosis 3. Inadequate early intervention services 4. Inadequate special education services 5. Inadequate family support

2.4.6 Prevalence of intellectual disability. The data collected by the Australian Bureau of Statistics (ABS) in 2012 indicated that 668,100 people (2.9% of the Australian population) have been diagnosed with ID (ABS, (2014b). The data also showed that more men (3.3%) were being diagnosed with ID than women (2.6%). The number of people diagnosed with intellectual disability increases every year across every age group (Lai, Tseng, Hou & Guo, 2012) due to improved preventative health care (Patja, Livanainen,Vesala Oksanen & Ruoppila, 2000) and possibly due to improved assessment strategies. According to Harris (2006 *cited by* Maulik, Mascarenhas, Mathers, Dua & Saxena, 2011), the prevalence of intellectual disability ranges from 1% to 3% globally. Considering the population of individuals with intellectual disability, studies by King, Toth, Hodap, & Dykens (2009 c*ited by* Maulik, Mascarenhas, Mathers, Dua & Saxena, 2011) have found that 85% have mild intellectual disability, 10% have moderate intellectual disability, 4% have severe intellectual disability while 2% have profound intellectual disability. The prevalence of intellectual disability varies among nations. It ranges between 0.6% and 1.1% of the population in Finland (Westerinen, Kaski, Virta, Almqvistm, & Livanainen, 2007), 0.7% of the population in the Netherlands (Wullink, Lantman-de Valk, Dinant & Metsemakers, 2007) and 2.7% of the population in Australia (Australian Institute of Health & Welfare, 2004).

2.4.7 Life expectancy of individuals with intellectual disability. Studies by Patja, Livanainen,Vesala Oksanen and Ruoppila (2000) have demonstrated that people with mild intellectual disability enjoy a similar life expectancy with the general population. The authors also noted that individuals with profound intellectual disability experience a decreased life expectancy across every age group, with few persons attaining old age. In general, individuals with intellectual disability have a shorter life expectancy than the general population with considerable variations depending on the underlying causes of disability (Reynolds, Zupanick & Dombeck 2013).

2.4.8 Intellectual disability and comorbidity/dual diagnosis. Evidences in the literature have demonstrated that a variety of other conditions often occur among people with intellectual disability and this co-occurrence is usually described as comorbidity (Matson, J. & Matson, M. 2015). Similar to comorbidity is the concept of dual diagnosis which refers to the presence of intellectual disability and a co-occurring mental illness (Werner & Stawski, 2012). It has been observed that generally, people with intellectual disability are at risk of having a co-occurrence of mental illness (Horovitz, Matson, Sipes, Shoemaker, Belva & Bamburg, 2011). Other conditions that co-occur with intellectual disability include epilepsy, challenging behaviours (including Self-Injurious behaviours, autism spectrum disorder and ADHD among others.

2.4.9 Policies and guidelines related to the education of people with intellectual disability

The special school where this research was conducted complies with the policies and guidelines related to the education of people with ID including the following:

Disability Discrimination Act (DDA) 1992. The Disability Discrimination Act (DDA) 1992 (Australian Government, n.d.) is an effort by Australia to meet its international human rights obligations under the Convention on the Rights of Persons with Disabilities. These obligations which are associated with non-discrimination are also being met under other treaties, including the International Covenant on Civil and Political Rights (Australian Government, n.d; Australian Government Department of Education and Training, 2015). The Act was enacted in Australia in 1992 to ensure that Australians with disability are respected and treated fairly in the same manner as other members of the general population. The DDA makes the harassment and discrimination of people with disability across many sectors of Australia's public life unlawful. It outlines the procedure for people with disability to make complaints and seek redress if they think they have been discriminated against on the ground of their disability. The DDA provides legal protection for individuals with disability against discrimination while participating in many areas of Australia's public life such as education, employment, accessing public places, getting or using services and accommodation (Australian Government Department of Education and Training, 2015). The Act describes two categories of discrimination against people with disability, namely: direct or indirect discrimination. Direct discrimination include failure to make reasonable adjustments that the individual requires and treating people with disability less favourably than those without disability under similar circumstances. Indirect discriminations include situations such as demanding or expecting individuals with disability to comply with a requirement or condition when they are not able to do so and when compliance with the condition without reasonable adjustments being made would disadvantage them (Australian Government, n.d.).

***Disability Standards for Education*.** The Disability Standards for Education (DSE) is an offshoot of the Disability Discrimination Act (DDA) 1992 (Australian Government Department of Education and Training (2012). It came into effect in August 2005 to clarify the rights of people with disability in matters related to education and training and to make explicit the obligations of education and training services providers under the Disability Discrimination Act. The primary objective of the DSE is to ensure that students with disability are able to access and participate in education through the provision of similar opportunities of choices that are made available to mainstream students in matters related to admission, participation in courses/programs and the use of facilities and services (Australian Government Department of Education and Training (2012). Under the DSE, education and training providers are required to meet the following obligations:

Consultation: Work collaboratively with parents and care givers to formulate the most appropriate personalised learning program for the student. Education and training providers are required to hold review meetings regularly and records of such meetings are to be kept.

Reasonable Adjustments: Make reasonable adjustments as needed by taking measures or actions that allow students with disabilities to access and participate in learning activities (education and training) on the same basis as other students and to do so in consideration of the needs of other students and available resources (human and material).

Eliminating Discrimination: The DSE states that it is unlawful to subject people with disability to harassment and intimidation because of their condition and breaches are usually handled by the Australian High Commission for Human Rights (Australian Government Department of Education and Training, 2012). Schools and other education providers are required under the DSE to develop and implement strategies to stop individuals from engaging in behaviours that are likely to cause humiliation, offence, intimidation or distress to students with disability. The implementation of the 'no discrimination against students with disability' strategy must involve:

1. Communicating to all members of the school community (staff and students) that it is an offence under the law to harass or victimise students with disability.
2. Spelling out the consequence if a student with disability is harassed or victimised and
3. The complaint procedure for a student with disability that has been harassed and/or victimised.

The Salamanca Statement and Framework for Action on Special Needs Education. The *Salamanca Statement and Framework for Action on Special Needs Education* (United Nations Educational, Scientific and Cultural Organisation – UNESCO, 1994) is one of the most comprehensive international documents designed to promote inclusive education for students with special educational needs. The development of the Salamanca Statement involved the participation of over 300 participants representing 92 governments and 25 international organizations who met in Salamanca, Spain from 7 to 10 June 1994.

The *Salamanca Statement and Framework for Action on Special Needs Education* consists of 5 statements and 85-point guidelines for action at the national level (including policy and organization, school factors, recruitment and training of educational personnel, external support services, priority areas, community perspectives and resource requirements) as well as the regional and international levels. The statements for action include the following:

1. The equalization of opportunities for persons with disabilities
2. The right of every child to an education
3. That schools should accommodate **all children** regardless of their physical, intellectual, social, emotional, linguistic or other conditions. This should include disabled and gifted children, street and working children, children from remote or nomadic populations, children from linguistic, ethnic or cultural minorities and children from other disadvantaged or marginalized areas or groups.

4. Special needs education incorporates the proven principles of sound pedagogy from which all children may benefit. It assumes that human differences are normal and that learning must accordingly be adapted to the needs of the child rather than the child fitted to preordained assumptions regarding the pace and nature of the learning process.
5. The trend in social policy during the past two decades has been to promote integration and participation and to combat exclusion. Inclusion and participation are essential to human dignity and to the enjoyment and exercise of human rights
6. The fundamental principle of the inclusive school is that all children should learn together, wherever possible, regardless of any difficulties or differences they may have. Inclusive schools must recognize and respond to the diverse needs of their students, accommodating both different styles and rates of learning and ensuring quality education to all through appropriate curricula, organizational arrangements, teaching strategies, resource use and partnerships with their communities. There should be a continuum of support and services to match the continuum of special needs encountered in every school.
7. Within inclusive schools, children with special educational needs should receive whatever extra support they may require to ensure their effective education. Inclusive schooling is the most effective means for building solidarity between children with special needs and their peers (UNESCO, 1994, pp. 5-7)

Detail information on The *Salamanca Statement and Framework for Action on Special Needs Education* (UNESCO, 1994) can be found on http://www.unesco.org/education/pdf/SALAMA_E.PDF.

2.4.10 Assessment component of the education of students with intellectual disability. Effective teaching is a function of quality assessment and 'quality' in this regard encompasses a wide range of factors that define the suitability of the assessment tool for the targeted group of students. The notion that every manner of purposeful instruction is closely linked with assessment has gained wide support in the literature (Robinson & Melnychuk, 2009). Fleming and Stevens (2010), acknowledged the "important role of assessment in informing and improving teaching and learning – assessment for learning or assessment for pupil progress" (p. 124). The importance of assessment in the 21st century was reiterated by Reising (1998), who observed that "assessment will be the vehicle that will influence and guide education's big three in the 21st century: scheduling, curriculum, and planning" (p. 325). There is also an increasing disposition in education toward evidence-based practice and the use of assessment as criteria for measuring transparency, accountability and the quality of learning within schools (Docheff, 2010). From the perspective of mathematics instruction, the National Council of Teachers of Mathematics (2013) has given a very important and valid description of the role of assessment as a unified component of mathematics instruction that provides a framework for effective teaching and learning to improve student learning and drive instructional program among other roles.

2.4.11 Documented Plans as a key strategy for the education of individuals with special needs. As a teacher, disability advisor and administrator for schools that cater exclusively for students with ID and other forms of disability, I have developed and implemented a wide range of documented plans over the years. A documented plan is a "support document for teachers as they plan, monitor, assess and evaluate teaching and learning programs that are personalised for students" (Department of Education & Training of Western Australia – DETWA, 2011, p. 3).The term "documented plan" also refers to a wide range of planning documents that are targeted at "students whose academic, social and/or emotional attributes are a barrier to engagement with the content and standards defined in the Western Australian Curriculum" (Department of Education & Training of Western Australia – DETWA, 2016c, p. 3). This cohort of students is also known as "students at educational risk" (DETWA 2016c, p. 1). Documented plans identify both short and medium terms educational goals and are implemented accordingly to support the diverse needs of either individuals or small groups of students with similar academic, social and/or emotional needs.

Documented plans include individual education plans (IEP), individual attendance plan, personalised learning plan (PLP), education adjustment program (EAP), individual behaviour plans (IBP), individual transition plans (ITP) and risk management plans (RMP) (DETWA 2016d; Queensland Department of Education & Training, 2016; Northern Territory Government Department of Education, 2016a; Northern Territory Government Department of Education, 2016b).

Individual Education Plan (IEP). At the special school where this study was conducted, the development of individual education plan (IEP) was a core component of the instructional approach. An IEP is written for each student at the beginning of every semester (twice a year). The process usually commences with the collection of baseline data from various sources (previous records, diagnostic assessments, teachers' observations/anecdotal records, meeting with parents and so on) to determine students' learning needs and the focus of instruction. An Individual Education Plan (IEP) (also known as Individual Learning Plan – ILP) has been described as a "documented plan developed for a student with special needs that summarizes and records the individualization of a student's education program" (British Columbia Ministry of Education, 2009, p. 5). Under the Australian Disability Standards for Education and the Disability Discrimination Act (DDA) 1992, schools/teachers are mandated to make reasonable adjustments to the curriculum to enable students with disabilities to access and participate in learning (Australian Government Department of Education and Training, 2012). Therefore, the IEP is a legal document that clearly outlines the individualized goals, the strategies for achieving the goals, any additional services and resources to be provided as well as how they will be delivered (British Columbia Ministry of Education, 2009).

The development of an IEP is a cyclical process consisting of Assessment, Collaboration, Writing, Introducing, Monitoring, Reviewing and Reporting. All seven components fall within the stages of planning, implementing and evaluating (Figure 2.3).

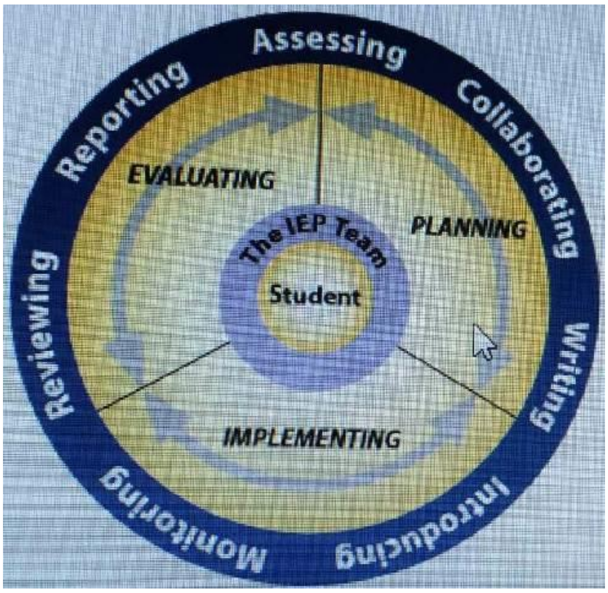

Figure 2.3: The process of developing an IEP (extracted from (British Columbia Ministry of Education, 2009, p. 3).

During the planning phase, the teacher engages in various forms of formal and informal assessments that guides the formulation of the IEP goals and collaboration with various stakeholders. According to the British Columbia Ministry of Education (2009, p. pp 7-8), the majority of formal and informal assessments that are employed prior to the development of an IEP fall within four main categories. These include reviewing (such as school records, teacher records and special services files), interviewing (e.g. talking to parents, teachers – past and present, students through questionnaires, self-assessments), observing (portfolios, functional assessments, work samples, rubrics and rating scales, achievement and behaviour checklists) and testing (diagnostic assessments, criterion-referenced tests, norm reference tests and other alternative formats). The collaboration component of the planning phase involves schools/teachers, parents and other stakeholders working together to address a concern of common interest.

There are different templates for writing IEP within the Australian public school system (Department of Education of Western Australia, 2016b; Northern Territory Department of Education, 2016a). Regardless of the template being used, some data are common to all including the name of the student, date of birth, the present level of educational achievement, goals that are SMART (specific, measurable, achievable, realistic and relevant as well as time-limited), the strategies to be used, the names of all that are involved in the implementation of the plan and review schedule (British Columbia Ministry of Education, 2009). Another item of information that is included in the writing of an IEP is the evaluation plan and the tools that will be used (e.g. checklist, rubrics and rating scales, student self-assessment, portfolio) (British Columbia Ministry of Education, 2009).

The implementation phase of the IEP involves putting it into practice and consists of the introduction of the IEP and monitoring of students' progress. The latter involves observation and consistent data collection that inform future adjustments to the goals and instructional approaches being adopted in the classroom. The effectiveness of the IEP is reviewed during the evaluating phase of IEP development to inform future planning and reporting of students' progress to parents. The main components of this phase include the revision of goals, instructional strategies, identification of priorities for the next teaching/reporting period, involvement of the parent and the student (if necessary), review of concerns and problems and the documentation of the next IEP review date (British Columbia Ministry of Education, 2009). The reporting phase takes a snapshot of the degree of progress being made by the student against the goals that were previously identified during the development of the IEP.

Education Adjustment Program (EAP). According to the Northern Territory Government Department of Education (2016a), an Education Adjustment Program (EAP) refers to "the development of appropriate adjustments for a student with disability based on the specific needs and abilities of the student which allows for greater participation and access to the curriculum" (p. 2).

Personalised Learning Plan (PLP). The Personalised Learning Plan (PLP) is an active document that is "usually developed by teachers, mostly in consultation with students and parents, to identify, organise and apply personalised approaches to learning" (Australian Government Department of Education, Employment and Workplace Relations − DEEWR, 2011, p. 2). It has been acknowledged that some teachers and school systems consider the PLP and IEP to be identical terms and use them interchangeably (DEEWR, 2011 p. 2) but there is a subtle difference between both terms. While the IEP is based on the understanding or expectation that given the right support, every student can learn but not necessary at the same level, a PLP is borne out of the belief that “all students can learn at the same level, provided the appropriate conditions are created” (DEEWR, 2011 p. 2). As a result of this difference, IEPs are specifically developed for students with disabilities or learning difficulties while PLPs are developed for disadvantaged groups such as Aboriginal and Torres Strait Islander students with the understanding that given the right teaching and learning conditions, these students can achieve to the same standard as the non-indigenous cohort.

Individual Transition Plan (ITP). An Individual Transition Plan (ITP) has been defined as a person-centred and “supportive framework that helps young people and their parents plan for their life after school in a coherent and coordinated way” (Department of Education and Training of Western Australia, 2014, p. 1). An Individual Transition Plan (ITP) encompasses the development of “short and long term goals and strategies to prepare a Senior School student with disability to transition to his/her chosen post-school pathway” (Northern Territory Government Department of Education, 2016b, p. 2). According to the Department of Education and Training of Western Australia (2014), Individual Transition Plans are important because they:

- provide a framework for young people, and those who support them, to plan in a deliberate way, with purpose and optimism
- prepare and assist young people to make informed and realistic choices about their future
- assist young people and their families to acquire information and access the fullest range of future options, opportunities and services
- help young people and their families negotiate and navigate their pathways to desired future destinations
- encourage young people to see the relevance of their learning and how it links to their future goals and aspirations;
- help young people make connections between school, home and community-based learning and experiences and future goals
- help young people to identify areas of possible improvement and development
- encourage young people to make decisions about their future, based on understanding of themselves as a person and as a learner

- facilitate communication, collaboration and coordination between school, family, and community and services and agencies
- provide young people with an opportunity to:
  - learn and practice self-determination skills
  - develop career-management skills
  - develop the skills to manage their lifelong learning needs (p. 1),.

Individual Behaviour Plans (IBP). The need to create and maintain a conducive environment for learning has made effective management of behaviour one of the key roles of teachers. This fact is stressed in documents such as the S*tudent Behaviour Policy* (Department of Education and Training of Western Australia, 2016e). An Individual Behaviour Plan (IBP) or Behaviour Support Plan (BSP) refers to "a school-based document designed to assist individual students who have experienced harm, are at risk of harm, or have caused harm to others" (Victoria State Government Department of Education and Training, 2013a, p. 1). This includes the provision of additional support to students with a diagnosis of severe behaviour disorders or display behaviours that are deemed to be challenging or disruptive, students that have been victims of bullying or committed bullying behaviour against others. There are eight basic steps to the development of an IBP (Victoria State Government Department of Education and Training, 2013a) including:

1. Gathering relevant information about the student.
2. Convening a meeting of relevant school staff and the student's parents.
3. Convening a meeting of relevant school staff to draft the BSP.
4. Refining the BSP.
5. Signing the BSP.
6. Providing a copy to staff, parents and if appropriate, the student.
7. Reviewing the BSP.
8. Concluding the BSP (p. 2)

Risk Management Plans (RMP). Generally, students with ID are more vulnerable to risks than mainstream students due to their cognitive and adaptive limitations. Schools and teachers have a duty of care to their students (Department of Education and Training of Western Australia (2007). The duty of care for students' policy (Education and Training of Western Australia, 2007), clearly states that:

a) Teaching staff owe a duty to take reasonable care for the safety and welfare of students whilst students are involved in school activities or are present for the purposes of a school activity. The duty is to take such measures as are reasonable in all the circumstances to protect students from risks of harm that reasonably ought to be foreseen. This requires not only protection from known hazards, but also protection from harm that could foreseeably arise and against which preventative measures can be taken.

b) In discharging their duty of care responsibilities, teaching staff must exercise their professional judgement to achieve a balance between ensuring that students do not face an unreasonable risk of harm and encouraging students' independence and maximising learning opportunities.

c) When non-teaching staff, volunteers and external providers agree to perform tasks that require them personally to care for Students (in the absence of a member of the teaching staff), they will also owe a duty to take such measures as are reasonable in all the circumstances to protect students from risks of harm that reasonably ought to be foreseen (p. 3).

There is always an element of risk when students with ID participate in incursions and excursions through community access programs which is a core part of their learning. It is therefore strongly advised for teachers to familiarise themselves on how to prepare a risk management plan (Queensland Government Business and Industry Portal, 2016; Department of Education and Training of Western Australia, 2016c). A risk management plan is an essential tool that is implemented on these occasions to ensure the safety and well-being of students while they are at school and/or participating in school related activities (Victoria State Government Department of Education and Training, 2013b).

A risk management plan has been described as the "process of identifying risks, assessing risks and developing strategies to manage risks" (Queensland Government Business and Industry Portal, 2016, p. 1). The Victorian Government Department of Education and Training (2014, p. 1) recommends the following flow chart for managing risks in schools (Figure 2.4).

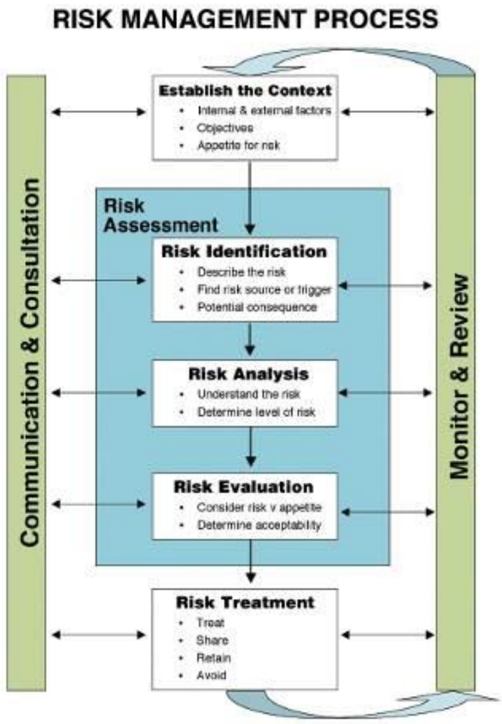

Figure 2.4: The risk management process (extracted from The Victorian Government Department of Education and Training (2014, p. 1).

Detail information on the process of identifying and dealing with risks associated with school excursions is described under 'Planning – Managing Risk' on the website of the Victoria State Government Department of Education and Training (2013b).

Who Must Have a Documented Plan?

According to the Department of Education and Training of Western Australia (2011, 2016d), students whose attendance is below 90% and whose absence is of concern to the school are required to have an individual attendance plan. Students that display significant behavioural concerns or needs who require a personalised/individualised management program or who are being considered for exclusion require documented plans in the form of an individual behaviour plan (Department of Education and Training of Western Australia, 2016e). It has been acknowledged that students who are in the care of the Chief Executive Officer of the Department of Child Protection and Family Services (CPFS) are often at risk and therefore a documented plan (IBP) that is developed in partnership with CPFS staff is part of the usual care plan for such students (Department of Education and Training of Western Australia (2011). Others include students requiring relevant adjustments to their educational programs, transiting school to the community or between schools.

2.5 Evaluating the Number Sense Competence of Students with ID

The primary focus of this study is to improve the mathematics achievement of students with ID. The categorisation of students with ID into borderline, mild, moderate, severe and profound groups is a clear recognition that these students do not belong to one homogenous group with identical characteristics and to treat them as such would be counterproductive. To the best of my knowledge, no study has been undertaken in the past to shed light on the extent to which the differences that have warranted individuals with ID to be placed into different groups impart on their learning of Mathematics. If the current push to improve the quality of education in Australia and particularly the teaching and learning of Mathematics, functional mathematics and number sense among students with ID is to be successful, it is imperative to understand the differences that may exist so that instruction and instructional approaches are maximised and better tailored to their needs.

2.6 Research on Students' Achievements – Mainstream Students

There is an ample amount of information in the literature on student achievement in relation to mainstream students (Bates, Smith, 2013; Shifflet & Lin, 2013; Haines & Mueller, 2013; Strayhorn, 2013). However, Guskey (2013) has observed that the differing opinions on the meaning of the term (student achievement) has created some difficulties which prompted that researcher to make the following observations and recommendations:

> Student achievement is a multifaceted construct that can address different

> domains of learning, often measured in many different ways, and for distinctly different purposes. To ensure the accuracy and validity of statements made about student achievement, therefore, researchers must be specific in the way they describe this important construct. In particular, they must identify the domain of the learning goals involved and the way student achievement is determined (e.g; attainment vs. improvement). In addition, they must include detailed information about the breadth, the depth, and the purpose (instructional sensitivity) of the instruments used to measure student achievement. All of these factors bear on interpretations of student achievement results (Guskey, 2013, p. 5).

One of the most comprehensive studies ever undertaken on students' achievements was carried out by Hattie (2009) and involved the synthesis of over 800 meta-analyses relating to achievement. The author found that student achievement is a complex, multidimensional and interrelated term comprising home, student, school, teacher, instructional approaches, and curriculum factors (Figures 2.5 and 2.6).

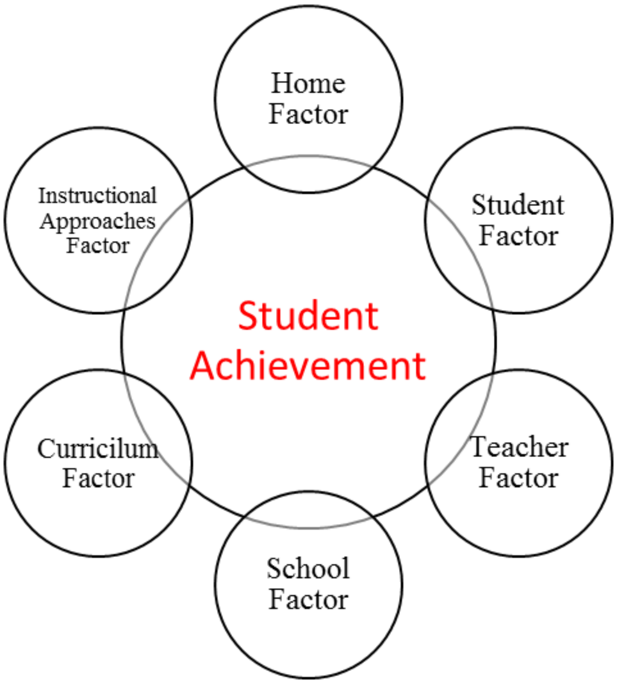

Figure 2.5: Essential components of student achievement.

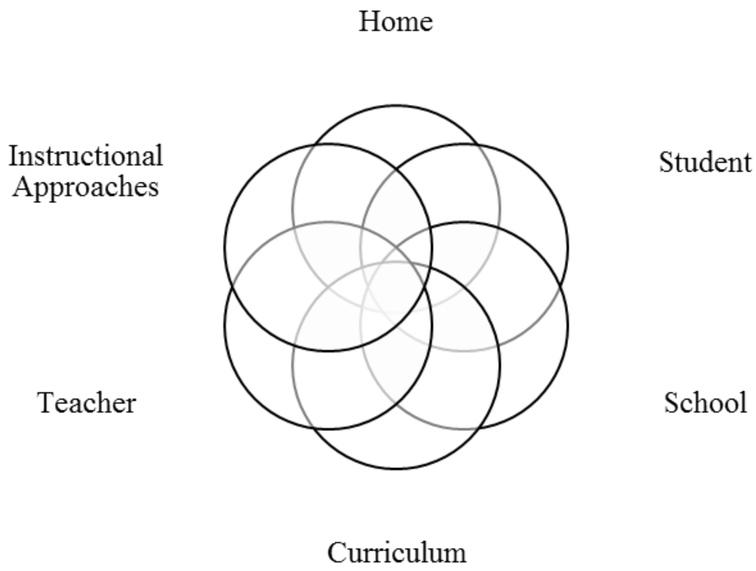

Figure 2.6: Relationship between the different parts of student achievement.

2.6.1 Student factor. As alluded to under the discussion on IEPs (Section 2.4.11) background knowledge about students is of tremendous importance to establishing their learning needs and the setting of instructional targets/goals. There are many evidences in the literature that corroborate the importance of prior knowledge to learning in general - regardless of whether it is related to Mathematics and Science or not (Amadieu, Tricot, & Marine, 2009; Spires & Donley, 1998; Nelson, Bajo, McEvoy, & Schreiber, 1989). Prior knowledge is the sine qua non of successful teaching and learning of Science and Mathematics as well as other learning areas. To the students, it is the light source that breaks down clouds of darkness embedded in the unknown, allowing students to connect with new knowledge/information to make a meaning or gain the required understanding and empowers them with the flexibility of thinking to be active and independent learners. For the teacher, an awareness of students' prior knowledge will ensure adequate planning of lessons and the delivery of learning experiences that are relevant, meaningful and extend the child as well as compatible with the student's ability – not too easy and not too difficult. Thus, effective science and maths education must establish students' prior knowledge and take them from there to the new. Linn, Lewis, Tsuchida, and Songer (2000) reiterated this point by observing that "previous knowledge and experiences are the starting point for new learning" (p. 5). Therefore, "it is important to know what students know prior to commencing a new topic in science and mathematics because this will most likely result in improved student learning". Other student-related factors that influence students' achievements include:

● Attitudes and dispositions such as the student personality, self-concept, motivation, concentration/persistence/engagement (time on task) and anxiety

● Physical influences such as pre-term birth, illness, diet, exercise/relaxation, drugs, gender and positive view of ethnicity.

● Preschool experiences including early intervention and preschool programs

2.6.2 Teacher factor. The role of teachers as managers of the curriculum is of fundamental importance in view of the fact that they are responsible for making key decisions that drive teaching and learning such as the content to be taught, resources required, when and how to teach as well as the sequence of learning activities (Sanders & Rivers, 1996). It has been acknowledged that teachers influence the achievements of their students through personal characteristics such as passion, perseverance, risk taking, pragmatism, patience, flexibility, respect, creativity, authenticity, love of learning, high energy and sense of humour (Colker, 2008). According to Hattie (2009), the essential elements of teachers' contribution to students' achievements also include:

- teacher effects
- teacher training
- microteaching
- teacher subject matter knowledge
- quality of teaching
- teacher-student relationship
- professional development
- teachers' expectation of their students
- Not labelling students and lowering expectation as a result
- teachers' estimates of students' ability/achievement
- teachers' efficacy
- their dedication to developing and implementing learning programs that are in harmony with Piagetian stages of cognitive development.
- teachers' beliefs in regard to their role is more influential than the lesson plan, classroom structure, the student and the assessment.

- response to intervention
- teacher credibility
- interventions for learning disabled
- interventions for disabled
- reflection of creativity in programming, assessment and instruction
- Teaching strategies

Clegg (1973) questioned if the idea of referring to teachers as managers of the curriculum has now become obsolete in the light of the emergence of the systems approach (e.g. the principal and the school board that define the goals, philosophy and priorities of the school) and the borrowed business-like management of schools

It has been acknowledged that teachers' effectiveness is the singular most dominant factor impacting on students' achievements (Sanders & Rivers, 1996). It is simply not enough to put teachers in front of the students without consideration for their preparedness for the role. Teachers' effectiveness to make improvements in their students is greatly compromised when they lack the knowledge, skills and attitudes to make a positive difference to their learning. Hattie (2009) alluded to this fact in his observation that "not all teachers are effective, not all teachers are experts, and not all teachers have powerful effects on students… it is teachers' variability in effect and impact that is critical" (p. 108).

2.6.3 School factor. The school environment has been found to have a strong impact on students' achievements (Barry & King, 1999). Higgins, Hall, Wall, Woolner, and McCaughey (2005) have attributed the influence of the school environment on students' educational outcomes to a range of factors. These include the school built environment (eg; air quality, temperature, noise), physical environment in the classroom (provision for the safety and well-being of students as well as relevant facilities), products and services (e.g; the implementation of breakfast and related programs for students that come to school without food) and communication (e.g. a quality communication system facilitates the creation of a school environment that is conducive to learning. Hattie (2009), has outlined the essential elements of schools' contribution to students' achievements as:

- Attributes of schools including school effects and finances.

- Types of school (e.g; Charter schools, Religious schools, etc)
- School composition effects such as school size, principals/school leaders and so on.
- Classroom composition effects including class size, ability grouping, multi-grade/age classes, within-class grouping, small group learning, mainstreaming and retention.
- Curricula for gifted students including ability grouping for gifted students, acceleration and enrichment.
- Classroom influences such as classroom management, classroom cohesion, classroom behaviour, decreasing disruptive behaviour and peer influences.

2.6.4 Curriculum factor. The curriculum makes immense contribution to students' achievements due to the central position that it occupies in teaching and learning (Southern Cross University, 2013). According to Hattie (2009), the essential elements of curriculum contribution to students' achievements include:

- Mathematics and Science including the use of calculators
- Other curricula programs such as values/moral education programs, social skills programs, career interventions, integrated curricula programs, perceptual motor programs, tactile stimulation programs, play programs, creativity programs, outdoor/adventure programs and bilingual programs.

For students with disabilities, an inclusive curriculum that recognises, accommodates and meets the learning needs of every student is of paramount importance. According to *InCurriculum* (n.d; p. 1) (an organisation based in the United Kingdom), such a curriculum "means acknowledging that your students have a range of individual learning needs and are members of diverse communities… avoids pigeonholing students into specific predictable and fixed approaches to learning".

2.6.5 Instructional approaches factor. The selection of appropriate Instructional approaches has been found to be of tremendous importance to students' achievements (Gelisli, 2009). The importance of teaching strategies to students' academic success has been acknowledged by Hattie (2009) as consisting of many parts. They include:

- Strategies emphasizing learning intentions including goals, behavioural organizers/advance, organizers, concept mapping, learning hierarchies

- Strategies emphasizing success criteria such as mastery learning, and worked examples.
- Strategies emphasizing feedback including feedback, frequency or effects of testing, teaching test taking and coaching, providing formative evaluation, questioning and teacher immediacy.
- Strategies emphasizing student perspectives in learning, such as time on task, spaced vs. massed practice, peer tutoring and mentoring.
- Strategies emphasizing student meta-cognitive/self-regulated learning Including meta-cognitive strategies, study skills, self-verbalization/self-questioning, student control over learning, aptitude-treatment interactions, matching style of learning and individualized instruction.

2.6.6 Home factor. It has been acknowledged that the home and family backgrounds of students exert a strong influence on their achievements at school (Nonoyama-Tarumi, 2008). This fact was reiterated by Behera and Makunja (2013) observing that:

> Home is the first and the most significant place for the child's inclusive growth and development. It provides not only the hereditary transmission of basic potentials for the development of the child, but also the favourable environment in terms of interpersonal relationship and cultural pattern (p. 1).

According Hattie (2009), the home factor impacts on students' achievements in manifold ways, including:

- Socioeconomic status – where individual's or family's or household's is relatively situated in the social hierarchy as defined by the resources in the home with the main indicators as parental income, parental education, and parental occupation.
- Welfare policies – welfare and work policies directed at low-income families have some unfavourable consequences on the school outcomes of adolescent members of the family ages 12 to 18 if required to look after younger siblings at home as parents go to work (Gennetian, Duncan, Knox, Vargas, Clark-Kauffman & London, 2004).
- Family Structure

- Home environment
- Television
- Parental involvement
- Home visiting

2.7 Research on the Mathematics Achievements of Students – Mainstream students

The literature also has a significant quantity of information with a focus on the mathematics achievements of mainstream students (in contrast to those that target students' achievements in general). Studies undertaken on University students in the Philippines by Andaya (2014) found that the mathematics achievements of the students correlated strongly with the student factor (attitude) and the teacher factor (through the instructional approaches employed). At the same time, Andaya (2014) found that the mathematics achievements of the students correlated moderately with classroom management and assessment factors (also components of the teacher factor). Andaya's findings, reinforce the importance of student and teacher factors to the mathematics achievements of students as well as justify why these factors were investigated as part of this this study.

Mathematics is a function of the cognitive and affective factors of students (Furinghetti & Morselli, 2009) such as IQ, mathematics anxiety of students (Lai, Zhu, Chen & Li, 2015), the mathematics self-efficacy of students (Guven & Cabakcor, 2013), the instructional approaches used by the teacher, and the attitude of teachers towards their students (not labelling students).

2.8 Intellectual Disability − Factors Influencing the Mathematics Achievements of Students that Were Evaluated Under the Current Study

There are so many factors that could have possible influence on the mathematics achievements of students with ID − some within the school and others outside the school (Hattie, 2009). Limited time, resources and logistic reasons which defined the scope of this study made it impossible to evaluate all of the factors. This research study evaluated the impacts of the following on the mathematics (number sense) achievements of the students:

1. Differences in cognitive abilities among students with ID such as borderline, mild and moderate ID (**research question 1**)
2. Effects of student factor such as age, gender, students' self-efficacy, maths' anxiety, social emotional states (part of **research question 2**)
3. Effects of teacher factor such as the mathematics teaching beliefs (**Part of research question 2**)
4. Effects of explicit instruction and a strategy based on the philosophy of constructivism on the development of number sense among high school students with borderline, mild and moderate intellectual disabilities (**research question 3**)
5. The development of a numeracy assessment tool that is specific to the needs of students with ID.

2.8.1 Impacts of the differences in the cognitive abilities of students with borderline, mild and moderate ID on their number sense achievements (research question 1**).** Individuals with ID are categorised into borderline (IQ 84 to 71), mild (IQ 70 to 55), moderate (IQ 54 to 35), severe (IQ 34 to 20) and profound (IQ below 20) (Wen 1997, p. 4) as detailed previously (Section 2.3). I have undertaken extensive literature review and have not found any report on the number sense achievements of students with borderline, mild and moderate ID. I am of the opinion that an understanding of the extent to which differences in IQ impact on the number sense achievements of this cohort of students will guide teachers in providing targeted and individualised instruction. Considering the non-availability of information on the connection between IQ and the number sense achievements of students with ID, this was investigated as part of this study under research question 1.

2.8.2 Effects of Student-related factors such as students' self-efficacy, maths' anxiety, age, gender and social emotional states on their mathematics achievements (part of research question 2)

2.8.2.1 The Self-efficacy of students with intellectual disability. According to Gist and Mitchell (1992), students' self-efficacy refers to beliefs in their capabilities "to mobilize the motivation, cognitive resources, and courses of action needed to meet given situational demands" (p. 184). This involves the "convictions that one can successfully carry out given academic tasks at designated levels" (Bong, 2004, p. 288). Embedded in this definition of self-efficacy is the affirmation of the importance of motivation and cognitive ability. Motivation and cognitive factors are essential ingredients of self-efficacy. Azar, Lavasania, Malahmadi and Amani (2010) have acknowledged that motivation and cognitive ability influence achievements among other factors. All around us today, there are everyday examples of mathematics impacting on our lives, including shopping, using the phone, transport, money, cooking and many others (Gouba, 2008). Students with ID require some functional knowledge of Mathematics to achieve some degree of independence in their lives. For example, the ability to read time is essential to employees arriving work on time and keeping their job ("if the short arm of a clock points to 3 and the long arm to 12, what is the time?"). Also, it is important to be able to identify one's phone number (functional mathematics) and name (functional literacy) on a bill to avoid paying the bill of a previous tenant in a rented accommodation and to be able to identify one's phone number (from a given set of numbers).

Past studies have been conducted on the self-efficacy of mainstream students including the development of English and mathematics self-efficacy by 3rd– and 4th–grade students (Phan, 2012a), the self-efficacy of middle school students from grades 7 to 9 in Korean, mathematics, English and Science (W. Lee, M-J. Lee & Bong, 2014), the mathematics self-efficacy of students in grade 6 (Pajares & Graham, 1999) and the self-efficacy of students within higher educational setting (Dinther, Dochy & Segers, 2011). Others include the mathematics self-efficacies of university undergraduates (Bates, Latham & Kim, 2011), university graduates (DeChenne, Enoch & Needham, 2012); people accessing correctional facilities (Allred, Harrison & O'Connell, 2013), mainstream high school students (O'Brien, Martinez-Pons &

Kopala 1999), mainstream elementary school students (Joet, Bressoux & Usher, 2011) and parent (Usher & Pajares, 2009). Sawtelle, Brewe and Kramer (2012) also explored the relationship between self-efficacy and retention in a University introductory physics course.

Self-efficacy has been found to be a good predictor of Mathematics achievements among mainstream students (Pajares, 1996). The predictive significance of self-efficacy and the mathematics achievements of students with ID is not certain. The outcome of studies undertaken by Enoma & Malone (2015c) on the impact of the self-efficacy of students with ID on their mathematics achievements leaned more towards the individual characteristics of the students than their self-efficacy. The authors did not find any strong correlation between the mathematics self-efficacy of students with ID and their achievements in Mathematics (number sense) but rather found the following scenarios:

- Students with low mathematics self-efficacy who achieved high scores in the test.
- Students with high mathematics self-efficacy who achieved low scores in the test.
- Students with high mathematics self-efficacy who achieved high scores in the test.
- Students with low mathematics self-efficacy who achieved low scores in the test (Enoma & Malone, 2015c, p. 228).

While there is a copious amount of information in the literature on the self-efficacy beliefs of individuals in mainstream educational settings, the impact of self-efficacy on the number sense achievements of high school students with ID has not been evaluated save for the paper referenced above (Enoma & Malone, 2015c), which is a published paper from the current study. As a result, the self-efficacy of the students was investigated as part of this study under research question 2.

2.8.2.2 Sources of mathematics self-efficacy of students with intellectual disabilities. Bandura (1986, 1997) has identified four sources of self-efficacy including mastery experience (an understanding of one's own performance), vicarious experience (observation of others), social persuasions and physiological and emotional states. Sawtelle, Brewe and Kramer (2012) corroborated Badura's findings and particularly noted that men and women draw on different sources of self-efficacy for their choices of career pathways. I have searched the literature for studies on the sources of mathematics self-efficacy of high school students with ID and found that no study of this nature appears to exist.

Previous studies on the sources of self-efficacy have focused almost entirely on the mainstream educational context including elementary school students (Joet, Usher & Bressoux, 2011), upper elementary school children (Phan, 2012b), middle school mathematics students (Usher & Pajares, 2009), Grade 6 students (Usher & Pajares, 2005), high school students (Ahn, Bong & Kim, 2016), the sources of self-efficacy in maths and reading among elementary and middle school students (grades 4 to 8) (Butz & Usher, 2015), the sources of teaching self-efficacy among University professors/researchers (Morris & Usher, 2011), the sources of self-efficacy among middle school students in Korea, the Philippines and United States (Ahn, Usher, Butz & Bong, 2016),

The only exception was the research undertaken by Hampton and Mason (2003) which was on the sources of self-efficacy of high school students with learning disabilities. However, students with learning disability and those with intellectual disability are two completely different cohorts of students. Williams (2011, p. 1) defines learning disability as the "communication handicaps that are not related to physical, developmental or intellectual disabilities". In other words, learning disability describes people with normal IQ who have difficulties in areas such as reading, writing and/or maths. In contrast, intellectual disability is a term used to describe individuals with "significant limitations both in intellectual functioning and in adaptive behaviour as expressed in conceptual, social, and practical adaptive skills (American Association of Intellectual and Developmental Disabilities, 2010, p. 1).

2.8.2.3 Mathematics anxiety of students with intellectual disability. It is crucial to the improvement of mathematics education to give consideration to mathematics anxiety (McLeod, 1992). Various studies have been conducted in this regard on the different aspects of mathematics anxiety. In one of those studies, Taylor and Fraser

(2013) investigated the relationships between the learning environment and students' mathematics anxiety, as well as the gender variations in relation to their perceptions of learning environment and mathematics anxiety. The authors found that mathematics anxiety has two components including, learning mathematics anxiety and mathematics evaluation anxiety, and that relative to males, females encountered lesser anxiety about the formal and greater anxiety about the latter.

2.8.3 Effects of teacher-related factors such as the Mathematics Teaching Efficacy Beliefs (part of research question 2)

2.8.3.1 The Mathematics Teaching Efficacy Beliefs of Teachers. One teacher-related factor that has been found to be influential to the teaching and learning of Mathematics is the teaching efficacy beliefs of teachers, an offshoot of Badura's social-cognitive theory (Bandurah, 1977). Teacher efficacy has been defined as a teacher's "judgment of his or her capabilities to bring about desired outcomes of student engagement and learning, even among those students who may be difficult or unmotivated" (Tschannen-Moran & Woolfolk, 2001, p. 783). The term describes "the extent to which teachers believe they can successfully execute teaching-related tasks" (Ekmekci, Corkin & Papakonstantino, 2015).

Bandura (1994), acknowledges that "self-efficacy beliefs determine how people feel, think, motivate themselves, and behave" (p. 1). While self-efficacy beliefs refer to individuals' capability to mobilise and carry out the needed courses of action to bring about desired outcomes (Bandura, 1997; Pampaka, Kleanthous, Hutcheson & Wake, 2011), mathematics self-efficacy has been defined as people's confidence in their ability to carry out and achieve in a particular mathematics task or problem within a given context (Hackett & Betz, 1989). It has been observed that teachers' perceptions, attitudes and expectations of students are often influenced by whether the label "disability" is attached to their names or not (Gutshall, 2013; Cook, J. A. 2001; Rolison & Medway, 1985; Dusek & Joseph, 1983; Levin, Arluke & Smith, 1982). Teachers learning expectations have been found to be lower for those with labels than non-labelled students, and particularly for those diagnosed or described as having intellectual disability (Foster, Ysseldyke, & Reese, 1975). For this reason, Shifrer (2013) expressed his disapproval of special education placements because of the vulnerability of students with disability to prejudicial attitudes and negative treatments which undermine the attainment of improved educational outcomes. For special schools with intellectual disability the main eligibility and funding criterion is a diagnosis of intellectual disability. In other words, the majority of students in such schools wear the label of intellectual disability. The teaching efficacy beliefs of teachers have been associated with students' achievements (Ross, 1992), instructional practices and behaviours of teachers (Allinder, 1994), teachers' enthusiasm and motivation in the classroom (Midgley, Feldlaufer & Eccles, 1989), and the effort teachers put into their lessons (Tschannen-Moran & Woolfolk, 2001).

Alongside social-cognitive theory and its self-efficacy offspring (Bandura, 1977, 1997), there is another strand of research that has a strong bearing on teachers' motivation and subsequently on students' achievements that should not be ignored. This line of research is conducted under the theory of self-determination (Deci & Ryan, 1985) and captures the fact that teachers cannot and do not operate in isolation of their school settings. Under the theory of self-determination, Deci and Ryan (1985) have identified three intrinsic needs that determine how people function, including the need for autonomy (allowed freedom to decide and carry out work decisions), the need for competence (mastering of tasks) and the need for connectedness (feeling supported at work). Studies by Holzeberger, Philipp and Kunter (2014) have demonstrated the tremendous importance of the interplay between self-efficacy and intrinsic needs in predicting teachers' instructional behaviours.

Having regard to the following, the importance of the mathematics teaching beliefs of teachers to students' mathematics achievements cannot be overemphasized. While researchers are united in their acknowledgement that the mathematics teaching beliefs of teachers is an essential teacher-related factor influencing students' achievements, there is no report of any study that has been conducted in specialist schools dedicated to students with ID. This study has made an endeavour to fill the gap by way of responding to the teacher factor component of research question 2 – effect of teacher factor on the mathematics (number sense) achievements of students with ID.

Previous studies and publications on self-efficacy beliefs have been undertaken across a wide spread of disciplines and participants including university undergraduates (Bates, Latham & Kim, 2011), university graduates (DeChenne, Enoch & Needham, 2012); people accessing correctional facilities (Allred, Harrison & O'Connell, 2013), mainstream high school students (O'Brien, Martinez-Pons & Kopala, 1999), mainstream elementary school students (Joet, Bressoux & Usher, 2011) and parent (Usher & Pajares, 2009).

Teacher efficacy has been acknowledged by Enoch, Smith and Huinker (2000) as a two-dimensional construct consisting of personal teaching efficacy (a belief exercised by a teacher that he or she has the capability to teach maths effectively) and teaching outcome expectancy (the belief of a teacher that effective teaching can yield positive learning outcomes for students, despite prevailing external factors).

2.8.3.2 Attitudes of teachers towards People with intellectual disability. Effective teachers are a significant asset in their classrooms and beyond (AITSL, 2011a) but teachers' biases and stereotypic behaviours against students are undermining their effectiveness (Dunkake & Schuchart, 2015). It has been observed that teachers' expectations of their students' performance determine to a large degree the type of interaction that teachers have with their students (Mizala, F. Martinez & S. Martinez, 2015). Studies undertaken by Brophy and Good (1970) have revealed that teachers engage in different classroom behaviours with students for whom they accord high or low academic expectations. According to Good (1987), such behaviours include teachers interacting less frequently with low expectation students, praising high expectation students more regularly for their accomplishments while criticizing low expectation students for their lack of success and giving low expectation students less response time when questions are asked.

Teachers' effectiveness encompasses the attitudes, beliefs and expectation held by teachers about learners with intellectual disability (ID) and others with learning difficulty. It also includes the effective utilization of para-professionals in their classrooms, management of lesson transition, knowledge of individual students and their disability diagnoses, knowledge of effective instructional strategies for students with learning difficulties and the individualization of teaching and learning through the modification or accommodation of learning activities. This is known as curriculum differentiation (Robert, & Winfried, 2012).

Teachers' attitudes towards students with intellectual disability are the singular most important factor that influences the former's effectiveness in the classroom because beliefs influence behaviour (Swann & Snyder, 1980). This point was supported by Pike, Bradley and Mansfield (1997), who acknowledged that "instructional belief system can either nurture or limit the way in which teachers function" (p. 125). Students' mathematics competence is a product of the interconnection between a range of factors that include the teacher and the learning environment. Teachers who exhibit a limiting instructional philosophy are more disposed toward taking a deficit perspective of students with ID. They have low expectations of students with ID, attend their classrooms without essential lesson preparations and planning and without a clear sense of instructional direction. These teachers allocate no time to reflect on their instructional practices, growth or ways to improve the learning of their students. Such teachers are overcome by a sense of powerlessness that is induced by the notion that the problem resides in the child and display "there is nothing I can do" attitude. Teachers with a nurturing philosophy of students with intellectual disability approach students with ID with a positive attitude, believing they can make a difference to their learning of numeracy regardless of the disability and learning challenges of the students. They understand the terms intellectual disability and learning disability are social constructions that depend on the complex relationship between the learning environment, learning activity and people (Dudley-Marling, 2004) of which the teacher is a major player. They accept their responsibility as instructional leaders and a catalyst for the enhancement of students' learning in their classrooms. As a result, they differentiate the curriculum, modify or accommodate learning programs according to the individual needs of their students and employ evidence-based instructional strategies. These teachers provide learning activities that are relevant, rigorous and meaningful but within the ability level of individual students. They constantly monitor the progress of their student learning, undertake critical reflection on their practice constantly and seek as well as embrace opportunities for their own professional growth.

Cook, B. G. (2001) conducted a comparative study on the attitudes of teachers towards their students with mild and severe disabilities from Kindergarten to Year six and found that "teachers do not know how to provide instruction that meets the unique needs of students with severe disabilities" (p. 211).

2.8.4 Effects of instructional approaches on the mathematics achievements of students with intellectual disability (research question 3). As part of this study, the explicit instructional approach was compared to a strategy based on the philosophy of constructivism. There is a copious amount of information in the literature on the instructional approaches for teaching various mathematical concepts to students with learning disabilities. These include using the concrete representational abstract (Mancl, Miller & Kennedy, 2012; Moreno, Ozogul, & Reisslein, 2011; Flores, 2010; Morin, & Miller, 1998), Concrete–Representational–Abstract Integration strategy (Strickland, & Macini, 2012), peer-mediated instruction (Kunsch, Jitendra, & Sood, 2007), counting-on strategies (Cihak, & Grim, 2008), process mnemonic instruction (Manalo, Bunnell, & Stillman, 2000), computerised external modelling and text analysis (Jaspers, & Van Lieshout, 1994). Other approaches to teaching mathematics to students with disability include the use of explicit or direct instruction (Witzel, Mercer, & Miller, 2003; Steedly, Dragoo, Arafeh, & Luke, 2008), cross-age tutoring (Vacc, & Cannon, 2001 *cited by* Butler, Miller, Lee, & Pierce, 2001), equality training (Hendler, & Weisberg, 1992), constant time delay (Koscinski, & Gast, 1993), multisensory approach (Scott, 1993; Bullock, 1992), one-minute time trials (Miller, Hall, & Heward, 1995), self-regulation with strategy instruction (Cassel, & Reid, 1996; Montague, 2007), calculators (Horton, Lovitt, & White, 1992), representational abstract (Butler, Miller, Crehan, Babbitt, & Pierce, 2003).

Details of specific strategies follow:

2.8.4.1 Concrete Representational Abstract (CRA). The concrete-representational abstract (CRA) is an evidence-based approach and a form of of explicit instruction. The CRA has been identified as another way of teaching students with learning disabilities or difficulties in Mathematics (Mudaly and Naidoo, 2015; Witzel, Riccomini & Schneider, 2008). According to Witzel, Riccomini, and Schneider

(2008), CRA is a sequence of instruction consisting of three levels of learning including:

1. C = learning through concrete or hands-on instruction using actual manipulative objects.
2. R = learning through pictorial representations of the previously used manipulative objects during concrete instruction.
3. A = learning through abstract notation such as Arabic numbers and operational symbols (p. 271).

CRA has been found to offer many great benefits for instructing students with mathematical difficulties. It provides several opportunities for students to learn mathematical skills through visual (seeing), auditory (hearing), kinaesthetic (muscle movement) and tactile (touch) all of which have been found to facilitate the retention and retrieval of mathematical concepts (Engelkamp & Zimmer, 1990; Witzel, Riccomini & Schneider, 2008). The "C" and "R" phases of the instructional sequence provide students with opportunities to manipulate concrete materials – an essential step to understanding abstract concepts (Demby, 1997; Noice H. & Noice, T. 2001). CRA also caters for the diverse learning styles of students (Witzel, Riccomini & Schneider, 2008).

***2.8.4.2 Video Modeling with Concrete– Representational–Abstract Sequencing for Students with Autism Spectrum Disorder*.** Studies by Yakubova, Hughes and Shinaberry (2016) have found the video modelling with concrete-representational-abstract sequencing approach to be effective for teaching Mathematics to students with Autism Spectrum Disorder.

Among the two most favoured instructional approaches in the literature for teaching mathematics to students with learning disabilities are the constructivist-based approach (Cobb, Yackel, & Wood, 1992; Schifter, & Simon, 1992) and explicit instruction (Witzel, Mercer, & Miller, 2003; Doabler, & Fien, 2013). The effectiveness of these strategies in relation to High School students with intellectual disabilities has not been investigated. Towards this end, this study undertook a *Comparative study of the effectiveness of both approaches* as outlined in my research question 3.

2.8.4.3 Constructivist-based approach to instruction. Constructivism as a learning theory has gained strong interest among educational researchers. It has been widely favoured in recent years for teaching Science and Mathematics to students (Cobern, 1993; Schifter & Simon, 1992). Constructivism is based on the outstanding work of a number of researchers including Piaget, Vygotsky, the Gestalt psychologists, Bartlett, Bruner and John Dewey (Woolfolk, 1998) as well as Glasersfeld (Glasersfeld, 1989; 1995). Central to this theory is the importance of the prior knowledge of the learner and perhaps no other learning theory has emphasized this better than constructivism. Constructivism has been described as a theory (Bevevino, Dengel, & Adams, 1999), model (Huang, Rauch, & Liaw, 2010; Cobern, 1993), an epistemology (Applefield, Huber, & Moallem, 2001) or an approach to teaching and learning (Harris & Graham, 1994) that explains the active participation of learners in their own learning, recognising that learning does not occur by passive transmission of information but through interpretation and negotiation provoked by prior knowledge. Thus, when learners encounter new information, they draw on their prior knowledge to construct their own meaning. Applefield, Huber, and Moallem (2001) have outlined four essential characteristics of constructivism including: (1) learners constructing their own learning, (2) learners relying on their prior knowledge to construct their own learning, (3) learners having an opportunity to interact (social interaction) in relation to the topic or learning experience provided and (4) provision of well-planned, rich and stimulating learning activities or tasks is essential for meaningful learning to occur. Three types of constructivism have been identified in the literature including exogenous constructivism (otherwise known as social constructivism), endogenous constructivism (also known as personal constructivism) and dialectical constructivism (McInerney & McInerney, 2002; Moshman, 1982).

Constructivist-based approaches are preferred for teaching science and mathematics (Schifter & Simon, 1992). According to Brooks G. and Brooks M. (2001), constructivist teachers:

1. Encourage and accept student autonomy and initiative
2. Use raw data and primary sources, along with manipulative, interactive and physical materials
3. Use cognitive terminology such as classify, analyse, predict, and create (when framing tasks)

4. Allow student responses to drive lessons, shift instructional strategies and alter contexts
5. Inquire about students' understanding of concepts before sharing their own understandings of those concepts
6. Encourage students to engage in dialogue, both with the teacher and with one another
7. Encourage student inquiry by asking thoughtful, open-ended questions and encouraging students to ask questions of each other
8. Seek elaboration of students' initial response
9. Allow wait time after posing questions
10. Nurture students' natural curiosity through frequent use of the learning cycle model
11. Engage students in experiences that might engender contradictions to their initial hypothesis and then encourage discussion
12. Provide time for students to construct relationships and create metaphors (pp. 103-116).

The point needs to be made that while the majority of mathematics educators acknowledge that learning mathematics is a constructive process (Cobb, Yackel, & Wood, 1992), constructivism has been found to be applicable to all learning areas.

2.8.4.4 Explicit instruction. According to Archer and Hughes (2011), explicit instruction is

> a structured, systematic, and effective methodology for teaching academic skills. It is called **explicit** because it is an unambiguous and direct approach to teaching that includes both instructional design and delivery procedures. Explicit instruction is characterized by a series of supports or scaffolds, whereby students are guided through the learning process with clear statements about the purpose and rationale for learning the new skill, clear explanations and demonstrations of the instructional target, and supported practice with feedback until independent mastery has been achieved (p. 1).

Miller and Hudson (2006) has described four sequential phases of explicit instruction including:

1. *Advance organizer:* This phase of explicit instruction covers a review of the relevant pre-requisite knowledge and a declaration of the objectives of the lesson.
2. *Demonstration:* This is the phase where the teacher demonstrates the concepts or solves the problem while the students watch.
3. *Guided practice:* During this phase, the teacher and his/her students do the work together commencing with a high level of teacher's support and fading away gradually as students master the required skills.
4. *Independence practice:* This is the phase where students work independently and demonstrate how well they comprehend the concept without receiving support from the teacher.

2.8.5 An appropriate assessment tool/the development of mathematics assessment tool that is specific to the needs of students with ID (research question 4**)**. As a disability advisor, teacher and principal for a school dedicated to the education of students with intellectual disability (ID) for many years, I have been frustrated by the lack of suitable assessment tools for students with ID to inform the development of individual education plans (IEPs) or education adjustment plans (EAPs) that target students' numeracy needs and to evaluate the extent of learning that has taken place after a period of instruction. I am of the opinion that teaching numeracy to students with intellectual disability (ID) has been hampered by the lack of appropriate assessment tools.

It has been acknowledged that the performance of students in a test might be influenced by the format of the test as well as its content and presentation (Danii & Reid, 2006). The majority of Mathematics assessment tools reported in the literature are not suitable for students with intellectual impairments for a number of reasons: (1) The research that informed the development of some of the tools were carried out in mainstream educational settings and therefore fell short of assessing essential elements of the conceptual domain of adaptive functioning; (2) As a result of the mainstream setting of most of the assessment tools, questions are often too difficult or irrelevant for individuals with ID or both; (3) Some test instruments restrict students to a set time to complete questions which disadvantage people with ID, many of whom are slow at processing information and often require more time than their mainstream counterparts to be able to give accurate responses; (4) Some students with ID have significant limitations in language including receptive and expressive language (Laws & Bishop, 2004) and yet many assessment tools available in the literature have not given consideration to this factor. Test questions are written in a language that are far too superior for the level of individuals with ID and therefore many students with ID perform badly in tests because the tests failed them, and (5) Many students with ID do not cope well with pressure and stressful situations. Subjecting students to a time frame to complete questions or/and using testers that are different from their regular classroom teachers could easily elevate their anxieties to alarm level and consequently affect the performance of students in the test. As part of this study, the development and administration of IMPELS (Enoma & Malone, 2015b) has addressed these shortcomings.

Individuals with ID are "characterized by significant limitations in both cognitive functioning and adaptive behaviour" (American Association on Intellectual and Developmental Disabilities, 2013, p. 1) associated with conceptual, social and practical skills and these limitations usually begin before the age of 18. Of the three domains of adaptive behaviour, the conceptual skills area has more mathematical contents such as money, time, and number concepts and therefore imperative for these areas to be addressed in any purposeful numeracy instruction for students with ID. For students with ID, the development and implementation of individual education plans (IEPs) or education adjustment plans (EAPs) are key components of effective instructional strategy. Therefore, it cannot be overemphasized that informed planning that is targeted at the individual learning needs of students accompanied with appropriate instructional strategies and progress evaluation are essential components of effective numeracy instruction for students with ID.

It is a well-documented fact that individuals with autism (some of whom also have ID) learn in ways that are different from the rest of the population. Temple Grandin (2006), a notable scholar with autism, gave an insider perspective of the learning style of individuals with disability and how they process information:

> I THINK IN PICTURES. Words are like a second language for me. I translate both spoken and written words into full-color movies, complete with

> sound, which run like a VCR tape in my head. When somebody speaks to me, his words are instantly translated into picture (p. 1).

The difference in learning style between individuals with disability and the mainstream population was also reiterated by the Centres for Disease Control and Prevention (2016):

> people with Autism Spectrum Disorder (some of whom have ID) may communicate, interact, behave, and learn in ways that are different from most other people. The learning, thinking, and problem-solving abilities of people with Autism Spectrum Disorder can range from gifted to severely challenged (p. 1).

As a result, students with ID cannot be restricted to the same time limit as mainstream students because they take more time to process information. The test items need to be written in a visually-supported language (they think in pictures) among other considerations. There is no report in the literature of any mathematics assessment tool that has considered the learning characteristics of people with ID in its development and administration. In addressing this need, an individualised mathematics tool that caters for the learning characteristics of individuals with ID has been developed (Enoma & Malone, 2015b) as part of this study in accordance with research question 4. The next chapter describes the research methodology and the statistical tools used in this study.

Chapter 3

RESEARCH METHODOLOGY

3.1 Introduction

Chapter 1 covered the introduction to this thesis and described the background and the theoretical framework under which the research was conducted. Additionally, it described previous efforts to improve educational quality in Australia. Chapter 2 encompassed a review of relevant literature. This chapter describes the different parts that constituted the research methodology employed in this study, including background information about the data collection site, scope, participants, design of the study, procedures, instrumentation and permissions (where required) as well as instructional approaches. The chapter also describes the statistical tools used in the analyses and interpretation of the data gathered and their justification. The following sections describe the:

Section 3.2 Theoretical and Conceptual Framework – Positivism and Post-Positive Paradigms
Section 3.3 Background of the school
Section 3.4 Participants
Section 3.5 Data sources, instrumentations and obtaining of relevant permissions
Section 3.6 Data collection procedures
Section 3.7 Data analyses and interpretation
Section 3.8 Summary of the chapter

Four research questions defined the pathways taken by this investigation:

1. Do students with borderline, mild and moderate intellectual disabilities possess specific number sense skills that distinguish members of one group from the other?
2. What are the effects of age, gender, student and teacher factors on the number sense achievements of students with borderline, mild and moderate intellectual disabilities?

3. What are the effects of explicit instruction and a strategy based on the philosophy of constructivism on the development of number sense among high school students with borderline, mild and moderate intellectual disabilities?
4. What numeracy assessment tool among those examined in the study is most appropriate for students with ID?

3.2 Theoretical and Conceptual Framework − Positivism and Post-Positive Paradigms

Two dominant research paradigms have been uncovered in the literature and they include the positivist and post-positive paradigms (Anderson, 1998, p. 4). The former, otherwise known as the scientific method is oriented in the belief or philosophy that things take up meaning if they are observable and can be verified. The positivist paradigm commences with the formulation of a hypothesis derived from a theory or theories and then embarks on data collection on the observable effects or consequences of the hypothesis to evaluate its validity in the real world. It particularly places emphasis on the view that there are fundamental truths about the world we live in that are explainable by mathematical models. It also emphasizes that any failure to find these models can be attributed to inaccurate measurement, using models that are not perfect or lack of control of relevant variables. This method which is quantitative in nature was originally employed in the Physical Sciences (hence its name, scientific method) but over the years, its use as a research approach has been extended to educational research.

Post-positivism was borne out of the criticism that observation, which is a core component of the positivist paradigm is not value-free as it was initially believed. Critics of positivism acknowledged that there are a number of things such as intentions and feelings that are not directly observable. Post-positivism, which has a predisposition to be used in naturalistic settings (in contrast to positivism which is used often under experimental conditions) accommodates values and perspectives as legitimate components in the quest for knowledge. According to Anderson (1998, p. 4), post-positivism is a holistic approach of qualitative significance that employs questionnaires to gather data while retaining the natural state or setting of the targeted population. This paradigm is dependent on the researcher for data collection in contrast to positivism which is dependent upon controlling variables and the use of precise measurement instruments as the chief pathways for data collection. The post-positivist paradigm was selected for my research in light of the fact that questionnaires and various test instruments were used in my data collection.

3.2.1 Constructivism and Action Research. The topic and research questions of this study were located in the *interpretivist* (also known as *constructivist*) paradigm (Guba, 1990, p. 25; Guba & Lincoln, 1994, p. 110; Willis, 2007, p. 7). The ontological position held in this study was that there is a reality about how high school students with intellectual disability understand number sense which can be unfolded. This reality, a construction of the number sense competence of these students, results from the social intersection of students with their learning environment (learning experiences and instructional staff) and myself as researcher, and it coalesces around consensus. This study also took the epistemological position that knowledge of selected aspects of how this group of students acquire number sense will facilitate effective instruction and therefore should be investigated. Methodologically, this study used the action research (AR) design (Stringer, 2008, p. 14; Bai, 2009, p. 143; Binnie, Allen & Beck, 2008, p. 347; Bryman, 2012, p. 379; Cohen, Manion & Morrison, 2011, p. 3; Tsafos, 2009, p. 197; Johnson, 2005, p. 21; Mason, 2005, p. 563; Merriam, 2009, p. 11; Maxwell, 2005; Punch 1998) in light of the following distinctions between action research and other forms of research that have been made by Holly, Arhar, and Kasten (2009). The authors have indicated that: (1) action research is conducted predominantly by practitioners or insiders rather than outsiders, (2) action research is strongly value-inclined and as such objectivity is an issue, (3) action research is aimed at enhancing the professional growth of the practitioner, and (4) action research is a self-critical enquiry that is shared with others.

This study was borne out of the desire to find a solution to the slow or seemingly lack of progress in mathematics among the targeted student population. I selected action research for this study specifically to improve the mathematics achievements of my students as well as the instruction of mathematics at the school. Thus, the primary goal of this research was to improve practice which is one of the core defining elements of action research (Holly, Arhar, & Kasten, 2009). As the principal and leading educational professional of a school (an insider), I was responsible and accountable for the quality of education that students received and for ensuring that my students became the best that they could be (Australian Institute for Teaching and School Leadership, 2011a). Creswell (2012, p. 577) has recommended action research to be used "when you have a specific educational problem to solve". The choice of action research was therefore justifiable as the central goal of this study was to seek solution to a specific educational problem that affects students — to improve the achievement of my students in mathematics. Holly, Arhar, and Kasten (2009) have also attested to the suitability of Action Research for practitioners such as teachers. Besides, the title of this research and the associated research questions fall within the four characteristics of action research identified by Holly, Arhar, and Kasten (2009), namely, **ethical commitment**: how best can my staff and I serve the learning needs of my students in mathematics? **cycle of reflective practice**: reflecting on ways to improve practice — reflecting, acting and observing; **public character**: adopting a systematic and sustained enquiry approach whose outcomes are intended to be shared with others within and outside my school; **collaboration**: listening to others and particularly students and staff, seeking their opinions and support (Holly, Arhar, & Kasten, 2009).

3.3 Background of the School

The school was located in regional Australia and catered for high school students with borderline, mild, moderate, severe, profound and multiple disabilities in Years 8 to 12. It had a population of 32 students, 5 teachers (excluding the principal) and 11 education assistants. Eligibility for enrolment of students was determined by a diagnosis of intellectual disability (ID) as determined by an IQ score of 70 and below and with concurrent deficits in at least 2 out of the 10 elements of adaptive functioning (American Association on Intellectual and Developmental Disabilities, 2010). The majority of the students were from low socioeconomic backgrounds and as a result, the school implemented a daily breakfast program. Providing students with daily breakfast was aimed at improving students' concentration and attention span while at school in view of the fact that "breakfast is the most important meal of the day, and studies have shown that children who face hunger fall behind in virtually every way" (Everett & Yocham, 2012). As indicated earlier, there were five classrooms: (1) Year 8 classroom, (2) Year 9 classroom, (3) Year 9 classroom, (4) Year 10 classroom, (5) Years 11 and 12 classrooms. Classes were small-sized, ranging from 5 to 7 students per classroom which approximated to a student-staff ratio of 1:1. A teacher and one to four education assistants (EA) were allocated to each classroom. The number of education assistants assigned to a classroom was dependent on students' classroom demography, and the individual learning and medical needs of students. For example, a classroom with two high needs students had five students and five staff (4 education assistants + 1 teacher).

3.4 Participants

The participants in this study were high school students from an Australian school dedicated to the education of students with intellectual disabilities. All students attending this school had a diagnosis of intellectual disability ranging from Full Scale IQ Scores of below 30 to 79. For the purpose of this study, only students that fell within the IQ categories of borderline (71 to 79), mild (55 to 70) and moderate (30 to 54) were selected. Of the 32 students that were enrolled at the school during the period of this study, 24 students consisting of 11 boys and 13 girls were selected for participation in the study for three reasons: (1) four students had severe to profound ID and as a result fell outside the sphere/range of this study, (2) two students had very poor school attendance and rarely came to school, as well as (3) Two students who had not completed their reassessment and confirmation of ID diagnosis at the commencement of data collection. In addition to a diagnosis of intellectual disability, some of the students that participated in the study had a comorbidity of other conditions including Autism Spectrum Disorder (ASD), Asthma, vision impairment, Attention Deficit Hyperactivity Disorder (ADHD), self-injurious behaviour, seizures associated with a deficiency with body temperature regulation, Cerebral Palsy, Epilepsy and related seizures, Global Developmental Delay, Receptive and Expressive Language Delay and other forms of speech impairment.

IQ assessments were conducted by school psychologists employed by the Department of Education using Wechsler Intelligence Scale for Children (Fourth Edition WISC-IV). The IQ Scores of all participating students were determined by a qualified school psychologist and certified by a lead school psychologist.

At the specialist high school where this study was conducted, the shortage of qualified special education teachers was a perennial problem. Of the five teachers in the school that catered exclusively for students with ID, only one teacher (with 1½ years teaching experience in an education support setting) was fully qualified. There is a shortage of special education teachers in many parts of the world, including Australia, which has resulted in many specialist schools being staffed with teachers that are not qualified to teach students with special needs (Boe, 2006). In countries such as the United States, the shortage of special education teachers is so severe that it is felt by every geographic region (McLeskey, Tyler, & Flippin, 2004). Similarly, students with ID in mainstream settings encounter the same problem. Teaching mainstream students is not entirely the same thing as teaching students with ID – teachers who are effective in a mainstream setting may struggle in an education support setting. Teaching students with ID and other special needs require a greater depth of knowledge about individuals with ID, their diagnoses (e.g; Autism Spectrum Disorder, Down Syndrome, Foetal Alcohol Spectrum Disorder, etc) and the associated social incompetence than is usually not covered under the pre-service training program for general education teachers. Teaching students with ID also requires knowledge of teaching approaches that are effective for this cohort of students. These include the use of visuals, the writing of IEPs with SMART (Specific, Measurable, Achievable, Relevant and Timed) goals, the differentiation, modification and accommodation of the curriculum to the individual needs of students as needed.

3.5 Data Sources, Instrumentation and Obtaining of Relevant Permissions

A comprehensive approach was adopted for data collection to generate sufficient data that presented convincing evidence and clarity on factors that impact on the mathematics achievements of students with ID. Towards this end, a wide range of instrumentation was used in this study including four number sense assessment tools and the mathematics teaching efficacy beliefs instrument (MTEBI). Others included the mathematics self-efficacy items, the sources of mathematics self-efficacy, and the anxiety factor instruments. The analyses and interpretation of the data generated with these instruments provided answers to my research questions.

3.5.1 Number sense assessment tools – Description. The number sense assessment tools used in this study included IMPELS (Enoma & Malone, 2015b), the Delaware Universal Screening Tool for Number Sense Grade 2 (Delaware Department of Education, 2010), the Streamlined Number Sense Screening Tool (Jordan, Glutting & Ramineni, 2008) and the Number Knowledge Test (Okamoto & Case, 1996; Okamoto & Case 2004). The rationale for using four different number sense tools in this study is based on the understanding that four measures will give me a more accurate understanding of students' achievements than one. This is in recognition of the fact that every assessment tool differs from each other in language, structure, level of difficulty and how they are administered which could affect how each student performs in each assessment. Secondly, gathering data on students' achievements using multiple sources allows for comparison to be made between IMPELS (developed in this study) and other published number sense tools based on selected criteria.

The four number sense assessment tools contributed baseline data that were used to answer all three research questions. While answering the four research questions, these data were employed to compare the number sense achievements of students at both the pre-instruction and post-instruction phases of this study, and to validate factors that impact on the mathematics achievements of students with ID or used in concert with other factors/information that are pertinent to answering each research question.

3.5.1.1 IMPELS**.** IMPELS is an Individualised Mathematics Planning and Evaluation of Learning for Students with Intellectual Disability tool which was developed as part of this study (Enoma and Malone, 2015b). Teaching mathematics and numeracy to students with intellectual disability (ID) has been hampered by the lack of appropriate assessment tools. The majority of mathematics assessment tools reported in the literature are not suitable for students with intellectual impairments for a number of reasons: (1) The research that informed the development of some of the tools were carried out in mainstream educational settings and therefore fell short of assessing essential elements of the conceptual domain of adaptive functioning, (2) As a result of the mainstream setting of most of the assessment tools, questions are often too difficult or irrelevant for individuals with ID or both, (3) Some test instruments restrict students to a set time to complete questions which disadvantage people with intellectual disability many of whom are slow at processing information and often require more time than their mainstream counterparts to process information to be able to give accurate responses, (4) Most students with intellectual disability have significant limitations in language including receptive and expressive language and yet many assessment tools available in the literature have not given consideration to this factor. Test questions are written in a language that are far too superior to the level of individuals with intellectual disability and therefore many students with ID perform badly in tests because the tests failed them, and (5) Many students with ID do not cope well with pressure and stressful situations. Subjecting students to a time frame to complete questions or/and using a tester that is different from their regular classroom teachers could easily elevate their anxieties to alarm level and consequently affect the performance of students in the test.

The tool consists of 52 items that cover a range of skill areas in mathematics that are relevant to the functional needs of individuals with ID. It was the first out of the four number sense assessment tools employed in this study and commonly referred to in this thesis as “Tool 1”.

The use of IMPELS was principally targeted at answering my first and fourth research questions. My first research question was “Do students with borderline, mild and moderate intellectual disabilities possess specific number sense skills that distinguish members of one group from the other?”. To answer this research question, correlation graphs of the mathematics achievements of the different groups of students (borderline, mild and moderate ID) in IMPELS and the other three assessment tools were drawn. This was primarily aimed at establishing whether the categorization of students into borderline, mild and moderate ID is reflected in their mathematics achievements. The development and evaluation of IMPELS were also used to answer my fourth research question ― “What numeracy assessment tool among those examined in the study is most appropriate for students with ID?”. To answer this research question, the reliability and validity of IMPELS were analysed as detailed in Chapter Four (Section 4.5).

The development of IMPELS is justified by the fact that the other three number sense tools were developed for young mainstream students in their early years of schooling. As a result, the characteristics of students with ID and their learning styles were not considered in their developments. IMPELS bridges this gap by addressing these issues. This is an assessment tool that specifically targets the learning needs of students with ID both in content and administration. The construction of IMPELS' test items were informed by the components of number sense as described by Clarke and Shinn (2004); Faukner (2009), Chard, Clarke, Baker, Otterstedt, Braun and Katz (2005) as well as Clarke, Baker, Smolkowski and Chard,2008).

3.5.1.2 The Delaware Universal Screening Tool for Number Sense Grade 2. The second number sense assessment tool used in this study was the Delaware Universal Screening Tool for Number Sense Grade 2 (Delaware Department of Education, 2010) and often referred to in this thesis as "Tool 2". The instrument was used with permission from the Delaware Department of Education. The screening tool consisted of 22 questions that were divided into three sections of six, seven and nine questions recommended to be administered in the Fall, Winter and Spring semesters respectively (in accordance with the American school system). For the purpose of this study, only the first section of six questions was administered at both pre-instruction and post-instruction phases of the study. The Delaware Universal Screening Tool for Number Sense Grade 2 is designed to establish students' level of understanding of number sense, their knowledge and utilization of the various representations of numbers which suit the primary aim of this study. As indicated earlier, the Delaware Universal Screening Tool for Number Sense Grade 2 (Delaware Department of Education, 2010) was used together with IMPELS, the streamlined number and the number knowledge tests to collect data on the mathematical achievements of the students employed in answering some parts of research questions 1, 2, 3 and 4.

3.5.1.3 The Streamlined Number Sense Screening Tool. The Streamlined Number Sense Screening Tool (Jordan, Glutting & Ramineni, 2008) was the third instrument used during this phase of the study. As with the previous instrument, it was used with permission from the corresponding author. The tool measures various components of number sense including counting and number recognition, number knowledge and number operations (Jordan, Glutting & Ramineni, 2008). The assessment tool is composed of 33 questions and targeted at young children in their early school years. Considering the fact that the subjects of this study were students with significant cognitive limitations and recognising the fact that students with ID typically perform within kindergarten and Year 2 levels (Department of Education of Western Australia, 2011b), the inclusion of this screening tool in the study was regarded as justifiable.

3.5.1.4 The Number Knowledge Test. The Number Knowledge Test (Okamoto & Case, 1996, Okamoto & Case, 2004) was the fourth number sense assessment tool used in this study. This instrument was used with permission obtained from the corresponding author. The test is employed to map children's developmental profile in numerical competence (Okamoto & Case, 1996) and screen for difficulties in Mathematics (Chard, Clarke, Baker, Otterstedt, Braun & Katz, 2005). When administered individually, this tool provides the opportunity to gain insight into a student's depth of understanding of numbers. The test consisted of 43 questions designed to measure (1) unidimensional thought: mental line structure, (2) bidimensional thought: two number lines (Group A Items – Understanding the additive relation between the ones column and the tens column in the base-ten system), (3) bidimensional thought: two number lines (Group B Items – Understanding of a numerical difference), (4) integrated bidimensional thought (Group A: Understanding the structure of multidigit numbers), (5) integrated bidimensional thought (Group B: Understanding the relation between two differences) and (6) integrated bidimensional thought (Group C: Understanding other numerical systems).

3.5.2 Other instruments used in the study. To answer Research Question 2 ("What are the effects of age, gender, student and teacher factors on the number sense achievements of students with borderline, mild and moderate intellectual disabilities?"), several other instruments were used. The teacher factor component of Research Question 2 was answered using the mathematics teaching efficacy beliefs instrument (MTEBI). For the student factor component of Research Question 2, the impacts of age and gender factors of students were analysed using the pre- and post-test data of students' achievements in the four number sense assessment tools described earlier. Other instruments and questionnaires such as the self-efficacy instrument, sources of self-efficacy, mathematics anxiety factor, student self-reflection questionnaire and the student emotional well-being questionnaire were employed to provide additional answers to the student factor component of research question 2. The broad approach to this study was adopted to gain a greater depth of understanding of the singular, corporate or the interrelationship of the student-related and teacher-related factors on the mathematics achievements of students with ID. These instruments and questionnaires include the following:

3.5.2.1 Mathematics Teaching Efficacy Beliefs Instrument (Teachers). Enochs, Smith and Huinker (2000) constructed the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) for teachers (Appendix A). The instrument was used in this study with permission. MTEBI has a total of 21 items of which thirteen measured the confidence of teachers in their ability to teach mathematics (Personal Mathematics Teaching Efficacy – PMTE) while eight items measured the strength of the belief that teachers' effective teaching is an influential factor to student learning (Mathematics Teaching Outcome Expectancy – MTOE). Each item was scored using a five-point Likert response scale comprising:

Strongly Agree (weighted 5),
Agree (weighted 4),
Uncertain (weighted 3),
Disagree (weighted 2) and
Strongly Disagree (weighted 1).

A high total score (obtained from adding individual item scores) on the MTEBI and each of the two subdivisions (PMTE and MTOE) demonstrated a higher level of perceived teaching efficacy. Scoring of MTEBI was carried out as recommended by Enochs, Smith and Huinker (2000). The MTEBI was administered twice – 6 months apart.

3.5.2.2 Mathematics self-efficacy items (for students). The Mathematics self-efficacy instrument used in this study was an adaptation of the instrument described by Joet, Bressoux and Usher (2011. It was modified to make it relevant and appropriate to students with borderline, mild and moderate ID by including functional numeracy questions – from questions 4 to 25 (Appendix B). The self-efficacy instrument was administered orally and clarifications provided where necessary to ensure the participants understood the questions. Only questions 1 to 3 were retained from among the Joet, Bressoux and Usher (2011) original Self-Efficacy items. The modified instrument (Appendix B) had 25 items. Each item was rated along five Likert response categories including:

Completely True (weighted 5),
Very True (weighted 4),
Moderately True (weighted 3),
Slightly True (weighted 2) and
Not At All True (weighted 1).

***3.5.2.3 Sources of mathematics self-efficacy*.** Bandura (1997) has hypothesized that self-efficacy beliefs are formed as people interpret information from four main sources including one's previous attainments (mastering experience), observing others (vicarious experience), encouragement received from parents, teachers, and peers (social persuasions) as well as emotional and physiological states (anxiety, stress, fatigue, and mood. The sources of self-efficacy in the mathematics instrument described by Usher and Pajares (2009) was used in this study (Appendix C). The instrument has 24 items, six on the mastery experience source of self-efficacy beliefs, two on the vicarious experience from adults, two on the vicarious experience from peers, two on the vicarious experience from self, six on the social experience source of self-efficacy beliefs and six on the physiological state source of self-efficacy beliefs (Appendix C) (Usher & Pajares, 2009). Each item was rated along five response categories including:

Completely True (weighted 5),
Very true (weighted 4),
Moderately true (weighted 3),
Slightly True (weighted 2) and
Not At All True (weighted 1).

***3.5.2.4 The mathematics anxiety factor of students*.** The student anxiety instrument used in this study was derived from the instrument used by Usher and Pajares (2009). It consisted of six items (Appendix D) and similar to the other instruments described above. Each item was rated along five response categories including completely true (weighted 5), very true (weighted 4), moderately true (weighted 3), slightly true (weighted 2) and not at all true (weighted 1). (Appendix D).

***3.5.2.5 Student factor questionnaire*.** The student factor questionnaire consisted of 14 items targeted at gathering data about each student participant's school attendance, attentiveness, motivation, behaviour and work ethics in class (Appendix E). The questionnaire was thoughtfully formulated in view of available information in the literature about student-related factors that affect their achievements at school. Considerations were given to studies by Bedi and Marshall (1999) which demonstrated that irregular school attendance leads to low achievements at school. With regard to motivation, Bryan, Glynn and Kittleson (2011) observed that motivated students make academic progress at school. Mrnjaus and Krneta (2014) have found a correlation between student behaviour (mindfulness and concentration) and achievements. This questionnaire was administered to teachers and education assistants to complete at the commencement (pre-intervention) and conclusion (post-intervention) of the study. Staff were not allowed to identify themselves but were required to identify the students that they commented on. The school structure was such that staff (teachers and education assistants) in each classroom work with multiple students daily on rotation basis. This meant that several staff completed separate copies of the student factor questionnaire for the same student and by so doing made it impossible for any staff to be identified individually by association. The administration of the student factor questionnaire was a supplementary instrument aimed at obtaining a greater depth of understanding of each student and for achieving a holistic interpretation of students' achievements data that were generated from the research.

***3.5.2.6 Student emotional wellbeing questionnaire*.** Teachers and Education Assistants were requested to complete an emotional well-being instrument (Enoma & Malone, *unpublished*) for each student who participated in the study (Appendix F).

This is in appreciation of the significance of the emotional wellbeing of students to their academic achievements.

***3.5.2.7 Student reflection questionnaire*.** The student self-reflection questionnaire was directed at the students and designed to find out from them what they thought of themselves. This was the student version of the "Student Emotional Wellbeing Questionnaire" that were completed by teachers and education assistants. Students being the central focus of this study, having an insight into their points of view was of fundamental importance to data analyses and interpretation. The student self-reflection questionnaire consisted of twenty-six items, half of which focused on establishing the emotional states of individual students while the other half focused on their learning habits (Appendix G). Having some understanding of an individual student's emotional state is of great importance in light of Sznitman, Reisel and Romer's (2011) findings that the emotional wellbeing of students and academic achievements are linked. Therefore, it was important to know if a student was happy at school, felt safe, or was bullied by staff or students and so on. Similarly, having some knowledge about individual students learning habits would shed light on individual differences in students' achievements.

3.6 Data Collection Procedure

3.6.1 Privacy, ethical and statutory considerations. As mentioned previously, this study encompassed the participation of students with ID. According to the Australian Law Reform Commission (n.d.), "Institutions that undertake research 'with or about people, their data or tissue are responsible for ensuring that research they conduct, or for which they are responsible, is ethically reviewed in accordance with the National Statement"

In compliance with this law, I completed Form A (Application for Ethical Approval of Research Involving Humans) and submitted it with my research proposal to the Human Research Ethics Committee (HREC) at Curtin University for approval. On the first review of my application, the HREC made some recommendations for me to address. Following my re-submission and second review of my application for ethical approval (after the relevant amendments have been made), ethical clearance was granted by the Human Research Ethics Committee (HREC) prior to the commencement of the study (Appendix H).

After approval to conduct research was granted by the HREC, a meeting was arranged and held with members of the School Council (School Board) to explain the research proposal. In consideration of the recommendations of the National Health and Medical Research Council (NHMRC) (2007) and Curtin University HREC guidelines for ethical and privacy matters, a participant information sheet (Appendix I) and consent form (Appendix J) were provided to each member of the council, student and staff. At my meeting with members of the School Council, I stressed to them that participation in the research was completely voluntary and that participants could withdraw their involvement in the study at any time in the course of the study. The School Council saw the research as a positive endeavour to improve students' learning of mathematics. Approval was granted by the School Council for the study to take place and members demonstrated their consent by unanimously signing and returning their consent forms. Meetings were held with teachers and students to explain the aims and objectives of the study, content, students' and staff' right, issues related to privacy and confidentiality, and their roles in data collection. It was emphasised at both meetings with staff and students that their participation in the study was entirely voluntary and that they could elect not to participate in the research at any time during the course of the study. Three education assistants elected not to participate in the study. The meetings provided opportunities for specific questions asked by staff and students to be answered after which participant information sheets and consent forms were provided to them. Students were directed to take their copies of both forms home with them to their parents so that the decision to participate or not in the study could be taken collaboratively.

The letters of consents for teachers, students, parents and members of the School Council (Appendix J) clearly advised that:

- participants were at liberty to withdraw their participation in the study at any time without prejudice.

- information gathered during the course of the study would be treated strictly as confidential except in instances of legal requirements such as court subpoenas, freedom of information requests, or mandated by some professionals.

- codes would be ascribed to all participants (including students, teachers and education assistants) to protect their identity.

- any research data gathered as a result of the study could be published provided participants' identities were protected.

- the protection of privacy of participants would be adhered to in accordance with Curtin University Human Research Ethics Committee's and the National Health and Medical Research Council's guidelines for the conduct of research involving humans.

Of the 32 students that enrolled at the school during the period of the study, 24 students and their parents consented to their participation in the study. Five teachers consented to participating in the study among which, one held a Master Degree in Learning Difficulty, two had first degrees in Special Education, while the remaining two had their first degrees in general education. Teaching experience among the teachers ranged from three to 30 years in mainstream education and 17 months to 30 months in a special education setting.

Of the 12 education assistants that consented to participating in the study, two were qualified teachers with first degrees in education, five had Certificate IV Special Needs and the remaining five were high school graduates. Their work experiences range from 16 months to 15 years in an education support facility and 3.5 years to 18 years in a mainstream school setting.

To avoid any confusion, the roles of all participating groups (teachers, students and education assistants) were defined. For the teachers, their roles in the study were clarified as follows:

- to complete: the Mathematics Teaching Efficacy Beliefs Instrument, ranking form for IMPELS and the emotional state questionnaire twice within the duration of the study – one at the start of the study (pre-instruction/intervention) and the other at the end of the study six months later (post-instruction/intervention).

• to administer and supervise the administration of the four number sense assessment tools to students in their classrooms within the same week. This should be conducted twice within the duration of the study as specified above (pre- and post-tests)

• to administer and monitor the administration of the self-efficacy, sources of self-efficacy and the anxiety factor questionnaires to their students at the beginning of the study (pre-instruction) and six months later (post-instruction).

• to administer the student factor and student reflection questionnaires at the pre-test and post-test phases of the study.

• to check all completed questionnaires and ensure students complete them correctly (e.g. ticking more than one box for an item; students forgetting to write their names or tick a box for each item, etc)

• to collate the questionnaires and assessments after completion

• to faithfully follow the instructional approaches selected for their classrooms

For the education assistants, their roles in the study were outlined as follows:

• to complete the emotional state questionnaire for each participating student in their classrooms.

• to support their teachers in checking that students in their classrooms complete the questionnaires correctly.

For the students, their roles in the study were:

• to participate in the learning activities provided by the teachers

• to take the four number sense assessments twice at the start and completion of data collection

• to complete the self-efficacy, sources of self-efficacy and the anxiety factor questionnaires twice during the period of the study as detailed above.

• to complete IMPELS ranking form and the student factor instrument as well as the student emotional state questionnaires at the pre-test and post-test phases of the study.

As the principal of the school, I recognised that conducting a research that involved my students, teachers and education assistants raised significant ethical issues. I was aware that my position of authority or ‘power’ could create a researcher-participant relationship in which participants may feel pressured or coerced to take part in the study. Yassour-Borochowitz (2010), Clark and Sharf (2007), Einardottir (2007) and Etherington (2007) were confronted with similar researcher-participants’ relationship and demonstrated that ethical issues associated with power imbalance and social inequality that tilt in favour of the researcher can be resolved in a manner that accords validity and credibility to the study. The potential power and coercion issues inherent in this study were addressed through a form of ethical methodology described by Yassour-Borochowitz (2010) as reciprocal dialogue. This process involved explaining to the participants (students, staff, members of the School Council) that they should not feel obliged to participate in the research because I am their principal and that they could withdraw their participation at any time (Etherington 2007). I made my commitment to respect and honour each participant’s right very clearly. I emphasized the fact that being students, teachers or education assistants and my status as their principal did not mean they must take part in the research or could not withdraw at any time during the study (Etherington, 2007). As indicated earlier, three education assistants opted out of the study.

3.6.2 Research design. The research design was in accordance with the recommendations of Fraenkel, Wallen, and Hyun (2012). The study was laid out in such a manner as to avoid upsetting existing school arrangements in order to ensure students’ learning was not disadvantaged, and that day-to-day school administration was not hampered as a result of this study. Prior to the study, the school had allocated students of mixed abilities but of similar age groups into five classrooms, namely ESC 1 (Year 8), ESC 2 (Year 9), ESC 3 (Year 9), ESC 4 (Year 10) and ESC 5 (Years 11 and 12) (Table 3.1). This arrangement was retained during this study and students in Classroom 1 (ESC 1) were taught according to explicit instruction (Explicit Instruction 1); students in Classroom 2 (ESC 2) were instructed using a hybrid of explicit instruction and the constructivist-based approach (ExpliCon 1) (explanation comes later p. 106); students in Classroom 3 (ESC 3) received explicit instruction (Explicit Instruction 2); students in Classroom 4 (ESC 4) as the control group were taught according to the teacher’s usual practice. The students in

Classroom 5 (ESC 5) were taught according to explicit-constructivist approach (ExpliCon 2).

Table 3.1

Research Design for instructional approaches.

Treatments	Number of Students	Gender Composition
Explicit Instruction 1 (Classroom 1)	4	2 Boys 2 Girls
ExpliCon 1 (Classroom 2)	4	3 Boys 1 Girl
Explicit Instruction 2 (Classroom 3)	3	3 Girls
Control Group (Classroom 4)	7	3 Boys 4 Girls
ExpliCon 2 (Classroom 5)	6	2 Boys 4 Girls

An information session was conducted for all the teachers to advise them about the data to be collected, when to collect the data (at the start and conclusion of the study) and how to collect the data. Teachers from the treatment classrooms (Classrooms 1, 2, 3 and 5) were given training before the commencement of data collection about how explicit instruction and ExpliCon should be implemented in their classrooms to ensure consistency. The researcher also took a lesson each week in each classroom (modelling) using either explicit instruction or ExpliCon according to the needs of each classroom for the period of the study to ensure the expected standard was maintained and as a result, there was no need for observation schedule. The teacher for the control group of students (Classroom 4) was advised to teach according to usual practice (shared some similarities with explicit instruction). On observation, the researcher found the control group teacher used an instructional approach that was akin to explicit instruction but with no strict compliance to the recommended sequence (Miller & Hudson, 2006).

3.6.3 Participants demographics and sampling procedures. The first semester of the 2014 school year began on 3rd February 2014 and that was when the pre-instruction phase of data collection commenced. Data collection covered the period from February to June 2014. A total of 24 high school students with borderline, mild and moderate ID ranging from Years 8 to 12 took part in this study. Figure 3.1 shows the relative proportions of borderline, mild and moderate ID students that participated in the study. The chart indicates that 13%, 54%, and 33% were of the borderline, mild and moderate categories respectively.

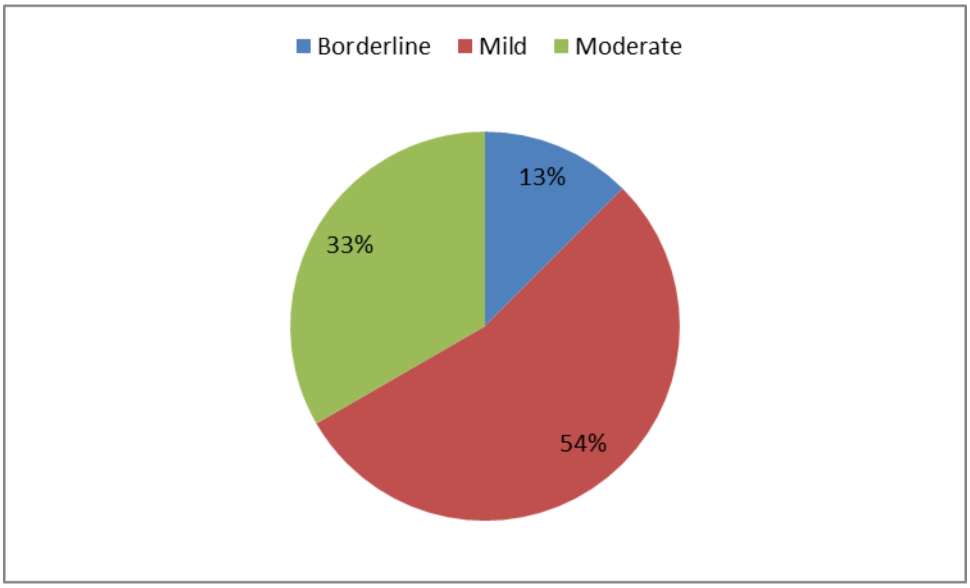

Figure 3.1: Relative sample sizes of students with borderline, mild and moderate ID.

The gender composition of the students that participated in the student consisted of 13% male students with borderline ID, 33% male students with mild ID, 21% female students with mild ID, 4% male students with moderate ID and 29% female students with moderate ID (Figure 3.2). There was no female representation in the students with borderline ID group (Figure 3.2).

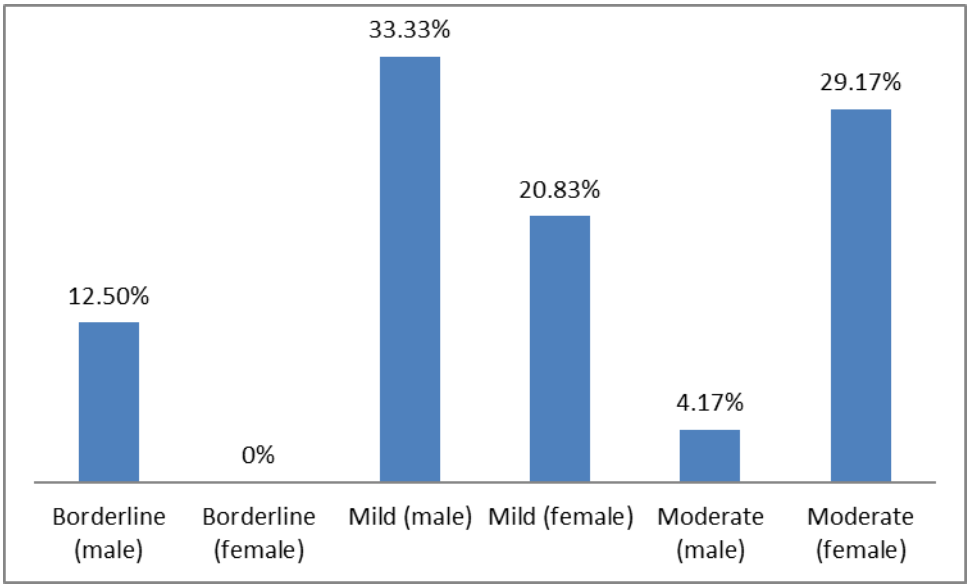

Figure 3.2: Gender representation of participants (students).

3.6.4 Pre-instruction administration of the number sense assessment tools, instruments and questionnaires. Teachers took the responsibility for explaining and administering the assessments, instruments and questionnaires to the students as well as collating, collecting, checking and submitting them to me after they had been completed by students. The process often began with students completing the preliminary section consisting of questions related to students' and teachers' names, year level, gender and date. The pre-intervention data collection began in February 2014 and followed by a period of instruction — classrooms were subjected to either Explicit instruction, ExpliCon approach or Control (Table 3.1). The second set of data collection occurred in June 2014 (post-intervention).

The pre-intervention data collection was targeted at answering the four research questions. The four number sense assessment tools, including IMPELS (Enoma & Malone 2015b), Delaware Universal Screening Tool for Number Sense Grade 2 (Delaware Department of Education, 2010), Streamlined Number Sense Screening Tool (Jordan, Glutting & Ramineni, 2008) and the Number Knowledge Test (Okamoto & Case, 1996; Okamoto, 2004) were administered to the students at the commencement of the study to establish baseline data on the students' prior knowledge of number sense. While administering the tests, the names of the authors of the four assessment tools were removed and simply designated them as 'Tool 1", 'Tool 2', 'Tool 3' and 'Tool 4' to avoid any bias regarding authors. The first administration of the Mathematics Teaching Efficacy Beliefs instrument (MTEBI) was administered to the teachers at this phase of the study to gauge their confidence in their ability to teach mathematics to students with ID. Additionally, the instrument was used to measure the strengths of their beliefs that effective teaching is an influential factor in student learning before the commencement of instruction using explicit and constructivist instructional approaches.

Similarly, the self-efficacy, sources of self-efficacy, and the anxiety factor instruments were administered to the students during this phase of the study. The administration of the self-efficacy items prior to instruction was aimed at gathering information about the beliefs that students held about their maths ability and their attitude towards mathematics. The rationale behind the administration of the sources of self-efficacy in mathematics items was to find out the degree of influence exerted by mastery experience, vicarious experience, social persuasions and Physiological and Emotional States on the mathematics achievements of students with ID.

Teachers and students also ranked all four tools using selected criteria including (1) suitability for students with intellectual disabilities, (2) suitability for generating information for writing IEPs, (3) suitability for progress monitoring, (4) teacher friendliness (relative ease of administration), (5) student friendliness (structure and language/vocabulary appropriate or close to the level of the majority of students with intellectual disability) and (6) the most preferred of all four tools in consideration of all the criteria described above. The data generated at this phase of the study was to be compared to the data generated during the post-intervention phase of this study.

3.6.5 The instructional phase of the study. The experimental groups comprising explicit instruction and Explicon varied in size, while the control group was of equal proportion to the explicit instruction group. Of the 24 students that participated in this study, 29% of the students were instructed under explicit instruction while teachers employed the ExpliCon approach to teach 42% of the students (Figure 3.3). The remaining 29% belonged to the control group where the teacher used her routine instructional method (an uncoordinated form of explicit instruction).

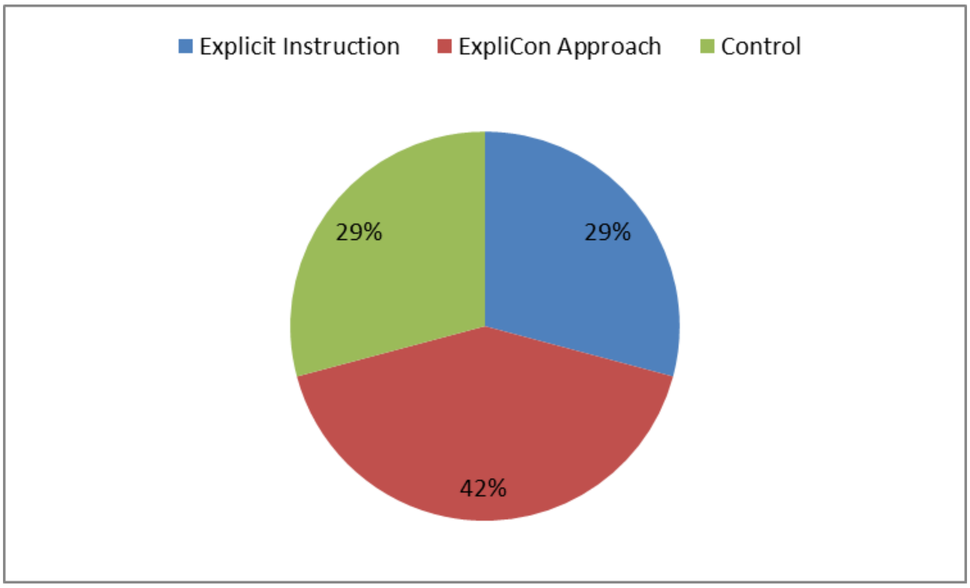

Figure 3.3: Proportion of students instructed under explicit, ExpliCon and control conditions.

The students were spread across five classrooms designated as Explicit Instruction 1 (Classroom 1 — 2 boys and 2 girls), ExpliCon 1 (Classroom 2 — 3 boys and 1 girl), Explicit Instruction 2 (Classroom 3 — 3 girls), Control Group (Classroom 4 — 3 boys and 4 girls) and ExpliCon 2 (Classroom 5 — 2 boys and 4 girls). Figure 3.4 indicates that 17% of the students were in the first explicit instruction class while 12% in the second explicit instruction class. The figure also shows that 17% of the students were located in the first ExpliCon class, 25% in the second ExpliCon class while the control group was made up of 29% of the student population that participated in the study.

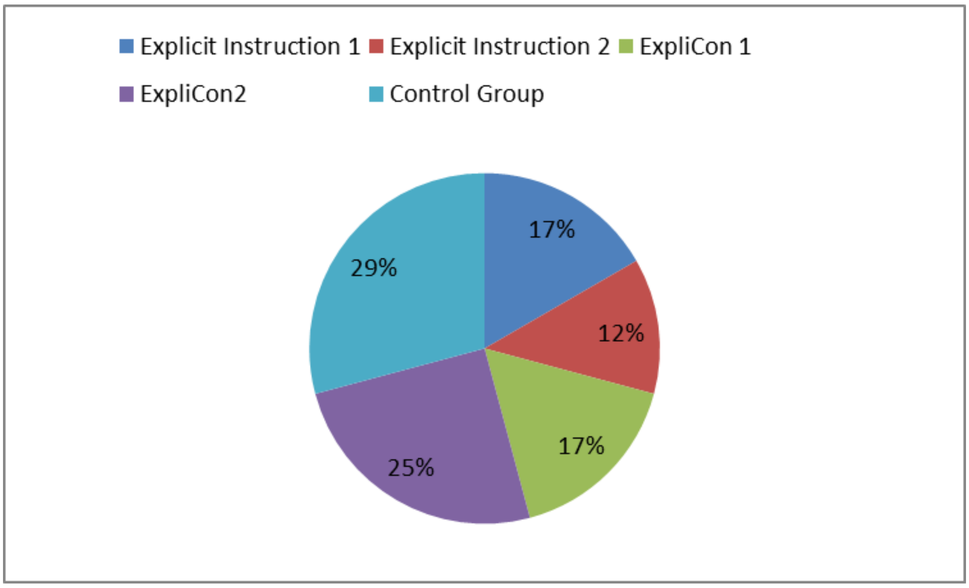

Figure 3.4: Students, their classrooms and instructional approaches.

Considering the gender performances of the students, the students who participated in comparing the effects of instructional approaches on the mathematics achievements of students with ID were the two male and one female students from Explicit Classroom 1, all female students (3) in Explicit Classroom 2, three male and one female students in ExpliCon Classroom 1, two male and four female students in Explicon Classroom 2 as well as three male and four female students in the Control Group (Figures 3.5 and 3.6).

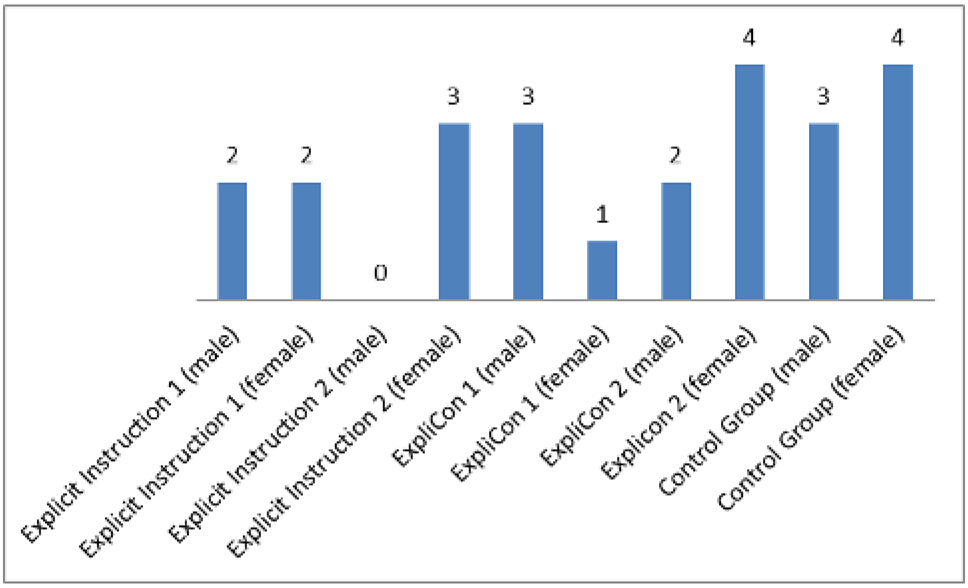

Figure 3.5: Gender distribution of students across the classrooms for explicit and ExpliCon instructional approaches and control.

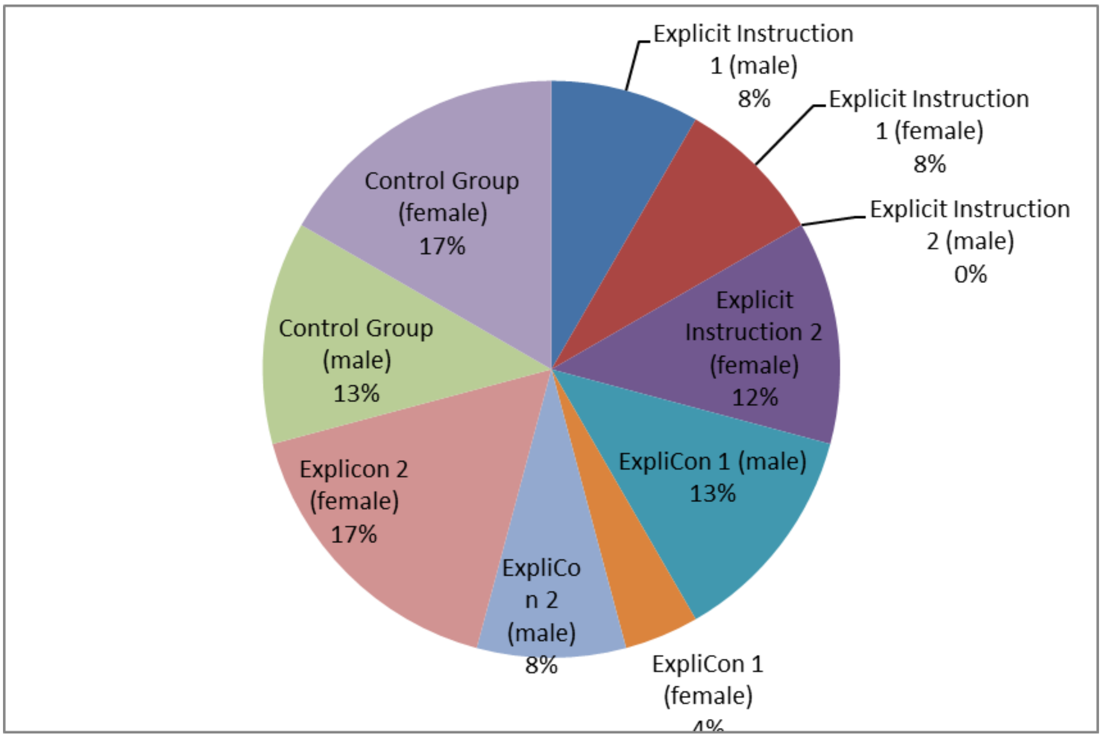

Figure 3.6: Proportion of male and female students in experimental and control groups.

3.6.6 Comparing explicit instruction and the constructivist-based approach. Research quality demands that I attend to matters of validity, fairness and reliability as recommended (Guba & Lincoln, 1989; Shenton, 2004). Thus, it is essential to compare participants with identical characteristics such as the same sample size and IQ but differing on the variable(s) being tested (different instructional approaches). Considering that all five student groups (Explicit Instruction 1, ExpliCon 1, Explicit Instruction 2, Control group and ExpliCon 2) differed in samples sizes and the cognitive ability of students, no direct comparison was made between the two instructional approaches investigated because of the many confounding variables. The instructional approaches were compared indirectly by comparing the pre-instruction and post-instruction mathematics achievements of the participants under explicit instruction separately, and similarly with the constructivist-based approach. Additionally, the average IQ of students in the Control (58.42), Explicit Instruction (62.57) and the ExpliCon (57.7) groups were compared with their respective average achievements in the tests.

To compare the effectiveness of the two instructional approaches (explicit and constructivist-based) as explained above, I applied the group design approach as recommended by Gersten, Baker and lloyd (2000) and used by Kroesbergen, Luit and Maas (2004). The design encompassed two experimental conditions that included explicit instruction (EI) and constructivist-based instruction which was modified and renamed explicon (ECI) as well as a control condition (regular curriculum instruction) (Control). The constructivist-based approach as reflected by the 5Es (Engage, Explore, Explain, Elaborate and Evaluate) implementation framework had to be modified after three weeks (consisting of 9 lessons totalling 18 hours) of implementation and frustration for both the teachers and students when it became increasingly obvious that the students did not have the cognitive ability to engage in dialogue with each other or demonstrate autonomy of learning and initiative (Brooks, J. & Brooks, M; 2001), these being essential characteristics of students in a constructivist classroom. While the school was hesitant to continue beyond three weeks with the 5E Instructional Model, it raised serious ethical issues to allow students and teachers to endure this situation for a prolonged period of time — it is contrary to the ethical standard regarding not causing harm to research participants. An amicable resolution was reached with the school to begin lessons with explicit instruction and then transit to the constructivist-based approach. By so doing, weak students were not denied the opportunity to be directly instructed and supported by their teachers, while the higher ability students are extended through the constructivist-based approach.

The ExpliCon instructional approach: This instructional approach is essentially a merging of explicit instruction and the constructivist-based approach (5E instructional model). The term ‘ExpliCon’ takes its name from two root words. ‘Expli’ represents ‘explicit’ while ‘Con’ represents ‘constructivist-based’ to demonstrate that ‘ExpliCon’ as an instructional approach was derived from combining both types of instructional approaches and that the explicit component comes before the constructivist-based component as described below:

Stages of the ExpliCon instructional approach

Explicit instruction component of ExpliCon (Stages 1-3)

1. Modelling (The “I do phase”)
2. Guided Practice (The “We do phase”)
3. Independent Practice (The “You do phase”

Constructivist-based component of ExpliCon (stages 4-7)

4. Explore
5. Explain
6. Elaborate
7. Evaluate

Theoretical basis for ExpliCon

Students with intellectual disabilities are characterised by pronounced deficits in social and communication skills (American Psychiatric Association, 2013). They also exhibit significant limitation in cognitive functioning. These deficiencies explain why these cohorts of students would be dependent on initial support through teacher’s modelling and guided practice to grow their confidence to be able to move to the independent practice phase of explicit instruction and either consolidate or extend their independent skills by progressing through the constructivist-based components of exploring, explaining, elaborating and evaluating.

ExpliCon provides for both weak and more functional students with ID. The explicit instruction component ensures that no student is disadvantaged. As the teaching of students with ID is characterised by individualised education, the teacher has the flexibility to limit the less able students to the first part of ExpliCon (the explicit instruction phase) and challenge the more able students by progressing them to the second part of ExpliCon (Constructivist-based approach). This intervention is in harmony with the acknowledgement of the Australian Curriculum that “All students with disability are entitled to rigorous and engaging learning programs drawn from a challenging curriculum that addresses their individual learning needs” (ACARA, n.d.). This encompasses the provision of work that is not too easy that students get bored or too hard that they become discouraged (Blazer, 2010).

Intensive training was provided to all teachers on how to implement explicit instruction and the constructivist-based approach in their classrooms. I taught the first lesson of each week in the experimental classrooms except for the control group. I took some units during my Master of Special Education degree that covered the implementation of explicit instruction in the classroom. During my doctoral study, I also took a unit on the constructivist-based approach and submitted a comprehensive report on its implementation in the classroom. I have used both approaches in my professional practice as a teacher. My educational and professional experiences with explicit instruction and the constructivist-based approach put me in good stead to support teachers in these areas. Logbooks and audio recordings were used for all lessons to ensure consistency in the implementation of instructional programs. The lessons were conducted thrice weekly at the time that students would normally receive their maths lessons. On the other two days of the week, students in the experimental conditions followed the regular maths curriculum based on the IEP targets of individual students.

In collaboration with the regular teachers, I wrote all the lessons used in the study. For the explicit instructional approach, the four-stage guidelines for explicit instruction (1. advance organizer, 2. demonstration, 3. guided practice and 4. Independent practice) as described by Miller and Hudson (2006) was followed. The teachers began their lessons with the "I do" phase, demonstrating step-by-step the concepts being taught. This was followed by the "we do phase" (guided practice) and concluded with the "you do" phase or independent practice.

For the constructivist-based approach, the planning and implementation of lessons were in accordance with the 5Es model (1. Engage, 2. Explore, 3. Explain, 4. Extend and 5. Evaluate) as described by Bybee, Taylor, Gardner, Scotter, Powell, Westbrook and Landes (2006) and Brooks J. and Brooks M. (2001). Lessons commenced typically with a review of the previous lesson and students organised into groups.

Students in the control group received instruction as per the regular curriculum of the school. It is worth noting that the control group of students was not a no-instruction condition but a control condition in the sense that the usual form of instruction was delivered as explained previously.

By indirectly comparing the two approaches as detailed earlier, I was able to obtain an indication of which of the two instructional approaches was more effective for teaching students with intellectual disabilities.

3.6.7 Post-instruction administration of the number sense assessment tools, instruments and questionnaires. The entire processes for the administration of the four number sense assessment tools, instruments, questionnaires and ranking of the tools executed during the pre-instruction phase as described in section 3.5.4 were replicated. The data generated from both pre-instruction and post-instruction for the four number sense assessment tools, instruments and questionnaires were encoded using Microsoft Word and Excel spreadsheet 2010. All completed work from the assessments, instruments and questionnaires were manually checked before data input. As encoding was being executed, it was observed that one student's response and three students' responses respectively to self-efficacy items and sources of self-efficacy items did not meet the criteria for inclusion and therefore discarded. The discarded questionnaires either had several unanswered questions, or a student had selected two answers for the same question, or the student only participated in one round of assessment instead of two (pre- and post-) due to illness.

3.7 Data Analyses and Interpretation

Analyses of all data generated from the study were centred on answering the four research questions. The analyses processes included the testing for the normality of the data by using Anderson Darling Normality Test (Minitab 17 Statistical Software, 2010a), calculations of the mean, standard deviation, percentiles, Pearson and Spearman rho correlation coefficients ((Minitab 17 Statistical Software, 2010b). For the normality test (Minitab 17 Statistical Software, 2010a), the null and alternative hypotheses were stated as follows:

Null Hypothesis: Data follows a normal distribution

Alternative Hypothesis: Data do not follow a normal distribution

The p-values of each set of data were calculated and compared to the significance level of 0.05 to determine whether the data followed or did not follow a normal distribution. The null hypothesis was rejected when the p-value was less than or equal to the significance level. On the other hand, a decision not to reject the null hypothesis was made on each occasion that the p-value was larger than the significance level because there was insufficient evidence to reach the conclusion that the data being evaluated did not follow a normal distribution (Minitab Statistical Software, 2010a).

A holistic approach was adopted in the interpretation of data – these were not interpreted in isolation but in consideration of other results to account for any possible influence of individual factors. The following chapter details how the data was analysed and the outcomes of the analyses.

CHAPTER 4

DATA ANALYSES AND RESULTS

4.1 Introduction

My research encompassed an evaluation of the mathematics competence of students with borderline, mild and moderate ID; the development of an assessment tool that is suitable for students with ID; the administration of four different number sense assessment tools (including IMPELS); the Mathematics Teaching Efficacy Belief Instrument (MTEBI) (Enoch, Smith & Huinter, 2000); questionnaires adapted from the Australian Professional Standards for Teachers (AITSL, 2011a); the Mathematics Self-Efficacy instrument adapted from Joet, Bressoux and Usher (2011); the Sources of Self-Efficacy instrument (Usher & Pajares, 2009); the Student Factor questionnaire (completed by students) and the Student Self-Reflection questionnaire (completed by teachers) at the beginning (pre-intervention) and end (post intervention) of this study. This chapter shows the analyses and the results that answer each of the following research questions:

1. Do students with borderline, mild and moderate intellectual disabilities possess specific number sense skills that distinguish members of one group from the other?
2. What are the effects of age, gender, student and teacher factors on the number sense achievements of students with borderline, mild and moderate intellectual disabilities?
3. What are the effects of explicit instruction and a strategy based on the philosophy of constructivism on the development of number sense among high school students with borderline, mild and moderate intellectual disabilities?
4. What numeracy assessment tool among those examined in the study is most appropriate for students with ID?

This chapter consists of four main sections (4.2-4.5) and a conclusion (section 4.6):

Section 4.2 Research Question 1: Do Students with Borderline, Mild and Moderate Intellectual Disabilities possess specific Number Sense skills that distinguish members of one group from the other?

This section covers:

4.2.1 The Mathematics Achievement of Students with Borderline, Mild and Moderate ID in IMPELS (Test 1)

4.2.2 The Mathematics Achievement of Students with Borderline, Mild and Moderate ID in Test 2

4.2.3 The Mathematics Achievement of Students with Borderline, Mild and Moderate ID in Test 3

4.2.4 The Mathematics Achievement of Students with Borderline, Mild and Moderate ID in Test 4

This part of the study is dedicated to answering Research Question 1 which is "Do students with borderline, mild and moderate intellectual disabilities possess specific number sense skills that distinguish members of one group from the other?" To answer the first research question, analyses of the mathematics achievements data of 24 High School students (Years 8 to 12) with borderline, mild and moderate ID were undertaken using four number sense tools including IMPELS (Enoma & Malone, 2015b – Test 1), Delaware Universal Screening Tool for Number Sense Grade 2 (Delaware Department of Education, 2010 – Test 2), Streamlined Number Sense Screening Tool (Jordan, Glutting & Ramineni, 2008 – Test 3) and the Number Knowledge Test (Okamoto & Case, 1996; Okamato, 2004 – Test 4). Detail information about each number sense tool and the development of IMPELS were provided in Section 3.3 of the previous chapter.

To find the relationship between the IQ of the students and their mathematics achievements in the four tests (pre-test and post-test), correlation coefficient graphs were plotted. It has been acknowledged that the use of Pearson Correlation in data analyses is appropriate for normally distributed data (Mukaka, 2012) and that a sample size (n) greater than 25 or 30 is needed for the assumption of normal distribution to be valid (Hogg & Tanis, 2001). As the sample size was less than 30 (n=24), Anderson-Darling normality tests were conducted on the data collected with the four number sense assessment tools using MINITAB 17 statistical software

(Minitab Statistical Software, 2010b). This was carried out to ascertain whether the data satisfy the normal distribution criterion for using Pearson Correlation, and if not, decide on an appropriate alternative. The outcomes of the Anderson-Darling normality tests were mixed (some data were found to be normally distributed while others were not). As a result, the decision was made to use both Pearson Correlation and Spearman rho Correlation (used for non-normally distributed data) for all the data to determine the degree of the relationship between the IQ of the students (including borderline, mild and moderate ID) and their mathematics achievements in the four tests (pre-test and post-test). A full report on this section commences on page 116.

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Section 4.3 Research Question 2: What are the effects of Age, Gender, Student and Teacher factors on the Number Sense achievements of students with Borderline, Mild and Moderate Intellectual Disabilities?

This section covers:

4.3.1 The effects of Age on the Mathematics Achievements of Students with Borderline, Mild and Moderate ID

4.3.2 The effects of Gender on the Mathematics Achievements of Students with Borderline, Mild and Moderate ID

- 4.3.2.1 Male Students with Borderline, Mild and Moderate ID
- 4.3.2.2 Female Students with Borderline, Mild and Moderate ID

4.3.3 The Mathematics Teaching Efficacy Belief Instrument (MTEBI)

4.3.4 The effects of Student Factor on the Mathematics Achievements of Students with Borderline, Mild and Moderate ID

- 4.3.4.1 The Mathematics Self-Efficacy of Students with Borderline, Mild and Moderate ID.
  - 4.3.4.1.1 Linear Regression Graphs
  - 4.3.4.1.2 The Mathematics Self-Efficacy of Students with ID – Summary of Findings
- 4.3.4.2 Sources of Self-Efficacy of Students with Borderline, Mild and Moderate ID.
- 4.3.4.3 Relationship between IQ and Sources of Self-Efficacy

A full report on this section commences on page 124.

Section 4.4 Research Question 3: What are the effects of Explicit Instruction and an Explicit-Constructivist based approach on the development of Number Sense among High School Students with Borderline, Mild and Moderate Intellectual Disabilities?

This section covers:

A full report on this section commences on page 186.

Section 4.5 Research Question 4: What numeracy assessment tool among those examined in the study is most appropriate for students with ID?

This section covers:

A full report on this section commences on page 194.

Section 4.6 Summary of Chapter (p. 211)

I will now consider each section in detail:

Section 4.2 Research Question 1: Do Students with Borderline, Mild and Moderate Intellectual Disabilities possess specific Number Sense skills that distinguish members of one group from the other?

4.2.1 The mathematics achievements of students with borderline, mild, and moderate intellectual disability in IMPELS (Test 1). Students' achievements in Test 1 ranged from 4.82 to 99.58 % (pre-intervention) and 5.45 to 99.79 % (post intervention) (Table 4.1a). The average marks of the entire 24 students who participated in Test 1 were 70.13% and 82.33% for pre- and post-interventions respectively. The average marks of students in Test 1 were 85.16 (Pre-intervention) and 90.98 (post-intervention) for those with borderline ID, 80.86 (pre-intervention) and 92.58 (post-intervention) for those with mild ID and 47.06 (pre-intervention) and 62.44 (post-intervention). In theory, students with borderline intelligence have higher cognitive ability than those with mild IQ who in turn have higher cognitive ability than those with moderate IQ and therefore achievements should be reflected in that order. While this was found to be true in Test 1 as indicated by the pre-intervention average scores of 85.16 % (borderline ID), 80.86% (mild ID) and 47.06% (moderate ID), students' achievements in the same test during the post-intervention phase was less straightforward. Students with mild ID (92.58%) outperformed those with borderline ID (90.98%) (Table 4.1a).

It is worthy of note that IQ did not have an absolute bearing on individual students' mathematics achievements in Test 1. It also emerged from this study that 76.92% and 61.54% of students with mild intellectual disability outperformed 33% and 66.67% of students with borderline intellectual disability respectively prior to intervention. Similarly, 92.31%, 46.15% and 7.69% of students with mild intellectual disability performed better than 33%, 66.67% and 100% of students with borderline ID respectively post intervention. In the main, the achievements of students in Test 1 at both the pre- and post-intervention phases were highly individualized.

Table 4.1a

The Mathematics Achievement of students with Borderline, Mild and Moderate Intellectual Disabilities.

ID Severity	Student code	IQ	Test 1 (%)		Test 2 (%)		Test 3 (%)		Test 4 (%)		Mean
			T_{pre}	T_{post}	T_{pre}	T_{post}	T_{pre}	T_{post}	T_{pre}	T_{post}	
Borderline IQ	1	79	71.00	77.99	75.00	75.00	99.00	98.78	56.82	80.68	79.28
	2	76	99.58	99.58	75.00	100.0 0	98.00	100.0	65.91	77.27	89.42
	3	71	84.91	95.39	75.00	83.33	96.00	98.78	64.77	73.86	84.00
Mild IQ	4	69	53.25	97.06	58.00	66.67	84.00	97.56	50.00	65.91	71.56
	5	69	48.63	70.27	75.00	25.00	93.00	84.15	29.55	34.09	57.46
	6	68	71.07	99.79	50.00	83.33	98.00	100	71.59	76.14	81.24
	7	66	86.00	92.87	83.00	66.67	86.00	98.78	73.86	73.86	82.63
	8	65	75.68	97.69	41.00	66.67	90.00	84.15	37.50	45.45	67.27
	9	63	99.00	93.08	58.00	75.00	99.00	100	60.23	67.05	81.42
	10	62	98.32	98.74	66.00	50.00	99.00	98.78	56.82	65.91	79.20
	11	61	95.81	96.86	58.00	91.67	100.0	100.0	70.45	76.14	86.12
	12	61	90.14	91.19	66.00	83.33	84.00	98.78	56.82	50.00	77.53
	13	60	54.72	87.00	41.00	8.33	74.00	78.05	25.00	43.18	51.41
	14	57	98.95	88.68	83.00	83.33	93.00	93.90	39.77	53.41	79.26
	15	57	85.95	91.19	75.00	91.67	100.0	100.0	54.55	59.09	82.18
	16	55	93.71	99.16	66.00	58.33	100.0	100.0	67.05	68.18	81.55
Moderate IQ	17	53	51.36	61.32	66.00	25.00	90.00	93.90	50.00	54.55	61.52
	18	52	62.68	88.68	66.00	91.67	99.00	100.0	52.27	47.73	76.00
	19	52	68.97	90.78	75.00	75.00	84.00	93.90	39.77	52.27	72.46
	20	49	56.39	90.36	75.00	75.00	100.0	98.78	56.82	56.82	76.15
	21	48	27.00	37.32	25.00	41.67	43.00	45.73	22.73	22.27	33.09
	22	47	63.94	83.23	50.00	58.33	98.00	97.56	43.18	47.73	67.75
	23	44	41.30	42.34	16.00	8.33	56.00	68.90	29.55	29.55	36.50
	24	40	4.82	5.45	0	0	9.00	12.20	19.32	20.45	8.91
Mean for each test event			70.13	82.33	59.08	61.81	86.33	89.28	49.76	55.90	
Class Mean for the 8 tests combined					69.33%						

The instruments were scaled down to be comparable in difficulty using *Z scores* (Table 4.1b). The mean results for each student across the four tests was calculated to compare students' achievements across the tests (Table 4.1b).

Table 4.1b

The Z Scores of the Mathematics Achievements of students with Borderline, Mild and Moderate Intellectual Disabilities.

ID Severity	Student Code	**IQ**	**Test 1 Z Scores**		**Test 2 Z Scores**		**Test 3 Z Scores**		**Test 4 Z Scores**		**Mean**
			T_{pre}	**T_{post}**	**T_{pre}**	**T_{post}**	**T_{pre}**	**T_{post}**	**T_{pre}**	**T_{post}**	
Borderline IQ	1	79	0.04	-0.19	0.76	0.46	0.59	0.47	0.44	1.45	0.50
	2	76	1.21	0.75	0.76	1.34	0.55	0.53	1.01	1.25	0.93
	3	71	0.61	0.57	0.76	0.75	0.45	0.47	0.94	1.05	0.70
Mild IQ	4	69	-0.69	0.64	-0.05	0.17	-0.11	0.41	0.02	0.58	0.12
	5	69	-0.88	-0.52	0.76	-1.29	0.31	-0.25	-1.27	-1.27	-0.55
	6	68	0.04	0.76	-0.43	0.75	0.55	0.53	1.37	1.18	0.59
	7	66	0.65	0.46	1.14	0.17	-0.02	0.47	1.51	1.05	0.68
	8	65	0.23	0.67	-0.87	0.17	0.17	-0.25	-0.77	-0.61	-0.16
	9	63	1.18	0.47	-0.05	0.46	0.59	0.53	0.66	0.65	0.56
	10	62	1.16	0.71	0.33	-0.41	0.59	0.47	0.44	0.58	0.48
	11	61	1.05	0.63	-0.05	1.05	0.64	0.53	1.30	1.18	0.79
	12	61	0.82	0.38	0.33	0.75	-0.11	0.47	0.44	-0.34	0.34
	13	60	-0.63	0.20	-0.87	-1.87	-0.58	-0.55	-1.55	-0.74	-0.82
	14	57	1.18	0.28	1.14	0.75	0.31	0.23	-0.63	-0.15	0.39
	15	57	0.65	0.38	0.76	1.05	0.64	0.53	0.30	0.19	0.56
	16	55	0.97	0.73	0.33	-0.12	0.64	0.53	1.09	0.72	0.61
Moderate IQ	17	53	-0.77	-0.91	0.33	-1.29	0.17	0.23	0.02	-0.08	-0.29
	18	52	-0.31	0.28	0.33	1.05	0.59	0.53	0.16	-0.48	0.27
	19	52	-0.05	0.37	0.76	0.46	-0.11	0.23	-0.63	-0.21	0.10
	20	49	-0.56	0.35	0.76	0.46	0.64	0.47	0.44	0.05	0.33
	21	48	-1.77	-1.95	-1.63	-0.71	-2.03	-2.14	-1.70	-1.96	-1.74
	22	47	-0.25	0.04	-0.43	-0.12	0.55	0.41	-0.41	-0.48	-0.09

	23	44	-1.18	-1.73	-2.06	-1.87	-1.42	-1.00	-1.27	-1.54	-1.51
	24	40	-2.68	-3.34	-2.83	-2.16	-3.62	-3.78	-1.91	-2.07	-2.80

4.2.2 The mathematics achievements of students with borderline, mild, and moderate intellectual disability in Test 2 (Delaware Universal Screening Tool for Number Sense Grade 2). Students' achievements in Test 2 ranged from 0 to 83% (pre-instruction) and 0 to 100 % (post-instruction) with average scores of 59.08% and 61.81 % for the pre- and post-instruction phases respectively (Table 4.1a). The average achievements of students in Test 2 within the borderline, mild and moderate categories were 75.00%, 63.08% and 46.63 (pre-intervention) respectively as well as 86.11%, 65.38% and 46.88% (post-intervention) respectively. Employing group achievements per se to rank the performances of the three groups indicate that students with borderline ID, mild ID and moderate ID came first, second and third respectively. The mathematics achievements of the students in Test 2 were in similar fashion as in Test 1(Table 4.1a). While there were pockets of instances of students with higher IQ scores outperforming those with lower IQ scores, generally, the students' performance pattern was defined more by their individuality than their compartmentalised cognitive groups of borderline, mild and moderate intellectual disability in both the pre- and post-intervention tests. These results are compatible with the observation that "every student is unique in his or her strengths and challenges" (Brandenberger, 2014). As a case in point, students with IQ scores of 49 and 52 (moderate ID), 57 and 69 (mild ID) as well as 71, 76 and 79 (borderline ID) had identical scores (75%) in Test 2 prior to intervention. Similarly, students with IQ scores 52 and 53 (moderate ID) and 55, 61 and 62 (mild ID) also achieved a common pre-intervention score of 66% regardless of the obvious differences in IQ.

Another dimension to the individuality of students reflected by the results (Table 4.1a) was the observation that a number of students with higher IQ scores were outperformed by those with lower IQ scores and the data generated suggest that the instructional method used did not account for this outcome. Some examples of this situation: a student with IQ 57 (83%) as compared to students with IQ scores 71, 76, 79 (75%) pre-intervention; a student with IQ 49 (75%) achieved higher marks than eleven other students with IQ scores between 52 and 69, and many more examples

(Table 4.1a). Similar patterns of achievement were also observed amongst students in the post-intervention phase of Test 2. The fact that students with relatively low IQ scores achieved the same marks in Test 2 pre- and post-intervention) as those with significantly higher IQ scores coupled with the observation of the former outperforming the latter in many instances demonstrate that the individuality of students far outweighs their IQ scores and labels such as ‘borderline’, ‘mild’ and ‘moderate’ in the mathematics education of students with ID.

4.2.3 The mathematics achievements of students with borderline, mild and moderate intellectual disability in Test 3 (Streamlined Number Sense Screening Tool). The mathematics achievements of the students in Test 3 ranged from 9.00% to 99.00% and 12.20% to 98.78% for pre- and post-interventions respectively (Table 4.1a). The average pre- and post-intervention achievements for students with borderline, mild and moderate ID in Test 3 were 97.67% and 99.19%, 92.31% and 94.93% as well as 75.44% and 78.99% respectively (Table 4.1a). The patterns of achievements of students were identical to those described previously in Tests 1 and 2.

4.2.4 The mathematics achievements of students with borderline, mild, and moderate intellectual disability in Test 4 (the Number Knowledge Test). Students’ achievements in Test 4 ranged from 19.32 to 73.86% (pre-instruction) and 20.45 to 80.68 % (post-instruction) (Table 4.1a). The average achievements of students in Test 4 within the borderline, mild and moderate categories were 62.50%, 53.32% and 39.21% (pre-intervention) respectively as well as 77.27%, 59.88% and 41.42% (post-intervention) respectively (Table 4.1a). There was also no departure from the patterns of students’ achievements noticed and described in the preceding paragraphs.

One might have expected students with the same IQ scores to have similar marks in a test, but analyses of students’ achievements in all four tests consistently proved this to the contrary. Comparing students’ achievements in Tests 1, 2, 3 and 4, students’ identification numbers one and five with the same IQ scores of 69; eleven and twelve with the same IQ scores of 61; fourteen and fifteen with the same IQ scores of 57 as well as eighteen and nineteen with the same IQ scores of 52 consistently scored dissimilar marks with their counterparts in Tests 1, 2, 3, and 4 in both pre- and post-intervention stages Table 4.1a).

One of the most significant findings of this study is the observation that many students with relatively low IQ score outperformed other students with higher IQ scores in Test 1 and this was consistent across the other tests (Table 4.1a). This observation is very significant considering the relatively small sample size of this study (24 students). For example, a student with IQ 47 (Moderate IQ) did better with a pre-intervention scores of 63.94% than seven students with higher IQ scores of 48 (27%), 49 (56.39%), 52 (62.68%), 53 (51.36%), 60 (54.72%), 69 (48.63%) and 69 (another student) (53.25%). Considering the post-intervention mathematics achievement score of 83.23%, the student with IQ 47 only outperformed two students with IQs 48 (37.32%) and 53 (61.32%) (Table 4.1a). This suggests that students with a relatively higher IQ respond more to instructional intervention than those below them. A student with IQ 52 achieved a pre-intervention mark of 68.97% in comparison to students with IQs 53 (51.36%), 60 (54.72%), 69 (48.63%), and another student with IQ 69 (53.25%) (Table 4.1a). Also, a student with IQ 55 achieved a pre-intervention mark of 93.71**%** in comparison to students with IQs 57 (85.95%), 60 (54.72%), 61 (90.14%), 65 (75.68%), 66 (86%), 68 (71.07%), 69 (48.63%), another 69 (53.25%), 71 (84.91%) and 79 (71%). Another significant finding of this study was the observation that one of the two students with IQ 57 achieved a better mark (98.95%) in Test 1 (Pre-intervention) than the student with the highest IQ score in the study (79) who obtained a mark of 71% in the test (Table 4.1a).

The mean scores of each cohort of students (borderline, mild and moderate ID) across the four tests were calculated to get a snapshot of the achievements of each group. The pre- and post-intervention mean scores of students across the four tests (all four tests combined) were 80.08% and 88.39% for students with borderline ID, 72.39% and 78.19% for students with mild ID as well as 50.38% and 56.78% for students with moderate ID (Table 4.1a). The class average (average mark of the students in the combined test events — 8 test sessions) was 69.33%. Considering the group performances of the students in the combined tests, 100% of the students with borderline ID performed above the class average as compared to about 77% and 8%

for students with mild and moderate ID respectively. Therefore, the borderline group were superior, followed by the mild ID group and then, the moderate ID cohort. A similar pattern of group performance was mirrored in the individual tests as explained earlier. However, the individual performances of each student in each test did not follow this trend as indicated by the scatter graphs in Figures 4.1 and 4.2.

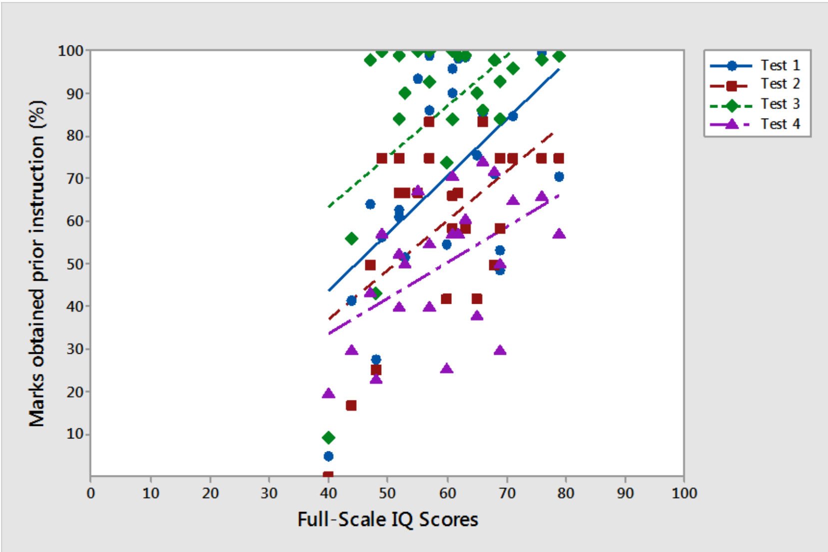


Figure 4.1: The relationship between the IQ scores of students and their mathematics achievements prior to instruction.

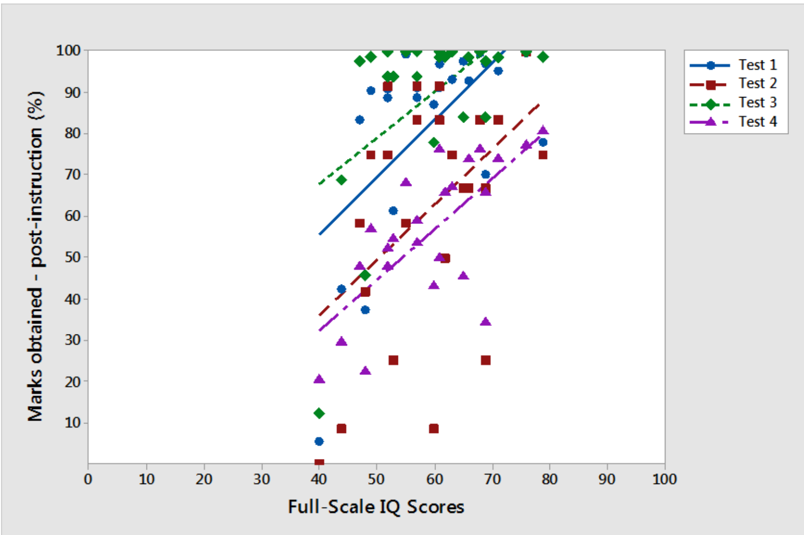


Figure 4.2: The relationship between the IQ scores of students and their mathematics achievements post-instruction.

On observing that some sample groups were normally distributed while others were not, both Pearson and Spearman's Rho correlation coefficients and their *P* values were calculated (Tables 4.2 and 4.3). It emerged from this study that the relationship between IQ scores and the mathematics achievements of students with ID is very weak. For the pre-intervention tests, this ranged from 0.52 to 0.55 and 0.22 to 0.51 for Pearson and Spearman rho coefficients respectively (Table 4.2). Similarly, the relationship between IQ scores and the mathematics achievements of the students (post-intervention) ranged from 0.46 to 0.71 and 0.38 to 0.66 for Pearson and Spearman rho coefficients respectively (Table 4.3).

Table 4.2

Correlation coefficients and p-values for Figure 4.1 (Pre-intervention).

Tests (pre-intervention)	**Pearson Correlation**	**Spearman rho Correlation**
Test 1 v IQ	0.542 (p = 0.006)	0.439 (P =0.032)
Test 2 v IQ	0.544 (p = 0.006)	0.395 (p = 0.056)
Test 3 v IQ	0.547 (p = 0.006)	0.217 (p = 0.308)
Test 4 v IQ	0.520 (p = 0.009)	0.505 (p = 0.012)

Table 4.3

Correlation coefficients and p-values for Figure 4.2 (Post-intervention).

Tests (post-intervention)	**Pearson Correlation**	**Spearman rho Correlation**
Test 1 v IQ	0.594 (p = 0.002)	0.566 (P =0.004)
Test 2 v IQ	0.460 (p = 0.024)	0.375 (p = 0.071)
Test 3 v IQ	0.537 (p = 0.007)	0.380 (p = 0.067)
Test 4 v IQ	0.705 (p = 0.000)	0.660 (p = 0.000)

These findings demonstrate that students with ID are individuals and suggest that individualised education (treating each student as an individual in meeting their learning needs) is the best approach to teaching students with intellectual disabilities.

Section 4.3 Research Question 2: What are the effects of Age, Gender, Student and Teacher factors on the Number Sense achievements of students with Borderline, Mild and Moderate Intellectual Disabilities?

This section of the study focuses on the determination of the extent to which student-related factors such as age, gender, self-efficacy and anxiety as well as the mathematics teaching efficacy beliefs of teachers (teacher-related factor) impact on the mathematics achievements of students with borderline, mild and moderate ID.

To answer the second research question, data on the performances of the twenty-four students in four number sense assessment tools were collected at the commencement and conclusion of the study. The data generated were subjected to appropriate statistical analyses using Minitab Statistical Software (2010a). Anderson-Darling normality tests were conducted on the data because the sample size (n = 24) was below 30. The results of the normality tests were mixed and as a result, both Pearson and Spearman rho correlations were calculated to ensure accurate interpretation of results.

4.3.1 Effects of age on the mathematics achievements of students with borderline, mild and moderate ID. The age of the students ranged from 12.67 years to 17.42 years during the period of the study (Table 4.4).

Table 4.4 shows that although student 22 was the oldest student at 17 years and 5 months, he was outperformed by approximately 58% (pre-intervention) and 71% (post-intervention) of younger students in Test 1. Similarly, student 24 was the second oldest student at 17 years of age but outperformed by all younger students (about 92% of the student that participated in the study) in both the pre- and post-tests of Test 1. There are numerous examples of non-age related achievements of students across all four tests which strongly demonstrated that there was no correlation between the age of students with ID and their mathematics achievement.

Ranking the students according to their age did not display any clear pattern or agreement with the percentile rankings of their scores in the tests (Table 4.5).

Table 4.4

Age and the Mathematics Achievement of students with Borderline, Mild, and Moderate Intellectual Disabilities.

Student Code	**Age Months**	**IQ**	**Test 1 (%)**		**Test 2 (%)**		**Test 3 (%)**		**Test 4 (%)**	
			T_{pre}	T_{post}	T_{pre}	T_{post}	T_{pre}	T_{post}	T_{pre}	T_{post}
22	209	47	63.94	83.23	50.00	58.33	98.00	97.56	43.18	47.73
24	204	40	4.82	5.45	0	0	9.00	12.20	19.32	20.45
15	199	57	85.95	91.19	75.00	91.67	100.0	100.0	54.55	59.09
3	194	71	84.91	95.39	75.00	83.33	96.00	98.78	64.77	73.86
19	192	52	68.97	90.78	75.00	75.00	84.00	93.90	39.77	52.27
20	191	49	56.39	90.36	75.00	75.00	100.0	98.78	56.82	56.82
11	191	61	95.81	96.86	58.00	91.67	100.0	100.0	70.45	76.14
4	190	69	53.25	97.06	58.00	66.67	84.00	97.56	50.00	65.91
18	189	52	62.68	88.68	66.00	91.67	99.00	100.0	52.27	47.73
2	185	76	99.58	99.58	75.00	100.00	98.00	100.0	65.91	77.27
14	183	57	98.95	88.68	83.00	83.33	93.00	93.90	39.77	53.41
12	183	61	90.14	91.19	66.00	83.33	84.00	98.78	56.82	50.00
6	183	68	71.07	99.79	50.00	83.33	98.00	100	71.59	76.14
23	177	44	41.30	42.34	16.00	8.33	56.00	68.90	29.55	29.55
9	176	63	99.00	93.08	58.00	75.00	99.00	100	60.23	67.05
16	175	55	93.71	99.16	66.00	58.33	100.0	100.0	67.05	68.18
13	173	60	54.72	87.00	41.00	8.33	74.00	78.05	25.00	43.18
8	173	65	75.68	97.69	41.00	66.67	90.00	84.15	37.50	45.45
5	168	69	48.63	70.27	75.00	25.00	93.00	84.15	29.55	34.09
17	166	53	51.36	61.32	66.00	25.00	90.00	93.90	50.00	54.55
10	165	62	98.32	98.74	66.00	50.00	99.00	98.78	56.82	65.91
21	163	48	27.00	37.32	25.00	41.67	43.00	45.73	22.73	22.27
7	158	66	86.00	92.87	83.00	66.67	86.00	98.78	73.86	73.86
1	152	79	71.00	77.99	75.00	75.00	99.00	98.78	56.82	80.68

Table 4.5

Age and the Percentile Rankings of the Mathematics Achievement of Students with Borderline, Mild, and Moderate Intellectual Disabilities.

Age (Years)	**IQ**	**ID Category**	**Percentile ranking**
17.42	47	Moderate	29%
17.00	40	Moderate	0%
16.58	57	Mild	79%
16.17	71	Borderline	88%
16.00	52	Moderate	38%
15.92	49	Moderate	46%
15.92	61	Mild	92%
15.83	69	Mild	33%
15.75	52	Moderate	42%
15.42	76	Borderline	96%
15.25	57	Mild	58%
15.25	61	Mild	50%
15.25	68	Mild	67%
14.75	44	Moderate	8%
14.67	63	Mild	71%
14.58	55	Mild	75%
14.42	60	Mild	13%
14.42	65	Mild	25%
14.00	69	Mild	17%
13.83	53	Moderate	21%
13.75	62	Mild	54%
13.58	48	Moderate	4%
13.17	66	Moderate	83%
12.67	79	Borderline	63%

For example, while the oldest student (17.42 years) and second oldest student (17.00 years) had the percentile rankings of 29% and 0% respectively, the tenth oldest student (15.42 years) and the twenty-third oldest student (who was also the second youngest at 13.17 years) had the percentile rankings of 96% and 83% respectively (Table 4.5). The fact that the youngest student (12.67 years old) did better than 63% of the students that took the tests in comparison to the third youngest student (13.58 years) who outperformed only 4% of the test's participants further brings to bear the unpredictability of the age-achievement relationship and the reinforcement of the individual characteristics of the students (Table 4.5). It was also observed that three students who were of the same age (15.25 years) performed better than 50%, 58% and 67% of the tests participants. Similarly, two students of approximately14 years of age (14.42 years) had different percentile rankings of 13% and 25% (Table 4.5).

Figure 4.3 compares the age of the students to their achievements in Tests 1, 2, 3 and 4 prior to instruction. The overwhelming majority of the students found Test 3 the easiest of the four tests, with an average mark of 86.33%. The line of regression for Test 3 tilted slightly downward as indicated by a slope of -0.11, thus indicating that students' performances in Test 3 tended to deteriorate slightly with increasing age. Test 1 was the second easiest of the four tests for the students with an average mark of 70.13%. The pattern of students' achievements in Test 1 prior to instruction also demonstrate a negative gradient (-0.14), which suggests declining performance with age. Figure 4.3 shows that Test 2 was the students' third easiest of the four tests (prior to instruction) with an average mark of 59.08%. The pattern of achievement in this test was similar to the previous two with a negative gradient of -0.21. The students found Test 4 the most challenging of the four tests with an average mark of 49.76% prior to instruction. Students' achievements in this test also displayed a negative gradient as in the other three tests with a slope of -0.044. Students' achievements in all four tests prior to instruction showed deterioration in performances with increased age. Considering that the magnitude of the slopes was relatively small or negligible (-0.044 to -0.21) suggests that a significant number of students do not fit into the "increasing age-decreasing mathematics achievements" pattern. For examples, an older student (student code 15) who was 199 months old outperformed 54.17% of younger students. Similarly, student code 3 (194 months old) did better than 50.00% of younger students. There are many other examples of older students who did better in the tests than their younger counterparts. The most obvious lesson that was learnt from the pre-instruction results was that the individual characteristics of the students were more influential in the mathematics achievements of the students than their age.

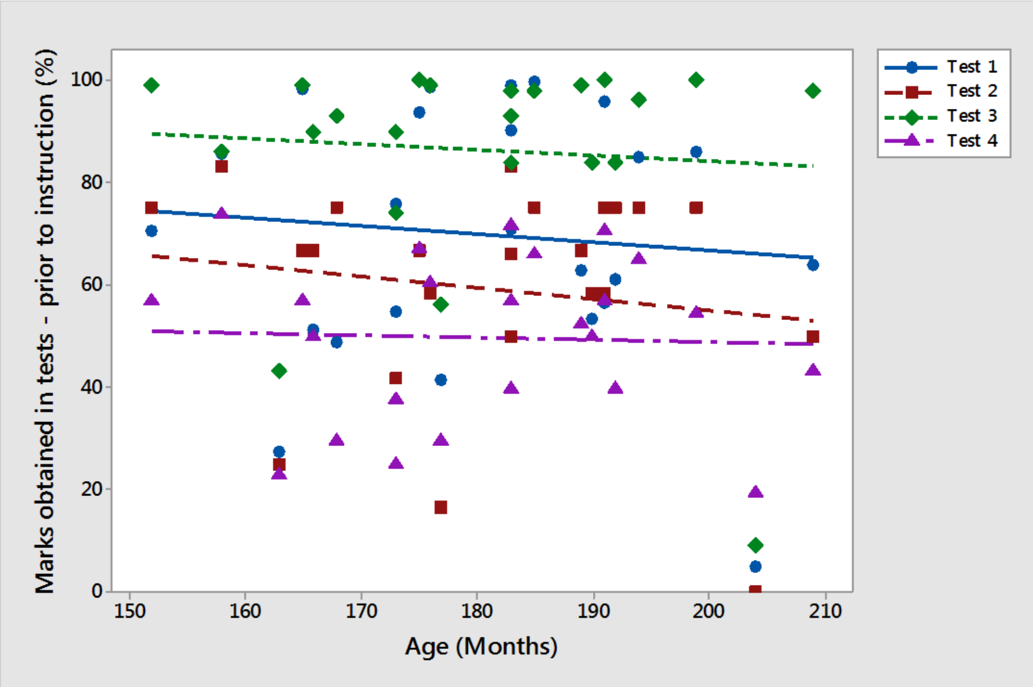


Figure 4.3: Relationship between age and the mathematics achievement of students with intellectual disability prior to instruction.

Figure 4.4 illustrates the comparison made between the age of the students and their achievements in Tests 1, 2, 3 and 4 post-instruction. As was the case prior to instruction, the majority of the students found Test 3 the easiest of the four tests during the post-instruction phase of the study with an improved average mark of 89.28% – in comparison to the 86.33% average mark for the same test during the pre-instruction phase. The pattern of students' achievements in Test 3 post-instruction indicated a negative gradient (-1.37) and which suggested that students' performances declined with their age. Although the size of the slope was negligible at -1.37, it was higher than what was obtained at the pre-instruction phase (-0.11) declining performance with age. Test 1 was the second most favourable test of the four tests for the students with a mean mark of 82.33% − compared to 70.13% average marks obtained during the pre-instruction phase. This amounted to an improvement of 12.20%. The trend of students' achievements in Test 1 (post-instruction) was reflected by a negative gradient of -0.006. This demonstrates the regression line was relatively flat (horizontal) and thus suggesting that the students scored relatively the same mark in the test regardless of their age. Test 2 was the third most favourable test (post-instruction) of the four tests with a mean mark of 61.81% − compared to 59.08% average mark obtained at the beginning of the study. The pattern of students' achievements in Test 2 displayed a positive slope of 0.42, suggesting that students' achievements in this test improved with age. This "performance increases as age increases" pattern is contrary to the previously observed pattern of "performance decreases as age increases". While there is no clear explanation why this was the case, it is important to consider the fact that Test 2 was the shortest of the four tests with only six questions in comparison to Test 1 (52 questions), Test 3 (33 questions) and Test 4 (43 questions). It is possible that the older the students, the better they were at learning from their experience/encounter with the same set of questions six months earlier and even more so because the questions were very few. Logically, it is easier to remember six questions (Test 2) than 52, 33 and 43 questions for Tests 1, 3 and 4 respectively. Test 4 was again the most challenging of the four tests for the students during the post-instruction phase of the study with an average mark of approximately 55.90% − indicating an improvement of 6.14% (having obtained a mean mark 49.76% during the pre-instruction phase). The pattern of students' achievements in Test 4 during the post-instruction phase was demonstrated by a negative gradient of -0.14 which suggests a declining performance with increased age relationship.

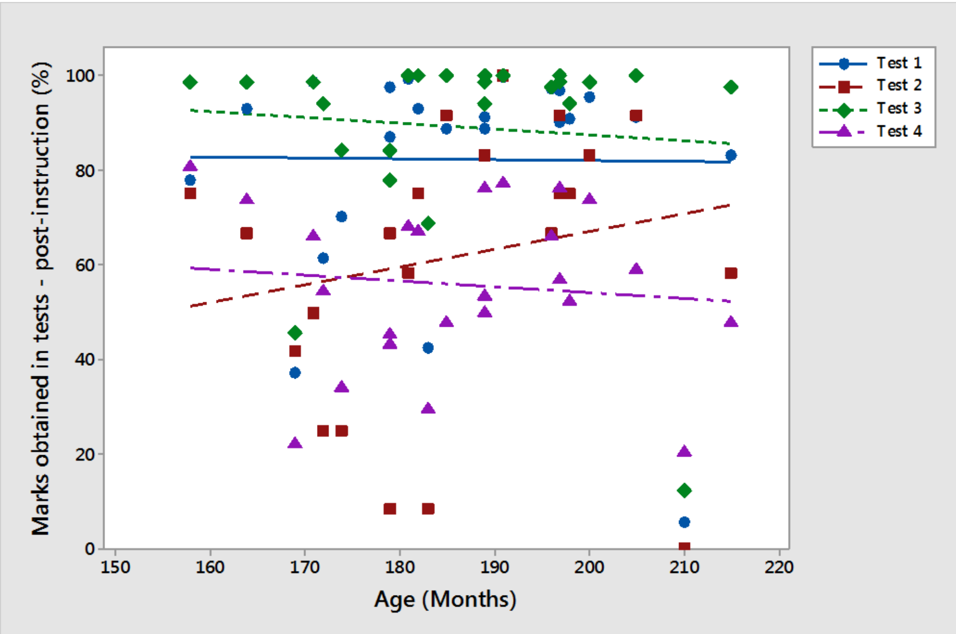


Figure 4.4: Relationship between age and the mathematics achievement of students with intellectual disability post-instruction.

In the main, a comparison of the age of the students with their marks in the tests has demonstrated that age has no absolute influence on the mathematics achievements of students with borderline, mild and moderate ID. This was made more evident by the highly staggered data points produced when the two variables (age vs maths achievement) were compared at both pre- and post-intervention stages (Figures 4.3 and 4.4) and as discussed above.

The correlation coefficients ranged from -0.151 to -0.04 (Pearson Correlation) and -0.051 to 0.133 (Spearman rho Correlation) as well as -0.10 to 0.19 (Pearson Correlation) and -0.02 to 0.36 (Spearman rho Correlation) for pre- and post-interventions respectively (Tables 4.6 and 4.7). The very poor correlation coefficients calculated for the data collected at both the beginning and end of the study further testify to the lack of relationship between the age and mathematics achievements of students with borderline, mild and moderate ID.

Table 4.6

Correlation coefficients and p-values for Figure 4.3 (Pre-intervention).

Tests	**Pearson Correlation**	**Spearman rho Correlation**
Test 1 v IQ	-0.091 (p = 0.672)	0.011 (P =0.960)
Test 2 v IQ	-0.151 (p = 0.483)	-0.051 (P =0.813)
Test 3 v IQ	-0.076 (p = 0.725)	0.133 (P = 0.536)
Test 4 v IQ	-0.040 (p = 0.854)	-0.015 (P = 0.946)

Table 4.7

Correlation coefficients and p-values for Figure 4.4 (Post-intervention).

Tests	**Pearson Correlation**	**Spearman rho Correlation**
Test 1 v IQ	-0.012 (p = 0.956)	0.097 (P =0.652)
Test 2 v IQ	0.185 (p = 0.388)	0.359 (P =0.085)
Test 3 v IQ	-0.086 (p = 0.688)	0.149 (P = 0.487)
Test 4 v IQ	-0.101 (p = 0.638)	-0.023 (P = 0.916)

4.3.2 Effects of gender on the mathematics achievements of students with borderline, mild and moderate ID. Gender variable was analysed to ascertain whether there are any gender differences in the mathematics achievements of students with ID. Of the 24 students that participated in this study, 11 were male while 13 were female. Within the male students with ID group, there were three male students with borderline ID, seven male students with mild ID and 1 male student with moderate ID. The female cohort consisted of six students with mild ID and 7 students with moderate ID. There were no female students within the borderline category.

Anderson-Darling normality tests were carried out on the data in consideration of the relatively small sample size as detailed previously. Some results that emerged from the normality tests were normal while others were not, and as a result both Pearson and Spearman rho correlations were calculated to ensure the ensuing interpretations of results were grounded.

4.3.2.1 Male students with borderline, mild and moderate ID. Of the 11 male students that participated in this study, three, seven and one were diagnosed with borderline ID, mild and moderate ID respectively (Table 4.8). The pre- and post-intervention performances of the students in the tests ranged from 53.25% to 99.58% and 77.99 to 99.79% for Test 1, 41.00% to 83.00% and 50.00% to 100.00% for Test 2, 84.00% to 100.00% and 84.15% to 100.00% for Test 3 as well as 37.50% to 71.59% and 45.45% to 80.68% for Test 4 (Table 4.8). The mean marks obtained by the male students for both pre-and post-interventions) were 88.17%, 68.05%, 96.53% and 60.70% for Tests 1, 2, 3, and 4 respectively (Table 4.8). About 73% of the male students that took the tests performed above the class average of 78.36%. The male students found Test 3 the easiest of the four tests, followed by Test 1 and then, Test 2. They found Test 4 the most challenging (Table 4.8).

Table 4.8

The Mathematics Achievements of Male students with Borderline, Mild, and Moderate Intellectual Disabilities.

ID Severity	Student code	**IQ**	**Test 1 (%)**		**Test 2 (%)**		**Test 3 (%)**		**Test 4 (%)**		**Mean**
			T_{pre}	**T_{post}**	**T_{pre}**	**T_{post}**	**T_{pre}**	**T_{post}**	**T_{pre}**	**T_{post}**	
Borderline IQ	1	79	71.00	77.99	75.00	75.00	99.00	98.78	56.82	80.68	**79.28**
	2	76	99.58	99.58	75.00	100.00	98.00	100.0	65.91	77.27	**89.42**
	3	71	84.91	95.39	75.00	83.33	96.00	98.78	64.77	73.86	**84.01**
Mild IQ	4	69	53.25	97.06	58.00	66.67	84.00	97.56	50.00	65.91	**71.56**
	6	68	71.07	99.79	50.00	83.33	98.00	100	71.59	76.14	**81.24**
	8	65	75.68	97.69	41.00	66.67	90.00	84.15	37.50	45.45	**67.27**
	9	63	99.00	93.08	58.00	75.00	99.00	100	60.23	67.05	**81.42**
	10	62	98.32	98.74	66.00	50.00	99.00	98.78	56.82	65.91	**79.20**
	14	57	98.95	88.68	83.00	83.33	93.00	93.90	39.77	53.41	**79.26**
	16	55	93.71	99.16	66.00	58.33	100.0	100.0	67.05	68.18	**81.55**
Moderate IQ	22	47	63.94	83.23	50.00	58.33	98.00	97.56	43.18	47.73	**67.75**
Average for each individual test			**82.67**	**93.67**	**63.36**	**72.73**	**95.82**	**97.23**	**55.79**	**65.60**	
Average for Tests 1, 2, 3 & 4			**88.17**		**68.05**		**96.53**		**60.70**		
Class Average for the 8 tests combined			**78.36**								

Figure 4.5 shows the mathematics achievements of male students with ID in Tests 1, 2, 3 and 4 prior to instruction. The majority of the male students with ID found Test 3 the easiest of the four tests, with an average mark of 95.82%. The students' achievements pattern in Test 3 (prior to instruction) showed a negative gradient of -0.05 which indicates that the students' performances declined slightly with

increasing IQ. Test 1 was the second most favourable of the four tests for the male students with ID during the prior instruction phase with an average mark of 82.67%. The pattern of students' achievements in Test 1 prior to instruction also demonstrate a negative gradient (-0.11), which gives an indication that the students performances declined slightly as their IQ increased. Test 2 was the third most favourable of the four tests (prior to instruction) for the students with an average mark of 63.36%. The pattern of students' achievements in Test 2 displayed a positive slope of 0.41, suggesting that students' achievements in this test improved as the intelligence quotients (IQs) of the male students increased. Test 4 was the most challenging of the four tests for the male students with a mean mark of 55.79%. The pattern of students' achievements in this test also displayed a positive gradient (0.49), suggesting that the students' performances in Test 4 tended to improve with increasing IQ. It is obvious from the above that the patterns of achievements of the male students with ID in the four tests prior to instruction were inconsistent. While the students' performances in Tests 3 and 1 followed the same pattern of declining performance with increasing IQ, their performances in Tests 2 and 4 were the exact opposite (achievements improved with increasing IQ). This conflicting outcome again reinforces the fact that the individual characteristics of students are far more superior to any other factors with regard to the mathematics achievements of students with ID and that students will perform differently in different test situations.

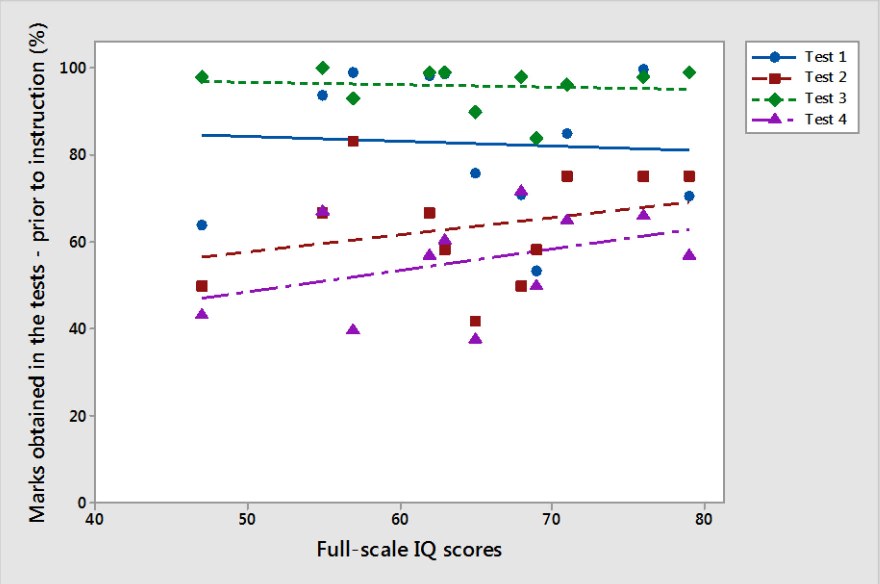


Figure 4.5: The mathematics achievement of male students with ID prior to instruction.

Figure 4.6 displays the mathematics achievements of male students with ID in Tests 1, 2, 3 and 4 post-instruction. As was the case prior to instruction, the majority of the students found Test 3 the easiest of the four tests during the post-instruction phase of the study with an improved average mark of 97.23% – in comparison to the 95.82% average mark for the same test during the pre-instruction phase. The pattern of students' achievements in Test 3 post-instruction indicated a positive gradient (0.06) and which suggests that students' performances improved slightly with increasing IQ. Test 1 was the second most favourable test of the four tests for the male students with a mean mark of 93.67% – compared to 82.67% average mark obtained during the pre-instruction phase. This amounted to an improvement of 11.00%. The trend of students' achievements in Test 1 (post-instruction) was reflected by a positive gradient of 0.05 which also depicts a pattern of achievements that was based on higher IQ. Test 2 was the third most favourable test (post-instruction) of the four tests with a mean mark of 72.73% – compared to 63.36% average mark obtained at the beginning of the study. The pattern of students' achievements in Test 2 displays a positive slope of 0.89, suggesting that students with higher intelligence quotients tended to achieve higher than those with lower intelligence quotients. Test 4 was again the most challenging of the four tests for the students during the post-instruction phase of the study with an average mark of approximately 65.60% – indicating an improvement of 9.81% (having obtained a mean mark 55.79% during the pre-instruction phase). The pattern of students' achievements in Test 4 during the post-instruction phase was demonstrated by a positive gradient of 0.92 which also reflects a trend of students with higher IQ outperforming those with lower IQ.

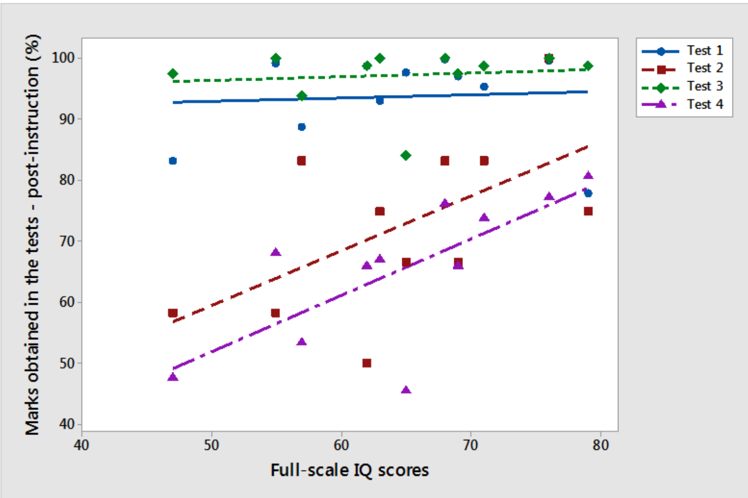


Figure 4.6: The mathematics achievement of male students with ID post instruction.

It is of significance to note the following observations:

(1) The pattern of students' performances at pre-test for Test 1 (slope = -0.11) and Test 3 (slope = -0.05) moved from decreasing with higher IQ to increasing with higher IQ at post-test (slope = 0.05 for Test 1 and slope = 0.06 for Test 3).

(2) The trend of students' achievements at pre-test for Test 2 (slope 0.41) and Test 4 (slope = 0.49) showed stronger "higher IQ-higher achievement" relationship at post-test (slope = 0.89 for Test 2 and slope = 0.92 for Test 4).

Both observations demonstrate that male students with ID but having higher cognitive ability (IQ) respond quicker to intervention than those with lower cognitive ability. The implications of these observations are manifold for classroom practice: (1) Teachers must allow more time in class for students to complete work and learn new concepts;

(2) They should break tasks into small parts and teach each part at a time as well as test for students' understanding before progressing to the next part; (3) They should avoid rushing through the teaching of new concepts. Repeat instruction over and over again to ensure mastery and consolidation of skills. Change the context slightly at each repetition to avoid monotony, and particularly for those students who appear to have grasped the concept until consistency of performance is achieved (regardless of context variations).

The outcome of this component of the study also implies that for students with ID, higher IQ does not necessarily translate to higher achievements and conversely, lower IQ does not always mean lower performance in mathematics. For example, the male student with IQ of 55 outperformed 63.64% of students with higher IQ scores than him. As another example, a male student with an IQ score of 47 and an average mark of 67.75% performed as well as a student with IQ 65 who achieved a mean mark of 67.27% in the tests. Similarly, the student with IQ of 76 did better in the tests with an average mark of 89.43% than the student with IQ 79 with an average mark of 79.28%. These observations suggest strongly that the individual characteristics of the students with ID are most influential to their performances in maths.

These findings were corroborated by the weak correlation coefficients which ranged from -0.098 to 0.397 (Pearson correlation) and -0.194 to 0.282 (Spearman Rho correlation) for the data collected at the beginning of the study (Table 4.9). Data collected at the end of the study reflected a similar pattern with correlation coefficients ranging from 0.068 to 0.73 and 0.073 to 0.68 for Pearson and Spearman rho correlations respectively (Table 4.10).

Table 4.9

Correlation coefficients and p-values for Figure 4.5 (Pre-intervention).

Tests (Pre-)	**Pearson Correlation**	**Spearman rho Correlation**
Test 1 v IQ	-0.067 (p = 0.844)	-0.091 (P = 0.790)
Test 2 v IQ	0.285 (p = 0.395)	0.282 (p = 0.401)
Test 3 v IQ	-0.098 (p = 0.773)	-0.194 (p = 0.567)
Test 4 v IQ	0.397 (p = 0.227)	0.251 (p = 0.457)

Table 4.10

Correlation coefficients and p-values for Figure 4.6 (Post-intervention).

Tests (Post-)	**Pearson Correlation**	**Spearman rho Correlation**
Test 1 v IQ	0.068 (p = 0.843)	0.073 (P = 0.832)
Test 2 v IQ	0.579 (p = 0.062)	0.587 (p = 0.058)
Test 3 v IQ	0.123 (p = 0.720)	0.184 (p = 0.589)
Test 4 v IQ	0.725 (p = 0.012)	0.683 (p = 0.020)

4.3.2.2 Female students with borderline, mild and moderate ID. As indicated earlier, 13 female students with ID took part in this study. This consisted of 46.15% of students with mild ID and 53.85% of students with moderate ID (Table 4.11). The performances of the students in the tests administered at the beginning and end of the study ranged from 4.82% to 95.18% and 5.45% to 96.86 for Test 1, 0% to 83.00 % and 0% to 91.67% for Test 2, 9.00% to 100% and 12.20% to 100% for Test 3 as well as 19.32 to 73.86% and 20.45 to 73.86% for Test 4 (Table 4.11). The mean marks of the female students who took the tests were 66.13%, 54.01%, 80.43% and 46.16% for Tests 1, 2, 3 and 4 respectively. Of the13 female students, 53.85% achieved above the average class mark of 61.69% (Table 4.11). Like their male counterparts, the female students found Test 3 the easiest of the four tests, followed by Test 1 and then, Test 2. They found Test 4 the most challenging (Table 4.11).

Table 4.11

The Mathematics Achievement of Female students with Borderline, Mild, and moderate Intellectual Disabilities.

ID Severity	Student Code	**IQ**	**Test 1 (%)**		**Test 2 (%)**		**Test 3 (%)**		**Test 4 (%)**		**Mean**
			T_{pre}	T_{post}	T_{pre}	T_{post}	T_{pre}	T_{post}	T_{pre}	T_{post}	
Mild IQ	5	69	48.63	70.27	75.00	25.00	93.00	84.15	29.55	34.09	**57.46**
	7	66	86.00	92.87	83.00	66.67	86.00	98.78	73.86	73.86	**82.63**
	11	61	95.81	96.86	58.00	91.67	100.0	100.0	70.45	76.14	**86.12**
	12	61	90.14	91.19	66.00	83.33	84.00	98.78	56.82	50.00	**77.53**
	13	60	54.72	87.00	41.00	8.33	74.00	78.05	25.00	43.18	**51.41**
	15	57	85.95	91.19	75.00	91.67	100.0	100.0	54.55	59.09	**82.18**
Moderate IQ	17	53	51.36	61.32	66.00	25.00	90.00	93.90	50.00	54.55	**61.52**
	18	52	62.68	88.68	66.00	91.67	99.00	100.0	52.27	47.73	**76.00**
	19	52	68.97	90.78	75.00	75.00	84.00	93.90	39.77	52.27	**72.46**
	20	49	56.39	90.36	75.00	75.00	100.0	98.78	56.82	56.82	**76.15**
	21	48	27.00	37.32	25.00	41.67	43.00	45.73	22.73	22.27	**33.09**
	23	44	41.30	42.34	16.00	8.33	56.00	68.90	29.55	29.55	**36.50**
	24	40	4.82	5.45	0	0	9.00	12.20	19.32	20.45	**8.91**
Average for each test event			59.52	72.74	55.46	52.56	78.31	82.55	44.66	47.69	
Average for Tests 1, 2, 3 & 4			**66.13**		**54.01**		**80.43**		**46.16**		
Class Average for the 8 test events combined			**61.69**								

Among the female students with ID, a female student with IQ 49 did better in the tests with a mean scores 76.15% than another female student with IQ as high as 69 who achieved a mean mark of 57.46% in the tests. As another example, a student with IQ of 52 outperformed 23.08% of students with higher IQ. These examples also point to the significance of the individual characteristics of the students with regard to the performances of female students with ID in mathematics.

Figure 4.7 shows the mathematics achievements of female students with ID in Tests 1, 2, 3 and 4 prior to instruction. The majority of the female students with ID found Test 3 the easiest of the four tests, with an average mark of 78.31%. The students' achievements pattern in Test 3 (prior to instruction) showed a positive gradient of 2.04 which indicates that the students' performances improved with increasing IQ.

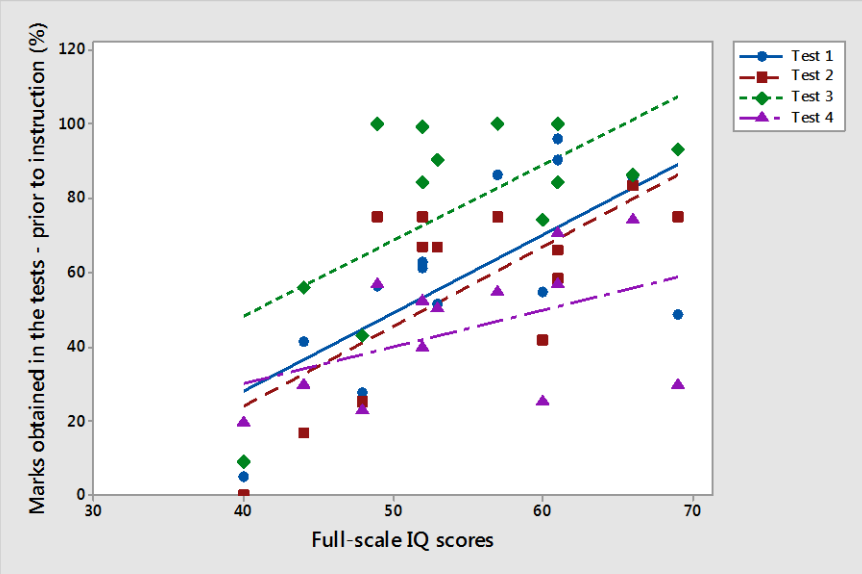


Figure 4.7: The mathematics achievement of female students with ID pre-instruction.

Test 1 was the second most favourable of the four tests for the female students with ID during the prior instruction phase with an average mark of 59.52%. The pattern of students' achievements in Test 1 prior to instruction also demonstrate a positive gradient (2.09), which gives an indication that the students performances improved as their IQ increased. Test 2 was the third most favourable of the four tests (prior to instruction) for the students with an average mark of 55.46%. The pattern of students' achievements in Test 2 displayed a positive slope of 2.15, suggesting that students' achievements in this test improved as the intelligence quotients (IQs) of the female students increased. Test 4 was the most challenging of the four tests for the female students, with a mean mark of 44.67%. The pattern of students' achievements in this test also displayed a positive gradient (0.99), suggesting that the students' performances in Test 4 tended to improve with increasing IQ. While the pattern of the female students' performances across the four tests consistently showed an improvement with increasing IQ, their highly-scattered points demonstrate that there are a significant number of individual students that do not fit this pattern. As an example, student code 19 with an IQ of 52 achieved higher individual mark (68.97%) in Test 1 (pre-instruction) than student code 17 with IQ 53 (51.36%), student code 13 with IQ 60 (54.72%) and student code 5 with IQ 69 (48.63%). Similar examples of this situation can also be observed in Tests 2, 3 and 4 pre-instruction. This reinforces the importance of considering the individual characteristics of students in the teaching of Mathematics to students with ID.

Figure 4.8 displays the mathematics achievements of female students with ID in Tests 1, 2, 3 and 4 post-instruction. As was the case with their prior to instruction, mathematics achievements, the majority of the students found Test 3 the easiest of the four tests during the post-instruction phase of the study with an improved average mark of 82.55% – in comparison to the 78.31% average mark for the same test during the pre-instruction phase.

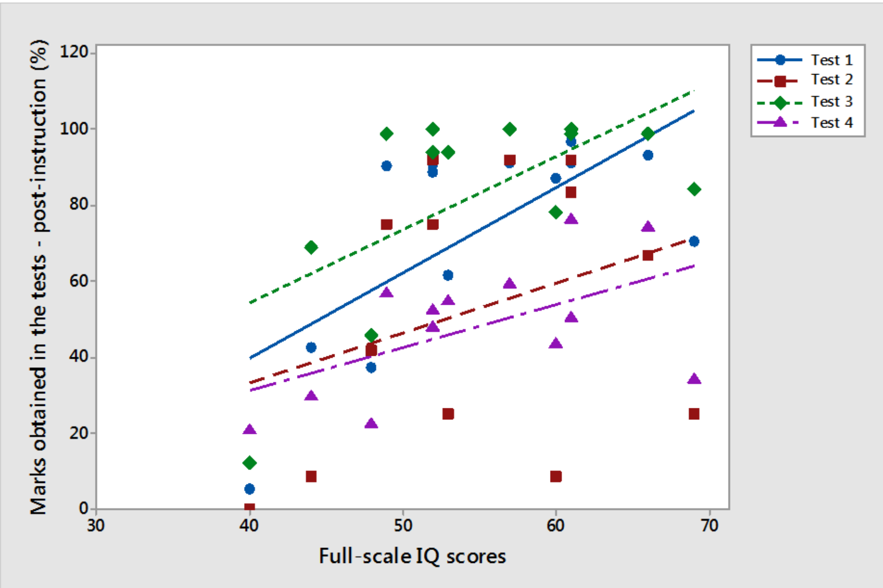


Figure 4.8: The mathematics achievement of female students with ID post-Instruction.

The pattern of students' achievements in Test 3 post-instruction indicated a positive gradient (1.92) and which suggests that students' performances improved with increasing IQ. Test 1 was the second most favourable test of the four tests for the female students with a mean mark of 72.74%% – compared to 59.52% average mark obtained during the pre-instruction phase. This amounted to an improvement of 13.22%. The trend of students' achievements in Test 1 (post-instruction) was reflected by a positive gradient of 2.25 which also depicts a pattern of achievements that was based on higher IQ. Test 2 was the third most favourable test (post-instruction) of the four tests with a mean mark of 52.56%. The pattern of students' achievements in Test 2 displays a positive slope of 1.30, suggesting that students with higher intelligence quotients tended to achieve higher than those with lower intelligence quotients. Test 4 was again the most challenging of the four tests for the students during the post-instruction phase of the study, with an average mark of approximately 47.69% − indicating an improvement of 3.02% (having obtained a mean mark 44.67% during the pre-instruction phase). The pattern of students' achievements in Test 4 during the post-instruction phase was demonstrated by a positive gradient of 1.13 which also reflects a trend of students with higher IQ outperforming those with lower IQ.

The relationship between the IQ of female students with ID and their achievements in mathematics was stronger than their male counterparts as shown by figures 4.7 and 4.8. The correlation coefficients ranged from 0.47 to 0.69 (Pearson correlation) and 0.46 to 0.60 (Spearman rho) (Table 4.12) as well as 0.31 to 0.68 (Pearson correlation) and 0.32 to 0.65 (Spearman rho) (Table 4.13) for both pre- and post-interventions respectively.

Table 4.12

Correlation coefficients and p-values for Figure 4.7 (Pre-intervention).

Tests (Pre-)	**Pearson Correlation**	**Spearman rho Correlation**
Test 1 v IQ	0.684 (p = 0.010)	0.601 (P = 0.030)
Test 2 v IQ	0.693 (p = 0.009)	0.551 (p = 0.051)
Test 3 v IQ	0.639 (p = 0.019)	0.455 (p = 0.118)
Test 4 v IQ	0.465 (p = 0.109)	0.535 (p = 0.060)

Table 4.13

Correlation coefficients and p-values for Figure 4.8 (Post-intervention).

Tests (Post-)	**Pearson Correlation**	**Spearman rho Correlation**
Test 1 v IQ	0.677 (p = 0.011)	0.650 (P = 0.016)
Test 2 v IQ	0.313 (p = 0.298)	0.319 (p = 0.289)
Test 3 v IQ	0.616 (p = 0.025)	0.473 (p = 0.103)
Test 4 v IQ	0.549 (p = 0.052)	0.523 (p = 0.066)

4.3.3 The Mathematics Teaching Efficacy Belief Instrument (MTEBI). Data obtained as a result of the administration of MTEBI to teachers at the beginning of the school year before the commencement of mathematics instruction were relatively high for both Mathematics Teaching Outcome Expectancy (MTOE) and Personal Mathematics Teaching Efficacy (PMTE) scales (Tables 4.14 and 4.15). The results of MTEBI after six months of instruction were both similar to those obtained during the pre-intervention phase of the study (Tables 4.14 and 4.15). When all MTEBI results are considered alongside the results of the Professional Standards for teachers assessment, it suggests that while teachers are confident about their ability to teach mathematics to students with ID, the teachers will benefit from the provision of professional development aimed at supporting them with the individualisation of learning programs for students with intellectual disability and particularly those with high needs.

Table 4.14

MTEBI - Comparing the Mathematics Teaching Outcome Expectancy (MTOE) subscale scores of the 5 teachers prior and post intervention.

	Outcome Expectancy Items	***TG**		***TH**		***TI**		***TJ**		***TK**	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	When a student does better than usual in Mathematics, it is often because the teacher exerted a little extra effort.	5	4	4	4	4	4	4	4	3	4
4	When the mathematics grades of students improve, it is often due to their teacher having found a more effective teaching approach.	4	4	3	4	4	3	4	5	5	3
7	If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.	1	2	2	4	3	2	4	4	3	3
9	The inadequacy of a student‘s mathematics background can be	4	3	4	4	3	3	4	4	4	4

	overcome by good teaching.										
10	When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher.	4	4	4	4	4	3	4	4	3	3
12	The teacher is generally responsible for the achievement of students in mathematics.	4	4	2	4	2	4	4	4	3	4
13	Students' achievement in mathematics is directly related to their teacher's effectiveness in mathematics teaching.	4	4	3	4	3	3	4	4	4	4
14	If parents comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child's teacher.	4	5	3	3	4	3	4	5	2	2
	Total scores	**30/40**	**30/40**	**25/40**	**31/40**	**25/40**	**25/40**	**32/40**	**34/40**	**27/40**	**27/40**

** 'Teacher G', 'Teacher H', 'Teacher I', 'Teacher J' and 'Teacher K'.*

Table 4.15

MTEBI – Comparing the Personal Mathematics Teaching Efficacy (PMTE) subscale scores of the 5 teachers prior and post intervention.

	Personal Mathematics Teaching Efficacy Items	***TG**		***TH**		***TI**		***TJ**		***TK**	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
2	I will continually find better ways to teach mathematics.	5	4	5	5	5	4	4	4	4	4
3	Even if I try very hard, I do not teach mathematics as well as I do most subjects.	4	4	4	4	4	3	4	5	3	4
5	I know the steps necessary to teach mathematics concepts effectively.	3	4	4	3	4	4	4	5	4	4

6	I am not very effective in monitoring mathematics activities.	4	4	4	4	3	3	4	5	4	4
8	I generally teach mathematics ineffectively.	4	4	4	4	4	4	4	5	4	4
11.	I understand mathematics concepts well enough to be effective in teaching mathematics.	4	4	4	4	4	4	4	4	4	4
15.	I find it difficult to use manipulatives to explain to students why mathematics works.	4	3	5	4	4	4	4	4	3	3
16.	I am typically able to answer students' mathematics questions.	4	4	1	4	4	4	4	4	5	5
17.	I wonder if I have the necessary skills to teach mathematics.	4	4	4	3	3	2	5	5	4	4
18.	Given a choice, I would not invite the principal to evaluate my mathematics teaching.	3	4	3	5	5	4	4	4	3	3
19.	When a student has difficulty understanding a mathematics concept, I am usually at a loss as to how to help the student understand it better.	4	4	4	1	4	4	4	5	4	4
20	When teaching mathematics, I usually welcome student questions	4	4	5	5	5	4	4	4	5	5
21	I do not know what to do to turn students on to mathematics	4	4	4	5	3	4	4	5	3	4
	Total scores	**51/65**	**51/65**	**51/65**	**51/65**	**52/65**	**48/65**	**53/65**	**59/65**	**50/65**	**52/65**

* *'Teacher G', 'Teacher H', 'Teacher I', 'Teacher J' and 'Teacher K'.*

4.3.4 Effects of student factor on the mathematics achievements of students with borderline, mild and moderate ID

4.3.4.1 The mathematics self-efficacy of students with borderline, mild and moderate ID. Table 4.16 showed that 20 students (about 86%) of participants achieved >50% in the Self-Efficacy 1 assessment. When the self-efficacy assessment was repeated after 6 months of teaching (Self-Efficacy 2 – Table 4.17), similar results were obtained. However, it was observed that some students with relatively high self-efficacy, achieved low marks in mathematics as indicated by a student with a self-efficacy score of 60% achieving 41% in the mathematics Test 1 (Table 4.16). This suggests possible cognitive limitation or some degree of over-confidence or both. Similarly, some students with low self-efficacy achieved high marks in mathematics. An example of this case was demonstrated by a student who had a self-efficacy score of 23.2% and achieved 70.27% in Test 1 (Table 4.17). An additional example of the low self-efficacy-high marks scenario was displayed by another student who achieved a relatively low self-efficacy score of 47.2% but achieved 90.14% in the mathematics Test 1 (Table 4.16). The situation described in the latter two examples has manifold implications: (1) students in this category possess some level of mathematics anxiety, (2) students in this group have the potential to do relatively well in mathematics, and (3) As a result of their mathematics anxiety, this cohort of students may not always perform to their potential in mathematics.

Table 4.16

Comparing pre-instruction Efficacy (Self-Efficacy 1) with Tests 1, 2, 3 & 4.

Student	Year Level	Severity of ID	Self-Efficacy 1 (%)	Test 1 (%)	Test 2 (%)	Test 3 (%)	Test 4 (%)
1	10	Borderline ID	56.00	84.91	75.00	96.00	64.77
2	10	Borderline ID	84.80	99.58	75.00	98.00	65.91
3	8	Borderline ID	62.40	70.65	75.00	99.00	56.82
4	11	Mild ID	73.60	53.25	58.33	84.00	50.00
5	10	Mild ID	81.60	71.07	50.00	98.00	71.59
6	9	Mild Id	74.40	75.68	41.67	90.00	37.50
7	8	Mild ID	77.60	98.74	58.33	99.00	60.23

8	9	Mild ID	65.60	98.32	66.67	99.00	56.82
9	10	Mild ID	86.40	98.95	83.33	93.00	39.77
10	11	Mild ID	76.00	95.81	58.33	100.00	70.45
11	11	Mild ID	73.60	85.95	75.00	100.00	54.55
12	8	Mild ID	76.80	85.53	83.33	86.00	73.86
13	9	Mild ID	72.00	93.71	66.67	100.00	67.05
14	9	Mild ID	66.40	54.72	41.67	74.00	25.00
15	9	Mild ID	55.20	48.63	75.00	93.00	29.55
16	10	Mild ID	47.20	90.14	66.00	84.00	56.82
17	9	Moderate ID	60.00	41.30	16.67	56.00	29.55
18	12	Moderate ID	48.00	63.94	50.00	98.00	43.18
19	10	Moderate ID	64.80	62.68	66.67	99.00	52.27
20	8	Moderate ID	38.40	27.46	25.00	43.00	22.73
21	9	Moderate ID	52.80	51.36	66.67	90.00	50.00
22	11	Moderate ID	76.00	56.39	75.00	100.00	56.82
23	10	Moderate ID	58.40	60.97	75.00	84.00	39.77

Test 1 = IMPELS (Enoma & Malone, 2015), Test 2 = the Delaware Universal Screening Tool for Number Sense Grade 2 (Delaware Department of Education, 2010), Test 3 = Streamlined Number Sense Screening Tool (Jordan, Glutting & Ramineni, 2008), Test 4 = Number knowledge Test (Okamoto & Case, 1996).

Table 4.17

Comparing post-instruction Efficacy (Self-Efficacy 2) with Tests 1, 2, 3 & 4.

Name	Year Level	Severity of ID	Self-Efficacy 2 (%)	Test 1 (%)	Test 2 (%)	Test 3 (%)	Test 4 (%)
1	10	Borderline ID	78.40	95.39	83.33	98.78	73.86
2	10	Borderline ID	64.80	99.58	100.00	100.00	77.27
3	8	Borderline ID	76.80	77.99	75.00	98.78	80.68
4	11	Mild ID	83.20	97.06	66.67	97.56	65.91
5	10	Mild ID	86.40	99.79	83.33	100.00	76.14
6	9	Mild ID	68.80	97.69	66.67	84.15	45.45
7	8	Mild ID	65.60	93.08	75.00	100.00	67.05
8	9	Mild ID	68.80	98.74	50.00	98.78	65.91
9	10	Mild ID	61.60	88.68	83.33	93.90	53.41
10	11	Mild ID	72.00	96.86	91.67	100.00	76.14

11	11	Mild ID	73.60	91.19	91.67	100.00	59.09
12	8	Mild ID	72.80	92.87	66.67	98.78	73.86
13	9	Mild ID	72.00	99.16	58.33	100.00	68.18
14	9	Mild ID	65.60	87.00	8.33	78.05	43.18
15	9	Mild ID	23.20	70.27	25.00	84.15	34.09
16	10	Mild ID	56.80	91.19	83.33	98.78	50.00
17	9	Moderate ID	60.00	41.30	8.33	68.90	29.55
18	12	Moderate ID	53.60	83.23	58.33	97.56	47.73
19	10	Moderate ID	64.80	88.68	91.67	100.00	47.73
20	8	Moderate ID	40.80	37.32	41.67	45.73	22.27
21	9	Moderate ID	69.60	61.32	25.00	93.90	54.55
22	11	Moderate ID	76.00	90.36	75.00	98.78	56.82
23	10	Moderate ID	44.00	90.78	75.00	93.90	52.27

Test 1 = IMPELS (Enoma & Malone, 2015), Test 2 = the Delaware Universal Screening Tool for Number Sense Grade 2 (Delaware Department of Education, 2010), Test 3 = Streamlined Number Sense Screening Tool (Jordan, Glutting & Ramineni, 2008), Test 4 = Number knowledge Test (Okamoto & Case, 1996).

Figure 4.9 provides a summary of the statistical report on the students' self-efficacy scores prior to instruction (Self-Efficacy 1).

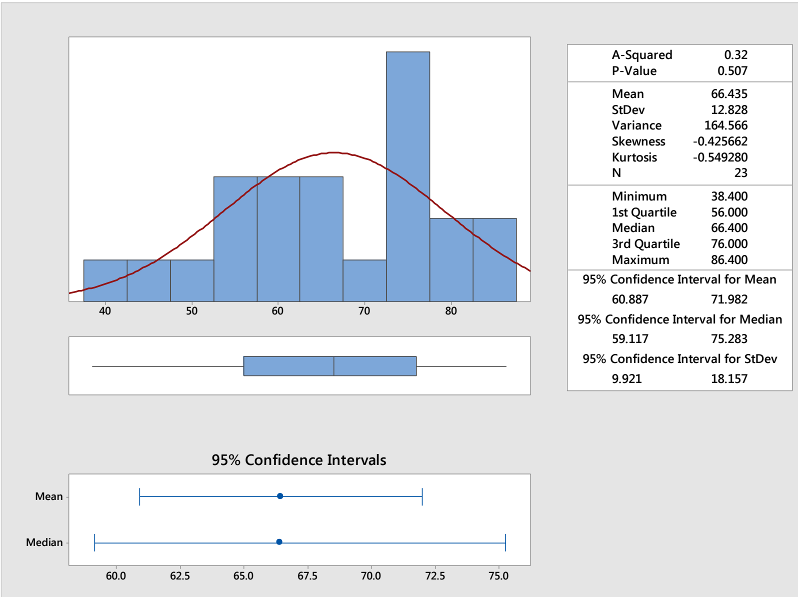


Figure 4.9: Distribution of Self-Efficacy 1 scores of students (pre- instruction).

The students' self-efficacy scores ranged from 38.4% to 86.4% for Self-Efficacy 1 (Figure 4.9). The mean of the students' self-efficacy scores was 66.44% (95%

confidence intervals of 60.89% and 71.98%). The standard deviation was 12.83 (95% confidence intervals of 9.92 and 18.16). Using a significance level of 0.05, the Anderson-Darling normality test (A-Squared = 0.32, P-Value = 0.50) indicates that the students' self-efficacy scores at the beginning of the study followed a normal distribution.

Figure 4.10 provides a summary of the statistical report on the students' self-efficacy scores post instruction (Self-Efficacy 2). The mean of the students' self-efficacy scores at the conclusion of the study (Self-Efficacy 2) was 65.18 (95% confidence intervals of 58.99 and 71.38). The standard deviation was 14.33 (95% confidence intervals of 11.09 and 20.29). Using a significance level of 0.05, the Anderson-Darling normality test (A-Squared = 0.75, P-Value = 0.042) indicates that the self-efficacy scores at the end of the study did not follow a normal distribution.

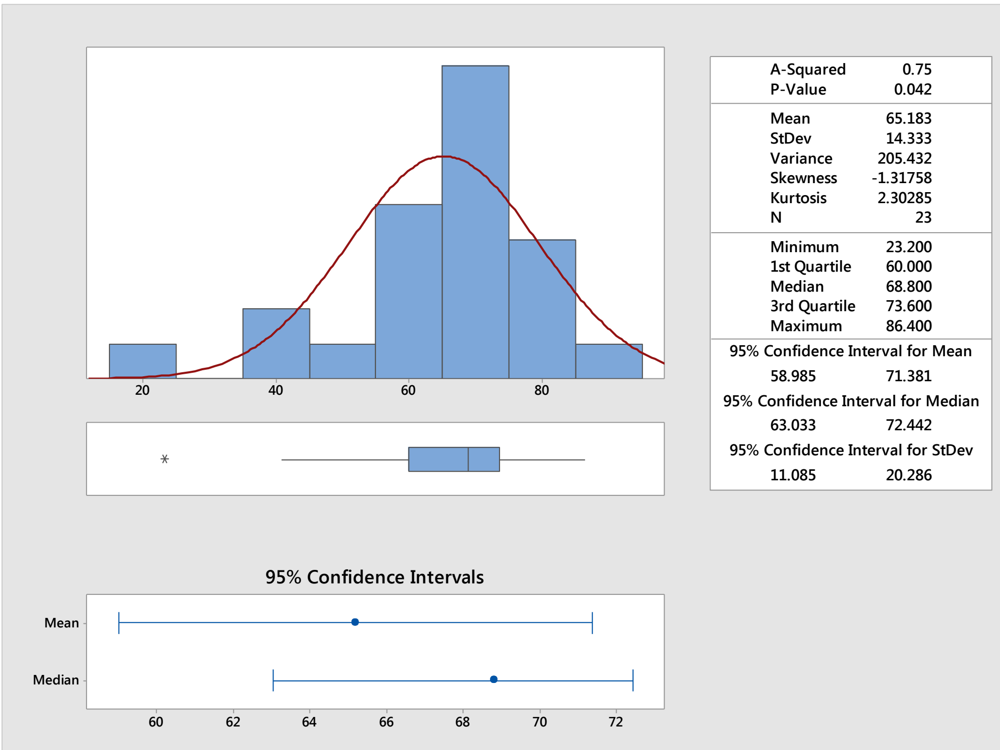


Figure 4.10: Distribution of Self-Efficacy 2 scores of students (post-instruction).

4.3.4.1.1 Linear regression graphs and test for normal distribution. Of the original 24 students that participated in this study, one student's self-efficacy item responses were discarded for not meeting the criteria for inclusion. Considering the sample size was less than 30 (n = 23), Anderson-Darling normality tests were undertaken on both pre- and post-instruction data using MINITAB 17 statistical software (Minitab Statistical Software, 2010a). The outcome was a mixed group of normally and non-normally distributed data comprising seven sets of normally distributed data and three sets of non-normally distributed data (Figures 4.11, 4.12 and 4.13).

Figure 4.11 shows the results of the test of normality tests using Anderson-Darling normality tests for Tests 1, 2, 3 and 4 prior to instruction. The results show that while Tests 1 and 4 were normally distributed, Tests 2 and 3 data were not normally distributed (Figure 4.11).

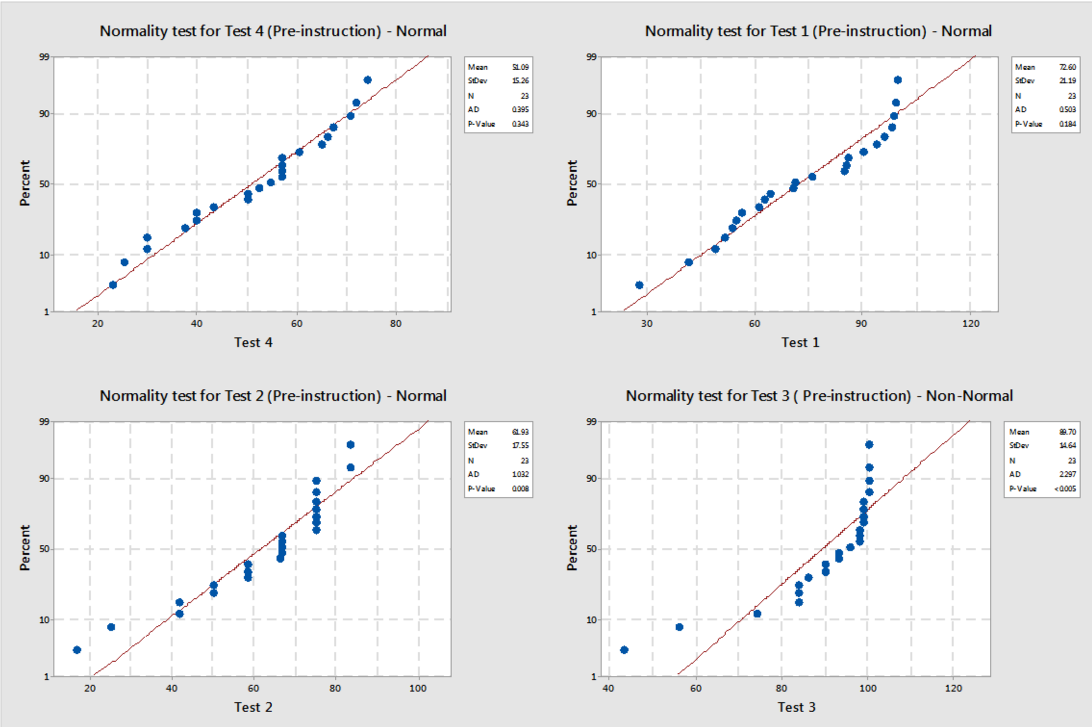


Figure 4.11: Test of Normality of the data collected pre-instruction.

Figure 4.12 shows the results of the test of normality tests using Anderson-Darling normality tests for Tests 1, 2, 3 and 4 post-instruction. The results show that while Tests 2 and 4 were normally distributed, Tests 1 and 3 data were not normally distributed (Figure 4.12).

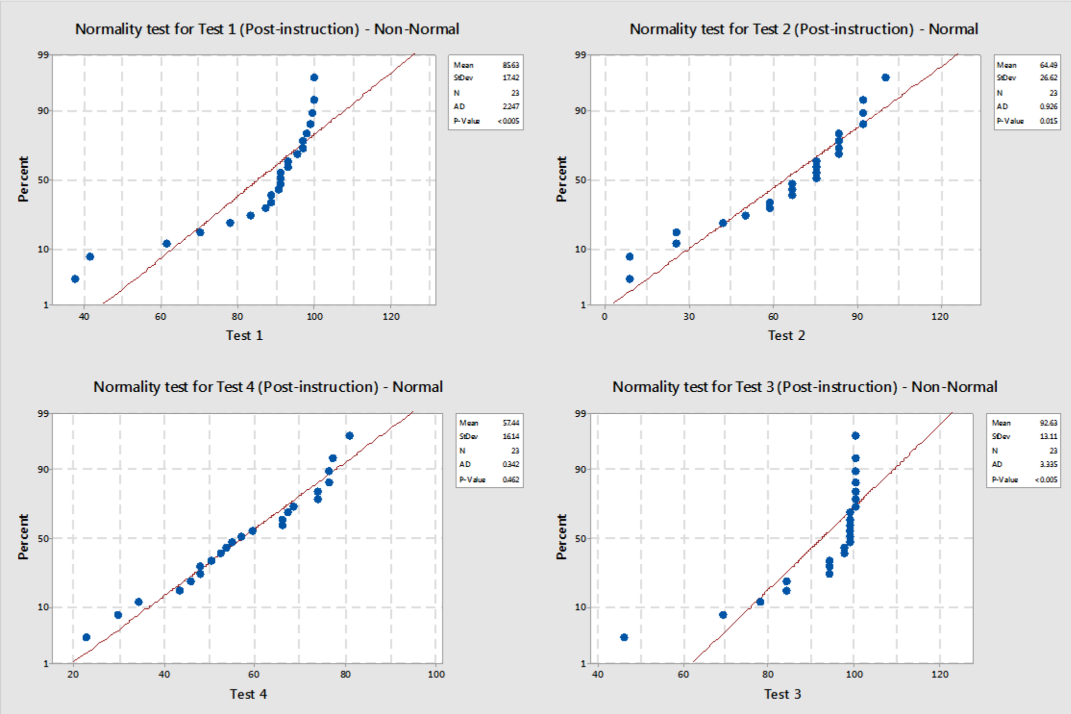


Figure 4.12: Test of Normality of the data collected post-instruction.

Figure 4.13: Test of Normality of self-efficacy scores (pre- and post-instruction data).

As a result, Pearson and Spearman Rho correlation coefficients were calculated. Pearson's pre-instruction correlation coefficients of 0.57 (P = 0.005), 0.33 (P =

0.122), 0.50 (*P* = 0.015), 0.48 (*P* = 0.02) and post-instruction correlation coefficients of 0.50 (*P* = 0.01), 0.38 (*P* = 0.07), 0.52 (*P* = 0.01) and 0.71 (*P* = 0.00) were obtained for Tests 1, 2, 3 and 4 respectively (Figures 4.14, 4.15, Tables 4.18 & 4.19). Similarly, Spearman Rho pre-instruction correlation coefficient of 0.59 (*P* = 0.003), 0.24 (*P* = 0.26), 0.38 (*P* = 0.06), 0.48 (*P* = 0.02) and post-instruction correlation coefficients of 0.50 (*P* = 0.015), 0.28 (*P* = 0.20), 0.48 (*P* = 0.02) and 0.71 (*P* = 0.00) were obtained for Tests 1, 2, 3 and 4 respectively (Figures 4.14, 4.15, Tables 4.18 & 4.19). The relationship between students' scores in Self-Efficacy 1 and their achievements in Mathematics showed a weak Pearson correlation coefficient (R) of 0.57, 0.33, 0.50 and 0.48 for Tests 1, 2, 3, and 4 respectively. Similar results were obtained for Self-Efficacy 2 with correlation coefficients of 0.50 (Test 1), 0.38 (Test 2) and 0.5 (Test 3). The only exception was Test 4 with a correlation coefficient of 0.71.

Figure 4.14: The relationship between self-efficacy scores and Tests 1, 2, 3, and 4 prior to instruction.

Table 4.18

Corresponding correlation coefficients for Pearson and Spearman rho for Figure 4.14 (pre-instruction data).

Tests	Pearson	Spearman rho
1	0.57	0.59
2	0.33	0.24
3	0.50	0.38
4	0.48	0.48

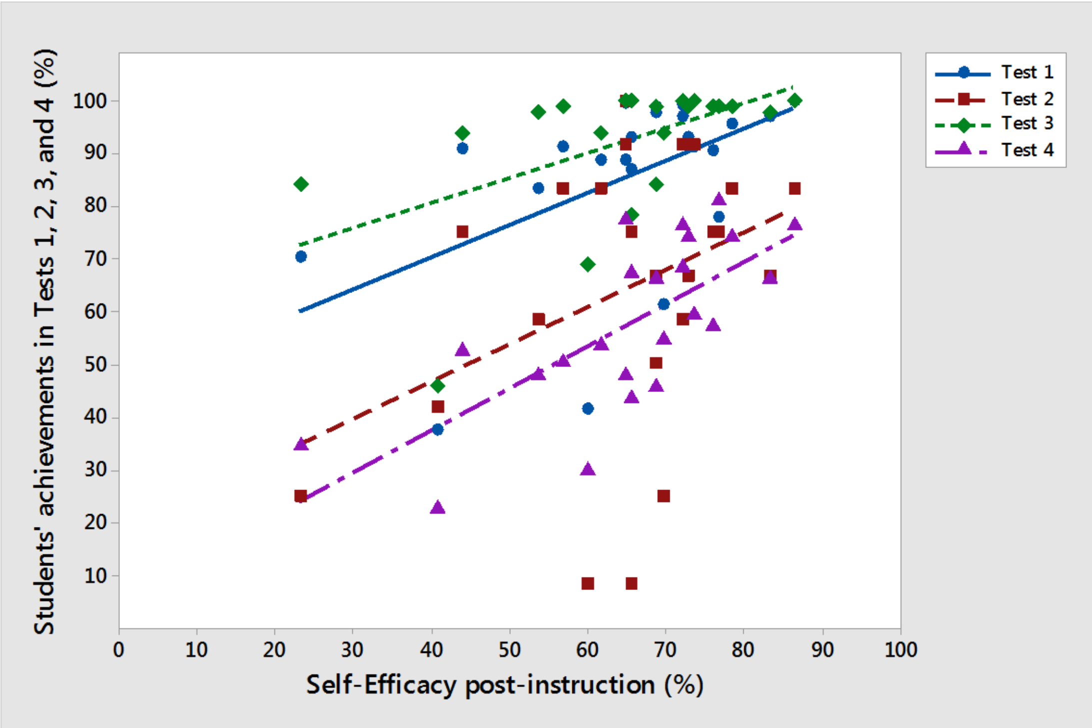


Figure 4.15: The relationship between self-efficacy scores and Tests 1, 2, 3, and 4 post-instruction.

Table 4.19

Corresponding correlation coefficients for Pearson and Spearman rho for Figure 4.15 (post-instruction data).

Tests	Pearson	Spearman rho
1	0.50	0.50
2	0.38	0.28
3	0.52	0.48

4	0.71	0.71

Figure 4.16 shows the relationship between Self-Efficacies 1 and 2 and the IQ scores of students. Achievements in the self-efficacy assessments correlated weakly with their IQ scores. Pearson correlation coefficients (R) of 0.36 and 0.30 were obtained for self-efficacy 1 (conducted at the beginning of the school year) and self-efficacy 2 (conducted 6 months after). This result shows that self-efficacy is an individual attribute as some students with high IQ scores demonstrated lower self-efficacy than those students with IQ scores below them. The reverse was also true for some students.

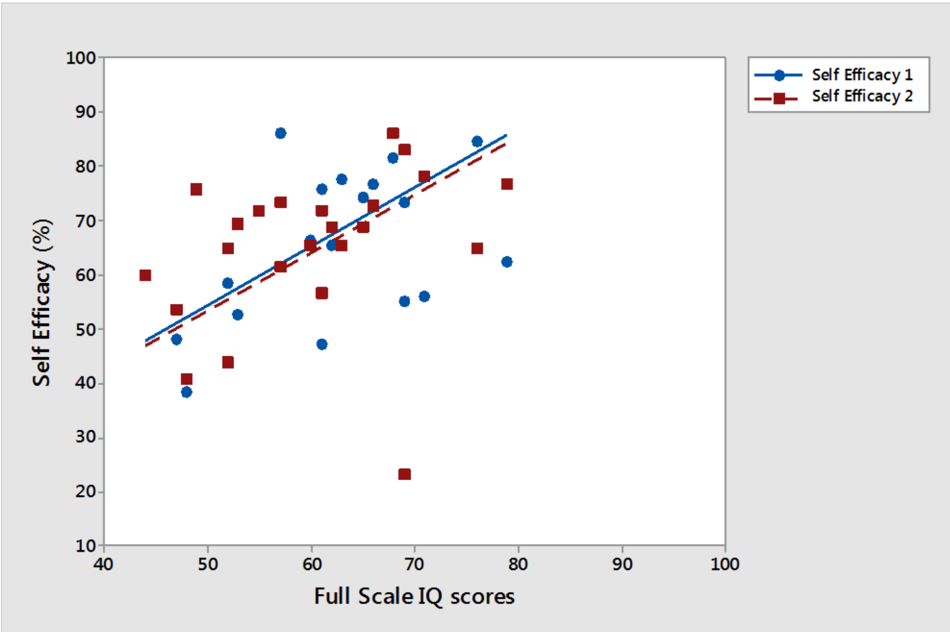


Figure 4.16: Relationship between Self-Efficacy and Full Scale IQ scores of Students.

4.3.4.1.2 The mathematics self-efficacy of students with ID – Summary of Findings.

The study found no strong correlation between the mathematics self-efficacy of students with ID and their achievements in Mathematics or with the categories of ID. The various scenarios that emerged from the study include students with low mathematics self-efficacy that achieved high scores in the tests, students with high mathematics self-efficacy that achieved low scores in the tests, students with high mathematics self-efficacy that achieved high scores in the tests and students with low mathematics self-efficacy that achieved low scores in the tests. These results further reinforced the importance of individualised mathematics education for students with ID.

4.3.4.2 Sources of self-efficacy of students with borderline, mild, and moderate ID. The instrument administered for sources of mathematics self-efficacy was similar to the one used by Usher and Pajares (2009) except for Item One ("I like Mathematics") (Table 4.20) which was added to have an idea about each respondent's existing attitude towards Mathematics. As a result, the sources of self-efficacy instrument comprised 25 items of which seven were targeted at obtaining information on students' previous attainments in maths (*mastery experience*); six items targeted at the positive influences of others such as peers, teachers, classmates and relevant adults (*vicarious experience*); six items were aimed at the positive acknowledgements received from others including teachers, peers and parents (*social persuasions*), and the final six items focused on the students' previous emotional reactions such as stress, anxiety, mood and fatigue) (*emotional and physiological states*) (Table 4.20).

Table 4.20

Sources of Mathematics Self-Efficacy items used in the study pre- and post-interventions.

	Sources of Mathematics Self- Efficacy items	**Categories**
1	I like Mathematics	Mastery Experience
2	I make excellent grades on maths test	
3	I have always been successful with maths	
4	Even when I study very hard, I do poorly in math	
5	I got good grades in math on my last report card	
6	I do well on math assignment	
7	I do well on even the most difficult math assignment.	
8	Seeing adults do well in math pushes me to do better	Vicarious experience
9	When I see how my math teacher solves a problem, I can picture myself solving the problem in the same way.	
10	Seeing other students do better than me in math pushes me to do better	
11	When I see how another student solves a math problem, I can see myself solving the problem in the same way.	
12	I imagine myself working through challenging math	

	problems successfully.	
13	I compete with myself in math.	
14	My math teachers have told me that I am good at learning maths	Social Persuasions
15	People have told me that I have a talent for math.	
16	Adults in my family have told me what a good math student I am.	
17	I have been praised for my ability in math	
18	Other students have told me that I'm good at learning math.	
19	My classmates like to work with me in math because they think I'm good at it.	
20	Just being in math class makes me feel stressed and nervous.	Emotional and Physiological states
21	Doing math work takes all of my energy	
22	I start to feel stressed-out as soon as I begin my math work	
23	My mind goes blank and I am unable to think clearly when doing math work.	
24	I get depressed when I think about learning math	
25	My whole body becomes tense when I have to do math	

Twenty-one out of the original twenty-four students participated in the sources of self-efficacy assessments – three students' sources of self-efficacy items responses were discarded for not meeting the criteria for inclusion (Table 4.21).

Table 4.21

Comparing pre-instruction Sources of Self-Efficacy with the Mathematics Achievements of students with Borderline, Mild, and Moderate ID.

ID Group	**Student**	**IQ**	**Sources of Self-Efficacy**				**Mathematics Achievement**			
			Mastery Experience (%)	**Vicarious experience** (%)	**Social Persuasions** (%)	**Emotional and Physiological states** (%)	**Test 1 (%)**	**Test 2 (%)**	**Test 3 (%)**	**Test 4 (%)**
Borderline ID	1	79	54.29	53.33	70.00	46.67	71.00	75.00	99.00	56.82
	2	76	54.29	63.33	50.00	26.67	99.58	75.00	98.00	65.91
	3	71	28.57	56.67	70.00	60.00	84.91	75.00	96.00	64.77
	4	69	62.86	63.33	83.33	86.67	53.25	58.00	84.00	50.00
	5	69	60.00	70.00	50.00	70.00	48.63	75.00	93.00	29.55
	6	68	82.86	83.33	96.67	23.33	71.07	50.00	98.00	71.59
	7	66	68.57	56.67	63.33	33.33	86.00	83.00	86.00	73.86

	8	65	68.57	40.00	56.67	63.33	75.68	41.00	90.00	37.50
	9	63	68.57	76.67	50.00	60.00	99.00	58.00	99.00	60.23
	10	62	54.29	70.00	66.67	63.33	98.32	66.00	99.00	56.82
	11	61	48.57	70.00	63.33	26.67	95.81	58.00	100.00	70.45
	12	61	34.29	20.00	20.00	100.00	90.14	66.00	84.00	56.82
	13	60	62.86	46.67	60.00	50.00	54.72	41.00	74.00	25.00
	14	57	48.57	60.00	93.33	40.00	98.95	83.00	93.00	39.77
	16	55	71.43	86.67	53.33	20.00	93.71	66.00	100.00	67.05
	17	53	51.43	53.33	53.33	46.67	51.36	66.00	90.00	50.00
	18	52	42.86	100.00	60.00	53.33	62.68	66.00	99.00	52.27
	19	52	40.00	60.00	40.00	33.33	68.97	75.00	84.00	39.77
	21	48	45.71	56.67	36.67	86.67	27.00	25.00	43.00	22.73
	22	47	58.57	46.67	60.00	60.00	63.94	50.00	98.00	43.18
	23	44	60.00	53.33	66.67	63.33	41.30	16.00	56.00	29.55

Test 1 = IMPELS (Enoma & Malone, 2015), Test 2 = the Delaware Universal Screening Tool for Number Sense Grade 2 (Delaware Department of Education, 2010), Test 3 = Streamlined Number Sense Screening Tool (Jordan, Glutting & Ramineni, 2008), Test 4 = Number knowledge Test (Okamoto & Case, 1996).

The students consisted of 10 female and 11 male students. Of the 21 students that took part in this component of the study (Table 4.21), three were students with borderline ID, twelve were students with mild ID and six were students with moderate ID. The average pre-instruction sources of self-efficacy scores of the students were 55.60% for mastery experience, 61.27% for vicarious experience, 60.16% for social persuasions and 53.02% for emotional and physiological states (Table 4.21). Considering the pre-instruction results on item by item basis, the percentage scores of students on the “My maths teachers have told me that I am good at learning maths” (Social Persuasion) (72.38%) exceeded any other item score. This suggests that students with ID take the feedback they receive from teachers (whether positive or negative) very seriously. This observation is particularly important in light of the fact that students with ID have low self-esteem (Valas, 1999). The item, “Seeing other students do better than me in maths pushes me to do better” (Vicarious Experience) came second with 68.56%, while “adults in my family have told me what a good maths student I am” (Social Persuasion) was the third most acknowledged source of self-efficacy identified by students with 65.71%. These results have also demonstrated the facts that: (1) some students naturally compete with their peers in a maths class and such a competition, if healthy, could be a good source of motivation for the weaker student to work harder, and (2) that positive feedbacks from the teacher at school and from parents and other relevant adults at home exert a strong influence on individual students attitudes and behaviour towards their learning of maths. Students who come from a nurturing home environment that supports and encourages them to do maths are more likely to strive harder at school and persevere when faced with challenging maths problem.

The items, “I have been praised for my ability in maths” (Social Persuasion) and “My maths teachers have told me that I am good at learning maths” (Social Persuasion) were highly regarded by students during the post-instruction phase of the sources of self-efficacy assessment with 69.52% and 67.62% respectively Table 4.22).

Table 4.22

Comparing post-intervention Sources of Self-Efficacy with the Mathematics Achievements of students with Borderline, Mild, and Moderate ID.

ID Group	**Student**	**IQ**	**Sources of Self-Efficacy**				**Mathematics Achievement**			
			Mastery Experience (%)	**Vicarious experience** (%)	**Social Persuasions** (%)	**Emotional and Physiological states** (%)	**Test 1 (%)**	**Test 2 (%)**	**Test 3 (%)**	**Test 4 (%)**
Borderline ID	1	79	77.14	80.00	80.00	73.33	77.99	75.00	98.78	80.68
	2	76	65.71	56.67	43.33	23.33	99.58	100.0	100.0	77.27
	3	71	68.57	86.67	83.33	86.67	95.39	83.33	98.78	73.86
	4	69	65.71	60.00	96.67	80.00	97.06	66.67	97.56	65.91
	5	69	28.57	30.00	30.00	40.00	70.27	25.00	84.15	34.09
	6	68	85.71	73.33	80.00	20.00	99.79	83.33	100.0	76.14
	7	66	77.14	83.33	66.67	23.33	92.87	66.67	98.78	73.86
	8	65	57.14	66.67	73.33	66.67	97.69	66.67	84.15	45.45
	9	63	82.86	83.33	80.00	23.33	93.08	75.00	100.0	67.05
	10	62	57.14	53.33	53.33	83.33	98.74	50.00	98.78	65.91

	11	61	77.14	73.33	76.33	30.00	96.86	91.67	100.0	100.0
	12	61	20.00	26.67	26.67	100.00	91.19	83.33	98.78	50.00
	13	60	37.14	56.67	46.67	80.00	87.00	8.33	78.05	43.18
	14	57	88.57	46.67	73.33	33.33	88.68	83.33	93.90	53.41
	16	55	65.71	50.00	40.00	60.00	99.16	58.33	100.0	68.18
	17	53	48.57	60.00	53.33	70.00	61.32	25.00	93.90	54.55
	18	52	20.00	86.67	20.00	100.00	88.68	91.67	100.0	47.73
	19	52	34.29	30.00	46.67	30.00	90.78	75.00	93.90	52.27
	21	48	57.14	56.67	46.67	83.33	37.32	41.67	45.73	22.27
	22	47	48.57	83.33	93.33	20.00	83.23	58.33	97.56	47.73
	23	44	60.00	66.67	56.67	73.33	42.34	8.33	68.90	29.55

Test 1 = IMPELS (Enoma & Malone, 2015), Test 2 = the Delaware Universal Screening Tool for Number Sense Grade 2 (Delaware Department of Education, 2010), Test 3 = Streamlined Number Sense Screening Tool (Jordan, Glutting & Ramineni, 2008), Test 4 = Number knowledge Test (Okamoto & Case, 1996).

The average pre-instruction scores for sources of self-efficacy were 61.27% (vicarious experience), 60.16 (social persuasions), 55.60% (mastery experience) and 53.02 (emotional and physiological states) (Table 4.21), while the post-instruction scores were 62.38% (vicarious experience), 60.30% (social persuasions), 58.23% (mastery experience) and 57.14% (emotional and physiological states) (Table 4.22). Both pre- and post-instruction test events yielded similar patterns of scores for the four sources of self-efficacy as represented (highest to lowest scores): Vicarious Experience (first) →Social Persuasions (second) → Mastery Experience (third) → Emotional and Physiological States (fourth). Thus, this study has demonstrated that comments by people who students perceive as having more ability in maths than themselves, such as teachers, fellow students and significant others (vicarious experience), and the positive feedback from teachers, family members and peers (social persuasions) are more confident-building factors in maths than students' previous achievements in mathematics (mastery experience).

4.3.4.2.1 Categories of ID and sources of mathematics self-efficacy. When the sources of self-efficacy were ranked according to the magnitude of affirmative responses received from the respondents, the study yielded mixed outcomes for the different categories of students with ID (borderline, mild and moderate) (Tables 4.21

and 4.22). At the beginning of the study (pre-instruction), indications from students with borderline ID were in the order of social persuasion (63.33%) → vicarious experience (57.78%) → mastery experience (45.72%) → emotional and physiological states (44.45%). However, after six months of instruction, their order changed to: vicarious experience (74.45% → mastery experience (70.47%) → social persuasions (68.89%). One possible reason why students with borderline ID revised their judgements is that their confidence and belief in themselves soared after going through six months of maths instruction and receiving positive feedback from their teachers. The students with mild ID responded similarly as the students with borderline ID at the commencement of the study as follows: social persuasions (63.06%) → vicarious experience (61.85%) → mastery experience (60.95%) → emotional and physiological states (53.06%). However, six months later (post-instruction), the students with mild ID indicated social persuasions (61.92%), such as encouragement and positive feedback from their teachers, peers and other significant adults, were equal to mastery experience 61.91%) such as previous attainments in mathematics, followed by vicarious experience (58.61%) and then, by emotional and physiological states (53.33%). The students with moderate ID differed significantly in opinion from their counterparts with borderline and mild ID with regard to sources of mathematics self-efficacy. At the start of the study, the students with moderate ID indicated that vicarious experience (observation of teachers and classmates – modelling) at 61.67% were their most important source of self-efficacy, followed by social persuasions (positive feedback and praise) at 52.78%, and then, mastery experience (previous performances in mathematics) at 49.76%, and their relatively high emotional and physiological states (57.22%) indicated that they were very terrified of mathematics. The students with moderate ID were the only group that did not shift their position even after six months of instruction. The post-instruction sources of self-efficacy data were almost a replica of those generated at the start of the study − vicarious experience (63.89%), social persuasions (52.78%), mastery experience (44.76%) and a relatively high level of fear of maths (62.78%). An important implication for classroom practice that has emerged from these findings is that while students with ID are individuals, in the example, those with moderate ID were the most stressed and terrified of maths of the three groups of students with ID (borderline, mild and moderate), and instructional approaches oriented in modelling (teacher, peers and other adults) and positive feedback as well as praise are paramount to their learning of mathematics.

4.3.4.2.2 Gender and the sources of mathematics self-efficacy. The outcomes of this study have also demonstrated some gender disparity with regard to the sources of mathematics self-efficacy of students with borderline, mild and moderate ID. At the beginning of the study, the male students with ID indicated social persuasions (68.18%) as their most favoured source of mathematics self-efficacy in contrast to the female students with ID who identified vicarious experience (58.67%). The second and third choices for the males were vicarious experience (63.64%) and mastery experience (59.35%) respectively in contrast to the females who had mastery experience (51.43%) and social persuasions (51.33%) to be of equal significance. It also unfolded from this study that female students with ID endured higher emotional stress (56.33%) of maths than their male counterparts (50.00%). The outcomes of the second assessment of the sources of self-efficacy (post-instruction) for male students with ID were identical to the first (pre-instruction) in many respects. As it was at the pre-instruction assessment, Social persuasions was their most important source of mathematics self-efficacy (72.42%) at the post-instructional phase assessment, although differing in the magnitude of affirmations received on both occasions. The fear of maths factor (emotional and physiological states) for post-instruction was relatively the same (51.82%) as when the assessment was first conducted at the beginning of the study (50.00%). The main difference in the outcomes that emanated from the male students with ID first and second sources of self-efficacy assessments was the interchanging of positions between vicarious experience and mastery experience. Initially (pre-instructional phase), vicarious experience (63.64%) was second to social persuasions (68.18%) in the degree of impact they had on their self-efficacy. It was the other way around at the post-instructional phase with mastery experience (69.35%) occupying second place and vicarious experience coming third place. The dimensions and order of the sources of self-efficacy for the female students with ID did not alter significantly during post instruction assessment. While vicarious experience maintained its first position (57.00%), social persuasions (47%) was second over mastery experience (46.00%).

In the main, the following conclusions can be reached about gender factor in relation to sources of mathematics self-efficacy: (1) Male students with ID are more likely to work harder and improve their mathematics confidence if mathematics instruction is accompanied with positive feedback and words of encouragement as reflected by the relatively high social persuasions in both pre- and post-intervention assessments, (2) Female students with ID are more likely to enjoy a boost in their mathematics confidence and work harder if modelling instructional approaches are adopted and accompanied with positive feedback as reflected by the relatively high vicarious experience scores in both pre- and post-intervention assessments (Tables 4.21 and 4.22). While social persuasions (positive feedback, words of encouragement, etc) as a source of mathematics self-efficacy is generally of tremendous importance to students with ID learning of mathematics, it is even more so for female students with ID as they endure higher mathematics stress than male students with ID.

Figure 4.17 shows that the sources of mathematics self-efficacy scores for mastery experience during the pre-instruction phase of the study ranged from 28.57% to 82.86%.

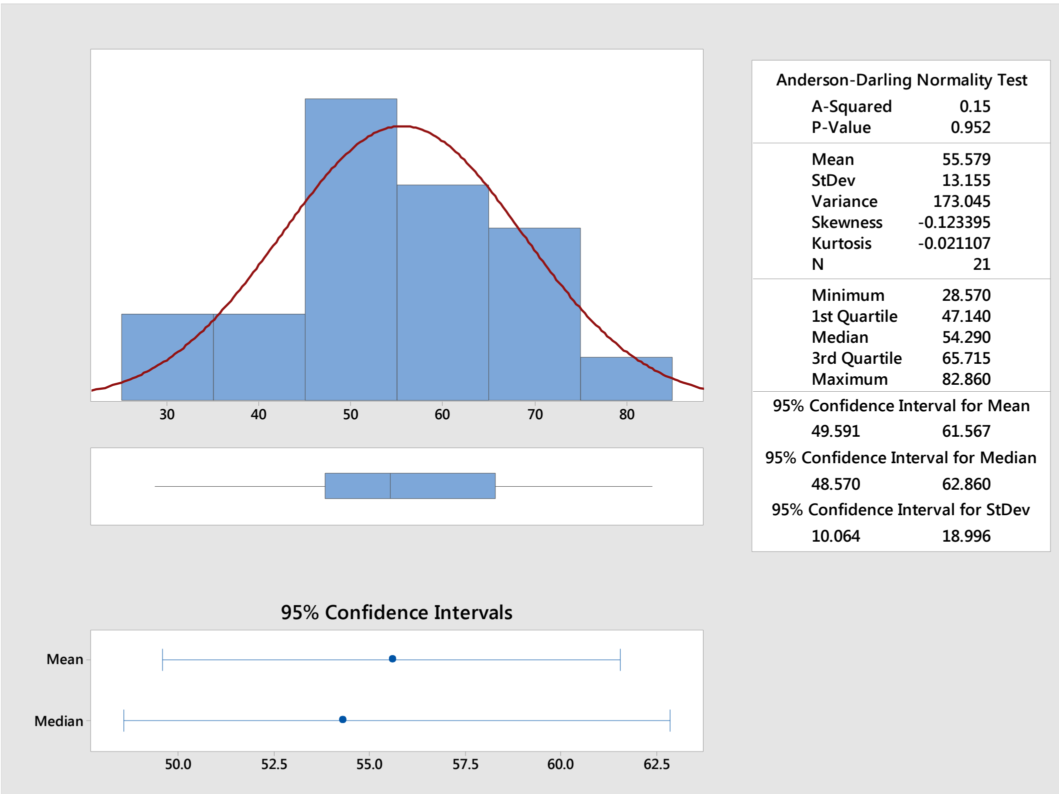


Figure 4.17: Distribution of the Mastery Experience scores of students prior to instruction.

The mean score of the students was 55.58% (95% confidence intervals of 49.59 and 61.57). The standard deviation was 13.16 (95% confidence intervals 10.06 and 18.99). The null and alternative hypotheses were that the data followed a normal distribution and did not follow a normal distribution respectively. The Anderson-Darling normality test (A-Squared = 0.15, P-Value = 0.952 at 0.05 significance level) indicates that while the alternative hypothesis is rejected, there is insufficient evidence to conclude that the sources of mathematics self-efficacy data for mastery experience during the pre-instruction phase of the study did not follow a normal distribution (Minitab Inc, 2010b). Therefore, it is likely that the data is normally distributed.

Figure 4.18 shows that the sources of mathematics self-efficacy scores for mastery experience during the post-instruction phase of the study ranged from 20.00% to 88.57%.

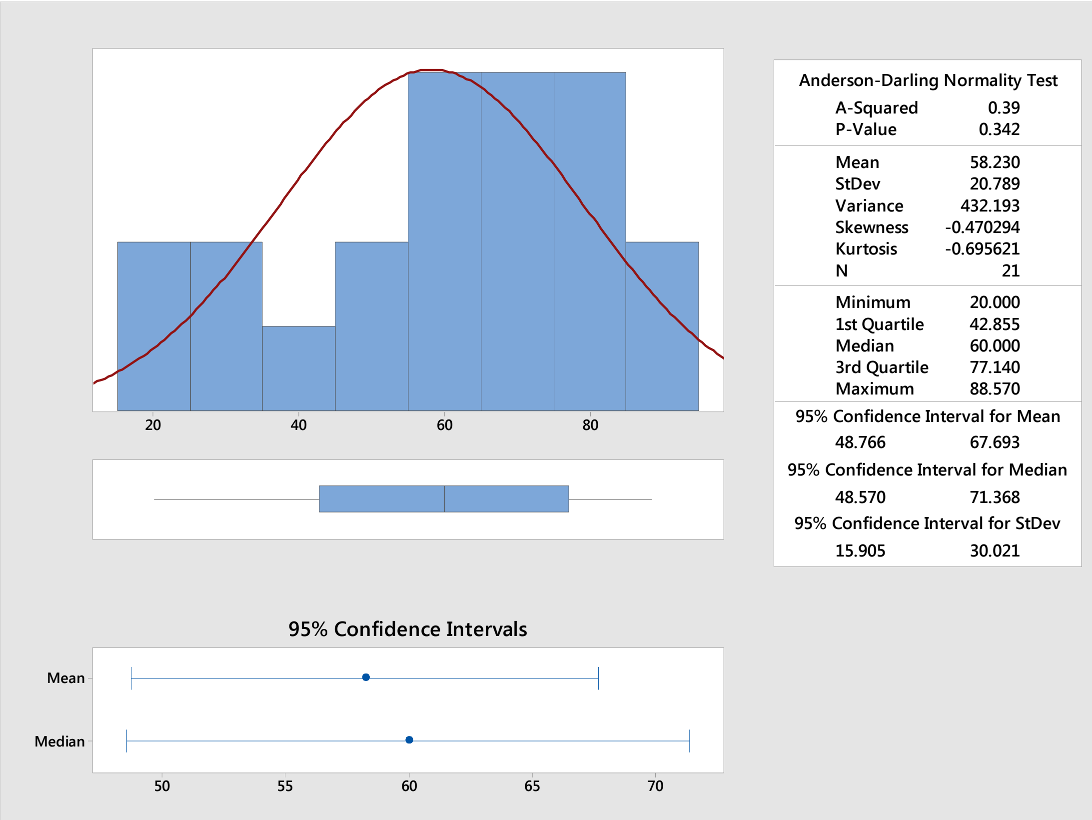


Figure 4.18: Distribution of the Mastery Experience scores of students post-Instruction.

The mean score of the students was 58.23% (95% confidence intervals of 48.77 and 67.69). The standard deviation was 20.79 (95% confidence intervals 15.91 and 30.02). The null and alternative hypotheses were that the data followed a normal distribution and did not follow a normal distribution respectively. The Anderson-Darling normality test (A-Squared = 0.39, P-Value = 0.34 at 0.05 significance level) also rejects the alternative hypothesis. However, there is insufficient evidence to conclude that the sources of mathematics self-efficacy data for mastery experience during the post-instruction phase of the study did not follow a normal distribution (Minitab Inc, 2010b). Therefore, it is likely that the data were normally distributed.

Figure 4.19 shows that the sources of mathematics self-efficacy scores for vicarious experience during the pre-instruction phase of the study ranged from 20.00% to 100.00%.

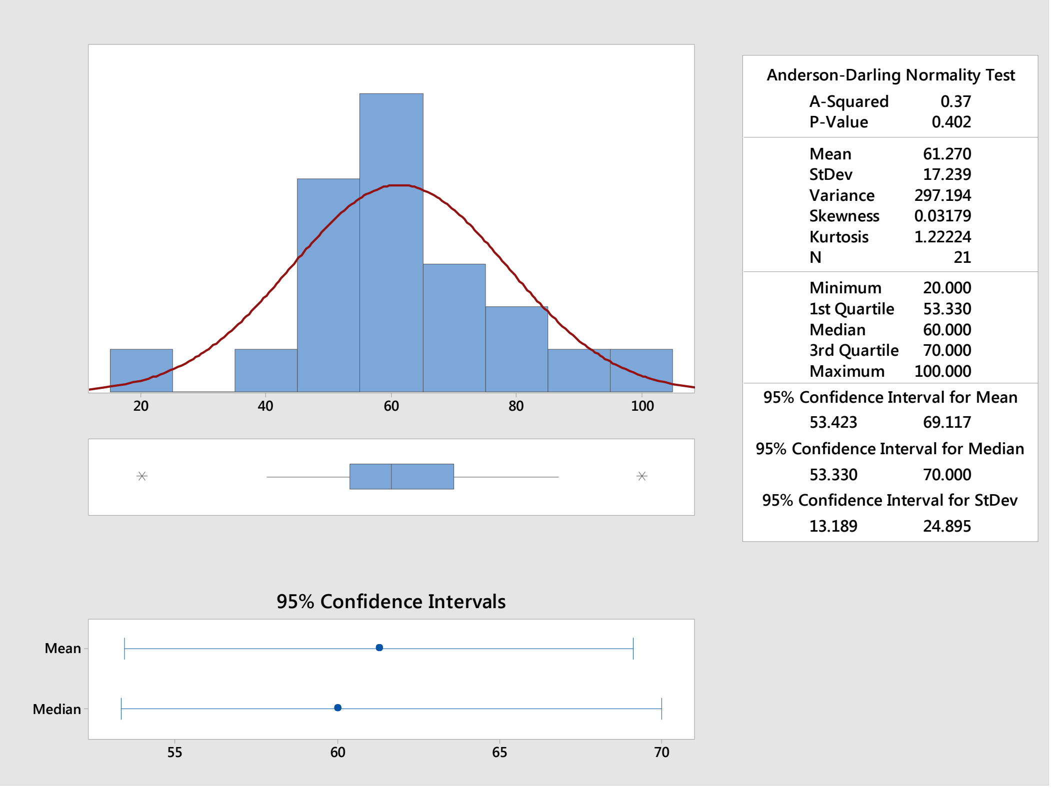


Figure 4.19: Distribution of Vicarious Experience scores of students prior to Instruction.

The mean score of the students was 61.27% (95% confidence intervals of 53.42 and 69.12). The standard deviation was 17.24 (95% confidence intervals 13.19 and 24.89). The null and alternative hypotheses were that the data followed a normal distribution and did not follow a normal distribution respectively. The Anderson-

Darling normality test (A-Squared = 0.37, P-Value = 0.402 at 0.05 significance level) indicated that while the alternative hypothesis is rejected, there is insufficient evidence to conclude that the sources of mathematics self-efficacy data for vicarious experience during the pre-instruction phase of the study did not follow a normal distribution (Minitab Inc, 2010b). Therefore, it is likely that the data were normally distributed.

Figure 4.20 shows that the sources of mathematics self-efficacy scores for vicarious experience during the post-instruction phase of the study ranged from 26.67% to 86.67%.

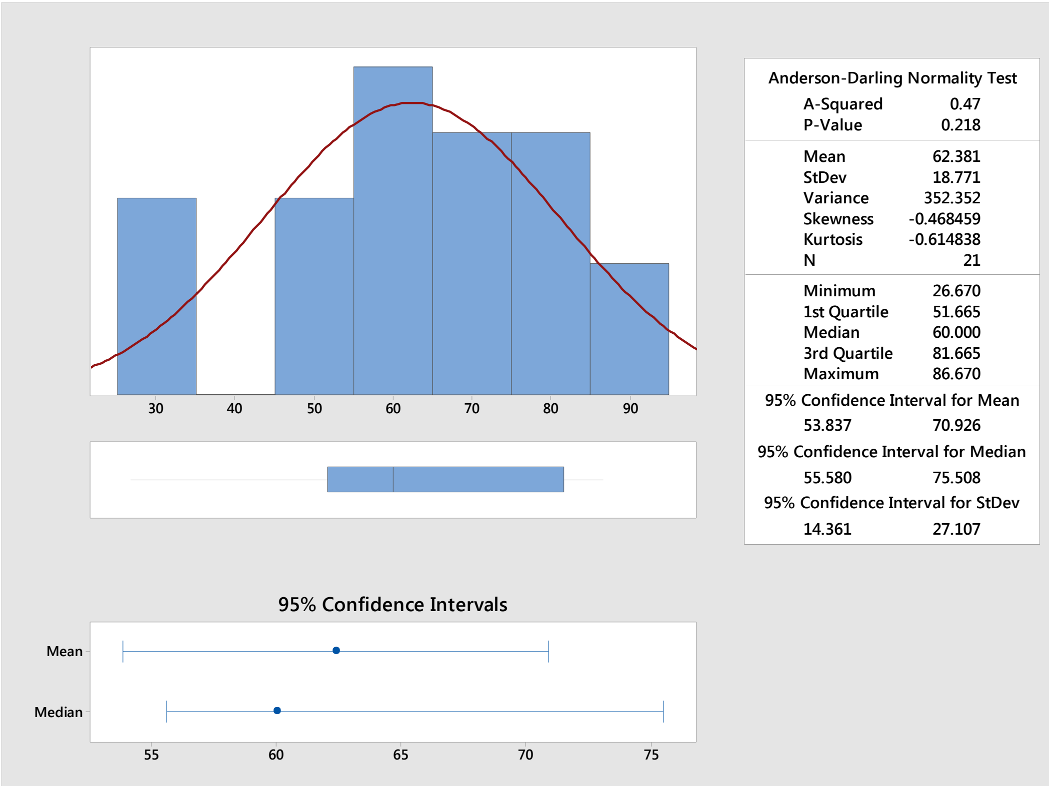


Figure 4.20: Distribution of Vicarious Experience scores of students post instruction.

The mean score of the students was 62.38% (95% confidence intervals of 53.84 and 70.93). The standard deviation was 18.77 (95% confidence intervals 14.36 and 27.11). The null and alternative hypotheses were that the data followed a normal distribution and did not follow a normal distribution respectively. The Anderson-Darling normality test (A-Squared = 0.47, P-Value = 0.218 at 0.05 significance level) also indicated that while the alternative hypothesis is rejected, there is insufficient evidence to conclude that the sources of mathematics self-efficacy data for vicarious experience during the post-instruction phase of the study did not follow a normal distribution (Minitab Inc, 2010b). Therefore, it is likely that the data were normally distributed.

Figure 4.21 shows that the sources of mathematics self-efficacy scores for social persuasions during the pre-instruction phase of the study ranged from 20.00% to 96.67%.

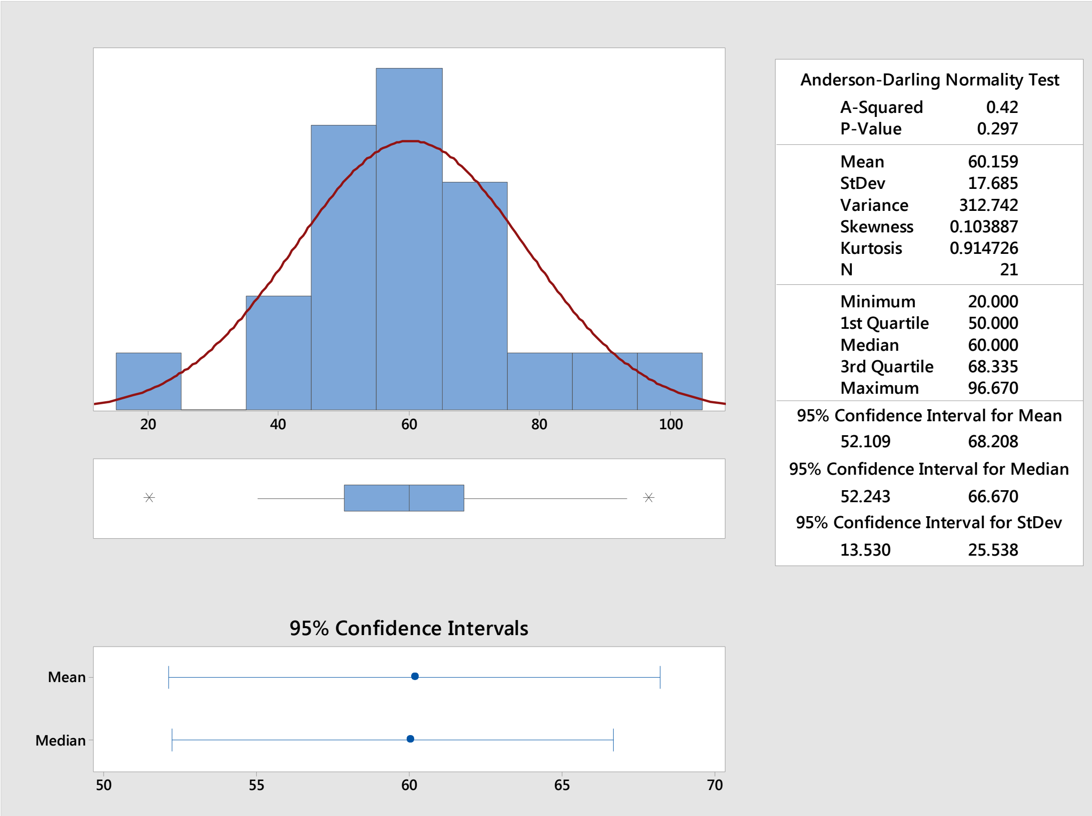


Figure 4.21: Distribution of Social Persuasions scores of students prior to instruction.

The mean score of the students was 60.16% (95% confidence intervals of 52.11 and 68.21). The standard deviation was 17.69 (95% confidence intervals 13.53 and 25.54). The null and alternative hypotheses were that the data followed a normal distribution and did not follow a normal distribution respectively. The Anderson-Darling normality test (A-Squared = 0.42, P-Value = 0.297 at 0.05 significance level) also indicated that while the alternative hypothesis is rejected, there is insufficient evidence to conclude that the sources of mathematics self-efficacy data for social persuasions during the pre-instruction phase of the study did not follow a normal distribution (Minitab Inc, 2010b). Therefore, it is likely that the data were normally distributed.

Figure 4.22 shows that the sources of mathematics self-efficacy scores for social persuasions during the post-instruction phase of the study ranged from 20.00% to 96.67%.

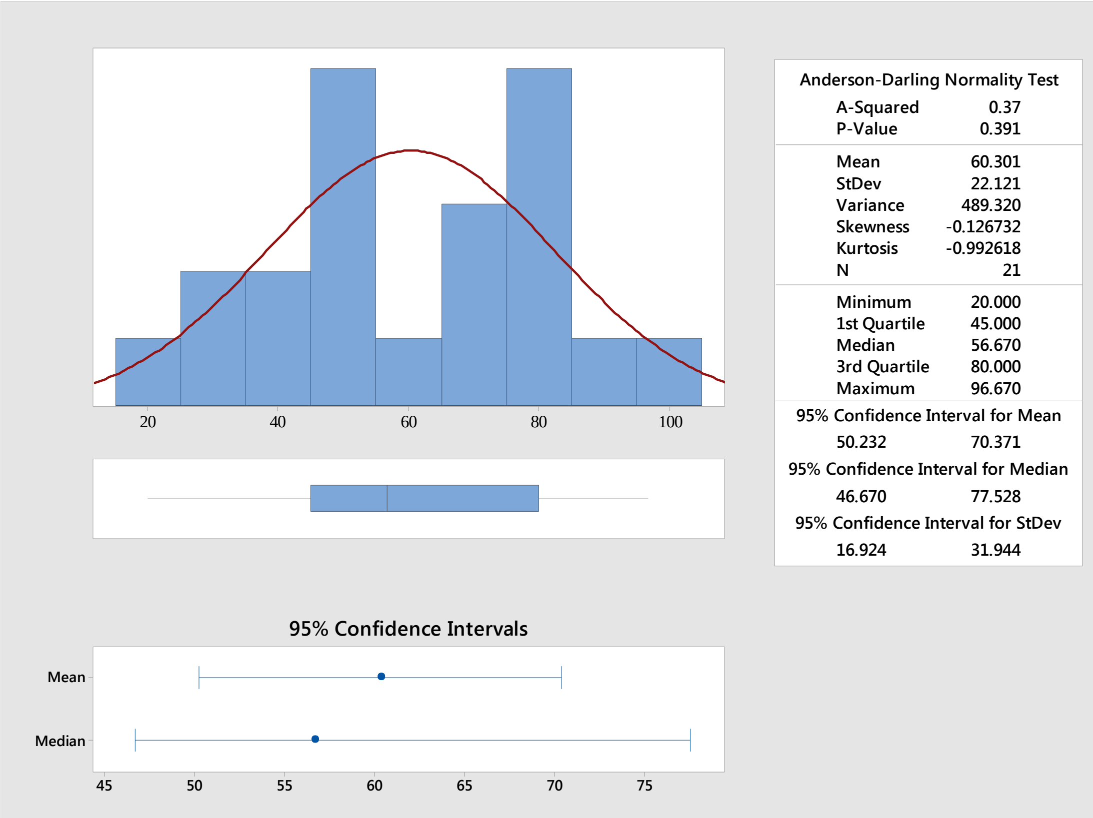


Figure 4.22: Distribution of Social Persuasions scores of students post instruction.

The mean score of the students was 60.30% (95% confidence intervals of 50.23 and 70.37). The standard deviation was 22.12 (95% confidence intervals 16.92 and 31.94). The median score was 56.67 (95% confidence intervals of 46.67 and 77.53). The null and alternative hypotheses were that the data followed a normal distribution and did not follow a normal distribution respectively. The Anderson-Darling normality test (A-Squared = 0.37, P-Value = 0.391 at 0.05 significance level) also indicated that while the alternative hypothesis is rejected, there is insufficient evidence to conclude that the sources of mathematics self-efficacy data for social persuasions during the post-instruction phase of the study did not follow a normal distribution (Minitab Inc, 2010b). Therefore, it is likely that the data were normally distributed.

Figure 4.23 shows that the sources of mathematics self-efficacy scores for the emotional and physiological states during the pre-instruction phase of the study ranged from 20.00% to 100.00%.

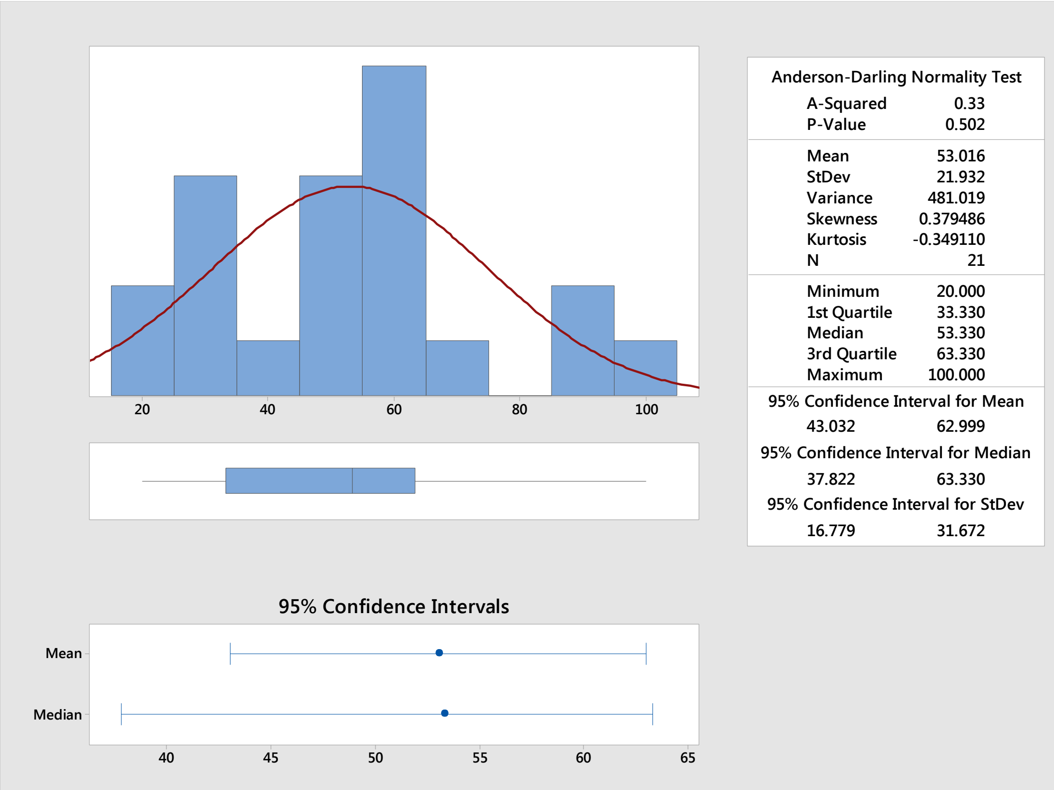


Figure 4.23: Distribution of the Emotional and Physiological States scores of students (prior to instruction).

The mean score of the students was 53.02% (95% confidence intervals of 43.03 and 62.99). The standard deviation was 21.93 (95% confidence intervals 16.78 and 31.67). The median score was 53.33 (95% confidence intervals of 37.82 and 63.33). The null and alternative hypotheses were that the data followed a normal distribution and did not follow a normal distribution respectively. The Anderson-Darling normality test (A-Squared = 0.33, P-Value = 0.502 at 0.05 significance level) also indicated that while the alternative hypothesis is rejected, there is insufficient evidence to conclude that the sources of mathematics self-efficacy data for the emotional and physiological states during the pre-instruction phase of the study did not follow a normal distribution (Minitab Inc, 2010b). Therefore, it is likely that the data were normally distributed.

Figure 4.24 shows that the sources of mathematics self-efficacy scores for the emotional and physiological states during the post-instruction phase of the study ranged from 20.00% to 100.00%.

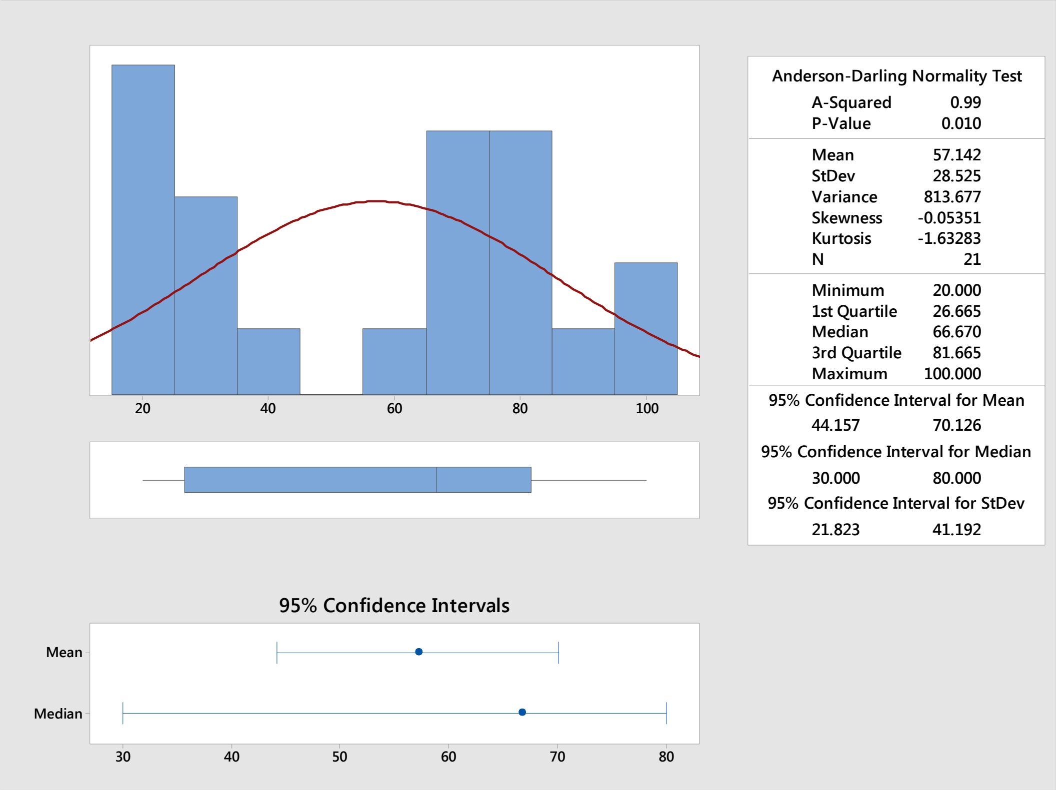


Figure 4.24: Distribution of the Emotional and Physiological States scores of students at post-instructional phase of the study.

The mean score of the students was 57.14% (95% confidence intervals of 44.16 and 70.13). The standard deviation was 28.53 (95% confidence intervals 21.82 and 41.19). The median score was 66.67 (95% confidence intervals of 30.00 and 80.00). The null and alternative hypotheses were that the data followed a normal distribution and did not follow a normal distribution respectively. The Anderson-Darling normality test (A-Squared = 0.33, P-Value = 0.502 at 0.05 significance level) also indicated that while the alternative hypothesis is rejected, there is insufficient evidence to conclude that the sources of mathematics self-efficacy data for emotional and physiological states during the post-instruction phase of the study did not follow a normal distribution (Minitab Inc, 2010b). Therefore, it is likely that the data were normally distributed.

The fact that the pre- and post-instruction mean scores of each of the four sources of mathematics self-efficacy were located within the same locus defined by a mean range of 53.02% to 62.38% suggest that all four sources wield some influence on the mathematics self-efficacy of students with ID.

4.3.4.2.3 The relationship between the sources of self-efficacy and the mathematics achievements of students with ID. In this section, the results are analysed and comparisons are made between each of the four sources of mathematics self-efficacy and the mathematics achievement of the students in Tests 1, 2, 3 and 4. Figures 4.25a, 4.25b, 4.25c and 4.25d show the relationship between the marks obtained by the students in each Test and mastery experience, vicarious experience, social persuasions and the emotional and physiological states prior to intervention.

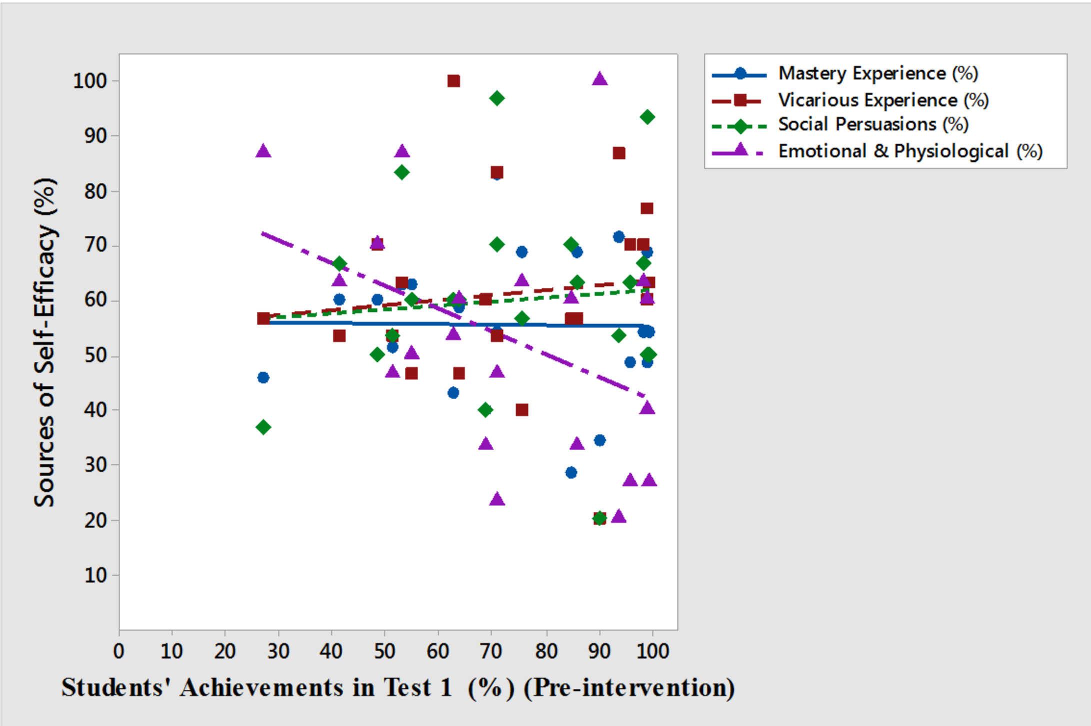


Figure 4.25a: Relationship between the Sources of Self-Efficacy and the Mathematics Achievements of Students with ID in Test 1 prior to instruction.

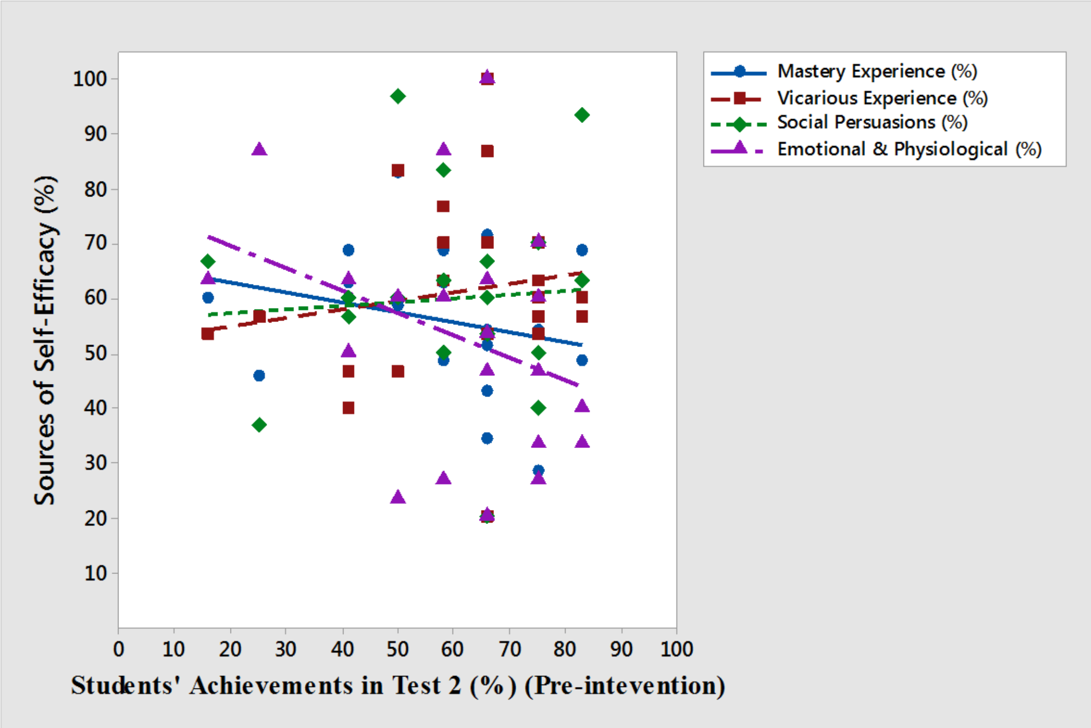


Figure 4.25b: Relationship between the Sources of Self-Efficacy and the Mathematics Achievements of Students with ID in Test 2 prior to Instruction.

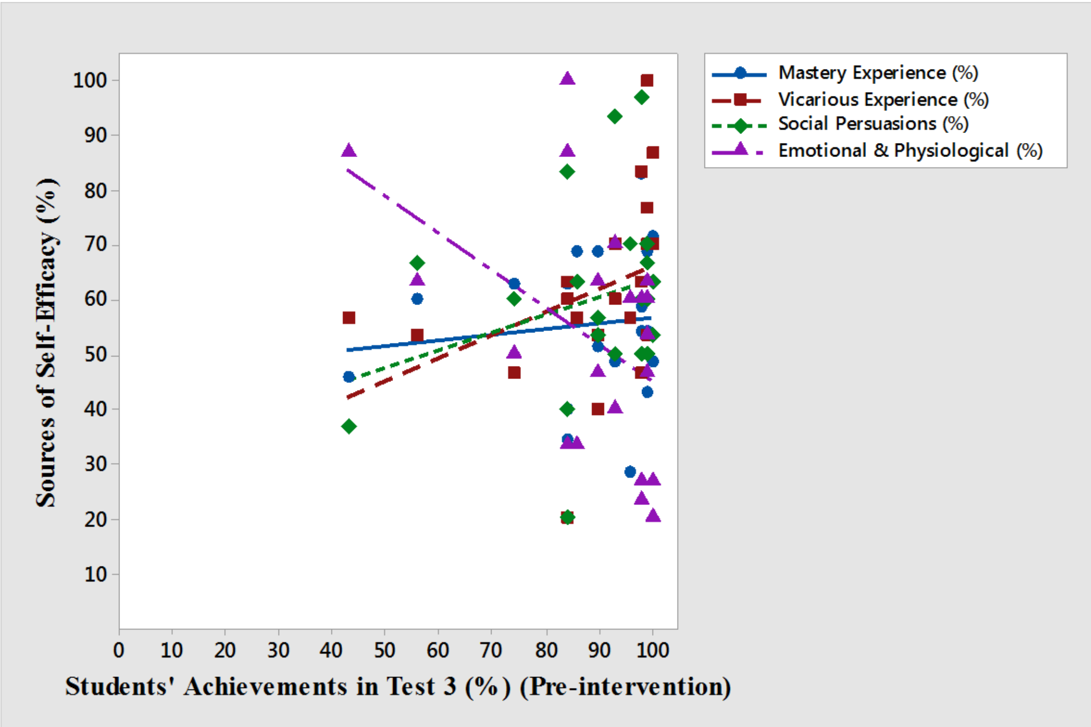


Figure 4.25c: Relationship between the Sources of Self-Efficacy and the Mathematics Achievements of Students with ID in Test 3 prior to instruction.

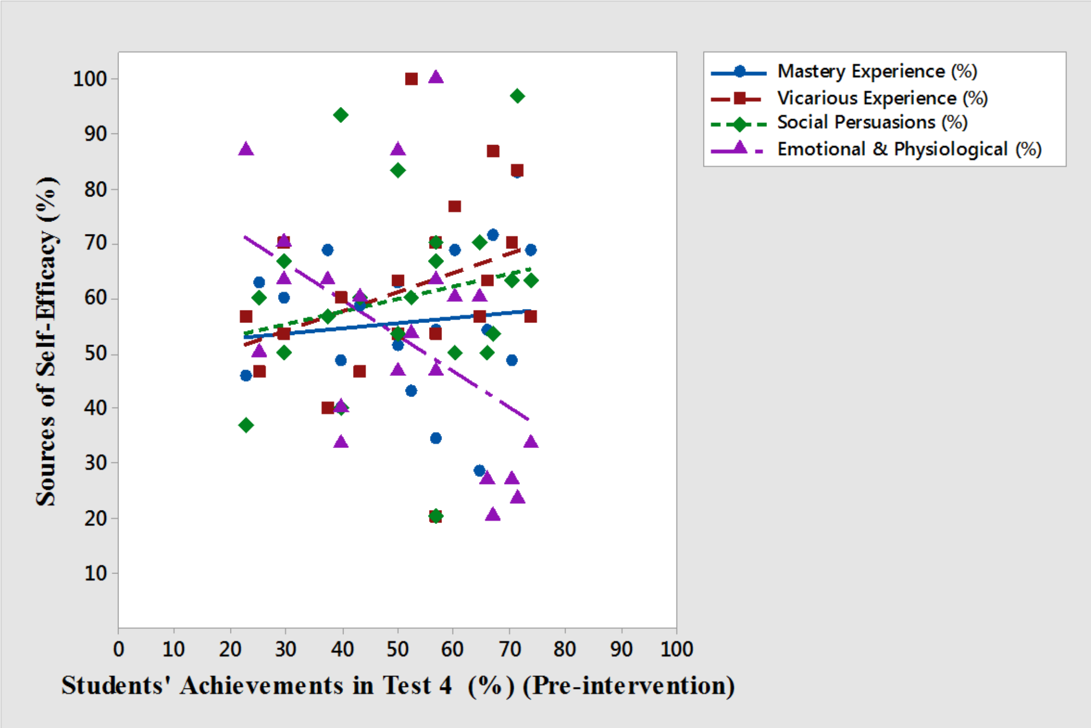


Figure 4.25d: Relationship between the Sources of Self-Efficacy and the Mathematics Achievements of Students with ID in Test 3 prior to instruction.

All four sources of mathematics self-efficacy displayed a very poor correlation with students' achievements in Tests 1, 2, 3 and 4 at the beginning of the study. For mastery experience, the Pearson correlation coefficients for Tests 1, 2, 3 and 4 were -0.02 (p-value = 0.95), -0.25 (p-value = 0.28), 0.12 (p-value = 0.62), and 0.12 (p-value = 0.61) respectively. For vicarious experience, the Pearson correlation coefficients for Tests 1, 2, 3 and 4 were 0.11 (p-value = 0.62), 0.12 (p-value = 0.47), 0.37 (p-value = 0.10) and 0.32 (p-value = 0.15) respectively. For social persuasions, the Pearson correlation coefficients for Tests 1, 2, 3 and 4 were 0.09 (p-value = 0.70), 0.07 (p-value = 0.76), 0.27 (p-value = 0.23) and 0.21 (p-value = 0.37) respectively. For emotional and physiological states, the Pearson correlation coefficients for Tests 1, 2, 3 and 4 were -0.41 (p-value = 0.07), -0.34 (p-value = 0.14), -0.46 (p-value = 0.04) and -0.48 (p-value = 0.03) respectively. Similarly, during the same period (pre-instruction), very weak Spearman rho correlation coefficients were observed between the sources of mathematics self-efficacy and students' achievements in the Test. For mastery experience, the Spearman rho correlation coefficients for Tests 1, 2, 3 and 4 were 0.04 (p-value = 0.86), -0.31 (p-value = 0.18), 0.12 (p-value = 0.61) and 0.17 (p-value = 0.47) respectively. For vicarious experience, the Spearman rho correlation coefficients for Tests 1, 2, 3 and 4 were 0.28 (p-value = 0.23), 0.19 (p-value = 0.40), 0.60 (p-value = 0.004) and 0.43 (p-value = 0.05) respectively. For social persuasions, the Spearman rho correlation coefficients for Tests 1, 2, 3 and 4 were 0.06 (p-value = 0.78), 0.05 (p-value = 0.83), 0.20 (p-value = 0.38) and 0.24 (p-value = 0.29) respectively. For emotional and physiological states, the Spearman rho correlation coefficients for Tests 1, 2, 3 and 4 were -0.42 (p-value = 0.06), -0.34 (p-value = 0.14), -0.48 (p-value = 0.03) and -0.57 (p-value = 0.007) respectively.

Figures 4.26a, 4.26b, 4.26c and 4.26d display the correlation between each of the sources of the mathematics self-efficacy and students' achievements in the Tests post-intervention. Likewise, the correlation between the variables was poor. For mastery experience, the Pearson correlation coefficients for Tests 1, 2, 3 and 4 were 0.19 (p-value = 0.40), 0.29 (p-value = 0.20), 0.17 (p-value = 0.46) and 0.58 (p-value = 0.006) respectively. For vicarious experience, the Pearson correlation coefficients for Tests 1, 2, 3 and 4 were 0.09 (p-value = 0.71), 0.22 (p-value = 0.34), 0.19 (p-value = 0.40) and 0.37 (p-value = 0.10) respectively. For social persuasions, the Pearson correlation coefficients for Tests 1, 2, 3 and 4 were 0.21 (p-value = 0.35), 0.19 (p-value = 0.40), 0.22 (p-value = 0.35) and 0.43 (p-value = 0.06) respectively. For emotional and physiological states, the Pearson correlation coefficients for Tests 1, 2, 3 and 4 were -0.25 (p-value = 0.27), -0.25 (p-value = 0.28), -0.28 (p-value = 0.23) and -0.34 (p-value = 0.13) respectively. The Spearman rho correlation coefficients reflected similar low level values as Pearson's. For mastery experience, the Spearman rho correlation coefficients for Tests 1, 2, 3 and 4 were 0.38 (p-value = 0.87), 0.33 (p-value = 0.14), 0.38 (p-value = 0.09) and 0.67 (p-value = 0.001) respectively. For vicarious experience, the Spearman rho correlation coefficients for Tests 1, 2, 3 and 4 were 0.03 (p-value = 0.89), 0.24 (p-value = 0.31), 0.35 (p-value = 0.12) and 0.31 (p-value = 0.17) respectively. For social persuasions, the Spearman rho correlation coefficients for Tests 1, 2, 3 and 4 were 0.16 (p-value = 0.49), 0.09 (p-value = 0.71), 0.06 (p-value = 0.79) and 0.38 (p-value = 0.09) respectively. For emotional and physiological states, the Spearman rho correlation coefficients for Tests 1, 2, 3 and 4 were -0.25 (p-value = 0.28), -0.14 (p-value = 0.54), -0.25 (p-value = 0.29) and -0.35 (p-value = 0.12) respectively.

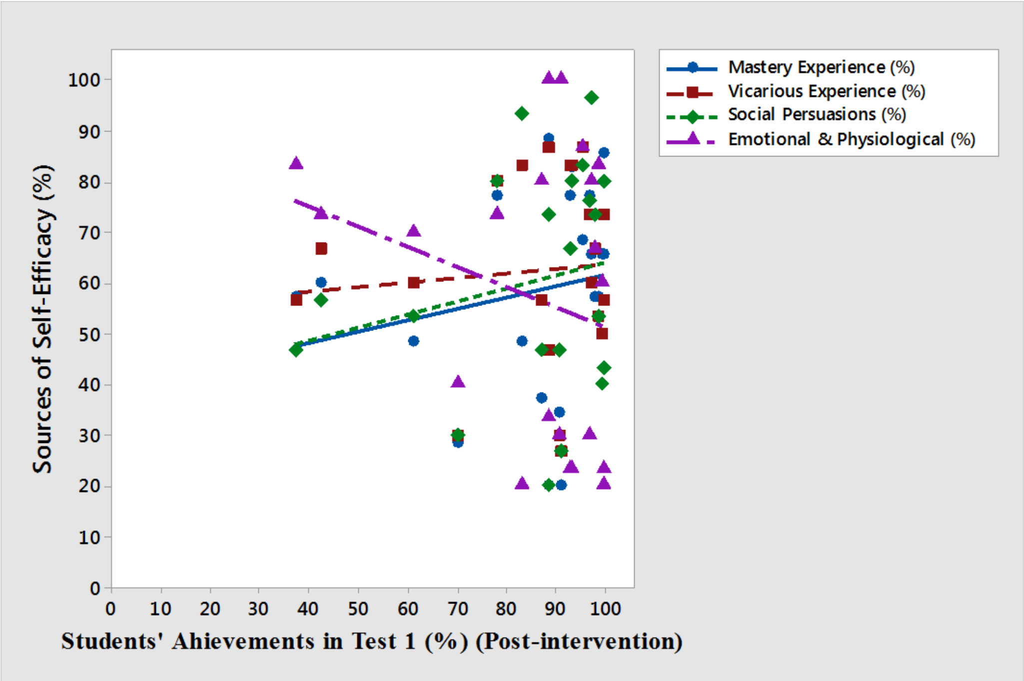


Figure 4.26a: Relationship between the Sources of Self-Efficacy and the Mathematics achievements of Students with ID in Tests 1 (post-instruction).

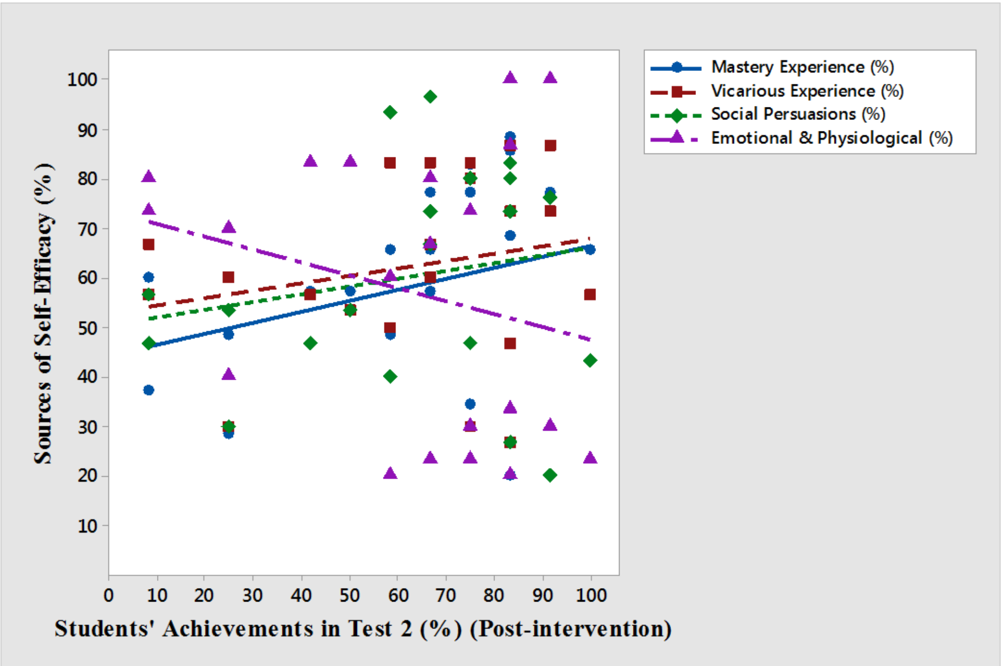


Figure 4.26b: Relationship between the Sources of Self-Efficacy and the Mathematics achievements of Students with ID in Tests 2 (post-instruction).

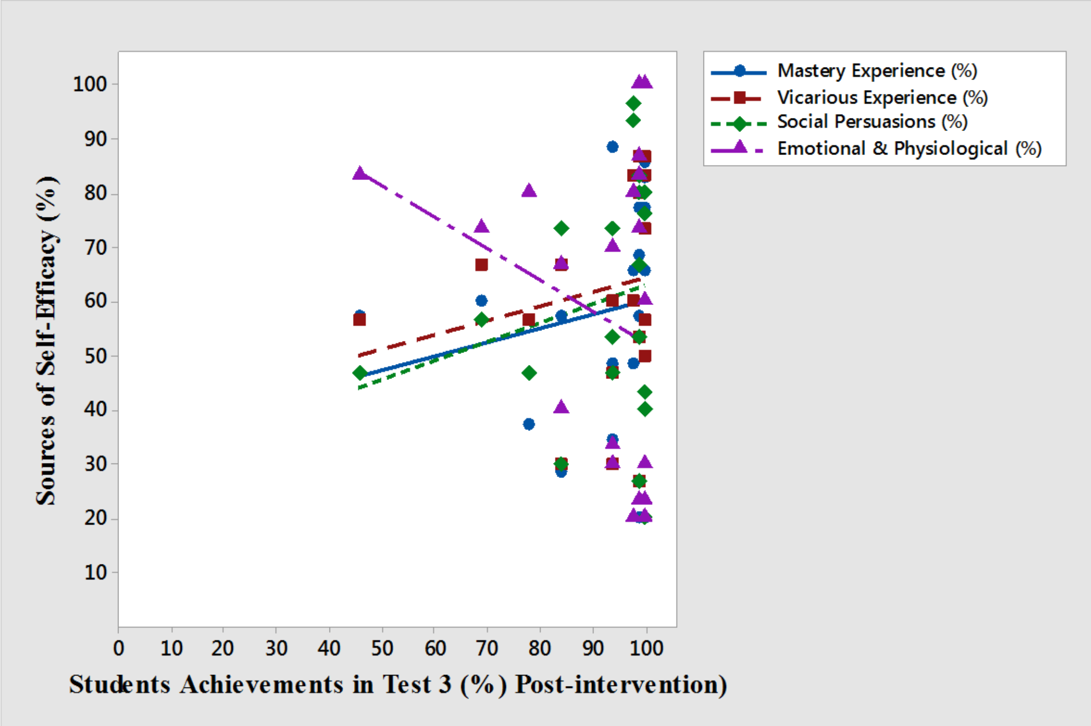


Figure 4.26c: Relationship between the Sources of Self-Efficacy and the Mathematics achievements of Students with ID in Tests 3 (post-instruction).

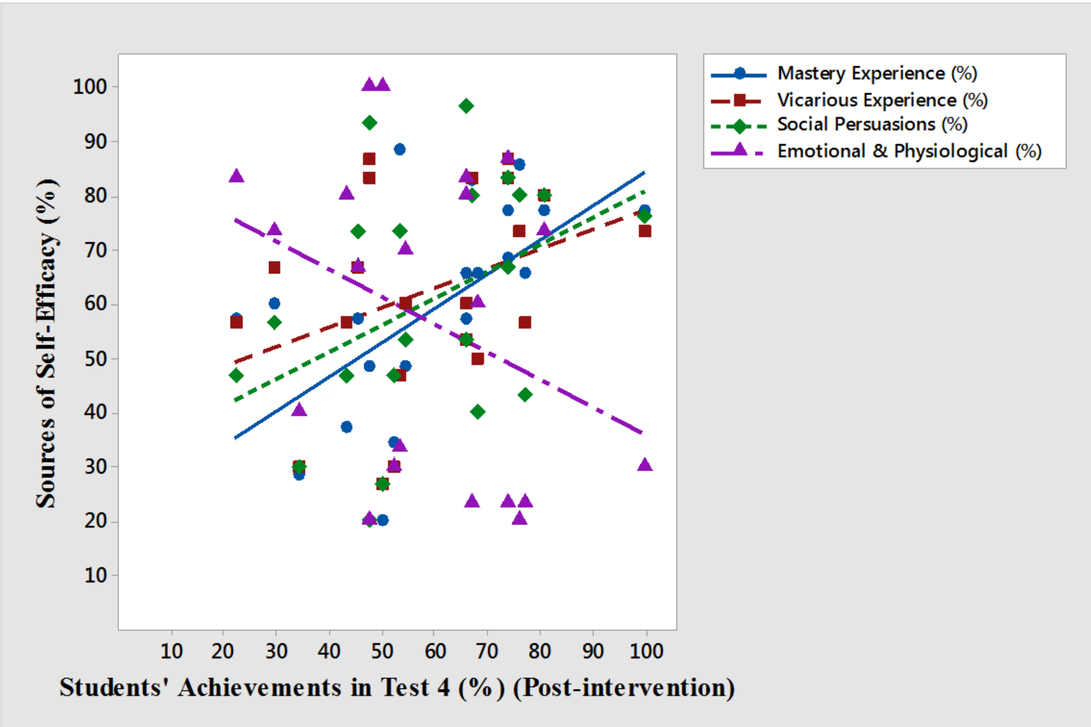


Figure 4.26d: Relationship between the Sources of Self-Efficacy and the Mathematics achievements of Students with ID in Tests 4 (post-instruction).

4.3.4.3 Relationship between IQ and the sources of mathematics self-efficacy scores. The relationship between the IQ scores of students and the sources of self-efficacy was represented graphically for pre-instruction (Figure 4.27) and post-instruction (Figure 4.28). A visual inspection of both graphs reveals points that are very scattered without any apparent relationship. Statistical analyses of the data using Pearson correlation and Spearman rho correlation confirmed the lack of relationship between IQ and the various sources of self-efficacy. For the data collected at the beginning of the study (pre-instruction), the Pearson and Spearman rho correlation coefficients for: mastery experience were 0.14 (p-value = 0.56) and 0.21 (p-value = 0.36), vicarious experience were 0.002 (p-value = 0.9) and 0.13 (p-value = 0.57), social persuasions were 0.24 (p-value = 0.29) and 0.27 (p-value = 0.23) and emotional and physiological states were -0.12 (p-value = 0.60) and -0.07 (p-value = 0.76). For the data collected at the conclusion of the study (post-instruction), the Pearson and Spearman rho correlation coefficients for mastery experience were 0.33 (p-value = 0.14) and 0.41 (p-value = 0.07), vicarious experience were 0.10 (p-value = 0.65) and 0.13 (p-value = 0.59), social persuasions were 0.25 (p-value = 0.65) and 0.28 (p-value = 0.22) and emotional and physiological states were -0.11 (p-value = 0.64) and -0.09 (p-value = 0.70).

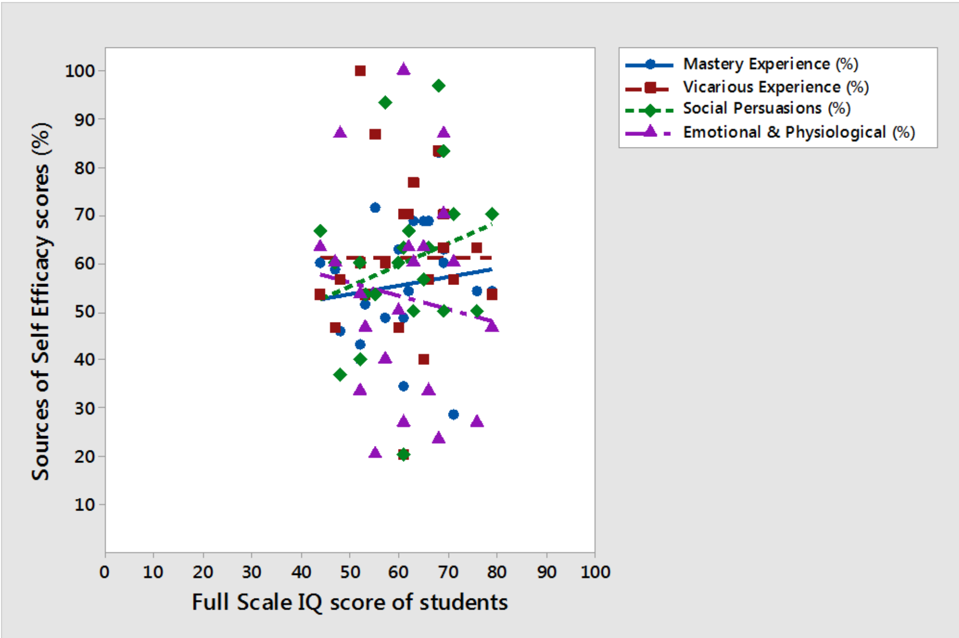


Figure 4.27: Relationship between sources of self-Efficacy (pre-instruction) and Full Scale IQ scores.

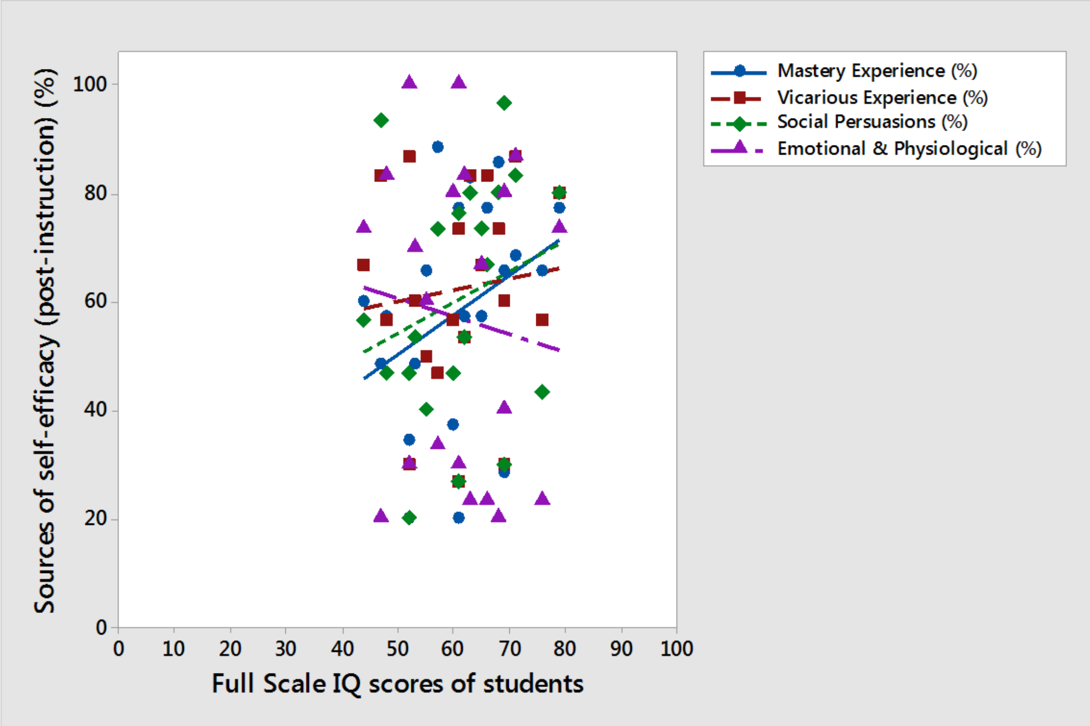


Figure 4.28: Relationship between sources of self-Efficacy (post-instruction) and Full Scale IQ scores.

4.3.4.4 The mathematics anxiety of students with borderline, mild and moderate ID. This section focuses on the analyses and interpretation of data on the mathematics anxiety of students with ID. The anxiety instrument employed in this study consisted of six items as listed in Table 4.23 that was measured on the Likert Scale with a rating ranging from 1 to 5.

Table 4.23

The Anxiety Items used in the study.

	Anxiety of students items
1	Just being in maths class makes me feel stressed and nervous.
2	Doing maths work takes all of my energy
3	I start to feel stressed-out as soon as I begin my maths work
4	My mind goes blank and I am unable to think clearly when doing maths work.
5	I get depressed when I think about learning maths
6	My whole body becomes tense when I have to do maths

4.3.4.4.1 Anxiety, responses to anxiety instrument items and maths Achievements. Tables 4.24 and 4.25 show the anxiety factors of students and their mathematics achievements prior to and post-instruction respectively.

Table 4.24

Comparing the Mathematics Achievements of Students with Borderline, Mild, and Moderate ID and their Maths Anxiety prior to intervention.

ID Group	Student	IQ		Mathematics Achievement				
			Anxiety factor (%)	**Test 1 (%)**	**Test 2 (%)**	**Test 3 (%)**	**Test 4 (%)**	**Average (%)**
Borderline ID	1	79	46.67	71.00	75.00	99.00	56.82	75.455
	2	76	26.67	99.58	75.00	98.00	65.91	84.6225
	3	71	60.00	84.91	75.00	96.00	64.77	80.17
Mild ID	4	69	86.67	53.25	58.00	84.00	50.00	61.3125
	5	69	70.00	48.63	75.00	93.00	29.55	61.545
	6	68	23.33	71.07	50.00	98.00	71.59	72.665
	7	66	33.33	86.00	83.00	86.00	73.86	82.215
	8	65	63.33	75.68	41.00	90.00	37.50	61.045
	9	63	60.00	99.00	58.00	99.00	60.23	79.0575
	10	62	63.33	98.32	66.00	99.00	56.82	80.035
	11	61	26.67	95.81	58.00	100.00	70.45	81.065
	12	61	100.00	90.14	66.00	84.00	56.82	74.24
	13	60	50.00	54.72	41.00	74.00	25.00	48.68
	14	57	40.00	98.95	83.00	93.00	39.77	78.68
	16	55	20.00	93.71	66.00	100.00	67.05	81.69
Moderate ID	17	53	46.67	51.36	66.00	90.00	50.00	64.34
	18	52	53.33	62.68	66.00	99.00	52.27	69.9875
	19	52	33.33	68.97	75.00	84.00	39.77	66.935
	21	48	86.67	27.00	25.00	43.00	22.73	29.4325
	22	47	60.00	63.94	50.00	98.00	43.18	63.78
	23	44	63.33	41.30	16.00	56.00	29.55	35.7125

Test 1 = IMPELS (Enoma & Malone, 2015), Test 2 = the Delaware Universal Screening Tool for Number Sense Grade 2 (Delaware Department of Education, 2010), Test 3 = Streamlined Number

Sense Screening Tool (Jordan, Glutting & Ramineni, 2008), Test 4 = Number knowledge Test (Okamoto & Case, 1996).

Table 4.25

Comparing the Mathematics Achievements of Students with Borderline, Mild, and Moderate ID and their Maths Anxiety post intervention.

ID Group	**Student**	**IQ**		**Mathematics Achievement**			
			Anxiety factor (%)	**Test 1 (%)**	**Test 2 (%)**	**Test 3 (%)**	**Test 4 (%)**
Borderline ID	1	79	73.33	77.99	75.00	98.78	80.68
	2	76	23.33	99.58	100.0	100.0	77.27
	3	71	86.67	95.39	83.33	98.78	73.86
Mild ID	4	69	80.00	97.06	66.67	97.56	65.91
	5	69	40.00	70.27	25.00	84.15	34.09
	6	68	20.00	99.79	83.33	100.0	76.14
	7	66	23.33	92.87	66.67	98.78	73.86
	8	65	66.67	97.69	66.67	84.15	45.45
	9	63	23.33	93.08	75.00	100.0	67.05
	10	62	83.33	98.74	50.00	98.78	65.91
	11	61	30.00	96.86	91.67	100.0	100.0
	12	61	100.00	91.19	83.33	98.78	50.00
	13	60	80.00	87.00	8.33	78.05	43.18
	14	57	33.33	88.68	83.33	93.90	53.41
	16	55	60.00	99.16	58.33	100.0	68.18
Moderate ID	17	53	70.00	61.32	25.00	93.90	54.55
	18	52	100.00	88.68	91.67	100.0	47.73
	19	52	30.00	90.78	75.00	93.90	52.27
	21	48	83.33	37.32	41.67	45.73	22.27
	22	47	20.00	83.23	58.33	97.56	47.73
	23	44	73.33	42.34	8.33	68.90	29.55

Test 1 = IMPELS (Enoma & Malone, 2015), Test 2 = the Delaware Universal Screening Tool for Number Sense Grade 2 (Delaware Department of Education, 2010), Test 3 = Streamlined Number Sense Screening Tool (Jordan, Glutting & Ramineni, 2008), Test 4 = Number knowledge Test (Okamoto & Case, 1996).

Twenty-one students participated in this aspect of the study (Table 4.24) – students 15 and 20 were omitted for not completing their questionnaires appropriately. The average anxiety factor for the students measured at the beginning and end of the study were 53.02% (pre-instruction) and 57.14% (post-instruction) respectively

(Tables 4.24 and 4.25). Considering the anxiety of students in relation to their gender, it was observed that the average mathematics anxiety for male and female students with ID were 49.09% and 56.33% (pre-instruction) as well as 51.82% and 63.00% (post-instruction) respectively (Tables 4.24 and 4.25), suggesting that mathematics anxiety was widespread among the students that participated in this study, regardless of the gender.

Among the male students with ID, 36.36% and 9.09% ‘strongly agreed’ and ‘agreed’ respectively that “just being in a maths class makes me feel stressed and nervous” in contrast to 30.00% and 10.00% for the female students during the same time period (pre-instruction). For the male students, 18.18% of them ‘strongly agreed’ at the beginning of the study that “doing maths work takes all of my energy” in comparison to 10.00% and 30.00% of female students who ‘strongly agreed’ and ‘agreed’ respectively. Also, 18.18% of male students with ID ‘strongly agreed’ and the same percentage of students ‘agreed’ that “I start to feel stressed-out as soon as I begin my maths work” whereas for the female students, 30% ‘strongly agreed’. For the male students, 9.09% either ‘strongly agreed’ or ‘agreed’ at the commencement of the study that “my mind goes blank and I am unable to think clearly when doing maths work”. During the same time period, 10.00% of the female students with ID either ‘strongly agreed’ or ‘agreed’. At the end of the study, the anxiety of the male students in relation to the fourth item (Table 4.25) appeared to have improved as only about 18% of them ‘strongly agreed’.

The remaining students either ‘strongly disagreed’, ‘disagreed’ or ‘neither agreed or disagreed’. During this same time period (post-instruction), 30.00% of the female students strongly agreed that “my mind goes blank and I am unable to think clearly when doing maths work”. There was a 20% rise in the number of female students that ‘strongly agreed’ with the fourth item at the end of the study. While it is not certain why this was the case, it is worth mentioning that many of the female students that participated in the study had autism. Previous research outcomes have documented that individuals with autism are more prone to anxiety because they find reading situational cues for fear and safety very challenging (Bedrossian, 2015). Having regard to the foregoing, it is important for teachers providing learning experiences to students with ID to be mindful of, and cater for, their anxiety by managing possible anxiety triggers adequately. It was also observed at the start of the study that 9.09% of the male students with ID either ‘strongly agreed’ or ‘agreed’ that “I get depressed when I think about learning maths” (item 5) as compared to 30.00% and 20.00% of the female students who ‘strongly agreed’ and ‘agreed’ respectively. At the conclusion of the study, the percentage of the male students that either ‘strongly agreed’ or ‘agreed’ with item 5 doubled, while the percentage of the female respondents stayed the same. At the pre-instructional phase of the study, 18.18% and 9.09% of the male students ‘very strongly’ and ‘strongly agreed’ respectively that “my whole body becomes tense when I have to do maths” as compared to 10.00% and 30.00% of the female students with ID that ‘strongly agreed’ and ‘agreed respectively’ (Table 4.24). At the end of the study, 27.27% of the male students ‘strongly agreed’ to item 6 while 30.00% and 10.00% of the female students with ID ‘very strongly agreed’ and ‘agreed’ respectively to the same item (Table 4.25). Overall, it was observed that mathematics anxiety was relatively greater among girls with ID (56.33%) than the boys (49.09%) during the pre-instruction phase of the study.

Both pre- and post-instruction results appear to follow a trend of higher stress levels resulting in lower mathematics achievements or vice versa. However, there were a number of exceptions. For example, “Student 12” with an anxiety factor of 100.00% for both pre- and post-instructions outperformed 61.90% and 81.82% of students respectively that had lower anxiety factors. Another example is “Student 1” who, having an anxiety factor of 73.33% did better than 38.10% of students who had lower anxiety factors. The key point again is to treat each student as an individual, and more so when you consider the fact that many students with ID have comorbidities of other conditions that impact on their anxiety levels.

4.3.4.4.2 Correlation and regression graphs. Figures 4.29 and 4.30 demonstrate a moderately weak (negative) and weak ‘downhill’ relationship for both pre- and post-instructions respectively regardless of whether Pearson or Spearman correlation was used. The pre-instruction Pearson correlation coefficients for Tests 1, 2, 3 and 4 were – 0.41 (p-value = 0.07), -0.34 (p-value = 0.14), -0.46 (p-value = 0.04) and -0.48 (p-value = 0.03) respectively. The Spearman rho correlation coefficients for Tests 1, 2, 3 and 4 for the same time period were -0.42 (p-value = 0.06), -0.34 (p-value = 0.14),

-0.48 (p-value = 0.03) and -0.57 (p-value = 0.007) respectively. The post-instruction Pearson correlation coefficients were -0.25 (p-value = 0.27) for Test 1, -0.25 (p-value = 0.28) for Test 2, -0.28 (p-value = 0.23) for Test 3 and -0.34 (p-value = 0.13) for Test 4.

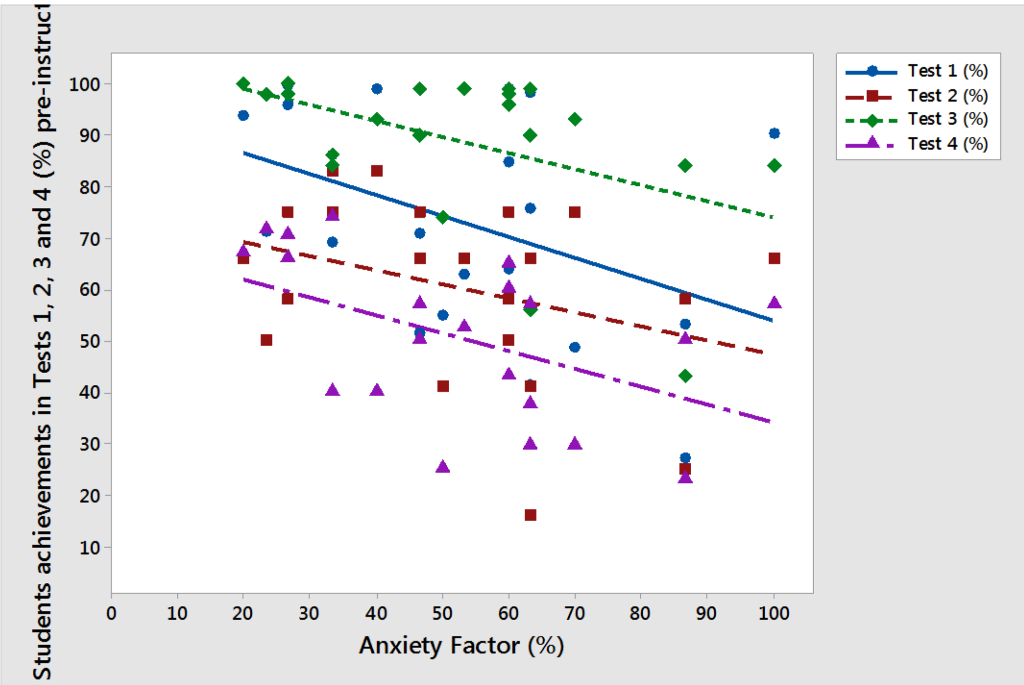


Figure 4.29: Relationship between anxiety and the mathematics achievements of Students with borderline, mild and moderate ID (pre-instruction).

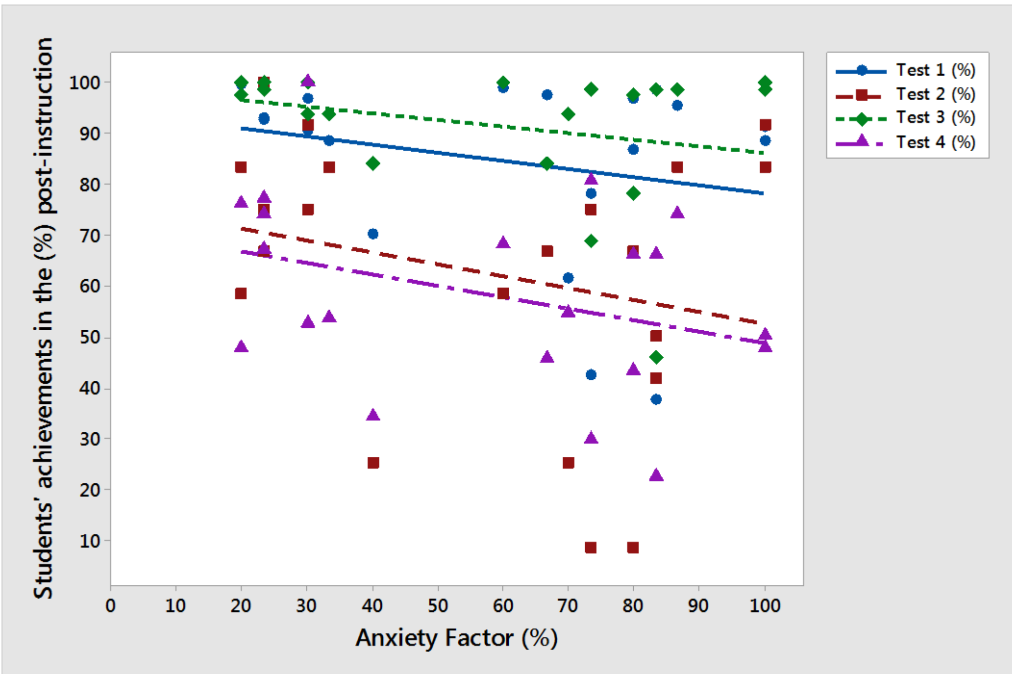


Figure 4.30: Relationship between anxiety and the mathematics achievements of Students with borderline, mild and moderate ID (post-instruction).

Similarly, the Spearman rho correlation coefficients for the same time period were -0.25 (p-value = 0.28) for Test 1, -0.14 (p-value = 0.54) for Test 2, -0.25 (p-value = 0.29) for Test 3 and -0.35 (p-value = 0.12) for Test 4. These moderately weak (pre-instruction) and weak (post-instruction) downhill relationships suggest that while there seems to be a high anxiety-low mathematics achievement relationship among students with ID, considerations must be given to their individual characteristics to ensure improved outcomes in their learning of mathematics.

4.3.4.4.3 Gender dichotomy - Correlation and regression graphs. Figure 4.31 compares the relationship between the anxiety factor of the male students and their mathematics achievements to the relationship between the anxiety factor of the female students and their mathematics achievements prior to instruction.

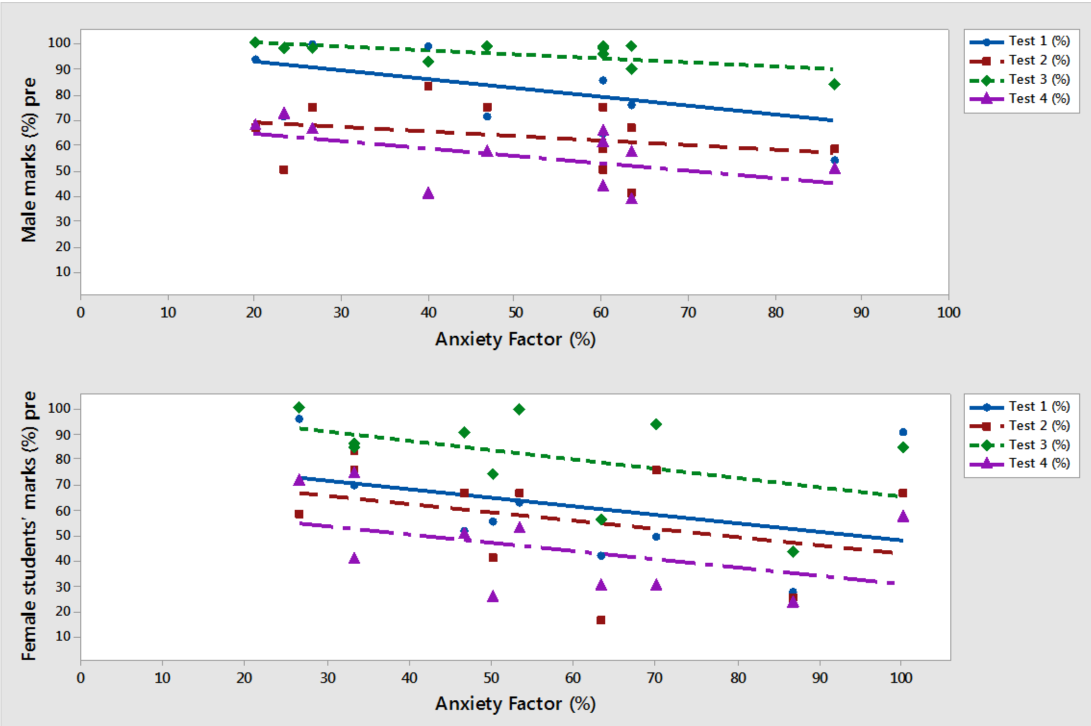


Figure 4.31: Relationship between the anxiety of female and male students with ID and their mathematics achievements prior to instruction.

The relationship between the variables ranged from weak to moderately weak negative/downhill relationship. While the pre-instruction Pearson correlation coefficients for the relationship between anxiety factor and the mathematics achievements of the male students with ID were -0.44 (p-value = 0.17) for Test 1, (

-0.28, p-value = 0.40) for Test 2, -0.62 (p-value = 0.04) for Test 3 and -0.53 (p-value = 0.10) for Test 4, their female counterparts were -0.36 (p-value = 0.31), -0.35 (p-value = 0.33), -0.47 (p-value = 0.17) and -0.43 (p-value = 0.21) for Tests 1, 2, 3 and 4 respectively. The Spearman rho correlation coefficients for the male students for the same period of time were -0.34 (p-value = 0.31), -0.33 (p-value = 0.32), -0.46 (p-value = 0.15 and – 0.64 (p-value = 0.03) as compared to the female students with -0.50 (p-value = 0.14), -0.30 (p-value = 0.40), -0.45 (p-value = 0.19) and -0.47 (p-value = 0.17) for Tests 1, 2, 3, and 4 respectively.

Figure 4.32 compares the relationship between the anxiety factor of male students and their mathematics achievements to the relationship between the anxiety factor of female students and their mathematics achievements post-instruction. One outstanding observation was that stress was test-specific. That is, students' anxiety levels were different for each type of Test. For example, the male students' achievements in Test 1 (post-instruction) ranged from 77.99% to 99.79% which did not reflect the wide differences in the anxiety levels of the students (ranging from 20.00% to 86.67%). The mathematics achievements of the male students with ID having anxiety factors of 20.00%, 23.33%, 33.33%, 60.00%, 66.67%, 73.33%, 80.00%, 83.33% and 86.67% were all located within the high scores locus as defined by the range of 77.99% to 99.79%. The mathematics achievements of the male students in Test 3 were indeed similar to their performance in Test 1. Regardless of the wide variations in their anxiety factor as described earlier, the students who displayed high anxiety levels performed as high as their counterparts with low anxiety factors with mathematics achievements ranging from 84.15% to 100.00%. The students' achievements in Test 4 were similar to Tests 1 and 3 – disparity in anxiety levels/factors did not have a proportional impact on the achievements of the students in the three tests. However, regarding the male students with ID, their achievements in Test 2 reflected a pattern of a low anxiety-high scores relationship. This explains why the lines of regression for the four Tests are a mixture of positive and negative trend lines (Figure 4.32).

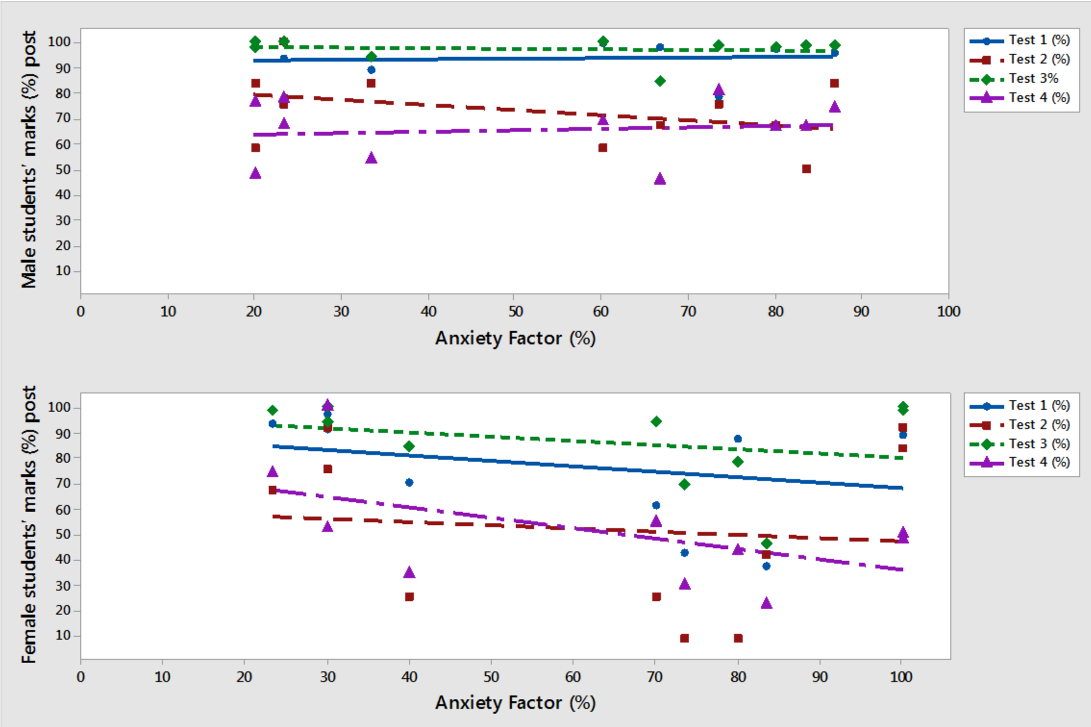


Figure 4.32: Relationship between the anxiety of female and male students with ID and their mathematics achievements post-instruction.

The post-instruction achievements of the female students in the Tests generally followed a downhill trend that described a low anxiety-high mathematics achievement relationship. The post-instruction Pearson correlation coefficients for male students with ID were 0.08 (p-value = 0.82), -0.40 (p-value = 0.23), -0.17 (p-value = 0.62) and 0.13 (p-value = 0.70) for Tests 1, 2, 3 and 4 respectively. Similarly, the Spearman rho correlation coefficients for the male students were -0.11 (p-value = 0.74), -0.23 (p-value = 0.50), -0.29 (p-value = 0.39) and 0.02 (p-value = 0.96) for Tests 1, 2, 3 and four respectively.

For the female students with ID, the Pearson correlation coefficients for the relationship between anxiety factor and their mathematics achievements during the same period (post-instruction) were -0.30 (p-value = 0.41), -0.11 (p-value = 0.76), -0.27 (p-value = 0.45) and -0.54 ((p-value = 0.11) for Tests 1, 2, 3 and 4 respectively. The Spearman rho correlation coefficients for the female students were -0.39 (p-value = 0.27), 0.03 (p-value = 0.95), -0.14 (p-value = 0.70) and –0.57 (p-value = 0.09) for Tests 1, 2, 3 and 4 respectively.

4.3.4.4.4 IQ and the mathematics anxiety of students with borderline, mild and moderate ID. Figures 4.33 and 4.34 display a cloud of points that are greatly dispersed around two trend lines in each figure, pre-instruction anxiety scores (Anxiety Factor 1) and post-instruction anxiety scores (Anxiety Factor 2). The figures demonstrate that there is no relationship between IQ scores of the students and test anxiety. These findings suggest that anxiety is not influenced by IQ scores.

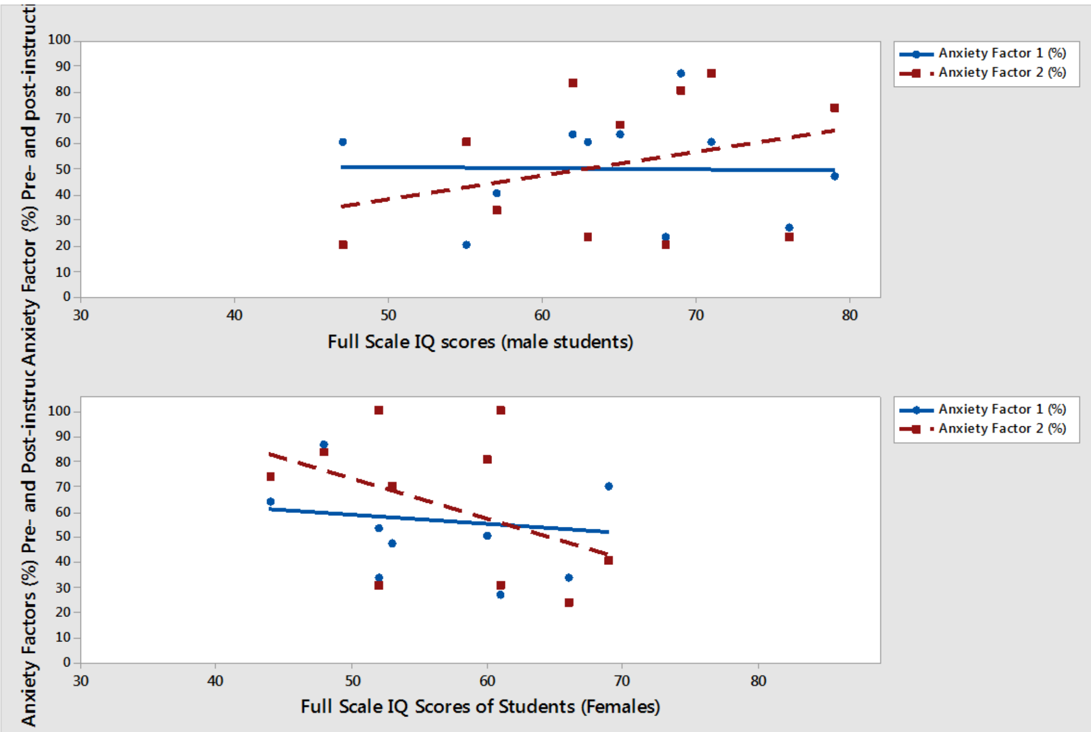


Figure 4.33: Comparing the anxiety of male and female students (pre- and post-instruction) to their IQ score.

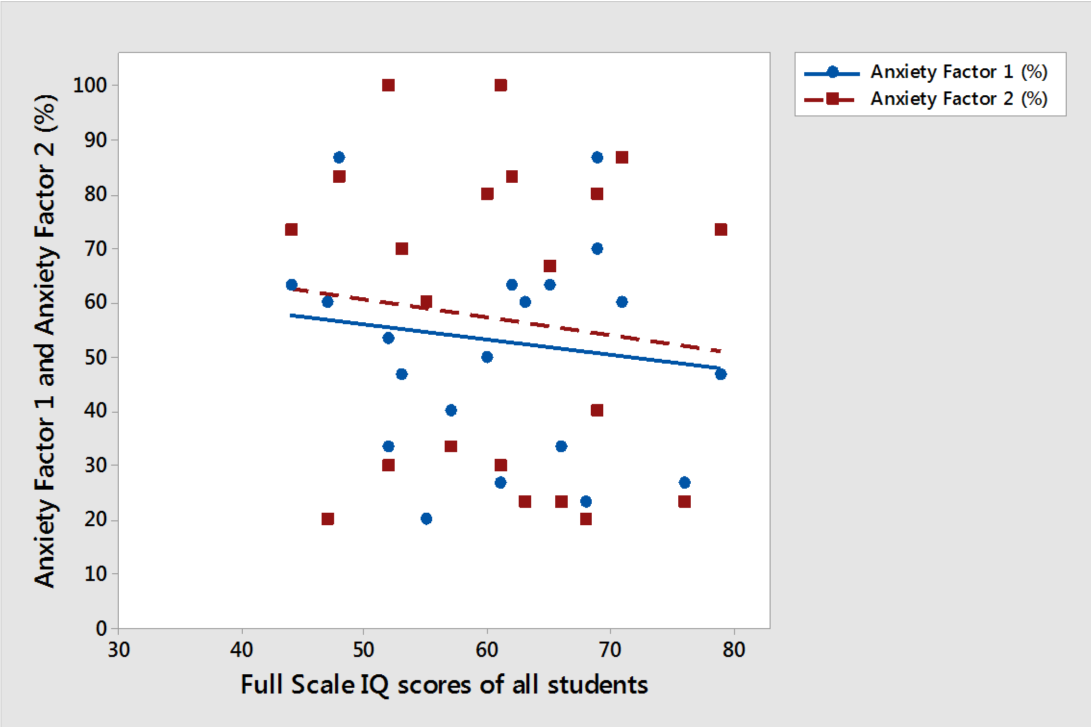


Figure 4.34: Relationship between the anxiety of the students as a whole (pre- and post-instruction) to their IQ score.

4.4 Research Question 3: What are the effects of Explicit Instruction and an Explicit-Constructivist based approach on the development of Number Sense among High School Students with Borderline, Mild and Moderate Intellectual Disabilities?

This section is dedicated to answering Research Question 3. To respond to this question, two different instructional approaches were employed to teach a common content to the students in five separate classrooms as outlined below:

Control (n = 7),

Explicitn 1 (n_1 = 4)

Explicit 2 (n_2 = 3)

ExpliCon 1 (n_3 = 4)

Explicon 2 (n_4 = 6)

All students (n = 24) participated in four pre-tests and post-tests and their performances under both instructional approaches compared. The explicit instruction as used in this study is as recommended by Miller and Hudson (2006) and consists of the following sequence:

1. Advance organizer (objectives of the lesson, review of relevant prerequisite).
2. Demonstration (modelling by the teacher) – the "I Do" phase of the lesson.
3. Guided Practice – the "We Do" phase of the lesson.
4. Independent practice – the You Do" phase of the lesson

The explicit-constructivist-based approach used is a hybrid of explicit instruction (Miller & Hudson, 2006) and the constructivist-based 5E instructional model recommended by Bybee, Taylor, Gardner, Van Scotter, Powell, Westbrook and Landes, (2006). This synthesis of two instructional approaches is also referred to in this study as ExpliCon. It comprises the following sequence:

Learning Phase (General – for all students with ID)

1. Advance Organizer (explicit instruction) and Engagement (accessing students' prior knowledge – 5E instructional model)
2. Demonstration/modelling by the teacher (explicit instruction)
3. Guided Practice (explicit instruction)
4. Independent Practice of the skills being learnt (explicit instruction)

Mastery Phase (for high-functioning students with ID)

5. Exploration (5E model)
6. Explanation (discussion and individual information sharing) (5E model)
7. Elaboration – extended piece of work (5E model)
8. Evaluation (5E model)

The control group experienced the instructional approach normally used by the routine teacher. On observation, the approach had some similarities with explicit instruction in that the teacher demonstrated the skills to be learnt, set independent work for the students thereafter and circulated around the classroom to offer individual support as needed.

4.4.1 Effects of explicit instruction. The average improvements made by the students in the control groups were 8.24% (Test 1), 10.81% (Test 2), 4.94% (Test 3) and 5.12% (Test 4) (Table 4.26). Individually, students' improvements in the control group ranged from 1.07% to 13.05%.

Table 4.26

Control Group

		Pre-intervention				Post-intervention			
ID Code	**IQ**	**Test 1 (%)**	**Test 2 (%)**	**Test 3 (%**	**Test 4 (%)**	**Test 1 (%)**	**Test 2 (%)**	**Test 3 (%**	**Test 4 (%)**
19	71	84.91	75.00	96.00	64.77	95.39	83.33	98.78	73.86
20	76	99.58	75.00	98.00	65.91	99.58	100.00	100.00	77.27
11	57	98.95	83.33	93.00	39.77	88.68	83.33	93.90	53.41
29	61	90.14	66.00	84.00	56.82	91.19	83.33	98.78	50.00
3	40	4.82	0	9.00	19.32	5.45	0	12.20	20.45
15	52	62.68	66.67	99.00	52.77	88.68	91.67	100.00	47.73
27	52	60.97	75.00	84.00	39.77	90.78	75.00	93.90	52.27
Mean Marks (%)		**71.72**	**63.00**	**80.43**	**48.45**	**79.96**	**73.81**	**85.37**	**53.57**

Table 4.27 shows the pre-test and post-test results of the students in the first classroom that were instructed under the explicit approach ($n_1 = 4$). The first explicit instruction class group (Table 4.27) made improvements with average marks of 4.72%, 4.17%, 4.07% and 7.56% for Test 1, Test 2, Test 3 and Test 4 respectively. There were variations in individual performances of the students. For example, Student 21 made improvements of 7.34% (Test 1) and 23.86% (Test 4) while scoring approximately the same marks in the pre-test as in the post-test for Tests 2 and 3. Student 9 achieved above 90.00% in both pre- and post-tests for Test1 but did better in the former than the latter. For Tests 2, 3 and 4, Student 9 improved by 16.67%, 1.00% and 6.82% respectively. Student 16 made improvements of 7.34% (Test 1) and 12.78% (Test 3), regressed by 16.66% (Test 2) and maintained the same marks for Test 4. Student 18 made improvements of 9.86%, 16.67% and 2.73% for Tests 1, 2 and 3 respectively but had about the same pre-test and post-test marks for Test 4 (Table 4.27).

Table 4.27

Explicit Instruction - Group 1

		Pre-intervention				**Post-intervention**			
ID Code	**IQ**	**Test 1 (%)**	**Test 2 (%)**	**Test 3 (%**	**Test 4 (%)**	**Test 1 (%)**	**Test 2 (%)**	**Test 3 (%**	**Test 4 (%)**
21	79	70.65	75.00	99.00	56.82	77.99	75.00	98.78	80.68
9	63	98.74	58.33	99.00	60.23	93.08	75.00	100.00	67.05
16	66	85.53	83.33	86.00	73.86	92.87	66.67	98.78	73.86
18	48	27.46	25.00	43.00	22.73	37.32	41.67	45.73	22.27
Mean Marks (%)		**70.60**	**60.42**	**81.75**	**53.41**	**75.32**	**64.59**	**85.82**	**60.97**

Of the sixteen pairs of pre- and post-test events in the first explicit instruction classroom (Explicit Instruction 1), 62.50% of the students improved, 31.25% neither regressed nor improved while 6.25% regressed.

Table 4.28 shows the pre-test and post-test results of the students in the second classroom (n_2 = 3) that were subjected to explicit instructional approach. For the second classroom of students that were instructed under the explicit approach (Explicit Instruction 2), the results were mixed. Considering the performance of the class group as a whole, the students made some improvements as indicated by the difference in mean marks of the pre-test and post-test which were 21.29 % (Test 1) and 9.09% (Test 4). While the group maintained about the same average pre-test and post-test marks for Test 3, the group regressed in Test 2.

Table 4.28

Explicit Instruction - Group 2

		Pre-intervention				**Post-intervention**			
ID Code	**IQ**	**Test 1 (%)**	**Test 2 (%)**	**Test 3 (%**	**Test 4 (%)**	**Test 1 (%)**	**Test 2 (%)**	**Test 3 (%**	**Test 4 (%)**
22	60	54.72	41.67	74.00	25.00	87.00	8.33	78.05	43.18
25	69	48.63	75.00	93.00	29.55	70.27	25.00	84.15	34.09
23	53	51.36	66.67	90.00	50.00	61.32	25.00	93.90	54.55
Mean Marks (%)		**51.57**	**61.11**	**85.67**	**34.85**	**72.86**	**19.44**	**85.37**	**43.94**

Individually, the performances of students at the beginning and end of this study were very inconsistent. One example of this inconsistency was demonstrated by Student 22 who made improvements of 32.28% (Test 1), 4.05% (Test 3) and 18.18 (Test 4) but regressed significantly in Test 2 (Table 4.28). As another example, Student 25 seems to have responded well to instruction with improvements of 21.64% (Test 1) and 4.54% (Test 4) but improvements were not demonstrated in Tests 2 and 3. Similarly, Student 23 made improvements in Test 1 (9.96%), Test 3 (3.9%) and Test 4 (4.55%) and regressed in Test 2 (Table 4.28). At the time of the study, Students 22, 23 and 25 were going through personal issues that will not be elaborated upon to protect their identities and these difficulties could have impacted negatively on their performances in the tests.

Overall, the results demonstrate that explicit instruction was effective in teaching students with borderline, mild and moderate ID.

Considering the two explicit groups together (Table 4.29), an overwhelming number (71.43%) of students subjected to explicit instruction made improvements ranging from 0.87% to 7.74% (average of the four Tests) during the period of the study.

Table 4.29

Explicit Instruction - Whole Group (Explicit Instruction Groups 1 and 2 combined).

		Pre-intervention				**Post-intervention**			
ID Code	**IQ**	**Test 1 (%)**	**Test 2 (%)**	**Test 3 (%**	**Test 4 (%)**	**Test 1 (%)**	**Test 2 (%)**	**Test 3 (%**	**Test 4 (%)**
21	79	70.65	75.00	99.00	56.82	77.99	75.00	98.78	80.68
9	63	98.74	58.33	99.00	60.23	93.08	75.00	100.00	67.05
16	66	85.53	83.33	86.00	73.86	92.87	66.67	98.78	73.86
18	48	27.46	25.00	43.00	22.73	37.32	41.67	45.73	22.27
22	60	54.72	41.67	74.00	25.00	87.00	8.33	78.05	43.18
25	69	48.63	75.00	93.00	29.55	70.27	25.00	84.15	34.09
23	53	51.36	66.67	90.00	50.00	61.32	25.00	93.90	54.55
Mean Marks (%)		**62.44**	**60.71**	**83.43**	**45.46**	**74.26**	**45.24**	**85.63**	**53.67**

4.4.2 Effects of explicit-constructivist based approach – ExpliCon. Table 4.30 shows the results of students in ExpliCon group 1 ($n_3 = 4$). Some variations were observed in the individual performances of the students. Student 7 made improvements of 22.01% (Test 1), 25.00% (Test 2) and 7.95% (Test 4) and regressed from 90.00 % to 84.15% in Test 3. Student 10 made improvements of 0.42% (Test 1) and 9.09% (Test 4), had approximately the same marks for pre-test and post-test but regressed in Test 2. Student 17 improved by 5.45% (Test 1) and 1.13% (Test 4) while scoring 100.00% in both pre-test and post-test in Test 3 but regressed from 66.67% to 58.33% in Test 2. Student 8 only improvement was in Test 3 (12.9%), having about the same pre-test and post-test marks for Tests 1 and 4 as well as regressing in Test 2.

Table 4.30

Explicit-Constructivist based approach Group 1 – ExpliCon 1

		Pre-intervention				**Post-intervention**			
ID Code	**IQ**	**Test 1 (%)**	**Test 2 (%)**	**Test 3 (%**	**Test 4 (%)**	**Test 1 (%)**	**Test 2 (%)**	**Test 3 (%**	**Test 4 (%)**
7	65	75.68	41.67	90.00	37.50	97.69	66.67	84.15	45.45
10	62	98.32	66.67	99.00	56.82	98.74	50.00	98.78	65.91
17	55	93.71	66.67	100.00	67.05	99.16	58.33	100.00	68.18
8	44	41.30	16.67	56.00	29.55	42.34	8.33	68.90	29.55
Mean Marks (%)		**77.25**	**47.92**	**86.25**	**47.73**	**84.48**	**45.83**	**87.96**	**52.27**

Student 8 had a history of poor retention and therefore her relatively poor response to instruction was anticipated. Taking each student's average marks in the four tests showed that Students 7 and 8 made improvements of 12.28% and 1.4% respectively. The average marks of Student 17 in the four tests at the beginning of the study stayed about the same as at the end (neither made progress nor went backward) but Student 10 regressed from 80.20% (pre-test average) to 78.36% (post-test average). Examining the group performance in each test, it was observed that ExpliCon 1 group made improvements in 75.00% of the tests as indicated by the mean marks of 7.23%, 1.71% and 4.54% for Tests 1, 3 and 4 respectively. As a group, they regressed from 47.92% at the beginning of the study to 45.83% at the end for Test 2.

Table 4.31 shows the results of the students in the second classroom (n_4 = 6) that were instructed under the ExpliCon teaching strategy. Various degrees of improvement were observed among the students across the board. The average improvements made by the entire student group were 22.01% (Test 1), 16.67% (Test 2), 2.31% (test 3) and 5.87% (Test 4).

Table 4.31

Explicit-Constructivist based approach – Classroom 2

		Pre-intervention				**Post-intervention**			
ID Code	**IQ**	**Test 1 (%)**	**Test 2 (%)**	**Test 3 (%**	**Test 4 (%)**	**Test 1 (%)**	**Test 2 (%)**	**Test 3 (%**	**Test 4 (%)**
5	69	53.25	58.33	84.00	50.00	97.06	66.67	97.56	65.91
28	68	71.07	50.00	98.00	71.59	99.79	83.33	100.00	76.14
12	61	95.81	58.33	100.00	70.45	96.86	91.67	100.00	76.14
13	57	85.95	75.00	100.00	54.55	91.19	91.67	100.00	59.09
14	47	63.94	50.00	98.00	43.18	83.23	58.33	97.56	47.73
24	49	56.39	75.00	100.00	56.82	90.36	75.00	98.78	56.82
Mean Marks (%)		**71.07**	**61.11**	**96.67**	**57.77**	**93.08**	**77.78**	**98.98**	**63.64**

Student 5 made improvements of 43.81% (Test 1), 8.34% (Test 2), 13.56% (Test 3) and 15.91% (Test 4). Student 28 showed improvements of varying degree including 28.72% (Test 1), 33.33% (Test 2), 2.00% (Test 3) and 4.55% (Test 4). Similarly, student 12 demonstrated 1.05% (Test 1), 33.34% (Test 2) and 5.69% (Test 4) improvements while achieving identical scores (100.00% in both pre- and post-test) for Test 3. Student 13 made improvements of 5.24 % (Test 1), 16.67% (Test 2) and 4.54 % (Test 4) while achieving same excellent marks (100%) in Test 3 (Pre- and post-tests). The improvements made by student 14 include 19.29% (Test 1), 8.33% (Test 2) and 4.55% (Test 4) while achieving about the same marks in Test 3 – pre- and post-tests. Student 24 made an improvement of 33.97% (Test 1) and achieved identical and near identical pre- and post-tests marks for the other three tests. Each student's average marks in the four tests showed improvements of 20.41%, 17.15%, 10.02%, 6.61%, 7.93% and 8.19% for students 5, 28, 12, 13, 14 and 24 respectively.

Considering the two ExpliCon classrooms together, Table 4.32 reveals both the individual and group performances of the students. While the students generally responded positively to the ExpliCon approach of instruction, the improvements made by each student reflected their individual characteristics. As a whole, the ExpliCon-instructed group of students made improvements of 16.1% (Test 1), 9.17% (Test 2), 2.07% (Test 3) and 5.34% (Test 4). Thus, this outcome of the study has demonstrated that the students in both groups of Explicit-Constructivist-based (ExpliCon) instruction made improvements during the period of the study.

Table 4.32

Explicit-Constructivist based approach – Whole Group (Explicit-Constructivist based approaches 1 and 2 combined).

		Pre-intervention				Post-intervention			
ID Code	**IQ**	**Test 1 (%)**	**Test 2 (%)**	**Test 3 (%**	**Test 4 (%)**	**Test 1 (%)**	**Test 2 (%)**	**Test 3 (%**	**Test 4 (%)**
7	65	75.68	41.67	90.00	37.50	97.69	66.67	84.15	45.45
10	62	98.32	66.67	99.00	56.82	98.74	50.00	98.78	65.91
17	55	93.71	66.67	100.00	67.05	99.16	58.33	100.00	68.18
8	44	41.30	16.67	56.00	29.55	42.34	8.33	68.90	29.55
5	69	53.25	58.33	84.00	50.00	97.06	66.67	97.56	65.91
28	68	71.07	50.00	98.00	71.59	99.79	83.33	100.00	76.14
12	61	95.81	58.33	100.00	70.45	96.86	91.67	100.00	76.14
13	57	85.95	75.00	100.00	54.55	91.19	91.67	100.00	59.09
14	47	63.94	50.00	98.00	43.18	83.23	58.33	97.56	47.73
24	49	56.39	75.00	100.00	56.82	90.36	75.00	98.78	56.82
Mean Marks (%)		**73.54**	**55.83**	**92.50**	**53.75**	**89.64**	**65.00**	**94.57**	**59.09**

4.4.3 Comparing explicit instruction and explicit-constructivist based approach.

Overall, the improvements made by the students under ExpliCon were more pronounced and substantial than those observed under explicit instruction. The average marks achieved by students in the tests (including pre- and post-) under the two different instructional approaches were 63.86% (explicit instruction) and 72.99% (ExpliCon), thus suggesting that ExpliCon is a more effective instructional approach for teaching students with ID than explicit instruction. Amongst the benefits of ExpliCon is the fact that it makes provision for high-functioning students with ID to be adequately challenged through the incorporation of *elaboration* (extension) in its sequence.

Section 4.5 Research Question 4: What Numeracy Assessment Tool among those examined is most appropriate for Students With ID?

This component of the study focused on the development and evaluation of an assessment tool in mathematics that is appropriate for students with ID and other students experiencing severe Mathematics difficulty – an assessment tool whose development and conditions of administration are considerate of the learning characteristics of individuals with intellectual disability.

4.5.1 The development of IMPELS. IMPELS, an acronym for Individualised Mathematics Planning and Evaluation of Learning for Students with Intellectual Disability (Enoma and Malone, 2015b) was one of the four number sense instruments used in this study. The development of IMPELS drew on the work of Clarke and Shinn (2004); R. Reys, B. Reys, McIntosh, Emanuelsson, Johansson and Yang (1999); Chard, Clarke, Baker, Otterstedt, Braun and Katz (2005); Jordan, Glutting and Ramineni (2008), Clarke, Baker, Smolkowski and Chard,2008), the extensive experience of my supervisor in research on mathematics education and my professional experience while working with students with ID. The original IMPELS had 53 items but after Rasch analysis was conducted, it was observed that one item (Item 50) did not fit and was removed.

IMPELS is organised into six sections consisting of the essential mathematical elements of the conceptual domain of adaptive functioning and number sense, including oral counting, number identification and representations (including cardinal numbers, money, time and counting the number of colours), number writing, quantity discrimination, missing number measure and knowledge of number operations (Appendix S). The first section (made up of 6 items) covers various aspects of oral counting including counting consecutive numbers, one-to-one correspondence and skip counting. The second section (27 items) focuses on number identification under different contexts including time and money. The third section measures the number writing competence of the student and comprises of two main items. The first of this item has 4 sub-items while the other has 5 sub-items, (for example "write the number 7"). The fourth section is dedicated to measuring quantity discrimination. This section of IMPELS consists of one main item with 10 sub-parts and each sub-item requires the assesse to identify the 'smaller' and 'bigger number from a given pair. The fifth section (One main item with sub-items) focuses on the identification of missing numbers from a given table of numbers. The final section has 16 items focusing on number operations.

The IMPELS tool is to be used for the (1) collection of baseline data on a student prior knowledge and understanding of number sense to facilitate the development of an IEP and (2) monitoring of the progress being made by individual students after a period of instruction. According to the Intellectual Disability Rights Service Inc (2009), people with ID take longer time to learn things, have difficulty reading and writing, encounter problem with comprehension and struggle with abstract concepts among other difficulties. Individuals with ID experience difficulty with processing information (Rhea, 2008) and the processing time differs from one person to the other. The above factors and other salient characteristics of students with ID were taken into consideration in both the development and administration of IMPELS as indicated in Table 4.38 following:

Table 4.33

Characteristics of individuals with ID catered for in the development and administration of IMPELS.

Some Characteristics of Students with ID catered for in IMPELS	Why IMPELS is suitable for Students with ID
1. Take longer time to learn information (Intellectual Disability Rights Service Inc, 2009, p. 2)	Students can take as much time as they require to answer each question – IMPELS is untimed.
2. Difficulty with processing information (Rhea, 2008, p. 208)	The tester uses a stopwatch or any other appropriate device (e.g. Ipad) to record the time taken (seconds) to answer each question.
3. Have difficulty reading and writing (Intellectual Disability Rights Service Inc, 2009, p. 2)	The test is administered individually and orally
4. Struggle with abstract concepts (Intellectual Disability Rights Service Inc, 2009, p. 2)	Inclusion of concrete objects in the test
5. Struggle with comprehension (Intellectual Disability Rights Service Inc, 2009, p. 2)	The tester explains the question where necessary
6. Some students with ID are non-verbal	Test is administered individually and therefore the tester adapts the test to the needs of each student in accordance with the philosophy of individualized education as per usual practice.
7. Some students have hearing impairments	Test is administered individually and therefore the tester adapts the test to the needs of each student in accordance with the philosophy of individualized education as per usual practice.
8. The test is administered by the usual teacher, education assistant or any other person that is familiar with the student and capable of administering the test to avoid a change in routines that some students with ID may find distressing (Akanksha, Sahil, Preemjit & Bhawna, 2011).	
9. Number writing component is only for those students that have no disability that affects their physical ability to write otherwise adapted to the needs of the student as deemed appropriate.	

IMPELS was validated against three number sense assessment tools. I administered the (1) Delaware Universal Screening Tool for Number Sense Grade 2 (Delaware Department of Education, 2010), (2) Streamlined Number Sense Screening Tool (Jordan, Glutting & Ramineni, 2008), (3) Number knowledge Test (Okamoto & Case, 1996; Okamoto, 2004) and IMPELS (Enoma & Malone, 2015b) to 24 High School students with borderline, mild and moderate ID from Years 8 to 12 at the beginning of the school year to collect baseline data on which the developments of IEPs (numeracy component) were based. The students underwent a semester (6 months) of instruction after which a second round of assessment was conducted using all four assessment tools named above.

4.5.2 Reliability and validity of IMPELS

4.5.2.1 Piloting IMPELS. The piloting process consisted of testing and retesting events both of which were administered at two weeks apart prior to instruction. The outcome of the pilot study on IMPELS is as indicated in Table 4.34. When the data was subjected to statistical analysis using Minitab 17 Statistical Software (2010a), the tool was found to be excellently reliable with a test-retest reliability coefficient of 0.94 (P-Value = 0.002).

Table 4.34

Test and Re-test Reliability Measures of IMPELS

		Test	**Re-Test**
ID Code	**IQ**	**Test 1 (%)**	**Test 1 (%)**
19	71	84.91	88.68
20	76	99.58	99.58
11	57	98.95	88.68
29	61	90.14	91.19
3	40	4.82	5.45
15	52	62.68	81.69
27	52	60.97	83.32

4.5.2.2 Rasch Analysis and the Split-Half Reliability Test. The reliability and validity of IMPELS as a numeracy assessment tool for students with ID were also evaluated using relevant statistical computations as recommended for the construction of test instruments. Rasch analysis was conducted as per standard procedures (Boone, Staver & Yale, 2014; Khairani & Razak, 2012). ConstructMap, a Rasch dichotomous model software developed by Wilson (2005) of the Berkeley Evaluation and Assessment Research Centre at the University of California, Berkeley (USA) was also employed. The Rasch model has been described as "a family of measurement models which converts raw scores into linear and reproducible measurement (Golia 2007, p. 254). It is characterized by item and person parameters and applicable where "all items forming the questionnaire measure only a single construct, i.e. the latent trait under study" (Golia 2007, p. 254). One of the main difficulties associated with any measurement or assessment tool is the interaction between the individual participating in the measurement and the instrument used (Khairani & Razak 2012). The Split-Half Reliability test was carried out on IMPELS to determine the reliability index by coefficient alpha and Kuder-Richardson formula 20 (KR-20). Coefficient alpha is suitable for establishing reliability in instances similar to IMPELS, where scores are calculated by the addition of item scores (Thompson, Green & Yang, 2010). Cronbach's alpha was measured as recommended (Cronbach, 1951; Bland & Altman, 1997; Gliem, J. & Gliem R. 2003).

4.5.3 Assessment of content validity of IMPELS. The content validity of IMPELS was determined and quantified as recommended by Lynn (1986). All four tests were administered anonymously with the names of the authors removed and simply designated as 'Tool 1", 'Tool 2', 'Tool 3' and 'Tool 4' to avoid any bias. Teachers were asked to rank all four tools using selected criteria including (1) suitability for students with intellectual disabilities, (2) suitability for generating information for writing IEPs, (3) suitability for progress monitoring, (4) teacher friendliness (relative ease of administration), (5) student friendliness (structure and language/vocabulary appropriate or close to the level of the majority of students with intellectual disability). The test items and the validity of IMPELS were assessed by five teachers, two of whom had Bachelor of Special Education degrees, one had a Master of Special Education degree (Learning Difficulty) and the remaining two had general Bachelor of Education degrees. Teaching experience of the teachers ranged from 3 years to 14 years in a mainstream educational setting and 1 year 5 months to 8 years in a special school setting for students with ID. While at this school, all teachers had received various professional learning opportunities targeted at improving their knowledge and understanding of the learning characteristics of students with ID and how to cater effectively for their learning needs.

4.5.4 The evaluation of IMPELS

4.5.4.1 Linear regression graphs. As the sample size was less than 30 (n=24), Anderson-Darling normality tests were conducted on the data collected with IMPELS and the other 3 instruments using MINITAB 17 statistical software (2010a).

Of the total 8 sample groups (pre- and post-instruction), 3 were found to be normally distributed while 5 were not (Appendices K-R). Confronted with this situation, it was decided that it was more appropriate to calculate both Pearson and Spearman's Rho correlation coefficients as well as their *P* values for better appreciation of the relationship between IMPELS (Enoma & Malone, 2015b) and the other tools investigated. Pre-instruction Pearson correlation coefficients (R) of 0.70, 0.78 and 0.74 and post-instruction Pearson correlation coefficients (R) of 0.73, 0.91 and 0.76 were obtained for the Delaware Universal Screening Tool for Number Sense (Delaware Department of Education, 2010), Streamlined Number Sense Screening Tool (Jordan, Glutting & Ramineni, 2008) and the Number Knowledge Test (Okamoto & Case, 1996; Okamoto, 2004) respectively. Pre-instruction Spearman's Rho correlation coefficients (R) of 0.45, 0.56 and 0.70 and post-instruction Spearman's Rho correlation coefficients (R) of 0.53, 0.68 and 0.68 were obtained for the Delaware Universal Screening Tool for Number Sense, Streamlined Number Sense Screening Tool and the Number Knowledge Test respectively. All correlations were statistically significant at $P<0.01$) save for Spearman's Rho correlation for IMPELS versus the Delaware Universal Screening Tool for Number Sense (pre-instruction) which was found to be statistically significant at $P< 0.05$. The 'moderately high' to 'high' correlation coefficients obtained suggest a strong construct validity for IMPELS. It has been acknowledged that strong construct validity is suggested where there is an established relationship of convergent and divergent nature between instruments (Jordan, Glutting & Ramineni, 2008). Considering that IMPELS and the other three tests measure one common numeracy skill area (number sense), a strong relationship was to be expected.

4.5.4.2 Reliability of IMPELS. The Cronbach's alpha and Split-Half Reliability calculated for IMPELS were both 0.96 (Tables 4.35, 4.36 and Appendices T and U) suggesting an excellent degree of consistency and reliability (George & Mallery, 2003, p. 231; Bland & Altman 1997). The person reliability as indicated by Cronbach's alpha in Tables 4.35, 4.36 and Appendix U was 0.96, suggesting a good estimate of students' ability as measured with IMPELS.

Table 4.35

IMPELS - Reliability Measurement

ID	Item 1	Item 2	Item 3	Item 4	Item 5	. . .	Item 52	Item 53	Total score
1	1	1	1	0	1	. . .	0	1	**42**
2	1	1	1	1	1	. . .	1	1	**45**
3	0	0	0	0	0	. . .	0	0	**14**
4	1	1	1	1	1	. . .	1	1	**47**
5	1	1	1	0	1	. . .	1	1	**49**
6	1	1	1	1	1	. . .	1	1	**45**
7	1	1	1	0	1	. . .	1	0	**36**
8	0	0	0	0	1	. . .	0	0	**23**
9	1	1	0	0	0	. . .	0	1	**32**
10	1	0	1	0	0	. . .	0	0	**29**
11	1	1	1	0	1	. . .	0	0	**30**
12	1	1	1	0	1	. . .	1	1	**45**
13	1	1	1	1	1	. . .	0	1	**48**
14	1	1	0	0	1	. . .	1	1	**37**
15	1	1	1	0	1	. . .	0	1	**34**
16	1	1	1	0	1	. . .	1	1	**44**
17	0	0	0	0	0	. . .	0	0	**5**
18	1	1	1	1	1	. . .	1	1	**51**
19	1	1	1	0	1	. . .	0	1	**39**
20	1	0	0	0	1	. . .	1	1	**41**
21	1	1	1	1	1	. . .	1	1	**50**
22	1	1	1	0	1	. . .	1	1	**41**
23	1	0	0	0	1	. . .	1	1	**41**
24	1	0	0	1	1	. . .	1	1	**49**
***NCA**	**21**	**17**	**16**	**7**	**20**	. . .	**14**	**18**	
***PP(P)**	**0.88**	**0.71**	**0.67**	**0.29**	**0.83**	. . .	**0.58**	**0.75**	
***PF (q)**	**0.12**	**0.29**	**0.33**	**0.71**	**0.17**	. . .	**0.42**	**0.25**	
pq	**0.11**	**0.21**	**0.22**	**0.21**	**0.14**	. . .	**0.24**	**0.19**	**7.2975**

NCA = Number of correct answers; PP = Proportion passed; PF = Proportion failed

Table 4.36

Data used for the calculation of Crobach's Alpha

ID	Item 1	Item 2	Item 3	Item 4	Item 5	. . .	Item 52	Item 53	Total score
1	1	1	1	0	1	. . .	0	1	**42**
2	1	1	1	1	1	. . .	1	1	**45**
3	0	0	0	0	0	. . .	0	0	**14**
4	1	1	1	1	1	. . .	1	1	**47**
5	1	1	1	0	1	. . .	1	1	**49**
6	1	1	1	1	1	. . .	1	1	**45**
7	1	1	1	0	1	. . .	1	0	**36**
8	0	0	0	0	1	. . .	0	0	**23**

9	1	1	0	0	0	. . .	0	1	**32**
10	1	0	1	0	0	. . .	0	0	**29**
11	1	1	1	0	1	. . .	0	0	**30**
12	1	1	1	0	1	. . .	1	1	**45**
13	1	1	1	1	1	. . .	0	1	**48**
14	1	1	0	0	1	. . .	1	1	**37**
15	1	1	1	0	1	. . .	0	1	**34**
16	1	1	1	0	1	. . .	1	1	**44**
17	0	0	0	0	0	. . .	0	0	**5**
18	1	1	1	1	1	. . .	1	1	**51**
19	1	1	1	0	1	. . .	0	1	**39**
20	1	0	0	0	1	. . .	1	1	**41**
21	1	1	1	1	1	. . .	1	1	**50**
22	1	1	1	0	1	. . .	1	1	**41**
23	1	0	0	0	1	. . .	1	1	**41**
24	1	0	0	1	1	. . .	1	1	**49**
Total	**21**	**17**	**16**	**7**	**20**	. . .	**14**	**18**	
Var	**0.1094**	**0.2066**	**0.2222**	**0.2066**	**0.1389**	. . .	**0.2431**	**0.1875**	**7.30**

4.5.4.3 Content validity of IMPELS. Teachers rated IMPELS on a scale of 1 to 4 across six criteria on its suitability for students with ID (1 being least and 4 most suitable) (Tables 4.37 and 4.38).

Table 4.37 shows the strong pre-instruction approval ratings/marks that IMPELS received from the teachers.

Table 4.37

Ranking of the four assessment tools by teachers — pre-intervention

#	Teachers Rating Items	1,2,3, 4, 5 IMPELS	1,2,3, 4, 5 Test 2	1,2,3, 4, 5 Test 3	1,2,3, 4, 5 Test 4
1	Suitable for students with intellectual disability (level of difficulty, etc)	3+2+2+3+4 = **14**	4+4+4+2+3 = **17**	2+3+3+4+2 = **14**	1+1+1+1+1 = **5**
2	Addresses the Mathematics curriculum for students with intellectual disability (e.g. relevance to students with intellectual disability, functional Mathematics, etc)	3+4+4+4+4 = **19**	4+3+3+2+2 **14**	2+2+2+3+3 = **12**	1+1+1+1+1 = **5**
3	Suitable for generating information for writing IEPs for students	3+4+4+4+4 = **19**	4+2+2+2+3 = **13**	2+3+3+3+2 = **13**	1+1+1+1+1 = **5**
4	Suitable for progress monitoring	3+4+4+4+3 = **18**	4+2+2+1+1 = **10**	2+1+3+3+4 = **13**	1+3+1+2+2 = **9**
5	Teacher-friendliness (relative ease of administration)	2+4+2+2+2 = **12**	4+3+4+3+3 = **17**	3+2+3+4+4 = **16**	1+1+1+1+1 = **5**
6	Student-friendliness (orally administered)	4+4+3+2+2 = **15**	3+3+4+3+3 = **16**	2+2+2+4+4 = **14**	1+1+1+1+1 = **5**
	Total	**97**	**87**	**82**	**34**

Test 1 = IMPELS (Enoma & Malone, 2015)
Test 2 = the Delaware Universal Screening Tool for Number Sense Grade 2 (Delaware Department of Education, 2010),
Test 3 = Streamlined Number Sense Screening Tool (Jordan, Glutting & Ramineni, 2008),
Test 4 = Number knowledge Test (Okamoto & Case, 1996)

The pre-instruction approval ratings were 75% for criterion 1 (Suitable for students with intellectual disability), 95% for criterion 2 (Addresses the Mathematics curriculum for students with intellectual disability – e.g. relevance to students with intellectual disability, functional Mathematics, etc), 95% for criterion 3 (Suitable for generating information for writing IEPs for students), 90% for criterion 4 (Suitable for progress monitoring), 60% for criterion 5 (Teacher-friendliness - relative ease of administration) and 75% for criterion 6 (Student-friendliness - orally administered).

Table 4.38 shows the similarly strong post-instruction approval ratings/marks that IMPELS received from the teachers.

Table 4.38

Ranking of the four assessment tools by teachers — post intervention

#	Teachers Rating Items	1,2,3, 4, 5 *IMPELS	1,2,3, 4, 5 *Test 2	1,2,3, 4, 5 *Test 3	1,2,3, 4, 5 *Test 4
1	Suitable for students with intellectual disability (level of difficulty, etc)	4+4+2+1+4 = **15**	2+3+4+4+3 = **16**	3+2+3+3+2 = **13**	1+1+1+2+1 = **6**
2	Addresses the Mathematics curriculum for students with intellectual disability (e.g. relevance to students with intellectual disability, functional Mathematics, etc)	4+4+2+1+4 = **15**	1+2+4+3+3 = **13**	3+3+3+4+2 = **15**	2+1+1+2+1 = **7**
3	Suitable for generating information for writing IEPs for students	4+4+2+4+4 = **18**	1+1+4+1+1 = **8**	2+3+3+2+2 = **12**	3+2+1+3+3 = **12**
4	Suitable for progress monitoring	4+4+2+4+4 = **18**	1+1+4+1+1 = **8**	2+3+3+2+2 = **12**	3+2+1+3+3 = **12**
5	Teacher-friendliness (relative ease of administration)	3+1+2+1+2 = **9**	4+4+4+4+4 = **20**	2+3+3+2+3 = **13**	1+2+1+3+1 = **8**
6	Student-friendliness (structure and language/vocabulary appropriate or close to the level of the majority of students with intellectual disabilities)	3+4+2+2+2 = **13**	4+3+4+4+4 = **19**	2+2+3+3+3 = **13**	1+1+1+1+1 = **5**
	Total	**88**	**84**	**75**	**50**

The post-instruction approval ratings were 75% for criterion 1 (Suitable for students with intellectual disability), 75% for criterion 2 (Addresses the Mathematics curriculum for students with intellectual disability – e.g. relevance to students with intellectual disability, functional Mathematics, etc.), 90% for criterion 3 (Suitable for generating information for writing IEPs for students), 90% for criterion 4 (Suitable for progress monitoring), 45% for criterion 5 (Teacher-friendliness - relative ease of administration) and 65% for criterion 6 (Student-friendliness - orally administered).

The one-to-one and oral administration of the test requires extra involvement from testers than conventional assessment tools in mathematics and these were acknowledged positively by the teachers. The benefits of IMPELS as recognised by the teachers in their responses to rating criteria 1 to 4 far outweigh the extra involvement of testers. Comparing IMPELS to the other 3 instruments across all six criteria, the teachers consistently rated IMPELS as the most appropriate tool for students with ID during both pre- and post- instruction reviews.

4.5.4.4 RASCH analysis. As indicated earlier, the Rasch model has been described as “a family of measurement models which converts raw scores into linear and reproducible measurement (Golia 2007, p. 254). It is characterized by item and person parameters and applicable where “all items forming the questionnaire measure only a single construct, i.e. the latent trait under study” (Golia 2007, p. 254).

According to Weesie (n.d.), the Rasch model can be written as a logit-linear model:

logit Pr(y(i j)=1 | eta(i)) = eta(i) − theta(j).

where eta(i) is a person’s ability parameter, theta(j) is the item-difficulty parameter, and y(ij) is the binary response parameter. Thus, the logit is an expression of the relationship between a person’s ability parameter and item-difficulty parameter.

The logits provided an estimation of the ability or competence of each student that was assessed using IMPELS – the higher the logit the higher the ability of the student and vice versa. For this purpose, each correct answer was scored a one while each wrong answer was scored a zero. For example, the top student (with an estimated logit of between 5.4 and 5.5) correctly responded to 51 items with only two items wrong. Hence, student 18 is top on the ability estimate scale with an estimated logit of about 5.8 (Figure 4.35).

A Wright Map is a map of students’ current proficiency levels versus item difficulties situated on the logit scale (Berkeley Evaluation and Assessment Research Centre, 2010). It indicates the distribution of student proficiencies against item difficulties (Berkeley Evaluation and Assessment Research Centre, 2010). The Wright Map for the 24 students that participated in the assessment using IMPELS is as displayed in Figure 4.35. The first column of data commencing from the left edge displays the logits scale from -6 (the lowest ability level) to +6 (the highest ability level). The second column of data from the left which bears the labelling ‘raw’ shows the raw scores obtained by the 24 students that participated in IMPELS. Each raw score represents the sum of correct responses achieved by a student. The next column labelled ‘students’ indicates each student’s competence in which ‘X’ represents a student’s position along the logit scale. There are 24 Xs under the ‘students’ column − one X per student that participated in the test. When the column labelled ‘students’ is matched with the ‘raw’ column, it shows the number of students who have achieved a particular raw score. For example, three students achieved the scores of 5, 14 and 23 respectively (Figure 4.35). Three other students had the same score of 41 and another three students had the same sore 45 respectively (Figure 4.35).

```
Logits
          ====================================================
             Raw        Students            Thurstonian Thresholds
       -----------------------------------------------------------
6 |                 |
  |                 |                      Item 50.1
  |          51               X|
  |                  |
5 |          50               X|
  |                            |           Item 51.1
  |          49              XX|           Item 48.1
  |          48               X|             Item 33.1
4 |          47               X|             Item 20.1
  |                  |                       Item 4.1 Item 45.1 Item 46.1
  |          45             XXX|
  |          44               X|
3 |                  |
  |          42               X|              Item 49.1
  |          41             XXX|          Item 21.1 Item 28.1
  |          39 --------------X|             Item 29.1
2 |                  |
  |          37               X|             Item 19.1 Item 22.1 Item 31.1 Item
32.1 ...
  |          36               X|             Item 47.1
  |          34               X|
1 |          32               X|             Item 3.1
  |                            |             Item 2.1 Item 39.1 Item 40.1
  |                            XX|           Item 12.1 Item 53.1
0 |                            |             Item 44.1
  |                            |
  |                            |             Item 6.1 Item 37.1 Item 43.1
  |          23               X|
-1|                            |              Item 5.1 Item 30.1 Item 36.1 Item
38.1
  |                            |
  |                            |
  |                            |              Item 1.1 Item 27.1 Item 34.1
-2|                            |              Item 16.1 Item 23.1
  |                            |              Item 15.1 Item 42.1
            |14               X|
  |                            |
-3|                            |              Item 25.1 Item 26.1 Item 35.1
  |                            |               Item 18.1 Item 24.1
  |                            |               Item 17.1
```

```
  |                        |              Item 14.1
-4 |                       |              Item 13.1
  |                        |
  |                        |              Item 11.1
  |          5            X|              Item 9.1
-5|                        |              Item 7.1
  |                        |
  |                        |
  |                        |
-6 |           |
==========================================
```

Each X represents one student, each row is 0.255 logits (represented by a bar (|) on the logits scale (first column of data commencing from the left edge)

Model Specifications:
Measurement Model = Dichotomous
Proficiency Estimation Method = EAP
Maximum Logit = 6.00
Minimum Logit = -6.00
Integration Method = Monte Carlo
Quadrature Nodes = 2000
EM convergence criteria = 0.001

Figure 4.35: Wright map for IMPELS' items

There are two categories of raw scores − disclosed and undisclosed raw scores. Raw scores are displayed or disclosed on a row only in instances where the proficiency level is equivalent to the raw score (Berkeley Evaluation and Assessment Research Centre, 2010). Examples of raw scores that are disclosed or displayed include 5, 14, 23 and 47 with indicated proficiency levels of -4.745, -2.49, -0.745 and 4.00 logits respectively, considering that each row on the logits is scaled is 0.255 (Figure 4.35). Notice that the entry "XX Item12.1 Item 53.1" on the students' column relates to a point oriented between 0 and 1 on the logits scale and no raw mark is indicated for this point on the "raw scores" column (Figure 4.35). This implies that there are two students whose scores are above the pass mark (0 logit) but their proficiencies as measured using IMPELS are lower than the suggested logit(s). Where scores are not displayed against 'X', 'XX' or 'XXX' (Figure 4.35), it signifies that the suggested logits are higher than the students' proficiency levels and hence the scores were omitted. For this purpose, each correct answer was scored a one while each wrong answer was scored a zero.

The last column, labelled "Thurstonian Thresholds" (Figure 4.35), indicates the threshold for every non-zero score for each IMPELS test item. Under the "Thurstonian thresholds" column, IMPELS test items are arranged in ascending order of increasing difficulty. Thurstonian thresholds are also the points or locations at which students possess a 50% probability of achieving that score or higher (Berkeley Evaluation and Assessment Research Centre, 2010). For example, the Thurstonian threshold of 1 for Item 3 (represented as Item 3.1) (Figure 4.35) implies that respondents with proficiency of 1.0 logits are as likely to pass Item 3 as they are of failing it.

Table 4.39 shows the Ability Estimates report of the 24 students that participated in the assessment using IMPELS. Table 4.39 supplements Figure 4.35 by providing additional information such as the identities of all the students which are needed for the interpretation of the Wright map. The Ability Estimates report provides a catalogue of each student's proficiency estimate. The participant data is presented in rows, one row per student. Being an estimation of the ability of the students as assessed using IMPELS, the raw scores displayed in Table 4.39 are scaled down (-2) in harmony with their computed ability levels and therefore differ from the raw scores displayed by the Wright map. Unlike the Wright map which displays data in the order of the students' ability, the ability estimates report presents results/data in the order of data entries. For example, student "16" data was entered first into the ConstructMap software (Wilson, 2005), followed by student "21", student "18" and so on. One example of how to read Table 4.39: student "# 1" whose real name is coded 16 had an estimated ability level of 2.73 logits based on his/her performance in IMPELS. We can also see from Table 4.39 that student "#18" whose real name is coded 20 was the most able student as demonstrated by the estimated ability level of 5.40 logits (higher than any other student) based on his/her performance in IMPELS.

Table 4.39

Ability Estimates report of Students that took IMPELS

#	Name	Raw	Max	Est.	Err.	Infit	T	Outfit	T
1	16	40	53	2.72851	0.47043	1.48	1.63	1.13	0.75
2	21	43	53	3.41761	0.49690	0.76	-0.79	0.29	0.72
3	18	12	53	-2.4285	0.45047	1.01	0.12	1.44	0.84
4	9	45	53	3.95233	0.53695	0.50	-1.93	0.16	0.78
5	17	47	53	4.57148	0.58107	0.66	-1.00	0.18	1.47
6	10	43	53	3.41761	0.49690	1.13	0.53	0.52	0.86
7	7	34	53	1.52578	0.40998	0.70	-1.38	0.57	-0.07
8	8	21	53	-0.7585	0.41600	0.70	-1.35	0.39	-0.52
9	25	30	53	0.82673	0.43487	1.05	0.27	1.05	0.38
10	23	27	53	0.27558	0.41609	0.73	-1.21	0.41	-0.73
11	22	28	53	0.45260	0.42556	0.82	-0.75	0.47	-0.58
12	29	43	53	3.41761	0.49690	0.58	-1.57	0.21	0.65
13	11	46	53	4.25042	0.55501	1.62	1.73	0.93	1.40
14	15	35	53	1.69804	0.42132	1.25	1.07	12.10	3.69
15	27	32	53	1.19042	0.41530	0.83	-0.69	0.53	-0.25
16	19	42	53	3.17869	0.48178	0.88	-0.36	0.64	0.66
17	3	3	53	-4.6412	0.74244	1.29	0.75	0.68	3.16
18	20	49	53	5.40159	0.73091	0.54	-1.18	0.12	2.13
19	14	37	53	2.08065	0.45270	0.99	0.03	0.59	0.07
20	5	39	53	2.50810	0.46832	1.10	0.44	0.63	0.37
21	12	48	53	4.93812	0.63599	0.54	-1.40	0.13	1.65
22	13	39	53	2.50810	0.46832	0.90	-0.32	0.76	0.47
23	24	39	53	2.50810	0.46832	0.72	-1.10	0.41	0.18
24	28	47	53	4.57148	0.58107	1.59	1.55	13.37	2.52
	Average	36	53	2.14964	0.50223	0.93	-0.29	1.57	0.86

```
====================================================================
Student count    = 24
Average EAP      = 2.14964
EAP Variance     = 5.63217
SE of the Mean   = 0.48443
Model Variance   = 5.44572
Person sep. rel. = 0.95372
MML (EAP/PV) rel. = 1.03424
=============================================================================
Cronbach's Alpha:  0.96148 (0% data missing)
  Model Specifications:
Measurement Model             = Dichotomous
Proficiency Estimation Method = EAP
Maximum Logit                 = 6.00
Minimum Logit                 = -6.00
Integration Method            = Monte Carlo
Quadrature Nodes              = 2000
EM convergence criteria       = 0.001
EM best fit iteration limit   = 10
Maximum EM Iterations         = 200
Newton-Raphson Iteration Limit = 10
Newton-Raphson Convergence Cri = 0.001
```

Figure 4.36 portrays the frequency map of the ability of students as measured using IMPELS assessment tool. It is evident from Figure 4.36 that 21 students passed the test (IMPELS) while 3 students did not have the ability to be successful in the test and the performances of the latter group were very far behind the former. Figure 4.36 also demonstrates a wide difference in ability levels among the students that failed the test as evident from the logits of -5, -2.9 and -1 for students 17, 5 and 8 respectively. These students will require significant support and explicit instruction to move them higher on the ability scale. For student 17 with the extremely low ability level of -5 logits, an alternative assessment may be needed as IMPELS seems to be far above the student's ability level.

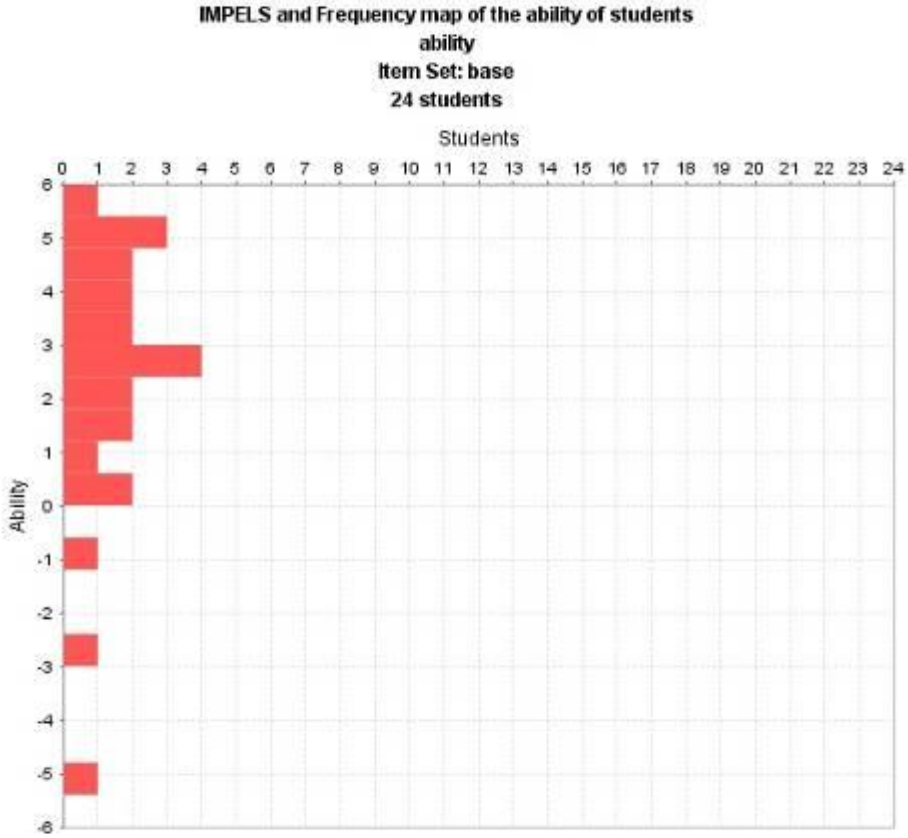


Figure 4.36: IMPELS and frequency map of the ability of students

Figure 4.37 demonstrates that the majority of the students passed item 1 of the test. It also shows the probability of students failing and passing item 1 were 0.25 and 0.75 respectively.

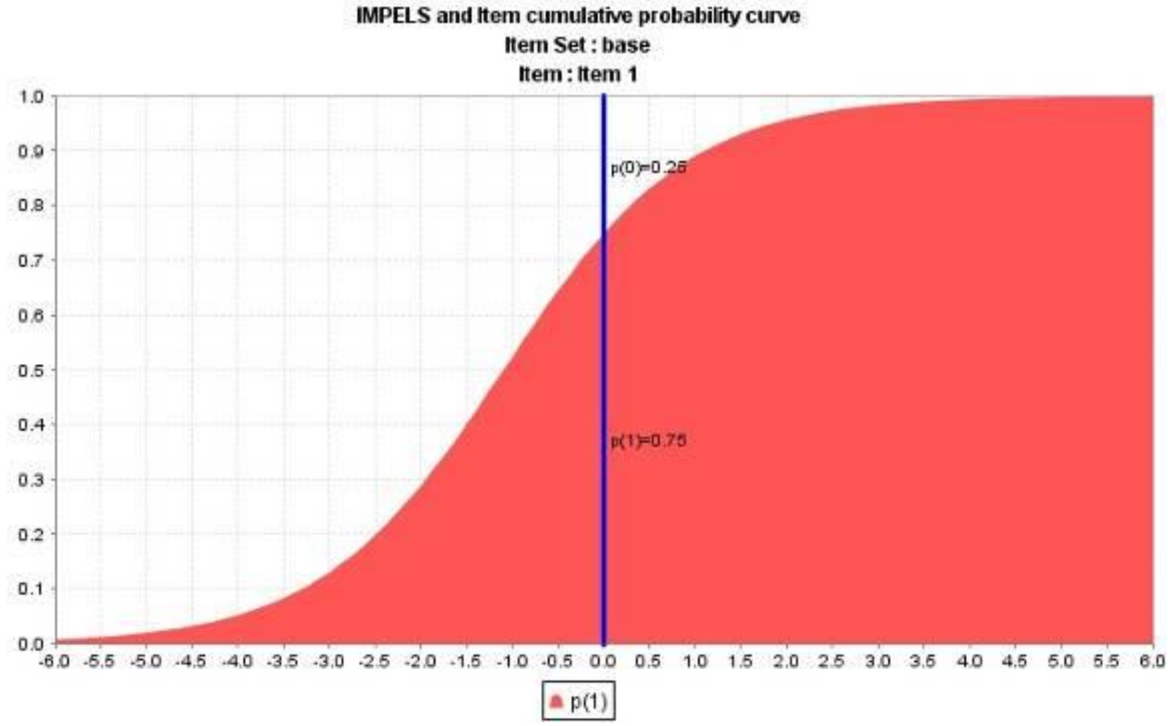


Figure 4.37: IMPELS and item cumulative probability curve

All 24 students (100% of participants) answered items 8 and 10 correctly while only two students (approximately 8% of all students) answered item 50. This suggests that students found items 8 and 10 too easy while they found item 50 to be too hard. The inclusion of item 50 (“17 x 15”) was an attempt to measure the ability of the students to multiply double-digit numbers. As a background to items 8 and 10, students were provided with a box containing 3 yellow, 2 blue, 5 red and 6 green counters. For item 8, students were asked “How many yellow?” and for item 10, students were asked “How many blue?” The inclusion of items 8 and 10 was aimed at including those students that may have very low ability in numeracy. Parmenter and Wardle (2000, p. 273) have noted that “if fewer than 20% of respondents answer an item correctly it is too difficult, and if more than 80% of respondents answer an item correctly it is too easy. On the basis of this analysis, it was resolved to exclude item 50 from the final IMPELS. However, considering the encompassing focus of IMPELS, and to make it available to students with severe and profound levels of intellectual disabilities as well as the opportunity it offers for concrete and visual measurement of a student’s numeracy ability, it was considered that there exists considerable benefit in retaining both items 8 and 10 in the final version of IMPELS. In making final decisions in relation to items that fall outside the item facility indices of 0.2 and 0.8, it is important and acceptable for the developer of the tools measuring instruments to exercise discretion (Parmenter & Wardle, 2000).

The person reliability was identical to the calculated $P_{RK20\ alpha}$ of 0.96.

4.5.5 IMPELS – Summary of Findings. Results emerging from this study strongly endorsed IMPELS as an appropriate numeracy assessment tool for students with intellectual disability and others with severe difficulty in Mathematics. Its construction and conditions of administration were highly regarded by reviewers as considerate of the learning characteristics of individuals with intellectual disability. The usefulness of IMPELS for the collection of baseline data to inform the development of IEPs/EAPs and for monitoring the progress of learning of individual students were similarly acknowledged.

4.6 Summary of Chapter

This chapter was dedicated to providing answers to my four research questions which were discussed in Chapters 1 and 3. The chapter described the analyses of the factors impacting on the mathematics achievement of students with borderline, mild and moderate ID.

The research questions included, (1) Do students with borderline, mild and moderate intellectual disabilities possess specific number sense skills that distinguish members of one group from the other? (2) What are the effects of age, gender, student and teacher factors on the number sense achievements of students with borderline, mild and moderate intellectual disabilities? (3) What are the effects of explicit instruction and an explicit-constructivist based approach on the development of number sense among high school students with borderline, mild and moderate intellectual disabilities? and, (4) What numeracy assessment tool among those examined in the study is most appropriate for students with ID? This chapter commenced with a report of the analyses for research question 1: Do students with borderline, mild and moderate intellectual disabilities possess specific number sense skills that distinguish members of one group from the other? To answer this research question, 24 students with ID comprising three students with borderline ID, thirteen students with mild ID and eight students with moderate ID were assessed using four number sense assessment tools at both the pre-intervention and post-intervention phases of the study. The tools used included IMPELS (Enoma & Malone, 2015b), the Delaware Universal Screening Tool for Number Sense Grade 2 (Delaware Department of Education, 2010), the Streamlined Number Sense Screening Tool (Jordan, Glutting & Ramineni, 2008) and the Number Knowledge Test (Okamoto & Case, 1996; 2004).

The group achievements and individual achievements of the students were evaluated. When the mathematics achievements of the three groups of ID (borderline, mild and moderate) considered in this study were compared, the results that emerged from this section of the study showed performances in the order of:

borderline (first)→mild (second) →moderate (third)

However, the difference in scores between the students with borderline and mild ID groups were only about 9.00%. Similarly, students with mild ID group outscored those with moderate group by about 20.00%. A comparison of the individual mathematics achievements of the students across the three cognitive ability-based categories (borderline, mild and moderate) showed several instances of students with lower IQs outperforming those with IQs above them. This finding, suggests that the mathematics achievements of students with ID, (particularly those with borderline, mild and moderate ID) is an interplay between IQ and the individuality of students and the wider the difference in IQ the bigger the difference in mathematics achievements. This is in harmony with previous observation that “negative attitudes, rather than a lack of innate talent, are at the root of our numeracy crisis” (National Numeracy for Everyone, for Life, 2015, p. 1).

The next section focused on evaluating the impacts of student-related and teacher-related factors on the mathematics achievements of students with ID in response to research question 2. The student-related factors covered included their mathematics self-efficacy and the sources of self-efficacy; anxiety; age; gender, and the social and emotional states factor. This section of the study also extended to evaluating the mathematics teaching Efficacy beliefs of teachers (a teacher-related factor). The outcome of this section of the study has demonstrated that age has no influence on the mathematics achievements of the students that participated in this study. In relation to the sources of self-efficacy and gender, the outcomes of this aspect of the study suggest that social persuasions and vicarious experience are the principal sources of self-efficacy for male and female students with ID respectively. It also emerged from the study that mathematics anxiety is a significant problem amongst students with ID. While the mathematics teaching efficacy beliefs of teachers were relatively high at both the pre-intervention and post-intervention phases of the study, there was a pronounced gap in their ability to provide adequately for the learning needs of students with high needs.

Regarding research question 3, the effects of explicit instruction and ExpliCon (a hybrid of explicit instruction and constructivist-based approach) were compared. While both instructional approaches were found to be effective for high school students with ID, Explicon was found to be more effective. Explicon has the added advantage of making provisions for the extension of higher ability students with ID, thus, ensuring that teachers of students with ID have high expectations of their students and extend them as the needs arise.

The last section of this chapter focused on the development and evaluation of IMPELS in response to research question 4. The development of IMPELS followed similar paths as other mathematics assessment tools in the literature (Clarke & Shinn, 2004; R. Reys, B. Reys, McIntosh, Emanuelsson, Johansson & Yang, 1999; Chard, Clarke, Baker, Otterstedt, Braun & Katz, 2005; Jordan, Glutting & Ramineni, 2008; Clarke, Baker, Smolkowski & Chard, 2008). However, the context of the research that informs the development of IMPELS (an educational setting for students with ID) and its focus on the needs of students with ID set IMPELS apart from other mathematics assessment tools in the literature. Independent reviewers have given it a strong endorsement in relation to the suitability of IMPELS for the mathematics assessments of students with ID.

The concluding chapter of this thesis discusses the major findings of this research, significance and limitations as well as recommendations for future studies.

Chapter 5

DISCUSSION AND CONCLUSION

5.1 Introduction

This is the concluding chapter of my thesis which reports on the outcomes of my research on the number sense competence of high school students with borderline, mild and moderate ID in an Australian high school that caters for the education of students with ID. The central focus of the study was to gain a greater depth of understanding on how students with ID learn mathematics (Number Sense) and to employ the knowledge so gained to facilitate improvements through effective mathematics instruction and assessment.

The educational landscape in Australian has undergone a number systemic changes in recent years (including the introduction of the Australian Curriculum) aimed at improving the quality of learning across all learning areas in Australian schools and their global competitiveness. One of the targets of recent changes as reported in the Australian Curriculum is to enhance the mathematics competence that all Australian students (including those with ID) require as they go about their personal, employment and civic engagements. The inspiration for this research was borne amidst the backdrop of current school improvement efforts prevailing in Australian schools and particularly leans towards advancing the quality of mathematics education for students with intellectual disability. This final chapter is organised under the following headings:

Section 5.2 Overview of the Thesis
Section 5.3 Major Findings of the Study
Section 5.4 Significance and Implication of the Findings for Educational Practice
Section 5.5 Constraints and Limitations of the Study
Section 5.6 Suggestions and Recommendations for Further Research
Section 5.7 Concluding Remarks

5.2 Overview of the Thesis

By way of introduction to the entire thesis, Chapter 1 detailed information on some of the recent changes in Australian school system aimed at improving educational quality. The chapter also covered the research questions, significance of the study and the conceptual and theoretical framework. The four research questions that were the focus of this study include:

1. Do students with borderline, mild and moderate intellectual disabilities possess specific number sense skills that distinguish members of one group from the other?
2. What are the effects of age, gender, student and teacher factors on the number sense achievements of students with borderline, mild and moderate intellectual disabilities?
3. What are the effects of explicit instruction and a strategy based on the philosophy of constructivism on the development of number sense among high school students with borderline, mild and moderate intellectual disabilities?
4. What numeracy assessment tool among those examined in the study is most appropriate for students with ID?

Extensive reviewing of available literature on number sense and individuals with disability was undertaken in Chapter 2. This chapter was dedicated chiefly to previous research efforts of relevance to this study. Thus, the review covered previous research on intellectual disability in general and the factors influencing their learning of mathematics/number sense in particular. These included the definitions of number sense and intellectual disability, diagnosis of ID, cognitive limitations of people with ID, severity categorisation of ID, possible causes of ID, prevalence of ID, policies and guidelines related to the education of students with ID, effectiveness of instructional approaches for students with ID, factors impacting on students with ID learning of mathematics and the prevalence of comorbidity among individuals with ID. The review also covered the assessment component of the education of students with ID and the development of an assessment tool for the mathematics education of students with ID in an effort to place this study in the body of literature and demonstrate where the study breaks new ground and charts new waters.

Chapter 3 gave a detail account of the research design, methods, techniques, instruments employed in data collection and the permissions obtained where such approvals were required. It described the four number sense assessment tools administered at the beginning (pre-test) and conclusion (post-test) of data collection on Years 8 to 12 students of an Australian high school that catered for students with ID.

Assessment Tool 1, IMPELS (Enoma & Malone, 2015b), which was developed as part of this study consisted of 52 items that covered oral counting, number identification and representations (including cardinal numbers, money, time and counting the number of colours), number writing, quantity discrimination, missing number measure and knowledge of number operations. Assessment Tool 2, the Delaware Universal Screening Tool for Number Sense (Delaware Department of Education, 2010) comprised 22 items that were divided into three sections of six, seven and nine questions which were recommended for administration in the Fall, Winter and Spring semesters respectively in accordance with the American school system). For the purpose of this study, only the first section of six questions was administered. Assessment Tool 3, the Streamlined Number Sense Screening Tool (Jordan, Glutting & Ramineni, 2008) consisted of 33 items covering counting and number recognition, number knowledge and number operations. Assessment Tool 4, the Number knowledge Test (Okamoto & Case, 1996) consisted of 43 items targeted at measuring (1) unidimensional thought: mental line structure, (2) bidimensional thought: two number lines (Group A Items – Understanding the additive relation between the ones column and the tens column in the base-ten system), (3) bidimensional thought: two number lines (Group B Items – Understanding of a numerical difference), (4) integrated bidimensional thought (Group A: Understanding the structure of multidigit numbers), (5) integrated bidimensional thought (Group B: Understanding the relation between two differences) and (6) integrated bidimensional thought (Group C: Understanding other numerical systems).

The Mathematics Teaching Efficacy Belief Instrument (MTEBI) (Enoch, Smith & Huinker, 2000) and two student factor instruments that were used in this study were also described in Chapter 3. The MTEBI comprised 21 items of which thirteen measured the confidence of teachers in their ability to teach mathematics (Personal

Mathematics Teaching Efficacy – PMTE) while eight items measured the strength of the belief that teachers' effective teaching is an influential factor to student learning (Mathematics Teaching Outcome Expectancy – MTOE). Each item was rated along five response categories including, strongly agree (weighted 5), agree (weighted 4), uncertain (weighted 3), disagree (weighted 2) and strongly disagree (weighted 1).

The first of the student factor instrument used was an adaptation of Joet, Bressoux and Usher (2011) Mathematics Self-efficacy instrument. It was made up of 25 items and each item was rated along five response categories including completely true (weighted 5), very true (weighted 4), moderately true (weighted 3), slightly true (weighted 2) and not at all true (weighted 1). The other student factor instrument that was used in this study was the anxiety factor (Joet, Bressoux & Usher, 2011) which consisted of 6 items.

Chapter 3 also described the instructional approaches — (explicit instruction) and a hybrid between explicit instruction and a strategy based on the philosophy of constructivism (ExpliCon) that were employed in this study.

As the sample size was less than 30, Anderson-Darling normality tests were conducted on all data collected and both Pearson and Spearman rho correlation coefficients were calculated using MINITAB 17 statistical software (Minitab Statistical Software, 2010a).

5.3 Major Findings of the Study

Chapter 4 described the results for my four research questions. A summary of the major findings of this study is as provided below:

5.3.1 The number sense competence of students with borderline, mild, and moderate ID. The mathematics achievements of three categories of students with ID (borderline, mild and moderate) were evaluated by (1) comparing performances across the three categories and (2) comparing the individual mathematics achievements of the students. The average mathematics achievements of the students in all four tests according to their categories were 84.23% for borderline, 75.29% for mild and 54.05% for moderate (both pre-intervention and post-intervention scores were considered). As the results suggest, the theoretical expectation that students with higher IQ would outperform those with lower IQ was not the general rule. A significant number of students with lower IQ outperformed those ranked above them in IQ. In the main, the performance pattern of the students was defined more by the interplay between the individual characteristics of the students and their IQ scores. The outcome of this component of the study also implies that for students with ID, higher IQ does not necessarily translates to higher achievements and conversely, lower IQ does not always means lower performance in mathematics. For students with borderline, mild and moderate ID, IQ (within a distinct band) is not a good predictor of mathematics outcomes. This finding is only valid within the IQ range of 40 to 79 that characterise the students with borderline, mild and moderate ID who participated in this study.

5.3.2 Effects of age on the mathematics achievements of students with borderline, mild and moderate ID. The effects of age on the mathematics achievements of students with ID were evaluated. The outcome of the study has indicated that the age of students with ID has no influence on their mathematics achievements. The finding should be interpreted within the relevant parameters under which this study was conducted such as high school students in the 12.67 to 17.42 years of age bracket and the exclusion of students with severe and profound ID (IQ 30 and below).

5.3.3 Effects of gender on the mathematics achievements of students with borderline, mild and moderate ID. The impacts of gender on the mathematics achievements of students with ID were also evaluated. The achievement patterns of male and female students with ID were analysed separately. For the male students with ID, the main findings were: (1) the mathematics achievements of male students with ID in the majority of cases increased with increasing IQ, (2) The students' mathematics achievements reflected their individual characteristics, (3) Male students with ID but having higher cognitive ability (IQ) respond more quickly to intervention than those male students with lower cognitive ability.

The mathematics achievement of female students with ID also displayed similar trends as the male students with ID. Mathematics achievement tended to increase with higher IQ. The correlation coefficients ranged from 0.313 to 0.68, suggesting that the individuality of the student is an important factor in the mathematics achievements of female students with ID.

Overall, the relationship between the IQ of female students with ID and their achievements in mathematics was stronger than that for the male students.

5.3.4 The Mathematics Teaching Efficacy Belief of Teachers. This study has demonstrated that while sampled teachers were confident about their ability to teach mathematics to students with ID, the teachers will benefit from the provision of regular professional learning opportunities aimed at supporting them with the individualisation of learning programs for students with intellectual disability, and particularly for students with high needs. To address the non-availability of relief teachers in regional and remote schools, schools need to seek and employ technological tools such as *webinar* (web-based seminar), *Microsoft Lync* and others to enhance their capacity to support staff and enhance the learning of students with ID and other learning needs. According to Beal (n.d; p. 1), the term webinar "is a presentation, lecture, workshop or seminar that is transmitted over the web using video conferencing software. A key feature of a webinar is its interactive elements: the ability to give, receive and discuss information in real-time". Microsoft Lync (often referred to as Lync) is an integrated communication tool developed by Microsoft and has a high definition video conferencing facility for holding meetings, workshops and other social gatherings (Bradley, 2013).

5.3.5 The self-efficacy of students with borderline, mild and moderate ID. The main finding from this aspect of the study was that there was no strong correlation between the mathematics self-efficacy of students with ID and their achievements in Mathematics or with the categories of ID. The various scenarios that emerged from the study include students with low mathematics self-efficacy who achieved high scores in the tests, students with high mathematics self-efficacy who achieved low scores in the tests, students with high mathematics self-efficacy who achieved high scores in the tests and students with low mathematics self-efficacy who achieved low scores in the tests.

5.3.6 Sources of self-efficacy of students with borderline, mild and moderate ID. The sources of self-efficacy of students with borderline, mild and moderate intellectual disability was evaluated for both the pre-instruction and post-instruction phases of the study. Below are the main findings:

Pre-intervention Phase

●*Borderline* **-** At the beginning of the study (pre-instruction), indications from students with borderline ID were in the order of social persuasion (63.33%) → vicarious experience (57.78%)→mastery experience (45.72%)→emotional and physiological states (44.45%).

● *Mild* **–** At the beginning of the study, the students with mild ID responded similarly as the students with borderline ID at the commencement of the study as follows: social persuasions (63.06%)→vicarious experience (61.85%)→mastery experience (60.95%)→emotional and physiological states (53.06%).

● *Moderate* **–** The students with moderate ID differed significantly in opinion from the students with borderline and mild ID with regard to sources of mathematics self-efficacy. At the start of the study, the students with moderate ID indicated that vicarious experience (observation of teachers and classmates – modelling) at 61.67% were their most important source of self-efficacy, followed by social persuasions (positive feedback and praise) at 52.78%, and then, mastery experience (previous performances in mathematics) at 49.76% and their relatively high emotional and physiological states (57.22%) indicated that they were very terrified of mathematics.

Post-intervention Phase

● *Borderline* **–** After six months of instruction, this group order changed to: vicarious experience (74.45%→mastery experience (70.47%) → social persuasions (68.89%). One possible reason why students with borderline ID revised their judgements is that their confidence and belief in themselves soared after going through six months of maths instruction and receiving positive feedback from their teachers.

● *Mild* **–** However, six months later (post-instruction), the students with mild ID indicated social persuasions (61.92%) such as encouragement and positive feedback from their teachers, peers and other significant adults were equal to mastery experience 61.91%) such as previous attainments in mathematics, followed by vicarious experience (58.61%) and then, by emotional and physiological states (53.33%).

● *Moderate* – The students with moderate ID were the only group that did not shift its position even after six months of instruction. The post-instruction sources of self-efficacy data were almost a replica of those generated at the start of the study - vicarious experience (63.89%), social persuasions (52.78%), mastery experience (44.76%) and a relatively high level of fear of maths (62.78%). An important implication for classroom practice that has emerged from these findings is that while students with ID are individuals, those with moderate ID are the most stressed and terrified of maths of the three groups of students with ID (borderline, mild and moderate). Instructional approaches oriented in modelling (teacher, peers and other adults) and positive feedback as well as praise are paramount to their learning of mathematics.

5.3.7 The sources of self-efficacy of male and female students with borderline, mild and moderate ID. The self-efficacy of male and female students was evaluated at both the pre-instructional and post-instructional phases of this study. The following were the main findings:

At the beginning of the study, the male students with ID indicated social persuasions (68.18%) as their most favoured source of mathematics self-efficacy in contrast to the female students with ID who identified vicarious experience (58.67%). The second and third choices for the males were vicarious experience (63.64%) and mastery experience (59.35%) respectively in contrast to the females who considered mastery experience (51.43%) and social persuasions (51.33%) to be of equal significance. It also unfolded from this study that female students with ID endured higher emotional stress (56.33%) through maths than their male counterparts (50.00%). The outcomes of the second assessment of the sources of self-efficacy (post-instruction) for male students with ID were identical to the first (pre-instruction) in many respects. As it was at the pre-instruction assessment, social persuasions was their most important source of mathematics self-efficacy (72.42%) at the post-instructional phase assessment, although differing in the magnitude of affirmations received on both occasions. The fear of maths factor (emotional and physiological states) for post-instruction) was relatively the same (51.82%) as when the assessment was first conducted at the beginning of the study (50.00%). The main difference in the outcomes that emanated from the male students with ID first and second sources of self-efficacy assessments was the interchanging of positions between vicarious experience and mastery experience.

5.3.8 The mathematics anxiety of students with borderline, mild and moderate ID. The mathematics anxiety of students with borderline, mild and moderate ID was evaluated. It emerged that the average anxiety factor for the students were 53.02% (pre-instruction) and 57.14% (post-instruction). Considering the anxiety of students in relation to their gender, it was observed that the average mathematics anxiety for male and female students with ID were 49.09% and 56.33% (pre-instruction) as well as 51.82% and 63.00% (post-instruction) respectively, thus, suggesting that mathematics anxiety was widespread among students with ID regardless of the gender.

5.3.9 Effects of explicit and ExpliCon instructional approaches on the development of number sense among high school students with borderline, mild and moderate ID. The effects of explicit and ExpliCon instructional approaches were evaluated. While both instructional approaches were effective in teaching students with ID, the improvements made by the students under ExpliCon were more pronounced and substantial than those observed under explicit instruction. The average marks achieved by students in the tests (including pre- and post-) under the two different instructional approaches were 63.86% (explicit instruction) and 72.99% (ExpliCon), thus suggesting that expliCon is a more effective instructional approach for teaching students with ID than explicit instruction. Amongst the benefits of expliCon is the fact that it makes provision for high-functional students with ID to be adequately challenged through the incorporation of *elaboration* (extension) in its sequence.

5.3.10 The development and evaluation of an individualised learning tool for mathematics students with intellectual disability: IMPELS. IMPELS was evaluated against three number sense assessment tools. The main results that emerged from this study strongly endorsed IMPELS as an appropriate numeracy assessment tool for students with intellectual disability and others with severe difficulty in Mathematics. Its construction and conditions of administration were highly regarded by reviewers as considerate of the learning characteristics of individuals with intellectual disability. The usefulness of IMPELS for the collection of baseline data to inform the development of IEPs/EAPs/PLPs and for monitoring the progress of learning of individual students were similarly acknowledged.

The development of an assessment tool in mathematics specifically for students with ID has, I believe, filled a critical void in the provision of improved mathematics instruction for students with ID.

5.4 Significance and Implication of the Findings for Educational Practice

The outcomes of this research will facilitate the effectiveness of mathematics instruction for students with ID in manifold ways including:

5.4.1 IQ versus students' achievements in Mathematics. While students with ID are often categorised into different IQ-based groups (borderline, mild, moderate, severe and profound groups), one significant finding of this study is that students' achievements in Mathematics do not follow a similar segregated pattern. Students with borderline, mild and moderate ID achievements in mathematics are more defined by their individuality than IQ per se. This finding concurs with Whitaker's (2013) observation that

> an individual's measured IQ and his/her true intellectual ability may differ by the order of 25 points...measured IQ and true intellectual ability are not the same thing and that measured IQ is only a rough estimate of true intellectual ability (p. 177).

Various errors are associated with IQ measurements. According to Whitaker (2013), these errors include lack of internal consistency (inconsistent test items in relation to the varied experiences of individual clients), lack of stability (an individual measured IQ is likely to change on every assessment event; even if done on the same day due to changes in the social-emotional state of the assesse, variation in test conditions/environment, including the behaviour of the assessor, etc) and scorer error (assessor's inconsistency while scoring tests). Others include the Flynn effect (associated with the variation in the intellectual ability of the population on which the standardised test was based), the floor effect (the sensitivity of the test – the lowest score that it can measure beyond which the test overestimates IQ), the practice effect (as a result of assessing an individual on the same assessment within a relatively short space of time) and the malingering effect (referring to when an assesse makes the deliberate decision to perform lower than he/she is capable of) (Whitaker, 2013; Whitaker & Gordon, 2012). In the light of this finding, it is important for effective mathematics instruction that teachers treat each student with ID as an individual, and not lower their expectations of these students on the account of their diagnostic labels.

It has been acknowledged that it is a common practice among teachers of special education students to engage in label-induced behaviours (such as the lowering of expectations) towards labelled students (Levin, Arluke, & Smith, 1982). This study has demonstrated that there is no basis for allowing diagnostic labels (in relation to the different categories of students with ID) to adversely influence teachers' opinion of their students unless it is backed up by independent assessments. It is imperative for teachers of students with ID to conduct their own independent assessments to establish the individual strengths and weaknesses of their students and determine the appropriate intervention measure.

5.4.2 Effects of age on the mathematics achievements of students with borderline, mild and moderate ID. The finding of this study demonstrates that the ages of high school students with ID have no bearing on their mathematics achievements. The implication of this finding further reinforces the importance of treating students with ID as individuals and to adopt individualised approach to mathematics instruction for students with ID. To the best of my knowledge, there is no reference in the literature on the effects of age on the mathematics performance of high school students with ID. However, some studies have been conducted on mainstream students in this area. Josiah and Adejoke (2014) studied the effect of age on the performance of mainstream college students in algebra and found that age did not have a significant effect on the achievements of the students.

5.4.3 Effects of gender on the mathematics achievements of students with borderline, mild and moderate ID. The finding from this aspect of the study indicates that gender difference between the mathematics (number sense) achievements of male students with ID (mean score of 78.36%) and female students with ID (mean score of 61.69%) were relatively small in favour of male students and the evidence points strongly towards the individuality of students rather than gender differences. While it appears no previous studies have been conducted on the gender differences in the mathematics performance among students with ID, the literature boasts a number of studies on mainstream students. These studies demonstrated the great divide and inconsistency of opinions held by researchers on this subject.

Some reports have indicated that men are better at maths than women (Hyde, Fennema & Lamon, 1990; Mwamwenda, 2002; Fennema & carpenter, 1981; Benbow & Stanley, 1982; Hyde, Lindberg, Lynn, Ellis & Williams, 2008). Lamb (1997) observed that “Across the Australian states and territories boys have higher rates of enrolments in university-approved mathematics courses in the final year of secondary school” (Lamb, 1997, p. 105) despite the fact that “women are more likely to complete secondary school than are men and they now enter higher education in larger numbers” (Lamb, 1997, p. 105) – suggesting that male students do better in mathematics than female students. Benbow and Stanley (1980; 1983) have also observed that males have superior ability in mathematical reasoning than females while the latter do better than the former in computation. Lindberg, Hyde, Petersen and Linn (2010, pp. 1124 & 1125) have acknowledged a cultural shift in stereotypic behaviour of society that has disadvantaged the performance of women in mathematics, observing that “the gender gap in mathematics performance narrows or even reverses in societies with more gender equality (for example, Sweden and Iceland), compared with those with more gender inequality (for example Turkey)”.

Others have found no significant difference in the mathematics achievements of males and females (Peterson & Fennema, 1985). Reporting on the outcomes of the research conducted by Lachance and Mazzocco (2006, p. 195) on 200 primary school age students, the authors have also found that "there was no persistent finding suggesting a male or female advantage in math performance overall, during any single year of the study, or in any area of math or spatial skills". However, the finding of my research in relation to gender disparity falls within the pattern of mathematics achievements of male and female students recorded in the literature:

> No significant differences between boys' and girls' mathematics achievement were found before boys and girls entered elementary school or during early elementary years. In upper elementary and early high school years significant differences were not always apparent. However, when significant differences did appear they were more apt to be in the boys' favor when higher-level cognitive tasks were being measured (Fennema, 1974; pp. 136 & 137).

The implication of this aspect of my research is consistent with earlier recommendations to treat students with ID as individuals.

5.4.4 Students' mathematics self-efficacy and mathematics anxiety. Among the main findings of this study is the observation that mathematics anxiety is widespread among students with ID regardless of gender differences. The implications of the outcome of the mathematics self-efficacy and anxiety of students with ID include (1) Male students with ID are more likely to work harder and improve their mathematics confidence if mathematics instruction is accompanied with positive feedback and words of encouragement as reflected by the relatively high social persuasions in both pre- and post-intervention assessments, (2) Female students with ID are more likely to enjoy a boost in their mathematics confidence and work harder if modelling instructional approaches are adopted and accompanied with positive feedback, as reflected by the relatively high vicarious experience scores in both pre- and post-intervention assessments (Tables 4.21 and 4.22). While social persuasions (positive feedback, words of encouragement, etc) as a source of mathematics self-efficacy is generally of tremendous importance to ID students' learning of mathematics, it is even more so for female students with ID as they endure higher mathematics stress than male students with ID.

5.5 Constraints and Limitations of the Study

A major constraint encountered in this study was the limitation imposed by the relatively small number of students and teachers that participated in this study. Large and representative samples are always preferred in research, but in this study only 24 students and 5 teachers from one specialist high school for students with ID and from one geographical area of Australia participated. It has been acknowledged that Australia's geographic regions comprises major cities, inner regional, outer regional, remote and very remote areas that are characterised by demographic, social, cultural and economic differences (Australian Bureau of Statistics, 2014c). Therefore, the participation of only 24 students and 5 teachers, and from only one school as well as one geographic region is far from representative. As a result, the findings from this study cannot be generalized.

Another limitation encountered in this study was the relatively short time of data collection. My data collection for this study was carried out for a period of six months. Due to logistics and issues associated with participants' consent, it was not possible to collect the data beyond this period. Long-term observation or collection of data has been found to enhance the validity of research data and findings (Zohrabi, 2013).

An additional limitation and constraint that was encountered was the fact that some of the teachers were not familiar with the explicit and constructivist-based instructional approaches. This difficulty was mitigated by the provision of training to all teachers prior to the commencement of data collection. I also delivered every first lesson of each week in both the explicit instruction and constructivist-based approach classrooms throughout the period of data collection to ensure that teachers were continually kept up-to-date.

The attendance of some students was another problem encountered during this study. Some students were absent from school due to illness and other reasons and as such participated in only some aspects of the study.

According to Kemmis and McTaggart (2005), Action Research encompasses a

> Spiral of self-reflective cycles of planning a change, acting and observing the process and consequences of the change, reflecting on these process and consequences, replanning, acting and observing again, reflecting again, and so on (p. 276).

I was unable to carry out this cyclic component of Action Research due to an unforeseeable change in my circumstance that occurred just as I began the analyses of my initial data.

5.6 Suggestions and Recommendations for Further Research

As data collection for this study was restricted to only one school, one locality and limited number of participants (both teachers and students), it is my recommendation for a much broader approach to be adopted in future studies on the mathematics achievements of students with ID. Such extensive approach should include the participation of a sizeable number of schools, students and teachers from different Australian geographic locations to reflect the diversity of modern day Australian society and to ensure the collection of truly representative data. Collecting larger and more diverse samples would enhance the generalizability of findings.

Another suggestion/recommendation for future research on the mathematics achievements of students with ID is for such research to be conducted beyond one year. Collecting data for an extended period of time would improve the validity and application of the findings.

The current study has sheds valuable light on the number sense achievements of students with ID. While this research has focused on number sense, it would be helpful to the fulfillment of the Australian Curriculum if future studies integrate other areas of Mathematics such as algebra, measurement, geometry as well as statistics and probability. Studies that could flow from this research therefore, include: (1) Gender differences in the mathematics achievements of students with ID, (2) The mathematics self-efficacy of students with ID, (3) The mathematics achievements of students with ID, and (4) The mathematics anxiety of students with ID. It is hoped that future research would build on the outcomes of this study through the above and other related studies.

5.7 Concluding Remarks

This research has focused on the evaluation of the mathematics achievements of students with borderline, mild and moderate ID in an effort aimed at improving the learning of mathematics instruction by this cohort of students.

As part of this study, I have undertaken extensive investigations on the impacts of student-related and teacher-related factors. Student-related factors such as IQ, age, gender, mathematics self-efficacy, students' social and emotional states were studied. Similarly, a teacher-related factor (the mathematics teaching efficacy beliefs of the teachers) was evaluated. Data on the mathematics achievements of the students were collected at both the pre-instructional and post-instructional phases of the study using four number sense assessment tools. The development of an individualised mathematics assessment tool that has been confirmed by reviewers (teacher participants) as appropriate to the needs of individuals with ID was among the major achievements of this study.

In the main, the study has demonstrated that efforts to improve the teaching and learning of mathematics for students with ID must adopt a multidimensional approach that:

(1) Identifies and responds to the individuality of students. Teachers must understand that students with ID are individuals and that disability does not equate to inability. Teachers must be conscious of the possibility of being misled by IQ scores and to recall to mind that "measured IQ and true intellectual ability are not the same thing and that measured IQ is only a rough estimate of true intellectual ability" and prone to errors (Whitaker,

2013, p. 177). It is important for teachers to recognise the intellectual giftedness that exists among people with disabilities (Whitmore & Maker, 1985). Similarly, teachers must overcome gender bias and understand that female students can do as well in maths as the male students.

(2) Utilises suitable assessment tools. It has been acknowledged that quality and purposeful instruction as well as appropriate assessment are inextricably linked (Robinson & Melnychuk, 2009). One major drawback that has dogged the effective teaching of Mathematics to students with ID over the years is the absence of appropriate assessment tools. The majority of Mathematics assessment tools reported in the literature are not suitable for students with intellectual impairments for a number of reasons as detailed in Chapter Two (section 2.8.5). The development of IMPELS (Enoma & Malone, 2015b), an assessment tool that is dedicated to the learning characteristics of individuals with ID is among the major accomplishments of this study.

(3) Employs effective instructional approach in order to stimulate interest and engage students in the learning process. The importance of using instructional approaches that are compatible with the learning styles of students has been acknowledged by Hattie (2009). For high school students with borderline, mild and moderate ID, this study has found explicit instruction and ExpliCon (a hybrid of explicit instruction and the constructivist-based approach) to be suitable for students with ID. A comparative evaluation of both approaches has demonstrated that ExpliCon is more effective for teaching students with ID than explicit instruction with the former having the additional advantage of catering for both low and high ability students. Overall, teachers must (i) allow more time in class for students to complete work and learn new concepts, (ii) break tasks into small parts and teach each part at a time as well as test for students' understanding before progressing to the next part), (iii) avoid rushing through the teaching of new concepts. Repeat instruction over and over again to ensure mastery and consolidation of skills. Change the context slightly at each repetition to avoid monotony, and particularly for those students that appear to have grasped the concept until consistency of performance is achieved (regardless of context variations).

References

Ahn, H. S., Bong, M., & Kim, S. (2016). Social models in the cognitive appraisal of self-efficacy information. *Contemporary Educational Psychology*, *1*(18).

Ahn, H. S., Usher, E., L, Butz, A., & Bong, M. (2016). Cultural differences in the understanding of modelling and feedback as sources of self-efficacy information. *British Journal of Educational Psychology*, *86*, 112-136.

Ahuja, A., Martin, J., Langley, K., & Thapar, A. (2013). Intellectual disability in children with Attention Deficit Hyperactivity Disorder. *Journal of Pediatrics*, *163*(3), 890-895.

Akanksha, M., Sahil, K., Premjeet, S., & Bhawna, K. (2011). Autism Spectrum Disorders (ASD). *International Journal of Research in Ayurveda & Pharmacy*, *2(*5), 1541-1546.

Algozzine, B., & Sutherland, J. (1977). The "Learning Disabilities" label: An experimental analysis. *Contemporary Educational Psychology*, *2*, 292-297.

Allinder, R. M. (1994). The relationship between efficacy and the instructional practices of special education teachers and consultants. *Teacher Education and Special Education*, *17*, 86–95.

Allred, S. L., Harrison, L. D., & O'Conell, D. J. (2013). Self-Efficacy: An important aspect of prison-based learning. *The Prison Journal*, *93*(2), 211-233.

Amadieu, F., Tricot, A., & Marine, C. (2009). Prior knowledge in learning from a non-linear electronic document: Disorientation and coherence of the reading sequences. *Computers in Human Behaviour*, *25*, 381-388

American Association on Intellectual and Developmental Disabilities. (2017). *Definition of Intellectual Disability*. Retrieved from http://aaidd.org/intellectual-disability/definition#.VKLdOVKAA

American Association on Intellectual and Developmental Disabilities. (2010). *Intellectual Disability: Definition, Classification, and Systems of Supports.* Washington DC: American Association on Intellectual and Developmental Disabilities.

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders – Fifth Edition (DSM-5).* Washington DC: American Psychiatric Publishing.

Andaya, O. J. F. (2014). Factors that affect mathematics achievements of students of Philippine Normal University – Isabella Campus. *Researchers World*, *5*(4), 83-91.

Anderson, G. (1998). *Fundamentals of Educational Research*. New York: Routledge Falmer.

Anwyll, B. (2013). Speaker discusses biases against disabled people. *University Wire*, p. 1.

Applefield, J. M., Huber, R., & Moallem, M. (2001). Constructivism in theory and practice: Toward a better understanding. *The High School Journal*, *84*(2), 35-53.

Archer & Hughes. (2011). *Explicit Instruction: Effective and Efficient Teaching*. New York: Guildford Press.

ASDAN (n.d.a). *ASDAN: What are the Preparing for Adulthood Programmes?* Retrieved from https://www.asdan.org.uk/courses/programmes/preparing-for-adulthood

ASDAN (n.d.b). *About ASDAN*. Retrieved from *https://www.asdan.org.uk/about*

Australian Bureau of Statistics. (2014a). *What are the causes of intellectual disability?* Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/4433.0.55.003main+features152012

Australian Bureau of Statistics. (2014b). *How many people have intellectual disability?* Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/4433.0.55.003main+features102012

Australian Bureau of Statistics. (2014c). *The Australian Statistical Geography Standard (ASGS) Remoteness Structure*. Retrieved from http://www.abs.gov.au/websitedbs/d3310114.nsf/home/remoteness+structure

Australian Curriculum, Assessment and Reporting Authority. (2016). *NAPLAN 2016 Information for Parents and Carers*. Retrieved from http://www.nap.edu.au/_resources/NAPLAN_2016_information_for_parents web.pdf

Australian Curriculum, Assessment and Reporting. (ACARA) (2010). *The Shape of the Australian Curriculum Version 2.0*. Retrieved from http://www.acara.edu.au/_resources/Shape_of_the_Australian_ Curriculum.pdf

Australian Curriculum, Assessment and Reporting Authority. (ACARA) (n.d.). *Students with Disability*. Retrieved from http://www.acara.edu.au/curriculum/student_diversity/students_with_disability.html

Australian Government (2013). *National Disability Insurance Scheme Act (No. 20) 2013*. Retrieved from https://www.legislation.gov.au/Details/C2013A00020

Australian Government (n.d.). *Disability Discrimination Act (DDA).* (1992). Retrieved from https://www.legislation.gov.au/Details/C2015C00252

Australian Government Department of Education and Training. (2016). *Independent Public Schools*. Retrieved from https://www.education.gov.au/independent-public-schools

Australian Government Department of Education and Training. (2012). *Disability Standards for Education 2005*. Retrieved from https://docs.education.gov.au/node/16354

Australian Government Department of Education and Training. (2015). *Disability Discrimination Act (DDA) 1992*. Retrieved from https://docs.education.gov.au/node/35941

Australian Government Department of Education and Training. (2015**).** *Evaluation of the More Support for Students with Disabilities Initiative 2012-2014 – Final Report*. *PhillipsKPA Pty Ltd*. Retrieved from https://docs.education.gov.au/node/38393

Australian Government Department of Education, Employment and Workplace Relations – DEEWR. (2011). *Guide to developing Personalised Learning Plans for Aboriginal and Torres Strait Islander Students – A professional Learning resource*. Retrieved from http://www.det.wa.edu.au/aboriginaleducation/detcms/cms-service/download/asset/?asset_id=16980781

Australian Institute of Health and Welfare (AIHW). (2004). Estimates of prevalence of intellectual disability in Australia. *Journal of Intellectual and Developmental Disability*, *29* (3), 284-209.

Australian Institute for Teaching and School Leadership. (2011a). *Australian Professional Standards for Teachers.*

Australian Institute for Teaching and School Leadership. (2011b). *Australian Professional Standards for Principals.*

Australian Law Reform Commission. (n.d.). Retrieved from http://www.alrc.gov.au/publications/65.%20Research%3A%20 Recommendations%20for%20Reform/human-research-ethics-committees

Azar, H.K., Lavasania, M. G., Malahmadia, E., & Amania, J. (2010). The role of self-efficacy, task value, and achievement goals in predicting learning approaches and mathematics achievement. *Procedia Social and Behavioral Sciences*, *5,* 942–947.

Bai, Y. (2009). Action research localization in China: three cases. *Educational Action Research*, *17*(1), 143-154.

Bailey, D. B., & Nelson, D. (1995). The Nature and Consequences of Fragile X Syndrome. *Mental Retardation and Developmental Disabilities*, 238-244.

Bandura, A. (1977). Self-efficacy: Toward a Unifying Theory of Behavioral Change. *Psychological Review, 34*(2), 191-215.

Bandura, A. (1997). *Self-efficacy: The exercise of* control. New York: Freeman.

Bandura, A. (1994). Self-efficacy. In V. S. Ramachaudran (Ed.), *Encyclopedia of Human Behaviour, 4,* 71-81. New York: Academic Press.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* New Jersey: Prentice-Hall.

Bandura, A. (1995). *Self-efficacy in Changing Societies*. United Kingdom: Cambridge University Press.

Baron, I. S. (2005). Test Review: Wechsler Intelligence Scale for Children-Fourth Edition (WISC-IV). *Child Neuropsychology*, *11*, 471- 475.

Barry, K. & King, L., (1999). *Beginning Teaching and Beyond* (3rd ed.). NSW (Australia): Social Science Press.

Bates, A. B., Latham, N., & Kim, J. (2011). Linking preservice teachers' mathematics self-efficacy and mathematics teaching efficacy to their mathematical performance. *School Science and Mathematics*, *111*, 325-333.

Bates, A, Shifflet, R., & Lin, M. (2013). In J. Hattie & E. M. Alderman (Eds.), *International Guide to Student Achievement,* 7-9, New York: Routledge.

Beal, V. (n.d.). *Webinar (Web-based seminar).* Retrieved from http://www.webopedia.com/TERM/W/Webinar.html

Bedrossian, L. (2015). Understand autism meltdowns and share strategies to minimize, manage occurrences. D*isability Compliance for Higher Education*, *20*(7), pp.6-6.

Bedi, A. S., & Marshall, J. H. (1999). School Attendance and Student Achievement: Evidence from Rural Honduras. *Economic Development and Cultural Change*, *47*(3), 657-682.

Behera, N. P., & Makunja, R. (2013). *Effects of Home Environment on Academic Achievement: A Regional Study from Tanzania*. Tanzania: Lambert Academic Publishing.

Beirne-Smith M., Patton, J. R., & Kim, S. H. (2006). *Mental retardation: An introduction to intellectual disabilities.* (7th. Ed). New Jersey: Pearson Merrill Prentice Hall.

Benbow, C. P., & Stanley, J. C. (1983). Sex Differences in Mathematical Reasoning Ability: More Facts. *Science*, *New Series*, *222*(4627), 1029-1031.

Benbow, C. P., & Stanley, J. C. (1982). Intellectually talented boys and girls: Educational profiles. *Gifted Child Quarterly*, *26*(2), 82-87.

Benbow, C. P., & Stanley, J. C. (1980). Sex Differences in Mathematical Ability: Fact or Artifact? *Science, New Series, 210*(4475), 1262-1264.

Berch, D. B. (2005). Making Sense of Number Sense: Implications for Children with Mathematical Disabilities. *Journal of Learning Disabilities, 38*(4), 333-339.

Berkeley Evaluation and Assessment Research Centre (2010). Retrieved from http://bearcenter.berkeley.edu/wiki/index.php/Wright_Map

Bevevino, M. M., Dengel, J., & Adams, K. (1999). Constructivist Theory in the Classroom: Internalising Concepts through Inquiry Learning. *The Clearing House*, *72*(5), 275-278.

Biklen, D. (2000). Lessons from the Margins, Narrating Mental Retardation: A Review Essay. *Mental Retardation*, *38*(5), 444-456.

Binnie, L. M., Allen, K., & Beck, E. (2008). Taking research into schools: the West Lothian Action Enquiry model. *Educational Psychology in Practice, 24*(4), 347-354.

Bland, J. M., & Altman, D. G. (1997). Cronbach's alpha. *British Medical Journal, 314*(7080), 572.

Blazer, C. (2010). *Information Capsule: Research Services*. Retrieved from http://files.eric.ed.gov/fulltext/ED544660.pdf.

Boe, E. (2006). Long-Term Trends in the National Demand, Supply, and Shortage of Special Education Teachers. *The Journal of Special Education*. *40*(3), 138-150.

Bong, M. (2004). Academic motivation in self-efficacy, task value, achievement goal orientations, and attributional beliefs. *Journal of Educational Research, 97*, 287-297.

Booker, G. (2004). Difficulties in mathematics: Errors, origins and implications. In B. Knight & W. Scott (Eds.), *Learning difficulties: Multiple perspectives* 129-140. Sydney: Pearson

Boone, J. W., Staver, J. R., & Yale, M. S. (2014). *Rasch Analysis in the Human Sciences.* West Lafayette: Springer.

Boyle, M. I., Jespersgaard, C., Brondum-Nielsen, K., Bisgaard, A. M., & Tumer, Z. (2015). Cornelia de Lange syndrome. *Clinical Genetics*, *88*(1), 1-12.

Bradley, T. (2013). *Five reasons Microsoft Lync 2013 matters*. Retrieved from http://www.pcworld.com/article/2014005/five-reasons-microsoft-Lync-2013-matters. html

Brandenberger, E. (2014). *The Best Foot Forward Project*. Retrieved from http://dailyedventures.com/index.php/2014/08/18/ellenbrandenberger/

Bray, A. (2003). *Definitions of intellectual disability: Review of the literature Prepared for the National Advisory Committee on Health and Disability to inform its project on services for adults with an intellectual disability*. Retrieved from http://www.moh.govt.nz/notebook/nbbooks.nsf/0/E9228E058EC737A6CC257D6900751918/$file/definition%20of%20intellectual%20disability.pdf

British Columbia Ministry of Education (2009). *Individual Education Planning for Students with Special Needs – A Resource Guide for Teachers*. Retrieved from https://www.bced.gov.bc.ca/specialed/docs/iepssn.pdf.

Brooks, J. G., & Brooks, M. G. (2001). Becoming a constructivist teacher. In J. G. Brooks, & M. G. Brooks, *In Search of Understanding: The Case for Constructivist Classrooms*. New York: Merrill/Prentice Hall.

Brophy, J. E. & Good, T. L. (1970). Teachers' communication of differential expectations for children's classroom performance: some behavioural data. *Journal of Educational Psychology*, *61*(5), 365-374.

Bruininks, R. H; Woodcock, R. W; Weatherman, R. F. & Hill, B. K. (1984). *Scales of Independent Behavior*. Itasca, Illinois: Riverside Publishing Company.

Bryman, A. (2012). *Social research methods* (4th Ed.). New York: Oxford University Press.

Bryan, R. R., Glynn, S. M., & Kittleson, J. M. (2011). Motivation, Achievement, and Advanced Placement Intent of High School Students Learning Science. *Science Education*, 1049-1065.

Buckingham, J. (2015). *The 'charter school' model could help our most needy students*. Retrieved from http://www.abc.net.au/news/2015-08-31/buckingham-'charter-school'-model/6736930

Bullock, J. (1992). Touch math (4th Ed). *Intervention in School and Clinic,* 28(2), 119-122.

Buntinx, W. H. E., & Schalock, R. L. (2010). Models of disability, quality of life, and individualized supports: Implications for professional practice in intellectual disability. *Journal of Policy and Practice in Intellectual Disabilities*, *7*(4), 283-294.

Butler, F. M., Miller, S. P., Lee, K. H., & Pierce, T. (2001). Teaching mathematics to students with mild-to-moderate mental retardation: A review of the literature. *Mental Retardation*, *39*(1), 20-31

Butler, F. M., Miller, S. P., Crehan, K., Babbitt, B., & Pierce, T. (2003). Fraction instruction for students with mathematics disabilities: Comparing two teaching sequences. *Learning Disabilities Research & Practice*, *18*(2), 99–111.

Butz, A. R., & Usher, E. L. (2015). Salient sources of early adolescents' self-efficacy in two domains. *Contemporary Educational Psychology, 42*, 49-61.

Bybee, R. W., Taylor, J. A., Gardner, A., Van Scotter, P., Powell, J. C., Westbrook, A., & Landes, N. (2006). *The BSCS 5E Instructional Model: Origins, Effectiveness, and Applications*. Retrieved from http://bscs.org/sites/default/files/_legacy/BSCS_5E_Instructional_Model-Executive_Summary_0.pdf.

Byler, D. L., Chan, L., Lehman, E., Brown, A. D., Ahmad, S., & Berlin, C. (2015). Tourette Syndrome: A general pediatrician's 35-year experience at a single center with follow-up in adulthood. *Clinical Pediatrics, 54*(2), 138-144.

Cassel, J., & Reid, R. (1996). Use of a self-regulated strategy intervention to improve word problem-solving skills of students with mild disabilities. *Journal of Behavioural Education*, *6*(2), 153-172.

Cassidy, S. B., Schwartz, S., Miller, J. L., & Driscoll, D. J. (2011). Prader-Willi syndrome. *Genetics in Medicine*, *14*(1), 10-26.

Center for Disease Control and Prevention (2016). *Facts About ASD*. Retrieved from http://www.cdc.gov/ncbddd/autism/facts.html

Cerebral Palsy Guide (2016). *Cerebral Palsy: Coexisting Conditions*. Retrieved from https://www.cerebralpalsyguide.com/cerebral-palsy/coexisting-conditions/

Chard, J. D., Clarke, B., Baker, S., Otterstedt, J., Braun, D., & Katz, R. (2005). Using measures of number sense to screen for difficulties in mathematics: Preliminary findings. *Assessment for Effective Intervention, 30*(2), 3-14.

Chomba, M.S; Mukuria, S. G; Kariuki, P. W; Tumuti, S. & Bunyasi, S. G. (2014). *Education for Students with Intellectual Disabilities in Kenya: Challenges and Prospects. Disability Studies Quarterly, 34*(4). Retrieved from http://dsq-sds.org/article/view/3846/3793

Cihak, D. F., & Grim, J. (2008). Teaching students with autism spectrum disorder and moderate intellectual disabilities to use counting-on strategies to enhance independent purchasing skills. *Research in Autism Spectrum Disorders, 2*,716–727

Clarke, B., Baker, S., Smolkowski, K., & Chard, D. J. (2008). An analysis of early numeracy curriculum-based measurement: Examining the role of growth in student outcomes. *Remedial and Special Education*, *29*(1), 46-57.

Clarke, B., & Shinn, M. R. (2004). A preliminary investigation into the identification and development of early mathematics curriculum-based measurement. *School Psychology Review, 33*(2), 234-248.

Clark, M., C., & Sharf, B. F. (2007). The dark side of truth(s): Ethical dilemmas in researching the personal. *Qualitative Inquiry*, *13,* 399-416.

Clegg, A. A. (1973). The teacher as "manager" of the curriculum? *Educational Leadership, 30*(4), 307-309.

Cobb, P., Yackel, E., & Wood, T. (1992). A constructivist alternative to the representational view of mind in mathematics education. *Journal for Research in Mathematics Education*, *23*(1), 2-33.

Cobern (1993). Constructivism. *Journal of Educational and Psychological Consultation*, *4*(1), 105-112.

Cohen, L., Manion, L., & Morrison, K. (2011). *Research Methods in Education* (4th Ed.). London: Routledge.

Colker, L. J. (2008). Twelve characteristics of effective early childhood teachers. *Young Children*, *63*(2), 68-73.

Commonwealth of Australia (2014). *Effectiveness of the National Assessment Program – Literacy and Numeracy*. Retrieved from http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Education_and_Employment/Naplan13/Report/index

Commonwealth of Australia (2009). *Shape of the Australian Curriculum: Mathematics*. Retrieved from www.acara.edu.au/_resources/Australian_Curriculum_-_Maths.pdf

Community-University Partnership for the Study of Children, Youth, and Families, (2011). *Wechsler Intelligence Scale for Children-Fourth Edition*. Retrieved from http://www.cup.ualberta.ca/wp-content/uploads/2012/06/FINAL_WISC-IV_May-2012.pdf

Cook, B. G. (2001). A comparison of teachers' attitudes toward their included students with mild and severe disabilities. *The Journal of Special Education*, *34*(4), 203-213.

Cook, J. A. (2001). Sexuality and people with psychiatric disabilities. *SIECUS Report*, *29*(3), 20-25.

Council of Australian Governments – COAG (2008). *National Partnership Agreement on Improving Teacher Quality*. Retrieved from http://www.curtin.edu.au/research/jcipp/local/docs/National_Partnership_Agreement_on_Improving_Teacher_Quality.pdf

Council of Australian Governments – COAG (n.d.). *Welcome to the Council of Australian Governments (COAG)*. Retrieved from https://www.coag.gov.au/

CPL (2015). *Impairments Associated with Cerebral Palsy.* Retrieved from http://www.cpl.org.au/childrens-services/newly-diagnosed-/cp/other-impairments

Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. NJ: Pearson.

Cronbach, L. J. (1951). Coefficient Alpha and the internal structure of tests. *Psycometrika*, *16*(3), 297-333.

Cuming, L., Diamond, D., Amirfeyz, R., & Gargan, M. (2010). Cri du Chat syndrome. *Orthopaedics and Trauma*, *24*(2), 164-166.

Danii, E., & Reid, N. (2006). Cognitive factors that can potentially affect pupils' test performance. *Chemistry Education Research and Practice*, *7*(2), 64-83.

DeChenne, S. E., Enochs, L. G., & Needham, M. (2012). Science, technology, engineering, and mathematics graduate teaching assistants teaching self-efficacy. *Journal of the Scholarship of Teaching and Learning*, *12*(4), 102-123.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum Press.

Delaware Department of Education. (2010). *Delaware Universal Screening Tool for Number Sense Grade 2*. Delaware Department of Education, USA.

Demby, A. (1997). Algebraic procedures used by 13-to-15 year old. *Educational Studies in Mathematics*, *33*, 45-70.

Department of Education and Training of Western Australia (n.d). *Current Independent Public Schools.* Retrieved from https://www.education.wa.edu.au/web/our-schools/independent-public-schools/current-independent-public-schools.

Department of Education and Training of Western Australia. (2011). *Documented Plans–Supporting Education for All: Guidelines for Implementing Documented Plans in Public Schools*, Retrieved from http://www.det.wa.edu.au/detcms/aboriginal-education/aboriginal-education/docs/guidelines-for-implementing-documented-plans-in-public-schools.en

Department of Education and Training of Western Australia. (2007). *Duty of Care For Students*. Retrieved from http://www.det.wa.edu.au/policies/detcms/policy- planning- and-accountability/policies-framework/policies/duty-of-care-for-students.en?cat-id=3457100.

Department for Education and Skills. (2007). *Resources to Support the Pilot of Functional Skills: Teaching and Learning Functional Mathematics*. United Kingdom: DfES.

Department of Education and Training of Western Australia. (2014). *What is an individual transition plan*. Retrieved from http://det.wa.edu.au/ssen/detcms/school-programs support-/schools-of-special-educational-needs/pathways-and-transition-planning/processes-and-practices/what-is-an-individual-transition-plan.en?cat-id=15617986

Department of Education of Western Australia. (2011a). *SENAT Special Education Needs Assessment Tool*. Retrieved from http://www.waespaa.com.au/pdf/Conference/2011/WAESPAA-Conference-2011-SENAT.pdf

Department of Education of Western Australia. (2011b). *Special Educational Needs: Practical Support for Teachers of Students with Special Educational Needs.* Retrieved 5 September 2016 from http://det.wa.edu.au/curriculumsupport/specialeducationalneeds/detcms/portal

Department of Education of Western Australia. (2016a). *List of Independent Public Schools*. Retrieved from http://www.education.wa.edu.au/home/detcms/navigation/about-us/programs-and-initiatives/independent-public-schools/?page=8#toc8

Department of Education of Western Australia. (2016b). *Reporting To Parents, Special Education Needs – SEN Planning*. Retrieved from http://www.det.wa.edu.au/curriculumsupport/reportingtoparents/detcms/navigation/special-education-needs/.

Department of Education of Western Australia. (2016c). *Students at Educational Risk policy*. Retrieved from http://www.det.wa.edu.au/policies/detcms/policy-planning-and-accountability/policies-framework/policies/students-at-educational-risk.en?cat-id=3457119

Department of Education and Training of Western Australia. (2016d). *Student Attendance Policy: Student Attendance Procedures*. Retrieve from http://www.det.wa.edu.au/policies/detcms/policy-planning-and-accountability/policies-framework/policies/students-attendance.en?cat-id=3458017.

Department of Education and Training of Western Australia. (2016e). *Student Behaviour Policy: Student Behaviour Procedures*. Retrieved from http://det.wa.edu.au/policies/detcms/policy-planning-and-accountability/policies-framework/policies/student-behaviour-policy-and-procedures.en?cat-id=3457115

Dhareshwar, S. S., Patel, Z. M., & Ambani, L. M. (1981). William syndrome. *The Indian Journal of Paediatrics*, *48*(2), 183-188.

Dinther, M. V., Dochy, F., & Segers, M. (2011). Factors affecting students' self-efficacy in higher education. *Educational Research Review*, *6*, 95-108.

Doabler, C. T., & Fien, H. (2013). Explicit mathematics instruction: What teachers can do for teaching students with mathematics difficulties. *Intervention in School and Clinic*, *48*(5), 276-285.

Dochef, D. M. (2010). Assessment: Trash It! *Journal of Physical Education, Recreation & Dance, 81*(1), 12.

Dudley-Marling, C (2004). The social construction of learning disabilities. *Journal of Learning Disabilities*, *37*(6), 482-489.

Dunkake, I., & Schuchart, C. (2015). Stereotypes and teacher characteristics as an explanation for the class-specific disciplinary practices of pre-service teachers. *Teaching and Teacher Education*, *50*, 56-59.

Dunphy, E. (2006). The development of young children's number sense through participation in sociocultural activity: Profiles of two children. *European Early Childhood Education Research Journal*, *14*(1), 57-76.

Dusek, J. B., & Joseph, G. (1983). The bases of teacher expectancies: A meta-analysis. *Journal of Educational Psychology*, *75*(3), 327-346.

Dvorsky, G. (2016). *Why Neglecting Maths Can Be Hazardous To Your Life*. Retrieved from http://www.lifehacker.com.au/2016/05/why-neglecting-math-can-be-hazardous-to-your-life/

Dyson, N.I., Jordan, N. C., & Glutting, J. (2011). A number sense intervention for low-income kindergartners at risk for mathematics difficulties. *Journal of Learning Disabilities*, *46*(2), 166-181.

Einarsdottir, J. (2007). Research with children: methodological and ethical challenges. *European Early Childhood Education Research Journal*, *15*(2), 197-211.

Ekmekci, A., Corkin, D., & Papakonstantino, A. (2015). *Mathematics Teachers' Beliefs about Teaching and Learning Mathematics*. *Research Council on Mathematics Learning. Retrieved from* https://rusmp.rice.edu/uploadedFiles/Research_and_Presentations/Research_Presentations/RCML%20Presentation%202015.pdf

Engelkamp, J., & Zimmer, H. D. (1990). Memory for action events: A new field of research. *Psychological Research*, *51*, 153-157.

Enochs, L. G., Smith, P. L., & Huinker, D. (2000). Establishing factorial validity of the mathematics teaching efficacy beliefs instrument. *School Science and Mathematics*, *100*(4), 194-202.

Enoma, A., & Malone, J. (2015a). Teachers' attitudes/professional standards and mathematics teaching efficacy beliefs regarding students with intellectual disability. In M. Sharma, & A. Yeung (Eds.), *The Proceedings of the Australian Conference on Science and Mathematics Education: Transforming Practice, Inspiring Innovation* (pp. 94-100). Sydney: Uniserve Science, The University of Sydney.

Enoma, A., & Malone, J. (2015b). The development and evaluation of an individualised learning tool for mathematics students with intellectual disability: IMPELS. In M. Sharma, & A. Yeung (Eds.), *The Proceedings of The Australian Conference on Science and Mathematics Education: Transforming Practice, Inspiring Innovation* (pp. 101-107). Sydney): Uniserve Science, The University of Sydney.

Enoma, A., & Malone, J. (2015c). The self-efficacy of students with borderline, mild and moderate intellectual disabilities and their achievements in mathematics. In M. Marshman, V. Geiger., & A. Bennison (Eds.). *Mathematics Education in the Margins*. *Proceedings of the 38th Annual Conference of the Mathematics Education Research Group of Australasia*, (pp. 221-228). Australia: MERGA.

Etherington, K. (2007). Ethical research in reflexive relationships. *Qualitative Inquiry*, *13*, 559-616.

Everett, J., & Yocham, K. E. (2012). *Texas Hunger Initiative: Texas School Breakfast Report Card*. Texas: Baylor University School of Social Work.

Faulkner, V. N. (2009). The components of number sense: An instructional model for teachers. *Teaching Exceptional Children*, *41*(5), 24-30.

Fennema, E. (1974). Mathematics learning and the sexes: A review. *Journal for Research in Mathematics Education*, *5*(3), 126-139.

Fennema, E., & Carpenter, T. P. (1981). Sex-related differences in mathematics: Results from national assessment. *The Mathematics Teacher*, *74*(7), 554-559.

Filho, J. A. F., & Shapiro, B. E. (2004). Tay-Sachs disease. *Arch Neurology*, *61*(9), 1466-1468.

Fleming, M., & Stevens, D. (2010). English Teaching in the Secondary School.

Flores, M. M. (2010). Using the concrete–representational–abstract sequence to teach subtraction with regrouping to students at risk for failure. *Remedial and Special Education*, *31*(3), 195-207.

Forsythe, E., & Beales, P. L. (2012). Bardet-Biedl syndrome. *European Journal of Human Genetics*, *21*, 8-13.

Foster, G. G., Ysseldyke, J. E., & Reese, J. H. (1975). "I wouldn't have seen it if I hadn't believed it." *Exceptional Children*, *41*, 469-473.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to Design and Evaluate Research in Education*. New York: McGraw-Hill.

Frieden, L. (2004). *Improving Educational Outcomes for Students with Disabilities.* Retrieved from https://ncd.gov/publications/2004/Mar172004 *National Council On Disability*, 1-87.

Furinghetti, F., & Morselli, F. (2009). Every unsuccessful problem solver is unsuccessful in his or her own way: affective and cognitive factors in proving. *Educational Studies in Mathematics*, *70*(1), 71-90

Gautam, P; Bhatia, M. S. & Rathi, A. (2014). Intellectual Disability and Multiple Co Morbid Psychiatric Disorders in a Child: A Case Report. *Journal of Clinical & Diagnostic Research*, *8*(11), WD01-2.

Gavrielatos, A. (2013). *NAPLAN Objectives. Australian Education Union, Committee Hansard*. Retrieved from http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Education_and_Employment/Naplan13/Report/~/media/Committees/Senate/committee/eet_ctte/naplan_2013/report/c02.pdf

Geary, D. C., Hoard, M. K., & Hamson, C. O. (1999). Numerical and arithmetical cognition: Patterns of functions and deficits in children at risk for mathematical disability. *Journal of Experimental Child Psychology*, *74*, 213-239.

Gelisli, Y. (2009). The effect of student centered instructional approaches on student success. *Procedia Social and Behavioral Sciences*, *1*, 469-473.

Gennetian, D., Duncan, G., Knox, V., Vargas, W., Clark-Kauffman, E., & London, A. S. (2004). How welfare policies affect adolescents' school outcomes: A synthesis of evidence from experimental studies. *Journal of Research on Adolescence*, *14*(4), 399-423.

George, D., & Mallery, P. (2003). *SPSS for Windows step by step: A simple guide and reference. 11.0 update* (4th Ed.). Boston: Allyn & Bacon.

Gersten, R., Baker, S., & Lloyd, J. W. (2000). Designing high-quality research in special education: Group experimental design. *Journal of Social Education*, *34*, 2-18.

Gersten, R., & Chard, D. (1999). Number Sense: Rethinking arithmetic instruction for students with mathematical disabilities. *The Journal of Special Education*, *33*(1), 18-25.

Ginsburg, L; Manly. M. & Schmitt, M. J. (2006). *The Components of Numeracy*. Retrieved from http://www.statlit.org/pdf/2006GinsburgManlySchmittNCSALLnumeracy.pdf

Gist, M., & Mitchell, T. (1992). Self-Efficacy: A theoretical analysis of its determinants and malleability. *The Academy of Management Review*, *17*(2), 183-211.

Glasersfeld, E. V. (1995). *A Constructivist Approach to Teaching*. Retrieved from http://www.univie.ac.at/constructivism/EvG/papers/172.pdf

Glasersfeld, E. V. (1989). *Constructivism in Education*. In T. Husen & T. N. Postlethwaite (Eds), *The International Encyclopedia of Education Supplement* (pp. 162-163). Oxford (New York): Pergamon Press.

Gliem, J. A., & Gliem, R. R. (2003). Calculating, interpreting, and reporting Cronbach's Alpha Reliability Coefficient for Likert-Type scales. In *Midwest Research to Practice Conference in Adult, Continuing, and Community Education*, 82-88.

Golia, E. B. S. (2007). Unidimensionality in the Rasch Model: How to detect and interpret. *STATISTICA, anno LXVII*, *3*: 253-261.

Good, T. L. (1987). Two decades of research on teacher expectations: findings and future directions. *Journal of Teacher Education*, *38*(4), 32-47.

Good Schools Guide (2016). *How independent public schools may change Australian education*. Retrieved from http://www.goodschools.com.au/news/how-independent-public-schools-may-change-australian-education

Gouba, L. (2008). *The importance of Mathematics in everyday life*. South Africa: African Institute for Mathematical Sciences.

Grandin, T. (2006). *Thinking in pictures: Autism and Visual Thought*. Retrieved from http://www.grandin.com/inc/visual.thinking.html

Graham, L., Bellert, A., & Pegg, J. (2007). Supporting students in the middle years with learning difficulties in mathematics: Research into classroom practice. *Australasian Journal of Special Education*, *31*(2), 171-182.

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. K. Denzin & Y.S. Lincoln (Eds.), *Handbook of Qualitative Research* (pp. 105-117). Thousand Oaks, CA: Sage.

Guba, E. G. (1990). The alternative paradigm dialog. In E. G. Guba (Ed.), *The Paradigm Dialog* (pp. 17-27). Newbury Park: SAGE Publications.

Guba, E. G., & Lincoln, Y. S. (1989). *Fourth Generation Evaluation*. Newbury Park, California (USA): Sage Publications, Inc.

Guskey, T. R. (2013). Defining student achievement. In J. Hattie & E. M. Alderman (Eds.), *International Guide to Student Achievement* (pp. 3-6). New York: Routledge.

Gutshall, C. A. (2013). Teachers' mindsets for students with and without disabilities. *Psychology in the Schools*, *50*(10), 1073-1083.

Guven, B, & Cabakcor, B. O. (2013). Factors influencing mathematical problem-solving achievement of seventh grade Turkish students. *Learning and Individual Differences*, *23*, 131-137.

Hackett, G., & Betz, N. E. (1989). An exploration of the mathematics self-efficacy/mathematics performance correspondence. *Journal for Research in Mathematics Education*, *20*(3), 261-273.

Haines, R. T., & Mueller, C. E. (2013). Academic achievement: An adolescent perspective. In J. Hattie & E. M. Alderman (Eds.), *International Guide to Student Achievement* (pp. 10-12). New York: Routledge.

Hampton, N. Z., & Mason, E. (2003). Learning disabilities, gender, sources of efficacy, self-Efficacy beliefs, and achievement in high school students. *Journal of School Psychology*, *41*, 101-112.

Harbour C.K., & Maulik P.K. (2010). History of intellectual disability. In: J.H. Stone, M Blouin, (Ed.), *International Encyclopedia of Rehabilitation*. Retrieved from: http://cirrie.buffalo.edu/encyclopedia/en/article/143/

Harris, J. C. (2006). *Intellectual disability: Understanding its development, causes, classification, evaluation, and treatment*. New York: Oxford University Press. 42-98.

Harris, K. R., & Graham S. (1994). Constructivism: principles, paradigms, and integration. *Journal of Special Education*, *28* (3), 233-247.

Harrison, P. L. & Oakland, T. (2003a). *Adaptive Behavior Assessment System — Second Edition*. San Antonio, TX: Harcourt Assessment.

Harrison, P. L. & Oakland, T. (2003b). Technical report: *ABAS-II Adaptive Behavior Assessment System — Second Edition*. San Antonio, TX: Harcourt Assessment.

Hattie, J. A. C. (2009). *Visible Learning: A synthesis of over 800 meta-analyses relating to achievement*. UK (London): Routledge.

Hendler, M., & Weisberg, P. (1992). Conservation acquisition, maintenance, and generalization by mentally retarded children using equality-rule training. *Journal of Experimental Child Psychology*, *53*, 258-276.

Hendricks, C. (2006). *Improving Schools Through Action Research: A Comprehensive Guide for Educators*. New York: PEARSON.

Higgins, S., Hall, E., Wall, K., Woolner, P., & McCaughey, C. (2005). *The Impact of School Environments: A Literature Review*. Retrieved from http://www.ncl.ac.uk/cflat/news/DCReport.pdf

Hogg, R. V., & Tanis, E. A. (2001). *Probability and Statistical Inference* (6th Ed). New Jersey: Prentice Hall.

Hollins, E. R. (2011). Teacher preparation for Quality teaching. *Journal of Teacher Education*, *62*(4), 395-407.

Holly, M. L., Arhar, J. M., & Kasten, W. C. (2009). *Action Research for Teachers: Traveling the Yellow Brick Road*. Boston: Allyn & Bacon

Holzberger, D., Philipp, A., & Kunter, M. (2014). Predicting teachers' instructional behaviors: The interplay between self-efficacy and intrinsic needs. *Contemporary Educational Psychology*, *39*, 100-111.

Horovitz, M., Matson, J. L., Sipes, M., Shoemaker, M., Belva, B., & Bamburg, J. W. (2011). Incidence and trends in psychopathology symptoms over time in Adults with severe to profound intellectual disability. *Research in Developmental Disabilities*, *32*(2), 685–692.

Horton, S. V., Lovitt, T. C., & White, O. R. (1992). Teaching mathematics to adolescents classified as educable mentally handicapped using calculators to remove the computational onus. *Remedial and Special Education*, *13*, 36-61

Howell, S. C., & Kemp, C. R. (2010). Assessing preschool number sense: skills demonstrated by children prior to school entry. *Educational Psychology*, *30*(4), 411-429.

Intellectual Disability Rights Service Inc (2009). *Introduction to Intellectual Disability*. Retrieved from http://www.idrs.org.au/pdf/IDRS_%20Introduction_intellectual%20disability_17Feb09.pdf

Huang, H. M., Rauch, U., & Liaw, S. S. (2010). Investigating learners' attitudes toward virtual reality learning environment based on a constructivist approach. *Computers & Education*, *55*, 1171-1182.

Hyde, J. S., Fennema, E., & Lamon, S. J. (1990). Gender differences in mathematics performance: A meta-analysis. *Psychological Bulletin*, *107*(2), 139-155.

Hyde, J.S., Lindberg, S. M., Linn, M. C., Ellis A. B., & Williams, C. C. (2008). Gender similarities characterize math performance. *Science, New Series*, 494-495.

InCurriculum (n.d.). *What is an inclusive curriculum?* Retrieved from http://www.incurriculum.org.uproject/what-is-an-inclusive-curriculum

Ivrendi, A. (2011). Influence of Self-Regulation on the Development of childrens' number sense. *Early Childhood Education Journal*, *39*, 239-247.

Janati, A. B., ALGhasa., N. S., Haq, F., Abdullah, A., & Osman, A. (2015). Nystagmus in Laurence-Moon-Biedl syndrome. *Hindawi*, 1-3.

Jarvis, C. (2004). *Physical Examination* & *Health Assessment*. St Louis Missouri, USA: Saunders Elsevier.

Jaspers, M. W. M., & Van Lieshout, E. C. D. M. (1994). The evaluation of two computerised instruction programs for arithmetic word-problem solving by educable mentally retarded children. *Learning and Instruction*, *4*, 193-215.

Jitendra, A.K., Rodriguez, M., Kanive, R., Huang, J., Church, C., Corroy, K.A., & Zaslofsky, A. (2013). Impact of small-group tutoring interventions on the mathematical problem solving and achievement of third-grade students with mathematics difficulties. *Learning Disability Quarterly*, *36*, 21-35.

Joet, G., Bressoux, P., & Usher, E. L. (2011). Sources of self-efficacy: An investigation of elementary school students in France. *Journal of Educational Psychology*, *103*(3), 649-663.

Johnson, P. A. (2005). *A Short Guide to Action Research*. New York: Pearson.

Jordan, N. C. (2010). Early predictors of mathematics achievement and mathematics learning difficulties. *Encyclopedia on Early Childhood Development*, 1-6.

Jordan, N. C., Glutting, J., & Ramineni, C. (2008). A number sense assessment tool for identifying children at risk for mathematical difficulties. In A. Dowker (Ed.), *Mathematical Difficulties: Psychology and Intervention* (pp. 45-58). San Diego: Academic Press.

Josiah, O., & Adejoke, E. O. (2014). Effect of gender, age and mathematics anxiety on college students' achievement in algebra. *American Journal of Educational Research*, *2*(7), 474-476.

Kemmis, S. & McTaggart, R. (2005). Participating Action Research: Communicative Action and the Public Sphere. In N. K. Denzin & Y. S. Lincoln (Eds.), *The Sage Handbook of Qualitative Research* (pp. 271-330). Thousand Oaks (California: Sage Publications.

Khairani, A. Z., & Razak, N. A. (2012). Advance in educational measurement: A Rasch Model analysis of a mathematics proficiency test. *International Journal of Social Science and Humanity*, *2*(3), 248-230.

King, B., Toth, K. E., Hodapp, R. M., & Dykens, E. M. (2009). Intellectual disability. In B. J. Sadock., V. A. Sadock., & P. Ruiz (Eds.). *Comprehensive Textbook of Psychiatry* (9thEd), (pp. 3444-3474). Philadelphia: Lippincott Williams & Wilkins.

Kitsera, N., Gastelger, K., Luhnsdorf, B., Allgayer, J., Epe, B., Carell, T., & Khobta, A. (2014). Cockayne Syndrome: Varied requirement of transcription-coupled nucleotide excision repair for the removal of three structurally different adduts from transcribed DNA. *PLoS One, 9*(4), 1-6.

Koscinski, S. T., & Gast, D. L. (1993). Use of constant time delay in teaching multiplication facts to students with learning disabilities. *Journal of Learning Disabilities*, *26*, 533-567

Kroesbergen, E. H., Van Luit, J. E. H., & Maas, C. J. M. (2004). Effectiveness of explicit and constructivist mathematics instruction for low-achieving students in the Netherlands. *The Elementary School Journal*, *104*(3), 233-251.

Kugelmass, J. (2004). *What is a Culture of Inclusion?* Retrieved from http://www.eenet.org.uk/resources/eenet_newsletter/news8/page14.php

Kunsch, C. A., Jitendra, A. K., & Sood, S. (2007). The effects of peer-mediated Instruction in Mathematics for Students with Learning Problems: A Research synthesis. *Learning Disabilities Research and Practice, 22*(1), 1–12.

Lachance, J. A., & Mazzocco, M.M.M. (2006). A longitudinal analysis of sex differences in math and spatial skills in primary school age children. *Learning and Individual Differences*, *16*(3), 195-216.

Lai, D. C., Tseng, Y. C., Hou, Y. M., & Guo, H. R. (2012). Gender and geographic differences in the prevalence of intellectual disability in children: Analysis of data from the national disability registry of Taiwan. *Research in Developmental Disabilities*, *33*, 2301-2307.

Lai, Y., Zhu, X., Chen, Y., & Li, Y. (2015). Effects of mathematics anxiety and mathematical metacognition on word problem solving in children with and without mathematical learning difficulties. *PLoS ONE*, *10*(6), 1-19.

Lamb, S. (1997). Gender differences in mathematics participation: an Australian perspective. *Educational Studies*, *23*(1), 105-125.

Laws, G., & Bishop, D. V. M. (2004). Verbal deficits in Down's syndrome and specific language impairment: a comparison. *International Journal of Language & Communication Disorder*, *39*(4), 423-451.

Lee, W., Lee, M-J., & Bong, M. (2014). Testing interest and self-efficacy as predictors of academic self-regulation and achievement. *Contemporary Educational Psychology*, *39*, 86-99.

Levin, J., Arluke, A., & Smith, M. (1982). The effects of labelling students upon teachers' expectations and intentions. *Journal of Social Psychology*, *118*(2), 207.

Lindberg, S. M., Hyde, J. S., Linn, M. C., & Petersen, J. L. (2010). New trends in gender and mathematics performance: A meta-analysis. *Psychological Bulletin*, *136*(6), 1123-1135.

Linn, C. M., Lewis, C., Tsuchida, I. & Songer, B. N. (2000). Beyond fourth-grade science: Why do U.S. and Japanese students diverge? *Educational Researcher*, *29*(3), 4-14.

Lymen, E., & Duatepe-Paksu, A. (2015). Analysis of 8th grade students' number Sense related to the exponents in terms of number sense components. *Egitim Ve Bilim*, *40*(177), 109-125.

Lynn, M. R. (1986). Determination and quantification of content validity. *Nursing Research*, *35*(6), 382-386.

Manalo, E., Bunnell, J. K., & Stillman, J. A. (2000). The use of process mnemonics In teaching students with mathematics learning disabilities. *Disability Quarterly*, *23*(2), 137-156.

Mancl, D. B., Miller, S. P., & Kennedy, M. (2012). Using the concrete-representational-abstract sequence with integrated strategy instruction to teach subtraction with regrouping to students with learning disabilities. *Learning Disabilities Research & Practice*, 27(4), 152–166.

Margolis, S. S., Sell, G. L., Zbinden, M. A, & Bird, L. M. (2015). Angelman Syndrome. *Neurotherapeutics*, *12*, 641-650.

Mason, R. (2005). Art teachers and action research. *Educational Action Research*, *13*(4), 563-579.

Matson, J. L, & Matson, M. L. (2015). Comorbid Conditions in Individuals with intellectual disability. In *Autism and Child Psychopology*. (pp.1- 443) Switzerland: Springer International Publishing.

Maulik, P. K., Mascarenhas, M. N., Mathers, C. D., Dua, T., & Saxena, S. (2011).
` Prevalence of intellectual disability: A meta-analysis of population-based studies. *Research in Developmental Studies*, *32*, 419-436.

Maxwell, J. A. (2005). *Qualitative Research Design: An Interactive Approach* (2nd Ed.). Thousand Oaks: SAGE Publications.

McInerney, D. M., & McInerney, V. (2002). *Educational Psychology: Constructing Learning*. New South Wales: Prentice Hall.

Mcintosh, A., Reys, B. J., & Reys, R. E. (1992). A proposed framework for examining basic number sense. *For the Learning of Mathematics, 12*(3), 2-44.

Mcintosh, A., Reys, B., Reys, C., Bana, J., Farrell, B., Emanuelsson, G., Johansson, B., & Yang, D. C. (1997). *Number Sense in School Mathematics: Student Performance in Four Countries*. Monograph Series No. 5. 12(3), 2-44. Edith Cowan University, Perth: Western Australia.

McLeod, D. B. (1992). Research on affect in mathematics education: A reconceptualization. In D. A. Grouws (Ed.), *Handbook of Research on Mathematics Teaching and Learning* (pp. 575-596). New York: Macmillan.

McLeskey, J., Tyler, N. C., & Flippin, S. S. (2004). The supply of and demand for special education teachers: A review of research regarding the chronic shortage of special education teachers. *The Journal of Special Education*, *38*(1), 5-21.

Merriam, S. B. (2009). *Qualitative Research: A Guide to Design and Implementation*. San Francisco, California: Jossey-Bass.

Midgley, C., Feldlaufer, H., & Eccles, J. (1989). Change in teacher efficacy and student self- and task-related beliefs in mathematics during the transition to junior high school. *Journal of Educational Psychology*, *81*, 247–258.

Miller, A. D., Hall, S. W., & Heward, W. L. (1995). Effects of sequential 1-minute time trials with and without inter-trial feedback and self-correction on general and special education students' fluency with math facts. *Journal of Behavioral Education*, *5*(3), 319-345.

Miller & Hudson (2006). Helping students with disabilities understand what mathematics means. *Teaching Exceptional Children*, 28-35.

Ministerial Council on Education, Employment, Training and Youth Affairs (1999a). *The Hobart Declaration on Schooling (1989)*. Retrieved from http://trove.nla.gov.au/work/32779019?selectedversion=NBD21925697

Ministerial Council on Education, Employment, Training and Youth Affairs (1999b). *The Adelaide Declaration on National Goals for Schooling in the Twenty-first Century*. Retrieved from http://www.scseec.edu.au/archive/Publications/Publications-archive/The-Adelaide-Declaration.aspx

Ministerial Council on Education, Employment, Training and Youth Affairs (2008). *Melbourne Declaration on Educational Goals for Young Australians*. Retrieved from http://www.curriculum.edu.au/verve/_resources/National_Declaration_on_the_Educational_Goals_for_Young_Australians.pdf

Minitab 17 Statistical Software (2010a). [Computer software]. State College, PA: Minitab, Inc. Retrieved from www.minitab.com

Minitab Inc. (2010b). *Interpret all statistics and graphs for Normality Test*. Retrieved from http://support.minitab.com/en-us/minitab-express/1/help-and-how-to/basic-statistics/summary-statistics/normality-test/interpret-the-results/all-statistics-and-graphs/

Mizala, A., Martinez, F., & Martinez, S. (2015). Pre-service elementary school teachers' expectations about student performance: How their beliefs are affected by their mathematics anxiety and student's gender. *Teaching and Teacher Education*, *50*, 70-78.

Montague, M. (2007). Self-regulation and mathematics instruction. *Learning Disabilities Research & Practice*, 22(1), 75–83.

Moreno, R., Ozogul, G., & Reisslein, M. (2011). Teaching with concrete and abstract visual representations: Effects on students' problem solving, problem representations, and learning perceptions. *Journal of Educational Psychology*, *103*(1), 32-47.

Morin, V. A., & Miller, S. P. (1998). Teaching multiplication to middle school students with mental retardation. *Education and Treatment of Children*, *21*(1), 22-36.

Morris, D. B., & Usher, E. L. (2011). Developing teaching self-efficacy in research institutions: A study of award-winning professors. *Contemporary Educational Psychology*, *36*, 232-245.

Moshman, D. (1982). Exogenous, endogenous, and dialectical constructivism. *Developmental Reviews*, *2*, 371-384.

Mrnjaus, K. & Krneta, M. (2014). Mindfulness, concentration and student achievement – Challenges and solutions. *Procedia - Social and Behavioral Sciences*, *116*, 1044 – 1049.

Mudaly & Naidoo (2015). The concrete-representational abstract sequence of Instruction in mathematics classrooms. *Perspectives in Education*, *33*(1), 42-56.

Muir, T. (2012). Ways for students to investigate and develop their number sense, *APMC*, *17*(1), 21-28.

Mukaka, M. M. (2012). A guide to appropriate use of correlation coefficient in medical research. *Malawi Medical Journal*, *24*(3): 69–71.

Mulford, W., Silins, H., & Leithwood, K. (2004*). Educational Leadership for Organizational Learning and Improved Student Outcomes*. Kluwer Academic Publishers: USA

Mwamwenda, T. S. (2002). Sex differences in mathematics performance among African university students. *Psychological Reports*, *90*(3 Pt 2), 1101-1104.

Naaldenberg, J., Banks, R., Lennox, N., Ouellette-Kunz, H., Meijer, M. & Lantman-de Valk, H. S. (2014). Health inequity in people with intellectual disabilities: From evidence to action applying an appreciative inquiry approach. *Journal of Applied Research in Intellectual Disabilities*, *28*, 3-11.

Nakano-Kobayashi, A., Tai, Y., Kasri, N. N., & Aest, L. V. (2014) The X-linked mental retardation protein OPHN1 interacts with Homer 1b/c to control spine endocytic zone positioning and expression of synaptic potentiation. *Journal of Neuroscience*, *34*(26), 8665-8671.

National Council of Teachers of Mathematics. (2013). Assessment. *The Mathematics Teacher*, *106*(8), 599.

National Council of Teachers of Mathematics (2008). *Number Sense —Right Now!* Retrieved from http://www.nctm.org/News-and-Calendar/Messages-from-the-President/Archive/Skip-Fennell/Number-Sense%E2%80%94Right-Now!/

National Council of Teachers of Mathematics. (2000). *The principles and standards for school mathematics*. Reston, Virginia.

National Disability Insurance Agency. (2014). Building the National Disability Insurance Scheme, *Progress Report: Year One.*

National Disability Insurance Scheme. (n.d.a). *Our history*. Retrieved from https://myplace.ndis.gov.au/ndisstorefront/about-us/our-history.html

National Disability Insurance Scheme. (n.d.b). *Access requirements*. Retrieved from https://myplace.ndis.gov.au/ndisstorefront/people-disability/access-requirements.html.

National Disability Insurance Scheme (n.d.c). *Our sites*. Retrieved from https://myplace.ndis.gov.au/ndisstorefront/about-us/our-sites.1.html

National Health and Medical Research Council (NHMRC). (2007). *National Statement on Ethical Conduct in Human Research*. Retrieved from https://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/e72_national_statement_may_2015_150514_a.pdf

National Mathematics Advisory Panel. (2008). *Foundations for success: The final Report of the National Mathematics Advisory Panel*. Washington DC: United States Department of Education.

National Numeracy (for everyone, for life). (2015). *Attitudes Towards Maths – Research and Approach Overview.* Retrieved from https://www.nationalnumeracy.org.uk/sites/default/files/attitudes_towards_maths_-updated_branding.pdf

Neece, C. L., Baker, B. L., Blacher, J., & Crnic, K. A. (2011). Attention-deficit/hyperactivity disorder among children with and without intellectual disability: an examination across time. *Journal of Intellectual Disability Research*, *55*(7), 623-635.

Nelson, D. L., Bajo, M. T., McEvoy, C. L., & Scheiber, A. T. (1989). Prior knowledge: The effects of natural category size on memory for implicitly encoded concepts. *Journal of Experimental Psychology*, *15*(5), 957-967.

Nesbit, W., & Philpott, D. (2008). The plight of individuals with cognitive disabilities: Social and educational facets of an arduous evolution. *The Morning Watch*, *36*(1-2), 1-21.

Noice, H., & Noice, T. (2001). Learning dialogue with and without movement. *Memory and Cognition*, *29*, 820-828.

Nonoyama-Tarumi, Y. (2008). Cross-national estimates of the effects of family background on student achievement: A sensitivity analysis. *International Review of Education*, *54*(1), 57-82.

Northern Territory Department of Education. (2016a). *Students with Disability*. Retrieved from https://education.nt.gov.au/support-for-teachers/students-with-disability

Northern Territory Government Department of Education. (2016b). *Guidelines – Transition from School for Students with Disability*. Retrieved from https://www.nt.gov.au/__data/assets/pdf_file/0006/268836/Transition_From_School_TFS_Guidelines.pdf.

O'Brien, V., Martinez-Pons, M., & Kopala, M. (1999). Mathematics self-efficacy, ethnic identity, gender, and career interests related to mathematics and science. *The Journal of Educational Research*, *92*(4), 231-235.

Okamoto, Y. & Case, R. (2004). The "Number Knowledge" Assessment. *National Longitudinal Survey for Children and Youth – Cognitive Measures*, 1-9.

Okamoto, Y., & Case, R. (1996). Exploring the microstructure of children's central conceptual structures in the domain of number. In R. Case & Y. Okamoto (Eds.), *The Role of Central Conceptual Structures in the Development of Children's Thought: Monographs of the Society for Research in Child Development* (Vol. 1-2, pp. 27-58). Malden, MA: Blackwell Publishers.

Open Access Government (2015). *Are teachers under too much pressure?* Retrieved https://www.openaccessgovernment.org/teachers-much-pressure/21870/

Ordonez, F. J., Rosety, M. A., Camacho, A., Rosety, I., Diaz, A. J., Fornieles, G., Garcia, N., & Rosety-Rodriguez, M. (2014). Aerobic training improved low-grade inflammation in obese women with intellectual disability. *Journal of Intellectual Disability Research*, *58* (6), 583-590.

Organization for Economic Cooperation and Development – OECD. (2012). *Equity and Quality in Education: Supporting disadvantaged students and schools*. Retrieved from http://www.oecd.org/education/school/50293148.pdf

Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of Educational Research*, *66*(4), 543-578.

Pajares, F. & Graham, L. (1999). Self-efficacy, motivation constructs, and mathematics performance of entering middle school students. *Contemporary Educational Psychology*, *24*, 124-139.

Pampaka, M., Klenthous, I., Hutcheson, G., & Wake, G. (2011). Measuring mathematics self-efficacy as a learning outcome. *Research in Mathematics Education*, *13*(2), 169-190.

Parmenter, K., & Wardle, J. (2000). Evaluation and design of nutrition knowledge measures. *Journal of Nutrition Education*, *32*(3), 269-277.

Patja, K., Livanainen, M., Vesala, H., Oksanen,H., & Ruoppila, I. (2000). Life expectancy of people with intellectual disability: a 35-year follow-up study. *Journal of Intellectual Disability Research*, *44*(5), 591-599.

Peterson, P. L., & Fennema, E. (1985). Effective teaching, student engagement in classroom activities, and sex-related differences in learning mathematics. *American Educational Research Journal*, *22*(3), 309-335.

Phan, H. P. (2012a). The development of English and Mathematics self-efficacy: A latent growth curve analysis. *The Journal of Educational Research*, *105*, 196-209.

Phan, H. P. (2012b). Relations between informational sources, self-efficacy and academic achievement: a developmental approach. *Educational Psychology*, *32*(1), 81-105).

Piek, J. P. (2006). *Down Syndrome*. Perth: Curtin University of Technology.

Pike, B., Bradley, F., & Mansfield, J. (1997). Philosophy of teaching: Developing a statement that thrives in the classroom. *The Clearing House*, *70*(3), 125-128.

Punch, K. F. (1998). *Introduction to Social Research: Quantitative & Qualitative Approaches*. London: SAGE Publications Ltd.

Queensland Curriculum and Assessment Authority. (2012). *Award Scheme Development & Accreditation Network (ASDAN)*. Retrieved from https://www.qcaa.qld.edu.au/downloads/senior/qce_recognised_asdan.pdf

Queensland Department of Education & Training. (2016a). *Education Adjustment Program (EAP) Handbook*. Retrieved from file:///C:/Users/Nisi/AppData/Local/Microsoft/Windows/INetCache/IE/ZRYT6L O9/eap-handbook.pdf.

Queensland Department of Education and Training. (2015). *Independent Public Schools*. Retrieved from http://education.qld.gov.au/schools/independent-public-schools/

Queensland Department of Education and Training (n.d.). *Fact Sheet. Improving Teacher Quality National Partnership*. Retrieved from http://education.qld.gov.au/nationalpartnerships/pdf/factsheet-improving-teacher-quality-final.pdf

Queensland Government Business and Industry Portal. (2016). *Preparing a risk management plan and business impact analysis*. Retrieved from https://www.business.qld.gov.au/business/running/risk-management/risk-management-plan-business-impact-analysis.

Reising, B. (1998). Assessment. *The Cleaning House*, *71*(6), 325.

Reynolds, T., Zupanick, C. E., & Dombeck, M. (2013). *Intellectual Disability*. Retrieved from https://www.mentalhelp.net/articles/about-introduction-to-intellectual-disabilities/

Reys, R; Lindquist, M. M; Lambdin, D. V. & Smith, N. L. (2009). *Helping Children Learn Mathematics (9th Ed.)*. USA: John Wiley & Sons, Inc.

Reys, R., Lindquist, M. M., Lambdin, D. V., & Smith, N. L. (2004). *Counting and Number Sense in Early Childhood and Primary Grades*. Nebraska: John Wiley & Sons, Inc.

Reys, R., Reys, B., McIntosh, A., Emanuelsson, G., Johansson, B., & Yang, D. C. (1999). Assessing number sense of students in Australia, Sweden, Taiwan, and the United States. *School Science and Mathematics*, 99(2), 61-70.

Rhea, P. (2008). Auditory processing disorder. *Journal of Autism and Developmental Disorders, 38*, 208-209

Riccomini, P. J., & Witzel, B. S. (2010). Number sense and initial maths skills. In P. J. Riccomini & B. S. Witzel (Eds.). *Response to Intervention in MATH* (pp. 65-77). California: Corwin/Sage.

Robert, S., & Winfried, H. (2012). Differentiated instruction in small schools. *Teaching and Teacher Education: An International Journal of Research and Studies*, *28*(8), 1152-1162.

Robinson, D., & Melnychuk, (2009). Assessing games understanding. *Strategies, 22*(5), pp. 25.

Rolison, M. A., & Medway, F. J. (1985). Teachers' expectations and attributions for student achievement: Effects of label, performance pattern, and special education intervention. *American Educational Research Journal*, *22*(4), 561-573.

Rosenberg, M. S., Westling, D. L., & McLeskey, J. (2013). *Primary Characteristics of Students with Intellectual Disabilities*. Retrieved from http://www.education.com/reference/article/characteristics-intellectual-disabilities/.

Ross, J. A. (1992). Teacher efficacy and the eff ect of coaching on student achievement. *Canadian Journal of Education*, *17*(1), 51–65.

Sanders, W. L. & Rivers, J. C. (1996). *Cumulative and Residual Effects Of Teachers and Future Student Academic Achievement*. Retrieved from http://www.cgp.upenn.edu/pdf/Sanders_Rivers-VASS_teacher%20effects.pdf

Sarason, B. S. (1985). *Psychology and mental retardation: Perspectives in change*. Austin, Texas: PRO-ED.

Sasanguie, D., Gobel, S. M., Moll, K., Smets, K. & Reynvoet, B. (2013). Approximate number sense, symbolic number processing, or number-space mappings: What underlies mathematics achievement? *Journal of Experimental Child Psychology*, *114*, 418-431.

Sawtelle, V., Brewe, E. & Kramer, L. H. (2012). Exploring the Relationship Between Self-Efficacy and Retention in Introductory Physics. *Journal of Research in Science Teaching*, *49*(9), 1096-1121.

Sayeski, K. L. & Paulsen, K. J. (2010). Mathematics reform curricula and special education: Identifying intersections and implications for practice. *Intervention in School and Clinic*, *46*, 13-21.

Schalock, R. L; Tasse, M. J. & Balboni, G. (2015). *Diagnosing Intellectual Disability Using the Diagnostic Adaptive Behavior Scale.* Louisville, Kentucky: AAIDD.

Scheiffele, P. & Beg, A. (2010). Angelman syndrome. *Nature*, *468*(7326), 907-908.

Schifter, D. & Simon, M. A. (1992). Assessing Teachers' Development of a Constructivist View of Mathematics Learning. *Teaching & Teacher Education*, *8*(2), 187-197.

Scott, K. S. (1993). Multisensory mathematics for children with mild disabilities. *Exceptionality*, *4*(2), 97-111.

Sheehan, T. J. (1968). Patterns of sex differences in learning mathematical problem-solving. *The Journal of Experimental Education*, *36*(4), 84-87.

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information*, *22*: 63-75.

Sherman, E. M., Brooks, B. L., Fay-McClymont, T. B. & MacAllister, W. S. (2012). Detecting epilepsy-related cognitive problems in clinically referred children: is the WISC-IV a useful tool? *Epilepsia*, *53*(6), 1060-1066.

Shifrer, D. (2013). Learning Disabilities and Inequality. *Sociology Compass, 7*(8), 656-669.

Shumway, J. F. (2011). *Number Sense Routines: Building Numerical Literacy Every Day in Grades K-3*. USA: Stenhouse Publishers.

Smith, M. C. (2013). Adult Education and Achievement. In J. Hattie & E. M. Alderman (Eds.), *International Guide to Student Achievement* (pp. 13-15). USA (New York): Routledge.

Smith, T. E., Polloway, E. A., Patton, J. R., & Dowdy, C. A. (2015*). Teaching Students with Special Needs in Inclusive Settings*. (6th Ed.). Noida, India: Pearson India Education Services.

Southern Cross University (2013). *A review of inclusive curricula, teaching, retention, achievement and progression: A report for the inclusive curricula and teaching project*. Retrieved from http://scu.edu.au/teachinglearning/download.php?doc_id=16267&site_id=301&file_ext=.pdf.

Sparrow, S. S; Cicchetti, D. V. & Balla, B. A. (2005). *Vineland Adaptive Behavior Scales Second Edition (Vineland-II)*. Circle Pines, MN: American Guidance Service.

Spires, H. A., & Donley, J. (1998). Prior knowledge activation: Inducing engagement with informational texts. *Journal of Educational Psychology*, *90*(2), 249-260.

Steedly, K., Dragoo, K., Arafeh, S., & Luke, S. D. (2008). Effective mathematics instruction. *National Dissemination Center for Children with Disabilities (NICHCY)*, *3*(1), 1-12.

Stevens, C., Pouncey, J., & Knowles, D. (2011). Adults with Rubinstein-Taybi syndrome. *American Journal of Medical Genetics*, *155*, 1680-1684.

Stobbs, P. (2016). What are P Scales and do we need them? Retrieved from https://senmagazine.co.uk/articles/articles/senarticles/what-are-p-scales-and-do-we-need-them-philippa-stobbs-investigates.

Strayhorn, T. L. (2013). Academic achievement: A higher education perspective. In J. Hattie & E. M. Alderman (Eds.), *International Guide to Student Achievement* (pp. 16-18). USA (New York): Routledge.

Strickland, T. K., & Maccini, P. (2012). The effects of the concrete–representational–abstract integration strategy on the ability of students with learning disabilities to multiply linear expressions within area problems. *Remedial and Special Education*, *34*(3) 142–153.

Stringer, E. (2008). *Action Research in Education* (2nd Ed.). New Jersey: Pearson Education, Inc.

Swann, W., & Snyder, M. (1980). On translating beliefs into action: Theories of ability and their application in an instructional setting. *Journal of Personality and Social Psychology*, *38* (6), 879-888.

Sznitman, S. R., Reisel, L., & Romer, D. (2011). The neglected role of adolescent emotional well-being in national educational achievement: Bridging the gap between education and mental health policies. *Journal of Adolescent Health*, *48*, 135–142

Targeted News Service. (2011). *Prime Minister, Minister for School Education Budget to Provide More Support to Students with Disabilities*. Dateline*:* Canberra, Australia.

Taylor, B. A., & Fraser, B. J. (2013). Relationships between learning environment and mathematics anxiety. *Learning Environments Research*, *16*(2), 297-313.

Texas Council for Developmental Disabilities (Project IDEAL) (2013). *Intellectual Disabilities* Retrieved from http:// disabilities/ www.projectidealonline.org/v/intellectual-disabilities/

Teicher, S. (2007**).** Schools strive for 'no parent left behind'; Public schools facing pressure to perform under No Child Left Behind Act are working to help parents be more engaged in their children's educations. *The Christian Science Monitor*, 13.

Thompson, B. L., Green, S. B., & Yang, D. C. (2010). Assessment of the Maximal Split-Half Coefficients to Estimate Reliability. *Educational and Psychological Measurement*, *70*(2), pp.232-251

Tsafos, V. (2009). Teacher–student negotiation in an action research project. *Educational Action Research*, *17*(2), 197-211.

Tschannen-Moran, M., & Woolfolk H. A. (2001). Teacher efficacy: Capturing an elusive construct. Teaching and Teacher Education, *17*, 783-805.

UK Department of Education. (2014). *P scales: attainment targets for pupils with SEN*. Retrieved from https://www.gov.uk/government/publications/p-scales-attainment-targets-for-pupils-with-sen.

UNESCO. (1994). *The Salamanca Statement and Framework for Action on Special Needs Education*. Retrieved from http://www.unesco.org/education/pdf/SALAMA_E.PDF

UNESCO. (2015). *Ten Questions on Inclusive Education*. Retrieved from http://www.unesco.org/new/en/education/themes/strengthening-education-systems/inclusive-education/10-questions-on-inclusive-quality-education/

UNESCO. (2013). *The Global Learning Crisis: Why Every Child Deserves a Quality Education. France*: UNESCO. Retrieved from http://www.globaleducationfirst.org/files/Global_Learning_final_web_spread.pdf

UNICEF. (2000). *Defining Quality in Education. The International Working Group on Education: Florence (Italy)*. Retrieved from http://www.unicef.org/education/files/QualityEducation.PDF

United Nations (2016). *Leaving no one behind: the imperative of inclusive development (Report on the World Social Situation).* Retrieved from http://www.un.org/esa/socdev/rwss/2016/full-report.pdf

United Nations. (1948). *The Universal Declaration of Human Rights*. Retrieved from http://www.un.org/en/universal-declaration-human-rights/

Usher, E. L. & Pajares, F. (2009). Sources of self-efficacy in mathematics: A validation study. *Contemporary Educational Psychology*, *34*, 89-101.

Usher, E. L. & Pajares, F. (2005). Sources of academic and self-regulatory efficacy beliefs of entering middle school students. *Contemporary Educational Psychology*, *31*, 125-141.

Valas, H. (1999). Students with learning disabilities and low-achieving students: Peer acceptance, loneliness, self-Esteem, and depression. *Social Psychology of Education*, (3), 173-192.

Victoria State Government Department of Education and Training. (2016a). *ABLES – Abilities Based Learning and Education Support*. Retrieved from http://www.education.vic.gov.au/school/teachers/teachingresources/diversity/Pages/ables.aspx.

Victoria State Government Department of Education and Training. (2016b). *The ABLES Assessment Tools*. Retrieved from http://www.education.vic.gov.au/school/teachers/teachingresources/diversity/Pages/ablesassessment.aspx.

Victoria State Government Department of Education and Training. (2015a). *Research Behind ABLES*. Retrieved from http://www.education.vic.gov.au/school/teachers/teachingresources/diversity/Pages/ablesresearch.aspx.

Victoria State Government Department of Education and Training. (2013a). *What is a Behaviour Support Plan?* Retrieved from http://www.education.vic.gov.au/Documents/about/programs/bullystoppers/bspwhatis.pdf.

Victoria State Government Department of Education and Training. (2013b). *Planning – Managing Risk*. Retrieved from http://www.education.vic.gov.au/school/principals/health/Pages/outdoorrisk.aspx.

Victoria State Government Department of Education and Training. (2014). *Managing Risk*. Retrieved from http://www.education.vic.gov.au/school/principals/spag/governance/Pages/risk.aspx.

Waters, L. (2015). *Teach the Way Children Learn: One Mother's Gratitude for a Teacher*. Retrieved from http://educationpost.org/teach-the-way-children-learn-one-mothers-gratitude-for-a-teacher/

Way, J. (2011). *Number Sense Series: Developing Early Number Sense.* Retrieved from https://nrich.maths.org/2477

Weesie, J. (n.d.). *The Rasch Model in Stata: Can Stata estimate a Rasch Model?* Retrieved from http://www.stata.com/support/faqs/statistics/rasch-model/

Wen, X. (1997). The definition and prevalence of intellectual disability in Australia. Australia (Canberra): Australia Institute of Health and Welfare.

Werner, S., & Stawski, M. (2012). Mental health: Knowledge, attitudes and training of professionals on dual diagnosis of intellectual disability and psychiatric disorder. *Journal of Intellectual Disability Research*, *56*(3), 291–304.

Westerinen, H., Kaski, M., Virta, L., Almqvistm, F., & Livanainen, M. (2007). Prevalence of intellectual disability: a comprehensive study based on national registers. *Journal of Intellectual Disability Research*, *51*(9), 715-725.

Whitaker, S. (2013). *Intellectual Disability: An Inability to Cope with an Intellectually Demanding World*. UK: Palgrave Macmillan.

Whitaker, S., & Gordon, S. (2012). Floor effects on the WISC-IV. *International Journal of Developmental Disabilities*, *58*(2), 111-119.

White, T. (2015). Engaging with the Australian curriculum. *Nurture: the Voice of the National Union of Associations for Christian Parent-controlled Schools*. *49*(1), 20-21.

Whitmore, J. R., & Maker, C. J. (1985). *Intellectual giftedness in disabled persons*. Rockville MD: Aspen.

Williams, D. (2011). *Differences between learning and intellectual disabilities*. Retrieved from http://www.kingstonthisweek.com/2011/01/20/differences-between-learning-and-intellectual-disabilities.

Willis, J. W. (2007). *Foundations of Qualitative Research: Interpretive and Critical Approaches*. California: Sage Publications, Inc.

Wilson, M. (2005). *ConstructMap.* Retrieved from http://bearcenter.berkeley.edu/software/constructmap

Witzel, B. S., (2013). Introduction to the characteristics of number sense. In B. S. Witzel., B. J. (Riccomini & M. Herlong (Eds.). *Number Sense Through The Common Core*. In B. S. Witzel., P. J. Riccomini & M. Herlong (Eds.). (pp. 1-9). Thousand Oaks, California: Corwin/Sage.

Witzel, B. S., Ferguson, C. J., & Mink, D. V. (2012). Number sense: Strategies for helping preschool through Grade 3 children develop math skills. *Young Children*, 89-94.

Witzel, B. S., Mercer, C. D., & Miller, M. D. (2003). Teaching algebra to students with learning difficulties: An investigation of an explicit instruction model. *Learning Disabilities Research & Practice*, *18*(2), 121–131.

Witzel, B. S., Riccomini, P. J., & Schneider, E. (2008). Implementing CRA with secondary students with learning disabilities in mathematics. *Intervention in School and Clinic*, *43*(5), 270-276.

Woolfolk, A. (1998). *Educational Psychology.* Boston (USA): Allyn and Bacon.

World Health Organization. (n.d.). *Disabilities.* Retrieved from http://www.who.int/topics/disabilities/en/.

World Health Organization. (2002). *Towards a Common Language for Functioning, Disability and Health – ICF*. Retrieved from file:///F:/PhD%20Thesis%20(11%20September%202015)/Towards%20a%20common%20language%20for%20Functioning%20Disability%20and%20Health%20(WHO)%20(1).pdf

Wullink, M., Lantman-de Valk, V. S., Dinant, G. J., & Metsemakers, J. F. M. (2007). Prevalence of people with intellectual disability in the Netherlands. *Journal Of Intellectual Disability Research*, *51*(7), 511-519.

Yakubova, G., Hughes, E., & Shinaberry, M. (2016). Learning with technology: video modelling with concrete-representational-abstract sequencing for students with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *46*(7), 2349-2362.

Yang, D. C. & Hsu, C. J. (2009). Teaching number sense for 6^{TH} Grades in Taiwan. *International Electronic Journal of Mathematics Education*, *4*(20), 92-108.

Yassour-Borochowitz, D. (2010). Reflections on the researcher-participant relationship and the ethics of dialogue. *Ethics & Behaviour*, *14*(2), 175-186.

Zohrabi, M. (2013). Mixed method research: Instruments, validity, reliability and reporting findings. *Theory and Practice in Language Studies*, *3*(2), 254-262.

Appendix A: MATHEMATICS TEACHING EFFICACY BELIEFS INSTRUMENT ITEMS

	Items	SA	A	U	D	SD
1.	When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort.					
2.	I will continually find better ways to teach mathematics.					
3.	Even if I try very hard, I do not teach mathematics as well as I do most subjects.					
4.	When the mathematics grades of students improve, it is often due to their teacher having found a more effective teaching approach.					
5.	I know the steps necessary to teach mathematics concepts effectively.					
6.	I am not very effective in monitoring mathematics activities.					
7.	If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.					
8.	I generally teach mathematics ineffectively.					
9.	The inadequacy of a student's mathematics background can be overcome by good teaching.					
10.	When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher.					
11.	I understand mathematics concepts well enough to be effective in teaching mathematics.					
12.	The teacher is generally responsible for the achievement of students in mathematics.					
13.	Students' achievement in mathematics is directly related to their teacher's effectiveness in mathematics teaching.					
14.	If parents comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child's teacher.					
15.	I find it difficult to use manipulatives to explain to students why mathematics works.					
16.	I am typically able to answer students' mathematics questions.					
17.	I wonder if I have the necessary skills to teach mathematics.					
18.	Given a choice, I would not invite the principal to evaluate my mathematics teaching.					
19.	When a student has difficulty understanding a mathematics concept, I am usually at a loss as to how to help the student understand it better.					
20.	When teaching mathematics, I usually welcome student questions.					
21.	I do not know what to do to turn students on to mathematics.					

- SA = Strongly Agree, A = Agree, U = Uncertain, D = Disagree and SD = Strongly Disagree

Appendix B: MATHEMATICS SELF-EFFICACY ITEMS FOR STUDENTS WITH ID

1	I am capable of solving math problems
2	I can solve geometry problems (e.g. identify shapes, calculate area and perimeter)
3	I am capable of getting good grades in math
4	I can solve addition problems involving single digit numbers
5	I can solve double-digit addition problems
6	I can subtract single-digit numbers
7	I can subtract double digit numbers
8	I can multiply single-digit numbers
9	I can multiply double-digit numbers
10	I can divide single-digit numbers
11	I can divide double-digit numbers
12	I can identify a number's place value
13	I know how to write numbers with their symbols up to 20
14	I know how to calculate the area of a rectangle
15	I am capable of measuring the sides and diagonals of a rectangle
16	I know how to add metres and centimetres
17	I know how many centimetres make a metre
18	I know how many cents make a dollar
19	I know how many minutes make 1 hour
20	I can count from 1 to 10
21	I can count from 1 to 20
22	I can count from 1 to 50
23	I can count from 1 to 100
24	I can count from 1 to 1000
25	I know my 12 times table

Appendix C: SOURCES OF MATHEMATICS SELF-EFFICACY ITEMS

	Sources of Mathematics Self- Efficacy items	**Categories**
1	I like Mathematics (**ME)**	Mastery Experience
2	I make excellent grade on maths test (**ME)**	
3	I have always been successful with maths (**ME)**	
4	Even when I study very hard, I do poorly in math (**ME)**	
5	I got good grades in math on my last report card (**ME)**.	
6	I do well on math assignment (**ME)**	
7	I do well on even the most difficult math assignment. (**ME)**	
8	Seeing adults do well in math pushes me to do better (**VE**)	Vicarious experience
9	When I see how my math teacher solves a problem, I can picture myself solving the problem in the same way. (**VE**)	
10	Seeing other students do better than me in math pushes me to do better (**VE**)	
11	When I see how another student solves a math problem, I can see myself solving the problem in the same way. (**VE**)	
12	I imagine myself working through challenging math problems successfully. (**VE**)	
13	I compete with myself in math. (**VE**)	
14	My math teachers have told me that I am good at learning maths (**SP**)	Social Persuasions
15	People have told me that I have a talent for math. (**SP**)	
16	Adults in my family have told me what a good math student I am. (**SP**)	
17	I have been praised for my ability in math (**SP**)	
18	Other students have told me that I'm good at learning math. (**SP**)	
19	My classmates like to work with me in math because they think I'm good at it. (**SP**)	
20	Just being in math class makes me feel stressed and nervous. (**PES**)	Emotional and Physiological states
21	Doing math work takes all of my energy (**PES**)	
22	I start to feel stressed-out as soon as I begin my math work (**PES**)	
23	My mind goes blank and I am unable to think clearly when doing math work. (**PES**)	
24	I get depressed when I think about learning math (**PES**)	
25	My whole body becomes tense when I have to do math (**PES**)	

- Mastery Experience (**ME**);Vicarious Experience (**VE**); Social Persuasions (**SP**); Physiological and Emotional States (**PES**)
- Student 1 = student code 19, Student 2 = student 20; student 3 = student code 21; student 4 = student code 5; student 6 = student code 28, etc

Appendix D: MATHEMATICS ANXIETY FACTOR

	Student Anxiety items
1	Just being in maths class makes me feel stressed and nervous.
2	Doing maths work takes all of my energy
3	I start to feel stressed-out as soon as I begin my maths work
4	My mind goes blank and I am unable to think clearly when doing maths work.
5	I get depressed when I think about learning maths
6	My whole body becomes tense when I have to do maths

Appendix E: STUDENT FACTOR QUESTIONNAIRE

(**completed by Teachers and Education Assistants**)

Name of Student: ________________________ Year level: _______ Date: _________

1. **Details of staff Completing this Questionnaire**
2. Gender

   _____________ (a) Female ________________ (b) male

3. Staff position at the school:

   __________________a. Work with the student in the class as a teacher

   ___________________ (b) Work with the student in the class as an Education Assistant

   _______________________ © How many months have you been working with this student?

4. For how many months have you been a staff at this school __________________

<u>Student Factor</u>

I. School attendance

1. How would you describe the attendance of this student this year?
   - (a) Excellent
   - (b) Very Good
   - (c) Average
   - (d) Satisfactory
   - (e) Poor

2. Has an individual attendance plan been put in place for this student this year?
   - (a) Yes
   - (b) No

3. Which of the factors below is affecting or has affected the school attendance of the student?
   (a) sickness
   (b) student dislikes attending school
   (c) unknown

II. Attentiveness in class

(1) How attentive is the student in class?
- (a) Always attentive
- (b) Sometimes attentive
- (c) Seldom attentive
- (d) Never attentive

(2) The student difficulty with attentiveness is associated with her/his:
- (a) Disability diagnosis
- (b) Medical condition
- (c) Both of the above
- (d) None of the above

III. Motivation

(1) Is the student happy at school?
- (a) Always
- (b) Sometimes
- (c) Never

(2) Is the student under the care of DCP?
- (a) Yes
- (b) No

(3) Is the student motivated in class
- (a) Always
- (b) Sometimes
- (c) Never

IV. Behaviour

(1) How would you describe the behaviour of this student?
- (a) Excellent
- (b) Good

(c) Satisfactory

(d) Poor

(2) How many times has the student been suspended from school this year?

(a) None

(b) < 5 times

(c) > 5 times

(3) The student behaviour problems are associated with her/his:

(e) Disability diagnosis

(f) Medical condition

(g) Both of the above

(h) None of the above

4. Has an individual behaviour plan been put in place for this student this year?

(c) Yes

(d) No

(4) How often has this student been reported to the principal this year for inappropriate behaviour?

(a) Always

(b) Sometimes

(c) Seldom

(d) Never

V. Productivity in class

(1) How would you describe the student attitude to school work?

(a) Very productive if the work is pitched at her level?

(b) Does the minimum amount of work that she needs to do regardless of the incentives

(c) Does no work most of the time

VI Comments

Appendix F: STUDENT EMOTIONAL WELL-BEING QUESTIONNAIRE
(completed by Teachers and Education Assistants)

Name of Student: _________________________ Year level: _____ Date: _________

5. **Other details of the student Completing this Questionnaire**
6. Gender

   ____________ (a) Female ________________ (b) male

7. How many years have you been at this school?_________________________________

Student Self-Reflection

VI. Social-Emotional Wellbeing

5. Is the student happy at school?
   (f) Yes
   (g) No
   (h) Sometimes
   (i) Never
6. Does the student like coming to school?
   (e) Yes
   (f) No
   (g) Sometimes
   (h) Never
7. Does the student feel safe at school?
   (d) Yes
   (e) No
   (f) Sometimes
   (g) Never
8. Does the student get along well with his/her classmates?
   (a) Yes
   (b) No
   (c) Sometimes
   (d) Never

9. Does the student get along well with his/her class teacher?
   (a) Yes
   (b) No
   (c) Sometimes
   (d) Never

10. Does the student get along well with other teachers
   (a) Yes
   (b) No
   (c) Sometimes
   (d) Never

11. Does the student get into a lot of trouble at school?
   (a) Yes
   (b) No
   (c) Sometimes
   (d) Never

12. Does the student participate in fun activities (e.g. sports) after school?
   (a) Yes
   (b) No
   (c) Sometimes
   (d) Never

13. Does the student get along well with members of his/her family?
   (a) Yes
   (b) No
   (c) Sometimes
   (d) Never

14. Does the student worry about schoolwork when at school?
   (a) Yes
   (b) No
   (c) Sometimes
   (d) Never

15. Does the student get bullied at school?
   (a) Yes
   (b) No
   (c) Sometimes
   (d) Never

16. Does the student get bullied by staff while at school?

(a) Yes
(b) No
(c) Sometimes
(d) Never

17. Is the student sad at school because he/she has no friend(s)?
(a) Yes
(b) No
(c) Sometimes
(d) Never

VII. Learning Skills

(3) Does the student work hard to complete schoolwork in class?
(e) Yes
(f) No
(g) Sometimes
(h) Never

(4) Does the student give up trying easily when he/she find the task challenging?
(a) Yes
(b) No
(c) Sometimes
(d) Never

(5) Does the student manage his/her time well in class?
(i) Yes
(j) No
(k) Sometimes
(l) Never

(6) Name the student favourite subject/learning area?

Yes

____

(7) Does the student you enjoy Maths? ☐ ☐ No

(8) If No, Why

(9) Does the student find the Maths work at school interesting?

(d) Yes

(e) No

(f) Sometimes

(g) Never

(10) Does the student find his/her Maths task in class too hard?

(c) Yes

(d) No

(e) Sometimes

(f) Never

(11) Does the student find his/her Maths task in class too easy and boring?

(d) Yes

(e) No

(f) Sometimes

(g) Never

(12) Does the student require more one-on-one support from staff during Maths lessons?

(e) Yes

(f) No

(g) Sometimes

(h) Never

(13) Which area(s) of Maths does the student enjoy doing?

(14) Which area(s) of Maths does the student dislike?

(15) What do you want to see done to help the student enjoy Maths?

III Comments

Appendix G: STUDENT SELF-REFLECTION QUESTIONNAIRE
(completed by students)

Name of Student: _________________________Year level: __________ Date: _____

8. **Other details of the student Completing this Questionnaire**
9. Gender

   ____________ (a) Female ______________ (b) male

10. How many years have you been at this school?_______________________________

<u>Student Self-Reflection</u>

VIII. Social-Emotional Wellbeing

18. Are you happy at school?
    (j) Yes
    (k) No
    (l) Sometimes
    (m) Never
19. Do you like coming to school?

    (i) Yes
    (j) No
    (k) Sometimes
    (l) Never
20. Do you feel safe at school?
    (h) Yes
    (i) No
    (j) Sometimes
    (k) Never
21. Do you get along well with your classmates?
    (e) Yes
    (f) No
    (g) Sometimes
    (h) Never

22. Do you get along well with your class teacher?
    (e) Yes
    (f) No
    (g) Sometimes
    (h) Never

23. Do you get along well with other teachers
    (e) Yes
    (f) No
    (g) Sometimes
    (h) Never

24. Do you get into a lot of trouble at school?
    (e) Yes
    (f) No
    (g) Sometimes
    (h) Never

25. Do you participate in fun activities (e.g. sports) after school?
    (e) Yes
    (f) No
    (g) Sometimes
    (h) Never

26. Do you get along well with members of your family?
    (e) Yes
    (f) No
    (g) Sometimes
    (h) Never

27. Do you get worried about schoolwork when at school?
    (e) Yes
    (f) No
    (g) Sometimes
    (h) Never

28. Do students bully you at school?
    (e) Yes
    (f) No
    (g) Sometimes
    (h) Never

29. Do staff bully you at school?

(e) Yes
(f) No
(g) Sometimes
(h) Never

30. Are you sad at school because you do not have friends?
(e) Yes
(f) No
(g) Sometimes
(h) Never

IX. Learning Skills

(16) Do you work hard to complete schoolwork in class?

(i) Yes
(j) No
(k) Sometimes
(l) Never

(17) Do you give up trying easily when you find the task challenging?

(e) Yes
(f) No
(g) Sometimes
(h) Never

(18) Do you manage your time well in class?

(m) Yes
(n) No
(o) Sometimes
(p) Never

(19) Which subject is your favourite?

Yes

____

(20) Do you enjoy Maths? ☐ ☐ No

(21) If No, Why

(22) Do you find the Maths work at school interesting?

(h) Yes

(i) No

(j) Sometimes

(k) Never

(23) Do you find your Maths task in class too hard?

(g) Yes

(h) No

(i) Sometimes

(j) Never

(24) Do you find your Maths task in class too easy and boring?

(h) Yes

(i) No

(j) Sometimes

(k) Never

(25) Do you need more one-on-one support from staff during Maths lessons?

(i) Yes

(j) No

(k) Sometimes

(l) Never

(26) Which area(s) of Maths do you enjoy doing?

(27) Which area(s) of Maths do you dislike?

(28) What do you want to see done to help you enjoy Maths?

III Comments

Appendix H: APPROVAL OF RESEARCH PROPOSAL BY THE HUMAN RESEARCH ETHICS COMMITTEE (HREC)

Curtin University

Memorandum

To	Professor John Malone, Science and Mathematics Education Centre
From	Professor Stephan Millett, Chair, Human Research Ethics Committee
Subject	Protocol Approval **HR 188/2013**
Date	3 December 2013
Copy	Agbon Osa Stephen Enoma Science and Mathematics Education Centre

Office of Research and Development
Human Research Ethics Committee

TELEPHONE 9266 2784
FACSIMILE 9266 3793
EMAIL hrec@curtin.edu.au

Thank you for providing the additional information for the project titled "*Understanding the number sense competence of high school students with mild, moderate, severe and profound intellectual disabilities*". The information you have provided has satisfactorily addressed the queries raised by the Committee. Your application is now **approved**.

- You have ethics clearance to undertake the research as stated in your proposal.
- The approval number for your project is **HR 188/2013.** *Please quote this number in any future correspondence.*
- Approval of this project is for a period of four years **03-12-2013** to **03-12-2017**.
- Your approval has the following conditions:
  i) Annual progress reports on the project must be submitted to the Ethics Office.
- **It is your responsibility, as the researcher, to meet the conditions outlined above and to retain the necessary records demonstrating that these have been completed.**

Applicants should note the following:

It is the policy of the HREC to conduct random audits on a percentage of approved projects. These audits may be conducted at any time after the project starts. In cases where the HREC considers that there may be a risk of adverse events, or where participants may be especially vulnerable, the HREC may request the chief investigator to provide an outcomes report, including information on follow-up of participants.

The attached **Progress Report** should be completed and returned to the Secretary, HREC, C/- Office of Research & Development annually.

Our website https://research.curtin.edu.au/guides/ethics/non_low_risk_hrec_forms.cfm contains all other relevant forms including:

- Completion Report (to be completed when a project has ceased)
- Amendment Request (to be completed at any time changes/amendments occur)
- Adverse Event Notification Form (If a serious or unexpected adverse event occurs)

Yours sincerely

Professor Stephan Millett
Chair Human Research Ethics Committee

Appendix I: PARTICIPANT INFORMATION SHEET

RESEARCH TITLE: **UNDERSTANDING THE NUMBER SENSE COMPETENCE OF HIGH SCHOOL STUDENTS WITH BORDERLINE, MILD, AND MODERATE INTELLECTUAL DISABILITIES**

PRINCIPAL INVESTIGATOR: **PROF JOHN MALONE**

CO- INVESTIGATOR: **DR AGBON STEPHEN ENOMA**

Dear Participants (students, staff, parents, School Council),

You are invited to participate in the research project as described below:

What is the project about?

The research is scheduled to be conducted at your school from the beginning of the 2014 school year and specifically seeks to answer the following questions:

1. Do students with mild, moderate and severe intellectual disabilities possess specific number sense skills that distinguish members of one group from the other?
2. What are the effects of age, gender, student and teacher factors on the number sense achievements of students with mild, moderate and severe intellectual disabilities?
3. What are the effects of the constructivist and explicit intervention strategies on the development of number sense among high school students with mild, moderate and severe intellectual disabilities?

Who is undertaking the research?

The research is being conducted by Dr Agbon Stephen Enoma as co-investigator and Prof John Malone (Curtin University) as principal investigator.

What will students be asked to do?

Students will be asked to:

1. Participate in Maths learning activities provided by their teacher
2. Complete a Self-Reflection Questionnaire
3. Participates in standardized testings

What will staff be asked to do?

Staff will be asked to:

1. Administer standardized testings on their students
2. Provide Maths instruction using the Explicit and Constructivist approaches
3. Complete Student Factor Questionnaire (to be completed by teachers)

Are there any risks associated with participating in this research project?

There are no foreseeable risks associated with this project.

What are the benefits of the research project?

The outcomes of this study will provide better insight into the teaching of number sense to special educational needs students with mild, moderate and severe intellectual disabilities in schools. The knowledge gathered will enable teachers to devise effective instructional approaches that are evidence-based to improve the number sense skills of these students.

Can students and staff withdraw from the study?

Your participation in this study is completely voluntary. Students, staff and parents are not under any obligation to participate.

Will anyone else know the results of the project?

Information gathered about, students, staff and parents will be held in strict confidence. This confidence will only be broken in instances of legal requirements such as court subpoenas, freedom of information requests, or mandated reporting by some professionals.

Participants will not be identified in any future publication that may result from the research. Confidentiality will be maintained at all times. Data will be stored securely for a period of five years. The overall results of the research may be published in an academic journal or conference paper.

Will students, staff and parents be able to find out the results of the project?

A summary of the findings of the research will be made available to all participants through a PowerPoint presentation which will be given by Dr Agbon Stephen Enoma at the completion of the study.

Who do I contact if I have questions about the project?

Please contact Dr Agbon Stephen Enoma on (08) 90213691 or Agbon.Enoma@education.wa.edu.au if there are any questions or concerns about the study.

What if students, staff, parents or the School Council have complaints or concerns?

This study has been approved by the Curtin University Human Research Ethics Committee (Approval Number HR xx/2013). The Committee is comprised of members of the public, academics, lawyers, doctors and pastoral carers. If needed, verification of approval can be obtained either by writing to the Curtin University Human Research Ethics Committee, c/- Office of Research and Development, Curtin University, GPO Box U1987, Perth, 6845 or by telephoning 9266 2784 or by emailing hrec@curtin.edu.au.

Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

Participation

A consent form has been included with this letter. Please sign and return to Dr Agbon Stephen Enoma if you wish to participate.

Yours sincerely,

Dr Agbon Stephen Enoma

Co-Investigator

Appendix J: INFORMED CONSENT FORM

CONSENT FORM

Understanding the number sense competence of High School students with borderline, mild, and moderate intellectual disabilities

INFORMED CONSENT FORM

I, *(The School Council Representative)* _________________________________ hereby agree for the staff and students to participate in the above-named research project.

• Members of the School Council have read and understood the information sheet about this

project and any questions have been answered to my satisfaction.

• Members of the School Council understand that staff and students may withdraw from

participating in the project at any time without prejudice.

• Members of the School Council understand that all information gathered by the researchers

will be treated as strictly confidential, except in instances of legal requirements such as court

subpoenas, freedom of information requests, or mandated by some professionals.

• Whilst the research involves small sample sizes, the members of the School Council

understand that a code will be ascribed to all participants to ensure that the risk of

identification is minimised.

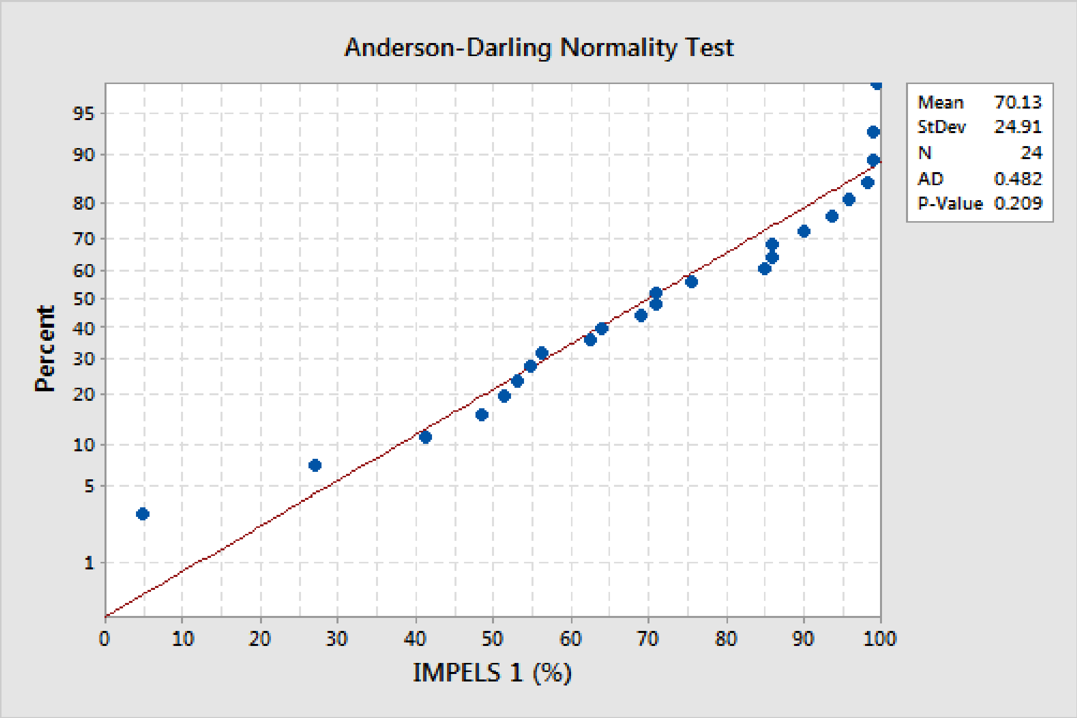
•Members of the School Council understand that the protocol adopted by Curtin University Human Research Ethics Committee for the protection of privacy will be adhered to and relevant sections of the *Privacy Act* are available at http://www.nhmrc.gov.au/

•Members of the School Council agree that any research data gathered for the study may be Published provided the names of the school, staff and students and other identifying information are not disclosed.

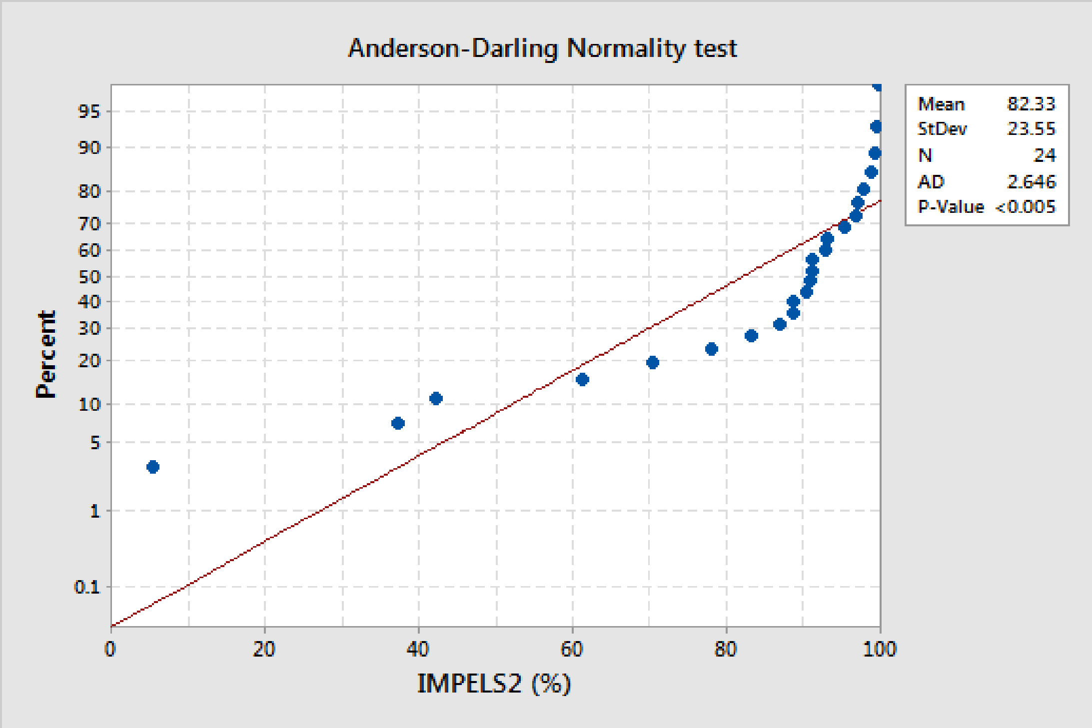
SIGNATURE SCHOOL COUNCIL REPRESENTATIVE		**DATE:**	

CO-RESEARCHER'S FULL NAME	DR AGBON STEPHEN ENOMA		
CO-RESEARCHER'S SIGNATURE		**DATE:**	

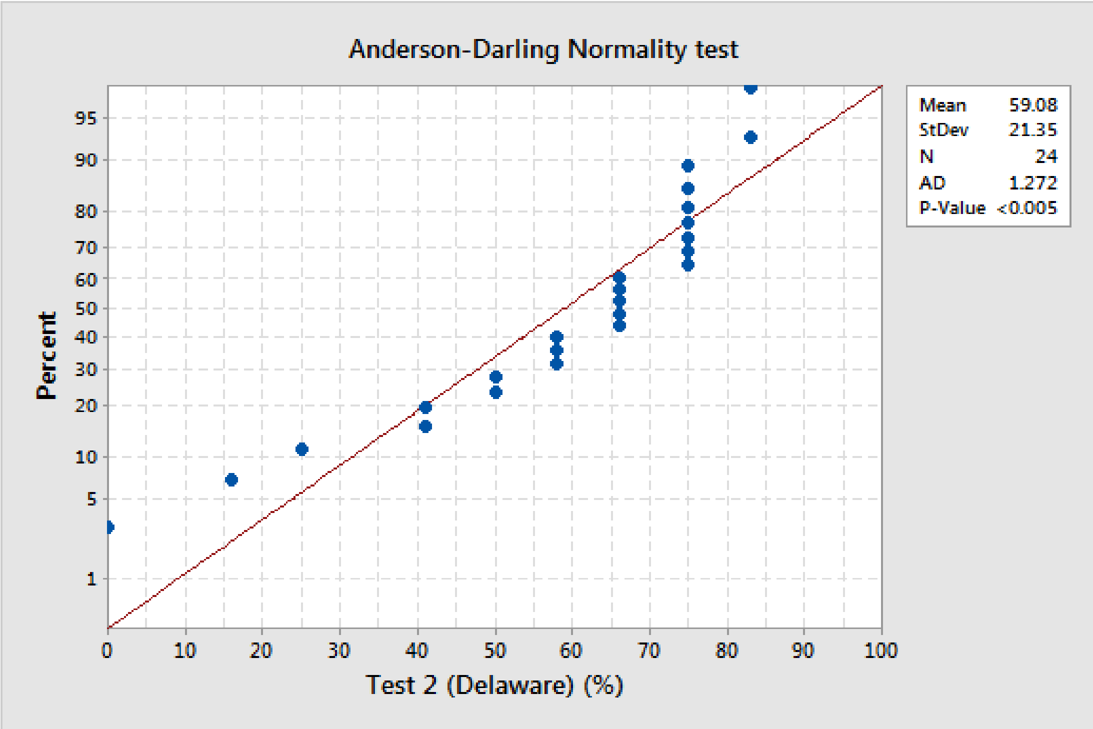
Appendix K: TEST OF NORMALITY FOR MARKS SCORED BY 24 STUDENTS IN IMPELS PRIOR TO INSTRUCTION



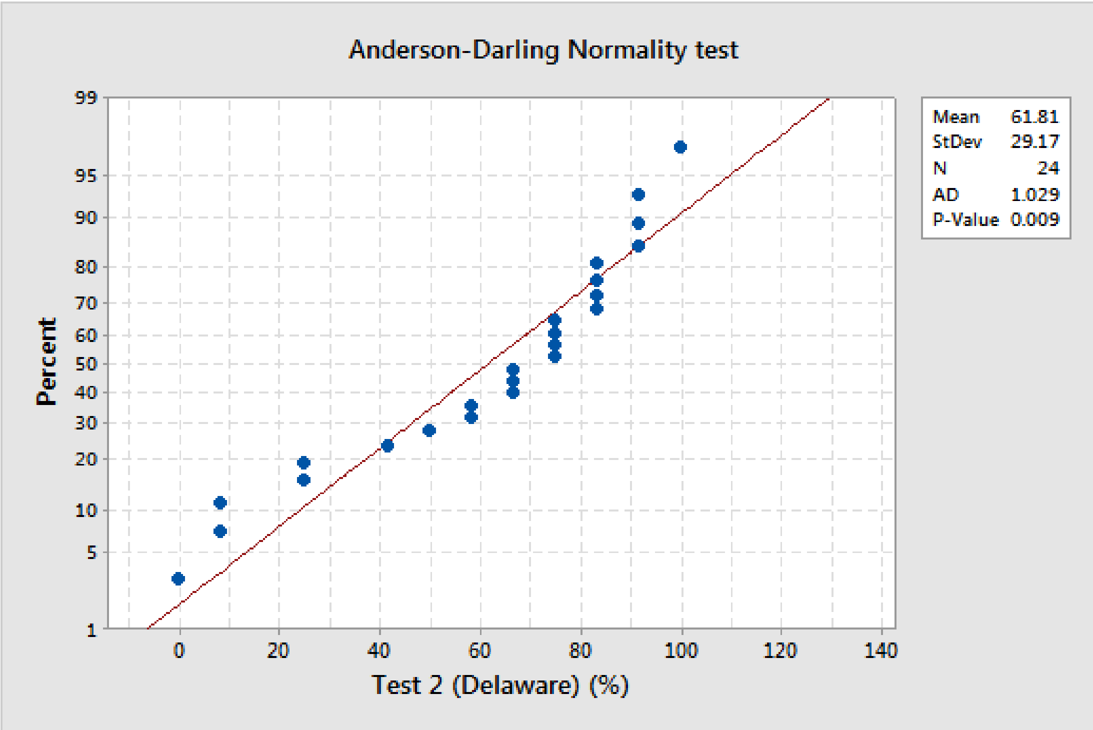
Appendix L: TEST OF NORMALITY FOR MARKS SCORED BY 24 STUDENTS IN IMPELS POST-INSTRUCTION - NOT NORMALLY DISTRIBUTED



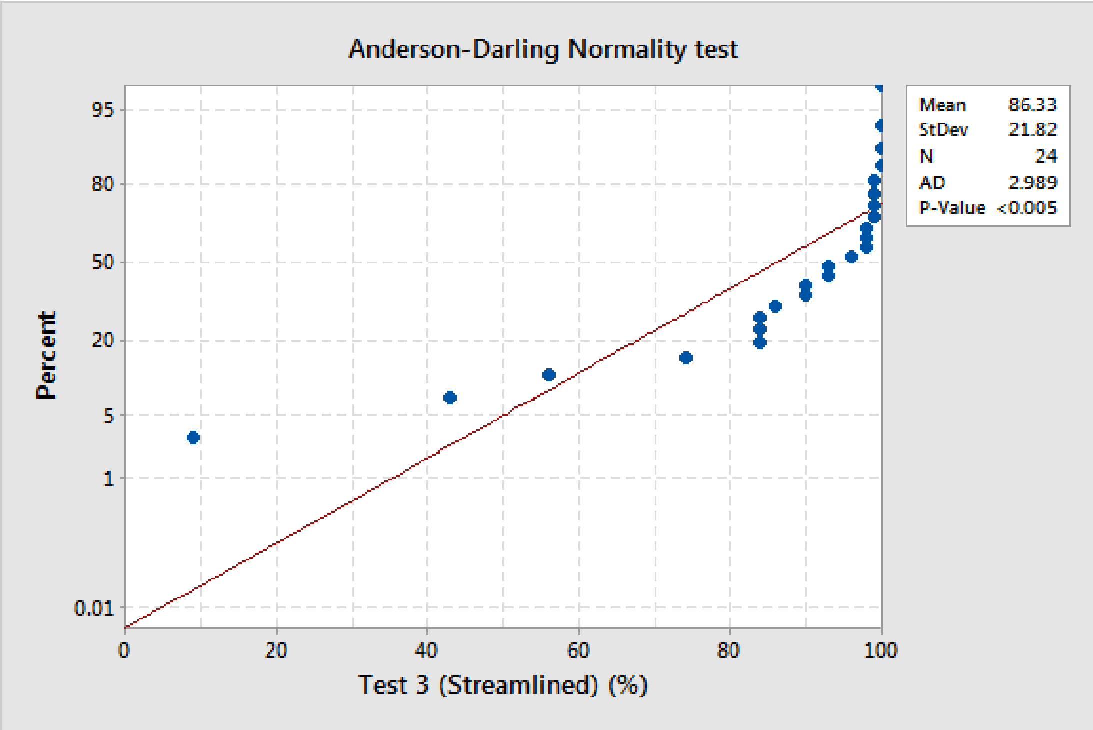
Appendix M: TEST OF NORMALITY FOR MARKS SCORED BY 24 STUDENTS IN TEST 2 (DELAWARE) PRIOR TO INSTRUCTION – NOT NORMALLY DISTRIBUTED DATA



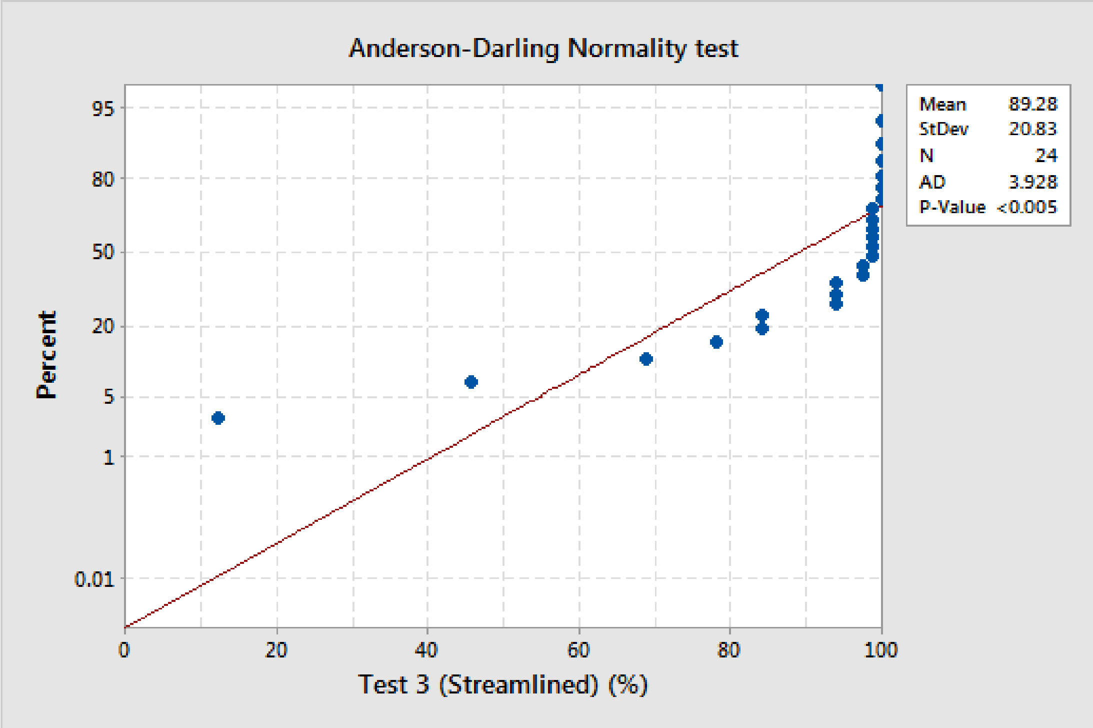
Appendix N: TEST OF NORMALITY FOR MARKS SCORED BY 24 STUDENTS IN TEST 2 (DELAWARE) POST-INSTRUCTION – NORMALLY DISTRIBUTED



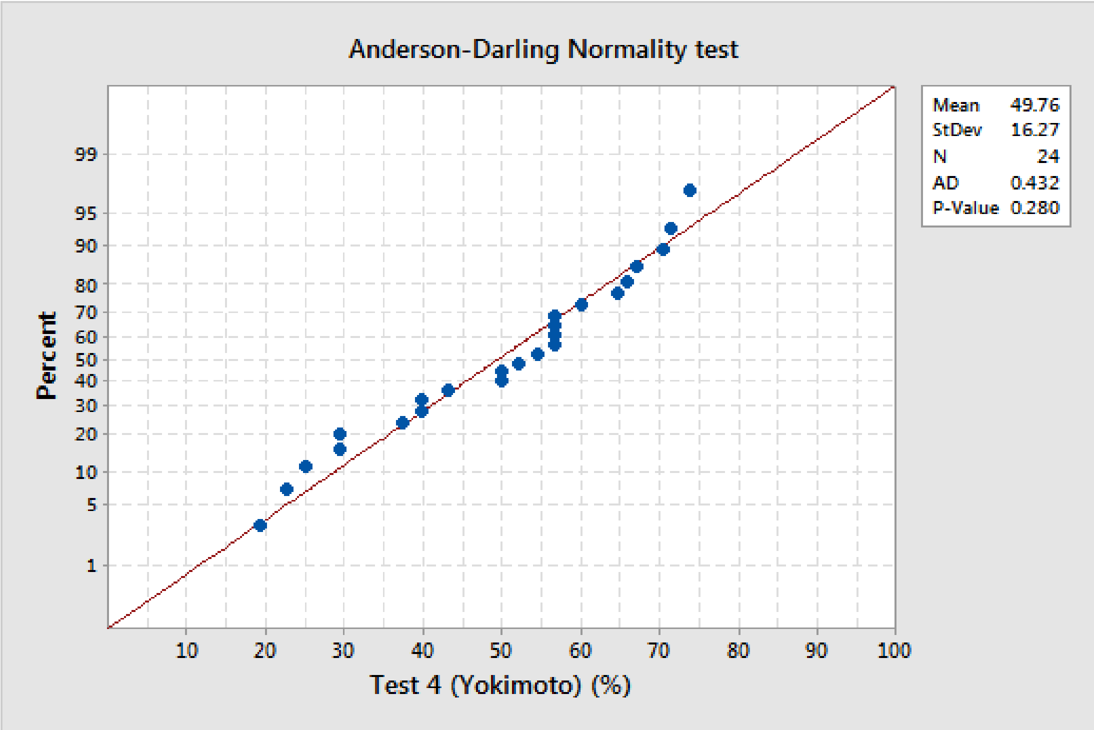
Appendix O: TEST OF NORMALITY FOR MARKS SCORED BY 24 STUDENTS IN TEST 3 (STREAMLINED) PRIOR TO INSTRUCTION – NOT NORMALLY DISTRIBUTED.



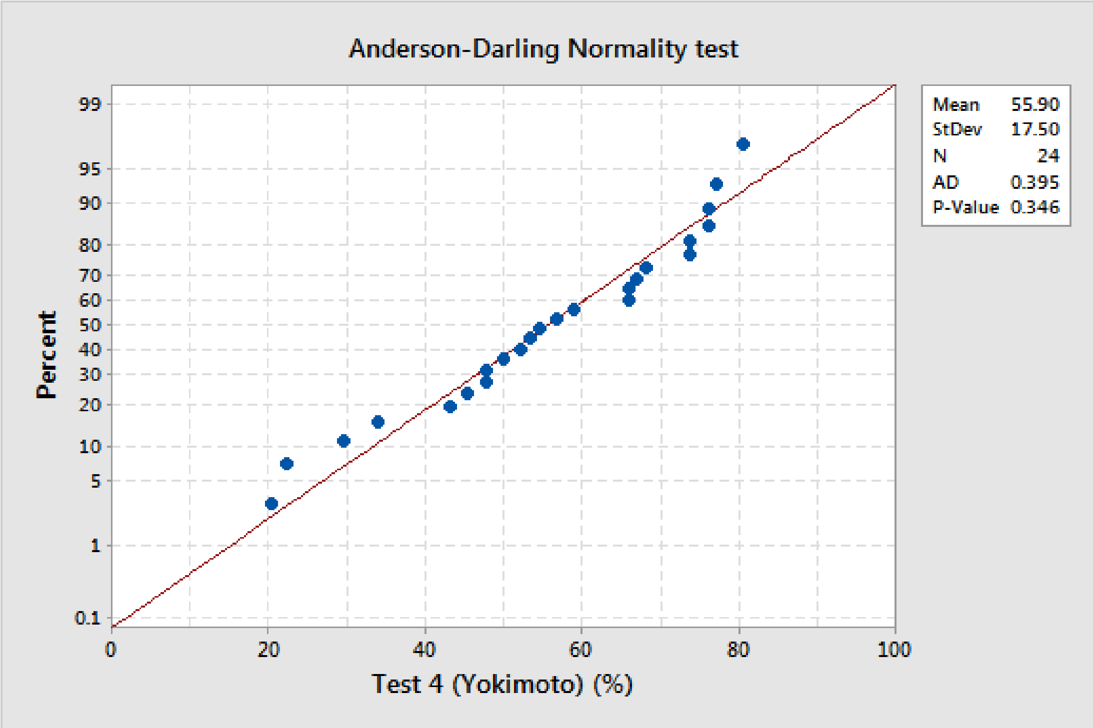
Appendix P: TEST OF NORMALITY FOR MARKS SCORED BY 24 STUDENTS IN TEST 3 (STREAMLINED) POST-INSTRUCTION NOT NORMALLY DISTRIBUTED.



Appendix Q: TEST OF NORMALITY FOR MARKS SCORED BY 24 STUDENTS IN TEST 4 (YOKIMOTO) PRIOR TO INSTRUCTION – NORMALLY DISTRIBUTED.



Appendix R: TEST OF NORMALITY FOR MARKS SCORED BY 24 STUDENTS IN TEST 4 (YOKIMOTO) POST-INSTRUCTION.



Appendix S: IMPELS NUMBER SENSE ASSESSMENT TOOL

IMPELS

Individualised Mathematics Planning and Evaluation of Learning Tool for Students with Intellectual Disability

In Alignment with the:

Australian Curriculum

&

Special Education Needs Assessment Tool (SENAT)

Test, Administration and Marking Guide

Authored by

Agbon Enoma

&

John Malone

About the Authors

Agbon Enoma

Agbon has had many years of classroom experience in Australia as a special needs teacher, senior teacher and principal for schools dedicated to educating students with intellectual disability. He has also been a Disability and Early Childhood Intervention Advisor to schools. As a special needs teacher, Agbon is highly experienced with the differentiation, modification and accommodation of the curriculum to meet the individual needs of students. In this role, he has also developed and implemented individualised learning programs in the forms of IEP (individual education plan), PLP (personalised learning program) or EAP (education adjustment program) in collaboration with parents and external agencies (e.g. school psychologist, physiotherapist, occupational therapist, audiologist, school nurse, relevant government agencies and so on). As a Disability and Early Childhood Intervention Advisor, he has supported teachers and school principals in Australian schools in various ways. These include travelling to many schools to deliver talks and presentations, coaching and mentoring teachers, modelling evidence-based instructional practices and offering classroom demonstrations on how to cater for the educational needs of students with intellectual disability among others. Agbon co-authored IMPELS with Professor John Malone as part of his doctoral degree program.

John Malone

Professor Malone is a longstanding, highly-experienced and distinguished mathematics lecturer and researcher at Curtin University, Australia. He has spent the early years of his teaching career as a High School mathematics teacher before taking up the position of a mathematics lecturer at Curtin University. As a lecturer and researcher, Professor Malone's primary focus has been on training teachers seeking postgraduate qualifications in education. He has had an outstanding record of high quality research publications that include Journal articles, Conference Articles and Book Chapters. He has also had longstanding experience with the supervision of undergraduate and postgraduate students, including master and doctoral degrees in education. Professor Malone has been in the forefront of Mathematics Education in Australia including serving as Chief Examiner for the Western Australian Tertiary Entrance Examinations and as President of the Mathematics Education Research Group of Australasia (MERGA). He is a prominent member of the Mathematics Education Research Group of Australasia and has served as president, conference convenor, conference proceedings editor, member of editorial boards of journals, author of review chapters and editor of monographs. John is a recipient of several awards including the Vice-Chancellor's Award for Excellence in Research and Practice as well as the MERGA Career Research Medal for his outstanding contributions to research in mathematics education across the years. Curtin University has awarded John the title of Emeritus Professor in recognition of his international reputation for academic distinction and research in mathematics education. Professor Malone co-authored IMPELS with Agbon Enoma while serving as the latter's main supervisor during his EdD program.

Background Information

IMPELS (the acronym for Individualised Mathematics Planning and Evaluation of Learning for Students with Intellectual Disability) is a tool targeted at diagnosing and meeting the mathematics needs of students with ID and others with severe mathematics difficulty. According to the Intellectual Disability Rights Service Inc (2009), people with ID take longer time to learn things, have difficulty reading and writing, encounter problem with comprehension and struggle with abstract concepts among other difficulties. Individuals with ID also experience difficulty with processing information (Rhea, 2008) and the processing time differs from one person to the other. The authors have put the above and other salient characteristics of students with ID into consideration in both the development and administration of IMPELS. It was developed after an extensive research was conducted on the Mathematics achievements of students with ID which occurred during the first author's doctoral study. All the data that informed the development of IMPELS were gathered in a special education/education support setting. IMPELS has been published as a refereed paper and therefore it is an evidence-based tool.

IMPELS is organised into six sections consisting of the essential mathematical elements of the conceptual domain of adaptive functioning and number sense including **Oral Counting**, **Number Identification** and representations (including cardinal numbers, money, time and counting the number of colours), **Number Writing**, **Quantity Discrimination**, **Missing Number** measure and **Knowledge Of Number Operations**. The first section is made up of 6 items that cover various aspects of oral counting including counting consecutive numbers, one-to-one correspondence and skip counting. The second section (27 items) focuses on number identification under different contexts including time and money. The third section measures the number writing competence of the student and comprises of two main items. The first of this item has 4 sub-items while the other has 5 sub-items (e. g. "write the number 7"). The fourth section is dedicated to measuring quantity discrimination. This section of IMPELS consists of one main item with 10 sub-parts and each sub-item requires the assesse to identify the 'smaller' and 'bigger number from a given pair. The fifth section (One main item with sub-items) focuses on the identification of missing numbers from a given table of numbers. The final section has 16 items focusing on number operations. The tool is to be used for the (1) collection of baseline data on a student prior knowledge and understanding of number sense to facilitate the development of an individual education plan/personalised education plan/education adjustment plan and (2) monitoring of the progress being made by individual students after a period of instruction.

Purpose of this Assessment Tool

IMPELS was developed to achieve the following key objectives:

1. To develop an assessment tool in numeracy that is appropriate for students with ID and other students experiencing severe Mathematics difficulty – an assessment tool whose development and conditions of administration are considerate of the learning characteristics of individuals with intellectual disability.
2. To develop a tool that enables the collection of relevant data that will inform the development of purposeful IEPs/EAPs/PLPs for students with borderline, mild and moderate intellectual disabilities.

3. To develop a tool that enables special education teachers to measure the learning or progress that have been made by students after a period of instruction.

Test Administration Guidelines

IMPELS is not time-specific as students can take the test over several days if necessary. The student version of the test (Students' Response Booklet) is well illustrated to ensure that students with poor reading/reading comprehension skills are not disadvantaged. The authors acknowledge the fact that students with ID often have a comorbidity of other conditions that affect their hearing, sight, fine or gross motor skills and so on. The test administrators can provide the following types of support during the test which must be recorded during the marking/scoring phase and considered while evaluating individual students' performances in the test:

1. Without Help (WH) – achieved independently
2. Reading Question Help (RH)
3. Re-phrasing Question Help (RQH)
4. Scribing Response Help (SRH) (*for students who are unable to write*)
5. Hand-over-hand Help (H-O-HH
6. Signing Help (SH)
7. Breaking-down question Help (BQH)
8. Illustrating Help (IH) (Giving examples)
9. Experiential Participation Help (EPH)

Prior to students taking the test, the test supervisor/administrator should have read the *Administration Guidelines* and have the required number of the *Students' Response Booklet* ready for distribution.

Student Materials

The following supplies should be made available to each student during the tests:

1. A *Students' Response Booklet*
2. Pencils
3. An eraser
4. A sharpener
5. A working out blank paper

Administering IMPELS

1. Remind students to write their names and other details on the front page of their booklet.

2. It is required that some questions be administered one-on-one with the student sitting in front of the teacher/Assessor (please see the table below for details) while the student can have a go at doing the rest independently if able to.

One-on-one Administration Questions	Questions to be attempted independently if able to or supported according to the support codes provided.
1, 2, 3, 4, 5, 6, 7, 23, 24, 25, 26, 27, 28, 29, 34 & 35.	The others.

3. Questions 22 and 23-27 are extended and optional.

TEST ITEMS/QUESTIONS

Oral Counting Measure (OC)

1. Count from number 1 to as far as you can go (*one-on-one administration*).

2. Count from 4 to 10 or as far as you can go (e.g. 4, 5, etc) (*one-on-one administration*)

3. Count from 5 to 10 or as far as you can go (e.g. 5, 6, etc) (*one-on-one administration*)

4. Count by 2s to 100 or as far as you can go (e.g. 2, 4, etc) (*one-on-one administration*)

5. Count by 5s to 100 or as far as you can go (e.g. 5, 10, etc) (*one-on-one administration*)

6. Count by 10s to 100 or as far as you can go (e.g. 10, 20, etc) (*one-on-one administration*)

Number Identification Measure (NI)

7. "Point to each number in sequence from I to 20" (Teacher/Assessor - using the number identification card similar to the table below) (*one-on-one administration*).

53	24	7	18	40	38	3	29
47	43	30	51	56	27	10	16
17	4	46	55	21	41	23	2
25	26	14	28	44	11	31	32
9	34	35	36	37	6	39	5
22	42	15	8	45	19	33	48
49	50	12	52	1	54	20	13

Questions 8-12

*(**Teacher/Assessor information only**: The students' Response Booklet shows a mixture of 3 yellow, 2 blue, 5 red and 6 green counters)*

8. How many yellow?

9. How many red?

10. How many blue?

11. How many green?

12. How many counters in total?

Money (Coins) *– Provide student with a cup containing a mixture of coins and ask the student to pick out the following or use the modified format of this question in the Students' Response Booklet*:

13. 20 cents

14. $1.00

15. 5 cents

16. 50 cents

17. $2.00

18. 10 cents

19. Give me $1.65 ("one dollar sixty-five cents")

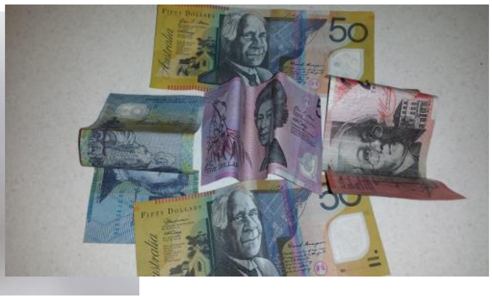
20. If one lollipop cost 10 cents, which of the six coins will buy you 20 lollipops?

21. Which of the six coins will buy you 1 lollipop?

22. Which of the six coins cannot buy a lollipop?

***Questions 23-29** (one-on-one administration)*

***Money (notes)** – Teacher/Assessor Provides the student with a container containing a mixture of $5.00, $10.00, $20.00, $50.00 and $100.00 plastic notes and ask the student to "show me":*



23. $50.00

24. $5.00

25. $100.00

26. $10.00

27. $50.00

28. "Give me $75.00"

29. "Give me $153.70"

Time

30. What is the time?

31. What is the time? →

32. What is the time?

33. What is the time? →

Number Writing (NW)

34. Teacher/Assessor requests the student to "Write the numbers 20, 13, 15, 8, 11, 9, etc (dictate one number at a time)" ***Note for the Teacher/Assessor***: Use the "*Number Writing Measure Card*" similar to the table below.

20	13	15	8	11
9	18	4	6	16
5	12	2	14	3
10	17	7	19	1

35. "Write the number…": 85, 36, 90, 47, 100 (dictate one number at a time)

Quantity Discrimination Measure (QD)

36. Which number is larger/bigger among the following pairs of

20	13	15	8	11
9	18	4	6	16

5	12	2	14	3
10	17	7	19	1

Missing Number Measure (MN)

37. Write the numbers that are missing from the table below:

1	**?**	**3**
?	**5**	**6**
7	**8**	**?**
10	**?**	**12**
?	**14**	**15**
16	**17**	**?**
19	**?**	**21**

Knowledge of Number Operations (KNO)

Teacher/Assessor requests the student to name or write in words the following:

38.	What sign is this?	**+**	
39.	What sign is this?	**-**	
40.	What sign is this	**x**	
41.	What sign is this?	**÷**	

42. 1 +1 =

43. 5+ 2 =

44. 9 + 4 =

For questions 45 to 52, provide counters if required.

45. 28 + 35 =

46. 109 + 98 =

47. 7 – 3 =

48. 32-19 =

49. 2 x 3 =

50. 8 ÷ 2 =

51. A butterfly has 6 legs. How many legs do 2 butterflies have?

52. There are 9 birds on a tree. If 5 flew away how many birds are left?

Individual Scoring of Students' Achievements

Teachers/Assessors are advised to use the scoring sheet below for recording their students' achievements in the test. IMPELS is aligned to the Australian Curriculum and the Special Education Needs Assessment Tool(SENAT) used in some government special schools in Australia. The Foundation level has been broken down into four achievement or Performance Description (PD) levels from PD 5 to PD 8. IMPELS measures a student ability level in Maths (particularly Number Sense) from PD 5 to Year 4 on the Australian Curriculum. In scoring individual students per question, indicate whether the student achieved it without help (WH)or with reading question help (RH), re-phrasing question help (RQH), scribing response help (SRH), hand-over-hand help (H-O-HH), signing help (SH), breaking-down question help (BQH), illustrating help (IH – giving the student some examples) and experiential/participation learning.

IMPELS Scoring Sheet for Individual Students

Name of Student: _______________________________ Date: ______________

Qs	Grade Achieved	Type of Support								
		WH	**RH**	**RQH**	**SRH**	**H-O-HH**	**SH**	**BQH**	**IH**	**E/PH**
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
22 Ext										
23										
24										
25										
26										
27										
23-27 Ext										
28										
29										
30										
31										
32										
33										
34										
35										
36a										

36b										
36c										
36d										
36e										
36f										
36g										
36h										
36i										
36j										
37										
38										
39										
40										
41										
42										
43										
44										
45										
46										
47										
48										
49										
50										
51										
52										

IMPELS Support/Scoring Code

1. *Without Help (**WH**) – achieved independently*
2. *Reading Question Help (**RH**)*
3. *Re-phrasing Question Help (**RQH**)*
4. *Scribing Response Help (**SRH**) (for students who are unable to write)*
5. *Hand-over-hand Help (**H-O-HH**)*
6. *Signing Help (SH)*
7. *Breaking-down question Help (**BQH**)*
8. *Illustrating Help (**IH**) (Giving examples)*
9. *Experiential/Participation Help (**EPH**)*

Interpretation of Students' Achievements in the Test

IMPELS focuses on measuring individual students' mathematical knowledge. Students who fall into achievement categories 'without help', 'reading question help', 'scribing response help' because of gross/fine motor skills difficulty and 'signing help' due to being non-verbal can be said to have achieved that question and may not require further instruction in that area.

IMPELS Support/Scoring Code

1. Without Help (WH) – achieved independently
2. Reading Question Help (RH)
3. Re-phrasing Question Help (RQH)
4. Scribing Response Help (SRH) (*for students who are unable to write*)
5. Hand-over-hand Help (H-O-HH
6. Signing Help (SH)
7. Breaking-down question Help (BQH)
8. Illustrating Help (IH) (Giving examples)
9. Experiential Participation Help (EPH)

Aligning IMPELS to the Australian Curriculum and Special Education Needs Assessment Tool (SENAT)

	Foundation Level				Yr 1	Yr 2	Yr 3	Yr 4
Questions	**PD 5**	**PD 6**	**PD 7**	**PD 8**	**PD 9**	**PD 10**	**PD 11**	**PD 12**
1	Count (Says, signs or positively acknowledges numbers in sequence from 1 to 5	Count (Says, signs or positively acknowledges numbers in sequence from 6 to 10	Count (Says, signs or positively acknowledges numbers in sequence from 11 to 15	Count (Says, signs or positively acknowledges number names) from 16 to 20	Count (Says, signs or positively acknowledges number names) from 21 to 100	Count (Says, signs or positively acknowledges number names) from 101 to 1,000	Count (Says, signs or positively acknowledges number names) from 1001 to 10,000	Count (Says, signs or positively acknowledges number names) from 10001 to 100,000
2	Count (Says, signs or positively acknowledges number names) from any starting point to 5.	Count (Says, signs or positively acknowledges number names) from any starting point to 10.	Count (Says, signs or positively acknowledges number names) from any starting point to 15.	Count (Says, signs or positively acknowledges number names) from any starting point to 20.	Count (Says, signs or positively acknowledges number names) from any starting point to 100.	Count (Says, signs or positively acknowledges number names) from any starting point to 1,000.	Count (Says, signs or positively acknowledges number names) from any starting point to 10,000.	Count (Says, signs or positively acknowledges number names) from any starting point to 100,000.
3	Count (Says, signs or positively acknowledges number names) from any starting point to 5.	Count (Says, signs or positively acknowledges number names) from any starting point to 10.	Count (Says, signs or positively acknowledges number names) from any starting point to 15.	Count (Says, signs or positively acknowledges number names) from any starting point to 20.	Count (Says, signs or positively acknowledges number names) from any starting point to 100.	Count (Says, signs or positively acknowledges number names) from any starting point to 1,000.	Count (Says, signs or positively acknowledges number names) from any starting point to 10,000.	Count (Says, signs or positively acknowledges number names) from any starting point to 100,000.
4					Skip counts by 5s to 50	Skip counts by 5s to 100		

5					Skip counts by 2s to 20.	Skip counts by 2s to 40.		
6					Skip counts by 10s to 100,	Skip counts by 10s to 200,		
7	Accurately identifies (points to or positively acknowledges) the numbers to 5	Accurately identifies (points to or positively acknowledges) the numbers from 6 to 10	Accurately identifies (points to or positively acknowledges) the numbers) from 11 to 15	Accurately identifies (points to or positively acknowledges) the numbers from 16 to 20	Accurately identifies (points to or positively acknowledges) the numbers from 21 to 100	Accurately identifies (points to or positively acknowledges) the numbers from 101 to 1,000	Accurately identifies (points to or positively acknowledges) the numbers from 1001 to 10,000	Accurately identifies (points to or positively acknowledges) the numbers from 10001 to 100,000
8			3 yellow counters					
9			5 red conters					
10			2 blue counters					
11			6 green counters					
12				16 counters altogether				
13					Correctly identifies/recognises Australian $1.00			
14					Correctly identifies/recognises Correctly identifies/recognises Australian Australian 10 cents			
15					Correctly identifies/recognises Correctly identifies/recognises			

					Australian Australian 50 cents			
16					Correctly identifies/recognises Australian $2.00			
17					Correctly identifies/recognises Australian 20 cents			
18					Correctly identifies/recognises Australian 5 cents			
19						Able to provide the equivalent of $1.65		
20						$2.00		
21					10 cents			
22					5 cents			
22 Ext					Order Australian coins according to their value.			
23						Correctly identifies $50.00		
24						Correctly identifies $5.00		
25						Correctly identifies $100.00		
26						Correctly identifies $10.00		
27						Correctly		

						identifies $50.00		
23-27 Ext						Order Australian notes according to their value		
28						$50+$20+$5 = **$75.00**		
29						**$153.70**		
30					Able to tell the time is 3 O'Clock			
31					Able to tell the time is half past five.			
32						Able to tell the time is "Quarter past 8" or "15 minutes past 8" O'clock		
33						Able to tell the time is "Quarter to 10.00" or "15 minutes to 10" O'clock		
34	Able to write numbers to 5	Able to write numbers to 10	Able to write numbers to 15	Able to write numbers to 20	Able to write numbers t0 100	Able to write numbers to 1,000	Able to write numbers to 10,000	Write numbers to 100,000
35	Able to write numbers to 5	Able to write numbers to 10	Able to write numbers to 15	Able to write numbers to 20	Able to write numbers t0 100	Able to write numbers to 1,000	Able to write numbers to 10,000	Write numbers to 100,000
36a				**20** is bigger than 9				
36b				**10** is bigger				

				than 5				
36c				**18** is bigger than 13				
36d				**17** is bigger than 12.				
36e				**15** is bigger than 4.				
36f				**2** is smaller than 7				
36g				**6** is smaller than 8.				
36h				**14** is smaller than 19.				
36i				**11** is smaller than 16.				
36j				**1** is smaller than 3				
37					Identifies that: **2** comes after 1 **4** comes after 3 **9** comes after 8 **11** comes after 10 **13** comes after 12 **18** comes after 17 **20** comes after 21			
38						Plus, add or addition		
39						Minus, subtract or "take away"		
40						times, multiply or multiplication		
41						Divide, to		

						share or sharing		
42						1 + 1 = **2**		
43						5 + 2 = **7**		
44						9 + 4 = **13**		
45							28 + 35 = **63**	
46							109+98 = **207**	
47						7 – 3 = **4**		
48							32 – 19 = 13	
49						2 x 3 = **6**		
50	`					8 ÷2 = **4**		
51						12 legs		
52						4 birds		

IMPELS Scoring Sheet for Individual Students

Name of Student: ________________________________ Date: _______________

Qs	Grade Achieved	Type of Support								
		WH	RH	RQH	SRH	H-O-HH	SH	BQH	IH	E/PH
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
22 Ext										
23										
24										
25										
26										
27										
23-27 Ext										
28										
29										
30										
31										
32										
33										
34										
35										
36a										

36b										
36c										
36d										
36e										
36f										
36g										
36h										
36i										
36j										
37										
38										
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45										
46										
47										
48										
49										
50										
51										
52										

IMPELS Scoring Code

1. *Without Help (**WH**) – achieved independently*
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7. *Breaking-down question Help (**BQH**)*
8. *Illustrating Help (**IH**) (Giving examples)*
9. *Experiential/Participation Help (**EPH**)*

Appendix T: SPLIT-HALF RELIABILITY CALCULATION FOR IMPELS

$$\rho_{KR20} = \frac{k}{k-1}\left(1 - \frac{\sum_{j=1}^{k} p_j q_j}{\sigma^2}\right)$$

k = 53

$\sum pq$ = 7.297575

σ^2 = 127.25

r_{KR20} = $\left(\frac{k}{k-1}\right)\left(1-\frac{\sum pq}{\sigma^2}\right)$

= $\left(\frac{53}{52}\right)\left(1-\frac{7.297575}{127.25}\right)$

= (1.01923)(1-0.0573490962)

= (1.01923)(0.9426509038)

= **0.96**

Appendix U: CALCULATION OF CRONBACH'S ALPHA FOR IMPELS

Cronbach's Alpha (α):

$$\alpha = \frac{K}{K-1}\left(1 - \frac{\sum_{i=1}^{K}\sigma_{Y_i}^2}{\sigma_X^2}\right)$$

$$\mathbf{\frac{53}{52}}\left(1 - \frac{7.30}{127.25}\right)$$

= 1.019230769(1- 0.057367387)

= 1.0192 X 0.9426

= 0.96