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Numeracy support for year two students

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Numeracy Support for Year Two Students.

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Abstract

Research of teaching theories and intervention programs internationally and in Australia suggests that the implementation of numeracy support programs can improve student achievement levels (Fuchs, 2005; Ketterlin-Geller, Chard & Fien, 2008; Van Kraayenoord & Elkins, 2004). An intervention program was conducted for a small group of Year Two students with the aim of improving their numeracy skills over a 20 week period.

Results of two mathematics assessments, together with information provided by teachers based on classroom observations and informal assessments were combined to select a group of twelve students who were considered to be at risk of developing mathematical difficulties. The program comprised of two 85 minute lessons and one 40 minute lesson per week in a room adjacent to the Year Two classroom. A social constructivist method of teaching was put into practice within the structure of a small group setting. A case study approach recorded the learning journey of each student with an individual profile of each participant maintained for the duration of the program.

At the conclusion of the program data obtained from formative assessments, teacher observations, and feedback from the student participants were used to evaluate the program's effectiveness. Students who were members of the intervention program improved their level of basic numeracy skills in the areas of addition, subtraction, multiplication, division, and number sequencing, and also demonstrated a positive disposition towards mathematics.

Declaration

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CHAPTER ONE

Introduction

This chapter is divided into a number of sections beginning with the context which includes a demographic profile of the school and description of the structure within it. This provides an outline of the environment in which the study took place. Results of Performance Indicators in Primary Schools (PIPS) testing during the Early Childhood Phase and the later achievement of students during the Primary Phase present the focal point of the study. Environmental influences which have an impact on student performance conclude the first section. The second section provides the rationale for the study, highlighting the importance of early identification obtained from a formative and summative assessments followed by measurement and recording of student progress. The purpose, scope and limitations of the support program together with the creation of individual profiles direct the research question.

Context

The study took place in a dual campus, independent Perth school. Over 2000 students were enrolled in the school, 900 of whom were in the Primary section. The campus catered for students from Kindergarten to Year Six and had two classes of between 30 and 33 students at each year level. Students came from a wide range of ethnic backgrounds and the Index of Community Socio Educational Advantage (ICSEA) for the school was 1003, which was within the national average range of between 900 and 1100. ICSEA is a measure of a student population which enables schools which share similar populations to be compared; the higher the number the more advantageous the background of the students. Data are gathered directly from the school population and indirectly from the national census, and include variables which influence education but which the school has no direct control over such as the educational level of parents or caregivers, and the socio-economic characteristics of the area.

The Primary section of the school was divided into two phases of learning: Early Childhood, which comprised Kindergarten to Year Two, and Primary, which comprised Years Three to Six. The two Year One and Year Two classes

operated in large open plan rooms. Teachers from both campuses collaborated and planned together; however, each class operated as an independent unit. Timetabling of the curriculum areas of music, art, dance, drama, Languages Other Than English, library and sport, which were taught by specialist teachers, reduced opportunities for shared teaching or grouping of students between two classes of the same year level.

The school assessed student attainment using PIPS, which was developed in 1991 by the Centre for Evaluation and Monitoring at the University of Durham in England and is authorised for use in Australia, where more than 25,000 students were assessed using PIPS in 2010. It is an interactive computer assessment used to identify students who could be at risk of developing a learning difficulty. Introduced in 2008 for all Pre-primary students in the subject school, PIPS measures student progress with an initial assessment completed early in term one and repeated in term four. The 2008 PIPS results indicated that 56% of the total number of fifty-nine students attending the campus in which the study took place were at risk of developing difficulty in mathematics or reading. Of these students 18% were identified with a difficulty in mathematics and 12% with a reading difficulty. Seventy percent of the students who were identified as at risk demonstrated difficulty in both mathematics and reading.

The number of Year Three students achieving numeracy outcomes below their age appropriate level in the school led to scrutiny of teaching practice. During the Early Childhood Phase the provision of literacy support for students experiencing difficulty had previously been a priority, with additional support for students experiencing difficulties in numeracy limited to the Primary Phase. In 2010 my role as the student support teacher at the school was altered to focus predominately on students at educational risk in the Early Childhood Phase. This was consistent with a management decision to develop and implement intervention strategies in the Early Childhood Phase in order to reduce the numbers of students requiring remediation during the Primary Phase.

Classroom factors have been found to have more effect on student achievement than intrinsic factors found within individual students. Cuttance

(1998) reported that research found 60% of student learning is influenced by the school or classroom and the remaining 40% due to influences surrounding the individual student. In comparison to the busy open plan Year One and Year Two classrooms, housing over 60 students, the room in which the support program took place was a small, enclosed, dedicated space with limited distractions. The room was specifically furnished for group tuition, contained sound absorbent display boards and carpeted floor which provided excellent acoustics.

Flexer and Rollow (2009) stressed the importance the acoustic features of a classroom have on student learning with the need to hear and process instructions. Wolfram (2012) reported that intruding noises from an adjacent class in open plan rooms were particularly intrusive and disruptive for students experiencing learning difficulties. Leistner, Klatte, Seidel and Hellbruck (2010) described sounds such as chairs moving, and leafing through papers as being particularly undesirable in rooms with poor reverberation time. They found that in rooms with poor acoustics students needed to concentrate more on decoding speech resulting in a lower capacity to process the information given. Results of research conducted by Whitlock and Dodd (2008) found both teachers and students raised the level of their voices in rooms with poor acoustics when students participated in group activities therefore intensifying the unfavourable listening conditions. It was envisaged that improving the acoustic environment by reducing noise levels and reverberation would have a positive impact on student learning in the intervention program.

Rationale

Bryant, Bryant, Gersten, Scammacca and Chavez (2008) advocated the need for early mathematics interventions to prevent difficulties that result from inadequate instruction. In comparison to the research and resources invested into learning difficulties in literacy, mathematics has been very much under resourced (Graham, Bellert & Pegg, 2007; Swanson & Jerman, 2006). Literacy development was prioritised in the school in which the study took place with additional support for numeracy not occurring until students were in Year Three and had entered the Primary Phase. Milton (2000) reported that the Department

of Education, Training and Youth Affairs (DETYA) study, Mapping the Territory (1998), found only isolated cases in which the school focus was on assisting students with learning difficulties in numeracy, with identification generally occurring as a result of state-wide assessment from Year Three. Fuchs (2005) emphasised the importance of prevention research in mathematics to decrease the difficulties experienced by students before they became too severe to remediate. The number of students who experienced mathematical difficulties during the Primary Phase at the subject school validated the investment of resources for the development of a support program during the Early Childhood Phase to improve the numeracy outcomes of students.

Students experiencing reading difficulties have problems with decoding, comprehension and the development of efficient strategies. Similarly, students experiencing difficulty in mathematics have problems in basic computation, language, and reasoning. Students experiencing difficulty may not have developed an understanding of mathematical concepts taught during previous lessons and, without success, begin to develop a negative attitude toward mathematics (Fuchs, Fuchs, Powell, Seethaler, Cirino & Fletcher, 2008; Gilbertson, Witt, Duhon & Dufrene, 2008). Research conducted by Wu, Farkas and Morgan (2011) found children may require extra support in mathematics in order to avoid an academic downward spiral. Ketterlin-Geller et al. (2008) suggested that supplementing learning experiences through the provision of support programs allows students to experience success and develop a positive attitude toward mathematics.

Results of student mathematical achievement in Pre-primary and Year Three at the subject school emphasised the need for a support program during the Early Childhood Phase. Fuchs (2005) stated “The primary goal of prevention research is to decrease mathematical difficulty before that difficulty becomes chronic, pervasive, severe and difficult to remediate” (p. 350). By the time students require intensive remediation many no longer have the motivation to try to improve due to fear of more failure (Fuchs et al. 2008). Ketterlin-Geller et al. (2008) reported on a lack of effective teaching and support for students who did not make the expected progress and emphasised the importance of

researchers documenting the effect of interventions aimed at addressing mathematical difficulties and changing the trajectory of student learning. The principal of the school in which the study took place deemed the provision of a support program during the Early Childhood Phase, when the achievement gap between students experiencing difficulties and their peers is narrow, preferable to remediation in the Primary Phase by which time the gap has increased.

The provision of an optimum classroom environment was a crucial element of the program. After being taught in an open plan classroom accommodating over 60 students, in both Year One and Year Two, receiving tuition with eleven other students in a small room with limited distractions was a significant variation. It was anticipated this change would lead to improved mathematical outcomes for the participants.

Purpose, Scope and Limitations of the Study

The purpose of the study was to develop a support program which would result in an improvement in the achievement levels of Year Two students at risk of developing mathematical difficulties. Formal standardised tests compare and measure student performance over time, but Stiggins and Chappuis (2005) declared feedback from state and national assessments too infrequent and broad to be useful, and suggested classroom assessment of students' mathematical understanding needs to be timely for effective teaching. Ketterlin-Geller et al. (2008) noted that the lack of basic numeracy skills in the junior years prohibited the addition of new understanding in the middle years of school. The provision of additional support in numeracy typically occurred when a student had developed an academic achievement level approximately two years behind their year level peers as evidenced in standardised assessments used during the Primary Phase. Shinn (2004) suggested the key to preventing difficulties and later failure in mathematics is through early identification of students who may be at risk and by providing appropriate early intervention. The support program during the Early Childhood Phase, Kindergarten to Year Two, which aimed at reducing the need for remediation in Primary Phase, required the identification of students performing below their peers prior to Year Three.

Van Kraayenoord and Elkins (2004) reported that regardless of the cause of difficulty, low achievement results in negative attitudes towards mathematics as a subject together with low self-concept. Stiggins and Chappuis (2005) suggested that in order to reduce the achievement gap, students must believe they are able to experience success, and with each small success a positive shift in self confidence occurs, which encourages more effort. In addition to increased numeracy skills, a goal of the program was for the participants to develop a positive association with mathematics as a result of gaining an understanding of concepts and experiencing success. Vaughan, Moody and Schumm (1998) recommended small group instruction as an effective learning environment in which students are able to practise and receive immediate feedback. The support program aimed to maintain student interest through active involvement in lessons by including mathematical activities appropriate for the students' current level of understanding. A low student to teacher ratio allowed for timely feedback, reducing frustration and the development of negative attitudes towards mathematics. Stiggins and Chappuis (2005) proposed that if classroom assessments have a clear purpose, deliver an accurate reflection of student achievement, provide continuous, descriptive feedback and involve students in the assessment process, the achievement gap between students can be narrowed. During the course of each lesson student involvement was sustained with feedback provided instantly as students worked through problems together with the teacher.

Milton (2000) reported that basic computation skill, word problems, the language of mathematics and mathematical reasoning were the key areas in which students experienced difficulty. The fundamental numeracy skills addressed throughout the program were initially based on results of formative assessment which preceded the program and on summative assessment of students' demonstrated competencies. Wright (2003) found close observation of students enabled detailed understanding of students' application of strategies from which teaching programs are able to be adjusted to students' style of learning. To enable higher order learning once the students had achieved

mastery of fundamental numeracy skills, learning activities provided opportunities for repeated practice of basic concepts.

During the course of the study a profile of individual students was developed from informative observations by teachers, results of pre and post-assessments and data obtained through students' participation in activities during lessons. This information was aggregated to create a summary of the progress of each student. The impact of the support program on student numeracy achievement was obtained from an analysis of the student profiles.

Research Question

The research question was developed to investigate the influence of a numeracy support program for Early Childhood Students in the subject school.

The research question was framed as:

> How does a support program in a small group setting impact on the mathematical achievement of Year Two students identified as being at risk?

Summary

Review of literature and results of student achievement within the subject school supported the implementation of intervention during the Early Childhood Phase. Formal assessment conducted during Pre-primary provided data which identified students at risk in numeracy. The influence of environmental factors such as poor acoustics and noises from adjacent classes substantiated the practice of withdrawing a small group of children to a specially furnished room, isolated from the distractions of the large, open plan classroom. The program was developed with a low student to teacher ratio to enable close observation, opportunities for repeated practice and timely feedback.

CHAPTER TWO
LITERATURE REVIEW

Introduction

A review of the terms and definitions applied to students who are experiencing difficulty in mathematics is followed by how the term ‘at risk’ was applied to student participants in the case study. The academic growth trajectory of students at risk and the potential for a downward spiral if intervention does not occur precedes an outline of the challenges faced by classroom teachers, including the need to provide instruction for a wide range of student ability whilst following a prescribed curriculum. The common cognitive processes linking literacy and numeracy demonstrate the impact literacy skills have on numeracy development. An analysis of explicit and constructivist teaching methods combined with lesson content and teaching strategies to maximise student achievement is provided. A summary of numeracy programs developed to support students experiencing difficulty in mathematics in Australia follows concerns identified worldwide regarding students performance in mathematics. The chapter concludes with a review of the formal and informal assessments including diagnostic, individual interview, observation and how these were incorporated into the study.

Students At risk

Van Kraayenoord and Elkins (2004) found that support for students at risk in Australia varied between states, sectors and schools with the terms ‘Mathematics disability’ and ‘Mathematics difficulty’ applied to students underperforming in mathematics. Generally, mathematical difficulty included children underachieving with or without a disability. Mazzacco (2005) found teachers used a range of assessment tools to identify students who would benefit from additional support and although research has been conducted, inconsistency exists both with terminology and measurement of the level of student mathematical difficulty. The inconsistency, lack of a common criteria and definition of at risk complicates the diagnosis of a student’s difficulty. In Australia the term learning difficulties is often applied to students who are not developing skills at the expected level and learning disabilities to students with severe long term problems (Van Kraayenoord & Elkins, 2004). Studies by

Australian researchers estimate between 3% and 30% of children experience difficulty in mathematics and require additional support. In a survey of 377 Australian primary schools, for the ‘Mapping the Territory’ report, Rohl and Milton (2002) reported that in over half of the schools, 10-30% of students experienced difficulties in mathematics but support programs for these students were few in number. Doig (2005) found that interpretation of the definition and the geographical location of students had a significant influence on the statistics, with rural and remote areas recording higher percentages of students who were classified as being at risk. For the purposes of the study the term ‘at risk’ included students identified by their teachers and through diagnostic assessment to be underachieving.

Students classified as being at risk have limited prospects of achieving reasonable educational outcomes without the provision of additional support. They exhibit a flat academic growth trajectory, make significantly slower progress and steadily fall further behind their peers (Fuchs, 2005; Templeton, Neel, & Blood, 2008). Torbeyns, Verschaffel and Ghesquiere (2004) stated that as age and experience increase, students without mathematical difficulties are able to more successfully choose an appropriate strategy to solve a problem. Alternatively, students with mathematical difficulties have access to fewer strategies and have less accurate fact recall, resulting in the gap between the groups widening. What begins as a small difference develops into a spiral of deficits known as the ‘Matthew Effect’ (Stanovich, 1986). In education, the Matthew Effect is the notion that while good students continue to improve, weaker students fall further behind their peers. Sherman, Richardson and Yard (2005) expressed concern that when the content of mathematics lessons is disconnected from the ability of students at risk they will remain lost unless there is appropriate intervention provided to assist students to master the concepts. They suggest that the earlier intervention is provided, the lower the remediation content of the program.

The challenge faced by teachers to cater for the large range of mathematical abilities in their classes, while maintaining appropriately paced instruction was recognised in research by Evans (2007). Classroom teachers are responsible

for the provision of teaching programs which assist all students to achieve the outcomes outlined in the curriculum, within a set time frame. In order to accommodate the needs of students with learning difficulties in mathematics, teachers must be knowledgeable of the most effective teaching approach to cater for the full range of student ability. Adjustments must be made to numeracy programs to ensure students with learning difficulties are catered for through instructional methods and manipulation of the environment, which can be difficult without appropriate resources, additional assistance and time.

Ketterlin-Geller et al. (2008) expressed concern that the length of a typical mathematics lesson does not provide sufficient time for students experiencing difficulty to master new concepts. This concern was acknowledged by the National Mathematics Advisory Panel with one of the goals in the development of the new national curriculum to reduce the crowded mathematics curriculum.

> Many mathematics teachers report that the scope of the curriculum creates pressures to move on to new topics before students have mastered the current one . . . It is possible to reduce some of the crowding by dealing with complementary topics and concepts together, but there may still be a need for the identification of other mechanisms that can allow teachers to feel less hurried. (MCEETYA, 2009, p. 12)

Munn (2005) reported on teachers' anxiety at the need to move on to a new topic knowing students had not mastered current concepts that were needed to understand future concepts. This is supported by Graham, Bellert, Thomas and Pegg (2007) who reported

> In the Australian context where students with LD [learning difficulties] do not routinely attract official funding or intensive aide support, teachers are increasingly required to make adjustments to their classroom instruction to accommodate students with particular learning needs. Because of the pressures in inclusive classrooms, these modifications, tend to be "on the spot" and do

> not always provide the intensity and duration of instruction needed to address persistent learning difficulties. (p. 410)

New concepts require a sound understanding of the previous ones in order for new knowledge to be built. Opportunities to apply new skills are vital for consolidation and development of competence. Munn (2005) reported that students are emotionally affected by mathematical demands they cannot meet. Rieg (2007) suggested that students at risk had not been able to succeed in a regular school program and therefore required the provision of an intervention program. Ketterlin-Geller et al. (2008) recommended that support programs would improve the achievement of students who had not developed an understanding of the mathematical concepts during the early years which were necessary in later years. The intervention program aimed to provide lessons that afforded sufficient time to reinforce concepts leading to understanding.

Literacy

Impact of Literacy Ability on Mathematical Ability

Literacy and numeracy difficulties are not isolated areas; the overlap cannot be dismissed, historically being literate encompassed both numeracy and literacy skills (Westwood, 2008). Research into mathematical difficulties extends beyond the previously narrow focus of computation to the recognition that reading difficulties impact negatively on mathematical achievement (Gersten, Jordan & Flojo, 2005). In order to communicate mathematical understanding, students require a level of reading fluency that exceeds the decoding level. Decoding is the strategy used to identify an unknown word by applying phonological awareness to letter sounds and blending combinations of letters to arrive at a pronunciation (Department of Education and Training Western Australia, 2004). Newman, cited in White (2005), maintained that in order to solve a mathematical word problem a person must first have the ability to read the text, and gain understanding (comprehend) before being able to process the information. Fuchs et al. (2008) stated that the difference between the solving of computation only and solving word problems is the reading of text needed to understand the information.

Zevenbergen (2000) emphasised the need for teachers to take into consideration the impact literacy has on the numeracy outcomes of students when teaching mathematics. Students with language difficulties often experience difficulty with direction, sequence and organisation; skills also required in mathematics (Wadlington & Wadlington, 2008). The cognitive process required to learn and retain alphanumeric symbols to memory are shared by both literacy and numeracy (Munro, 2003). Research by Quinnell (2011) noted the complexity of the language of mathematics such as with the terms subtract, take-away, minus and difference referring to the same concept. Numeracy involves interpretation of information, and a focus on the literacy used in mathematics is a crucial strategy to be incorporated into teaching programs.

Perry and Dockett (2008) stated that without age appropriate reading ability, a student's mathematical growth is limited. The recognition of the importance of literacy development on numeracy is evident in the research of Gersten and Chard (1999) who stated that reading ability had a 60% influence on mathematics achievement. Fletcher, Denton and Francis (2005) suggested that a group of students identified as at risk in reading would be similar to one identified as at risk in mathematics due to the associations between reading and mathematical difficulties. This was found to be true of the students selected to participate in the intervention program, with nine of the 12 students also members of the Year Two literacy support group. While the focus of this support program was on developing students' mathematical skills, students' literacy skills were acknowledged and catered for during the lessons.

Behaviour

Attentive behaviour and processing speed are significant contributors to student achievement in mathematics. Research conducted by Hamlett (2005) found that teachers reported the strongest predictor of students' mathematical achievement to be attention or distractibility and suggested a possible cause as a mismatch between the instruction given and that needed by students with poor attention. Fuchs (2005) found teachers who rated students on their ability to concentrate and display appropriate classroom behaviours were able to

predict the students who had difficulty solving mathematical word problems. Teacher participants in research by Maher (2007) reported students with low aptitude tended to play with equipment during lessons rather than use it mathematically; the students' limited ability resulting in a constant need for adult supervision and interaction. This was found to be relevant to the students who participated in the study with classroom teachers reporting that those students who displayed the most off-task behaviour and low levels of concentration in the mainstream class were also the lowest achievers in the pre-assessment. These students required frequent monitoring and contact with a teacher in order to maintain focus and use equipment purposefully rather than play with it. The study provided a setting for a small group of students with lessons targeted at their level of understanding which resulted in increased levels of participation and reduced off-task behaviour.

Teaching Methods

Research by Phillips (2010) found that achievement of students at risk correlated significantly with teacher effectiveness. Ketterlin-Geller et al. (2008) reported that teachers' lack of knowledge about effective teaching strategies led to insufficient support for students at risk resulting in limited academic progress. Westwood (2000) suggested improving the quality of instruction as the most effective way to overcome learning difficulties. This is supported by Martin (2007) who promoted the rationale that students' numeracy difficulties are a result of the teaching method implemented rather than the lesson content. He viewed formal and abstract instruction as failing to develop students' ability to think mathematically and construct connections with real life situations. Martin stated

> Mathematics should be taught using strategies that encourage mathematical literacy because when students ask, "When are we ever going to use this?" they are telling their teachers that they do not see the relevancy and importance of what they are being taught. (p. 31)

In a study of 350 lessons in United States of America (USA) schools over an 18 month period, Weiss and Pasley (2004) reported effective teaching occurred when lessons were challenging, at an appropriate level for the students and incorporated real life examples. Westwood (2008) stated that an effective mathematics program included a combination of explicit instruction, direct teaching and authentic learning experiences. An authentic learning experience is one in which students are actively engaged in constructing new knowledge by making a connection with real life situations. Explicit instruction involves each skill being taught to mastery before a new skill is introduced and is described by Mercer and Mercer (2005) as being "based on the belief that when learning is complex and difficult for learners, the teacher must provide extensive support to students and transmit knowledge that facilitates learning" (p. 128). During explicit instruction the teacher provides clear explanations, which reduce potential misunderstanding and learning challenges for the student (Fuchs et al. 2008). The material is presented to students in a way that they can understand with immediate feedback to increase understanding (Rowe, 2006). The pace of lessons is controlled by the teacher who decides how to present the lesson and how much time to spend on concepts. Chan and Dally (2001) reported explicit teaching of cognitive strategies was found to be an effective method of intervention to improve students' mathematical problem solving ability. Rowe (2006) stated that despite evidence supporting explicit teaching as superior for maximising student learning it is not as popular as constructivist pedagogy. He recommended students experiencing difficulty required explicit teaching of basic concepts in order to understand new concepts and develop strategies which can then be applied in constructivist style lessons.

Rowe (2006) expressed concern with the prevalence of a constructivist approach used in Australian classrooms as not in the best interests of students experiencing learning difficulties, with problems arising when students do not have the knowledge and skills needed to participate in mathematical activities. Powell and Kalina (2009) suggested that for constructivist lessons to be effective, teachers need to have up to date knowledge of each student's level of understanding and employ both cognitive and social constructivism teaching methods. MacMillan (2009) reported a negative feature of mathematics

teaching occurs when all children are expected to complete the same tasks regardless of their level of understanding. Teachers must build their knowledge of effective instruction methods in order to find a balance and not stipulate one method is better than another (Jackson & Neel, 2006; Watts & Jofili, 1998).

Although students experiencing mathematical difficulties respond well to explicit instruction, to meet curriculum requirements and catch up with their peers they also need opportunities to apply the skills required to think mathematically. McInerney and McInerney (2006) emphasised that learning transpires through exploration and discovery and is not conveyed from one person to another. Constructivist lessons encourage students to develop their understanding of abstract concepts by using real life examples and the manipulation of concrete objects. For constructivist teaching to be effective teachers must have knowledge of students' current level of understanding. During the support program direct teaching of concepts and strategies occurred as a whole group and individually as students participated in activities to promote consolidation of concepts. Repeated practice using a variety of hands-on and play-based activities incorporated a combination of direct instruction and constructivist teaching methods, both valued as equally important to maximise student learning.

Moch (2001) reported time restraints and the belief that using manipulatives took up too much time as the reason why many teachers did not use them in the classroom and when used were a reward. She suggested that if students were initially exposed to manipulatives, more effective teaching would occur, with less time wasted on reteaching concepts. Moyer and Jones (2004) found students exposed to the use of manipulatives and visual images in combination with abstract symbols developed a deeper understanding of mathematics. Ross and Kurtz (1993) reported that the key to the successful use of manipulatives was ensuring that every student was actively involved and that the teacher moved through the class to assist in maintaining student focus.

Ketterlin-Geller et al. (2008) highlighted the importance of locating an accurate starting point through valid and reliable data from assessments to develop

programs targeted to increase student achievement. The Zone of Proximal Development (ZPD), as defined by Vygotsky, is the gap between the level the student has already mastered and the next level that can be achieved when provided with support (Daniels, 1996). The teacher provides scaffolding while increasing the difficulty and range of tasks the students is able to complete independently. van de Pol, Volman and Beishuizen (2010) explained scaffolding is dependent upon the situation, task and student, with teacher strategies based on individual student response.

Ruiz-Primo (2011) stated:

> Everything that teachers and students do in classrooms can be described as an opportunity for collecting evidence of their students' understanding. Informal formative assessment is critical for teaching and learning because it makes students' thinking evident . . . Knowing where students stand on a day-to-day basis enables teachers to determine where they are in relation to where they should be, so that they can provide the appropriate scaffolding to move their students forward in their learning. (p. 23)

Starko (2009) explained that the process of learning requires the brain to build new connections onto existing neural pathways. However, if the information presented does not fit into any existing pathways, connections cannot be made and the information is rejected as meaningless. Scaffolding provided around each students' ZPD and language use in the classroom is considered to be the most important process in a social constructivist setting (Powell & Kalina, 2009). Students work within their ZPD and receive assistance to the next level with teacher guidance, until the student is able to complete the task independently. Young-Loveridge (2004) found the provision of scaffolding and structured learning to be vital in an intervention program. Powell and Kalina (2009) emphasised that all students can benefit from the collaboration and social interaction created in social constructivist classrooms, with ideas constructed through interaction with the teacher and other students following explicit teaching of concepts.

Thinking aloud, peer assisted learning and immediate feedback are strategies recommended to improve the outcomes of low achieving students. Kotsopoulos (2010) found students talked aloud to clarify their thinking, to express confusion and a combination of both. Her research highlighted the importance of teaching students how to express their thinking and she suggested teaching students to participate in the thinking aloud, pair problem solving method (TAPPS) to develop mathematical cognitive processing and listening skills. In TAPPS one student solves a problem while thinking aloud while another listens, without interrupting, but joining in to summarise.

The Australian Association of Mathematics Teachers (AAMT) described excellent teachers of mathematics as being “aware of a range of effective strategies and techniques to promote enjoyment of learning and a positive attitude” (AAMT, 2006, p.1). Through a critical analysis of the learning environment created in classrooms teachers are able to evaluate whether they are catering for all student needs. Hattie (2005) affirmed that teaching mathematics requires teachers using data obtained about student achievement to analyse their own teaching, rather than it being used to measure student success.

Numeracy Programs

Numeracy can be defined as the effective use and communication of mathematics. MacMillan (2009) described mathematics as “the abstract system used to become numerate and language as the abstract system to become literate” (p. 34). McDonald (2006) explained that in the primary phase most mathematics could be considered numeracy but in the abstract mathematics of the senior school the numeracy content was reduced. She defined numeracy as “The ability and disposition to fluently and critically use and interpret mathematical concepts and representations to successfully and purposefully operate in wide-ranging contexts” (p. 11).

There are worldwide concerns about students with mathematical difficulties and research and support programs have been implemented around the globe. Following results of the Trends in International Mathematics and Science Study,

(TIMMS, 1997) an official report, Improving Mathematics Education was produced in Scotland in response to the relatively poor performance of Scottish students. England and Wales responded to their results by introducing The National Numeracy Strategy. In New Zealand the Ministry of Education focused on improving both teacher education and increasing the time allocated to mathematics in the curriculum (MacNab, 2000). In the USA, the National Council of Teachers of Mathematics aimed to reform mathematics education from the 1980s to 2000 by introducing standards of teaching and assessment. The reform emerged from the realisation of the need for higher levels of competence in mathematics to meet the needs of a modern society. Previously it had been accepted as quite normal that many students would fail mathematics (Doig, 2005). Although achievement levels in mathematics is a problem worldwide, research into support programs for students experiencing mathematical difficulties is still developing (Malloy, 2008). Fuchs, Fuchs and Hollenbeck (2007) suggested more research is needed of students' responsiveness to mathematical interventions to assist in the diagnosis of mathematical learning difficulties and the development of numeracy support programs.

The content of mathematics support programs should focus on strategies to assist students' development in areas other than number skills. Jordan, Kaplan and Hanich (2002) have ascertained students with both reading and mathematical difficulties experience pervasive language and working memory problems. Swanson and Jerman (2006) emphasised that regardless of the type of disorder, the majority of research suggests that children with mathematical difficulties also experience memory deficits, particularly the inability to retrieve number facts from long term memory. McGlaughlin, Knoop and Holliday (2005) recommended providing students experiencing difficulties in mathematics with additional support not only in mathematics and literacy but in the development of their working memory to assist retention of concepts and skills taught. An overcrowded working memory reduces the ability to solve mathematical problems and is particularly notable in inattentive students (Lucangeli & Cabele, 2006). Although language skills are critical, attentive behaviour and processing speed are also significant contributors to student achievement in mathematics.

Mayo and Shotts (2004) maintain that early identification of students developing mathematical difficulties followed by early intervention programs could replicate the success of literacy programs such as Reading Recovery. Crawford and Ketterlin-Geller (2008) emphasised the need for well-designed support programs rather than a modified whole-class program as is commonly used in schools. Repeating concepts in the same way to a smaller group does not meet the needs of students requiring support. Instruction must be planned to meet the needs of students through continuous monitoring, the inclusion of aids, and appropriate strategies such as thinking aloud, and peer assisted learning. Even and Tirosh (2008) advocated teaching students at their current level of understanding to achieve success by building on from what they know and can do. Effective numeracy programs have a common focus of catering for the immediate learning needs of students with no single method appearing to be better.

The following table summarises numeracy intervention programs used in Australian primary schools to improve the mathematical outcomes of students. For each program the target group, method of instruction and feedback on the outcomes of the program are outlined.

Table 1. Summary of Australian numeracy programs

Intervention	Program	Result
Mathematics Recovery New South Wales 1992 – 1995	Targets the lowest achieving 30% of 6 to7 year old students. Daily, individualised lessons taught in cycles of 12 to 15 weeks. Explicit instruction by specially trained teachers. Framework of progressive levels used to profile students. Individual assessment - program adjusted on student progress targeting early number learning.	Positive feedback. Clear direction with framework and explicit instruction procedures Teachers were more confident in ability to teach mathematics. (Dowker, 2005; Wright, 2003)
Count Me In Too (CMIT) New South Wales 1996	Low achieving students K – Year 6. Focus on problem solving strategies and mathematical language. Collaborative group work, concrete materials and games. Structured framework, based in number, for 20 week period.	Teachers reported an increased knowledge of mathematical pedagogy. Increase in students' knowledge and understanding. (Bobis, 1996)
QuickSmart University of New England (prior 1998)	Year 6 and Year 7 students Improve fluency of basic mathematical skills and student performance in Standardised Assessment Tests. Small group instruction 30 minutes, three times a week for 26 weeks. Trained teacher assistant or teacher.	Increased accuracy and response speed of participants. Narrowed the gap between participant's achievement and peers. (Graham, Bellert, Thomas, & Pegg, 2007).
Mathematics Intervention Melbourne 1993	Key component - Verbal interaction by specially trained teachers who work with 1 to 3 students. Each lesson is built on the previous lesson. Accurate analysis of student difficulties is essential. Verbal communication between teacher and students and between students key component.	Has led to development of teaching strategies to assist students experience success. Doig (2001).
Victorian Early Years Numeracy Project Victoria 1999	Developed to inform future programs and policy. Small group instruction, Prep to Year 2, focused on number skills. Students at risk receive extra assistance and time.	Outperformed control groups. Teachers understanding and confidence teaching mathematics increased. (Bobis, Clarke, Clarke, Thomas, Wright & Young Loveridge, 2005)
Extending Mathematical Understanding 1999-2002	Targets students in first 3 years of school. Small group of 3 students for 10 to 20 weeks. Structured, based on constructivist principles. Concentrated interaction between the teacher and students during 30 minute lessons. Trained teachers assess student's knowledge prior to the program.	Positive results for both Year One and Year Two. (Bobis, 2000)
Building Accuracy and Speed in Core Skills (BASICS) SiMERR National Centre University of New England	To assist low achieving students or students with learning disability. Designed to improve automatic recall of basic facts and knowledge of procedures. Explicit teaching and questioning, modelling and diagnostic tasks, through 3 distinct levels. Continuous cycle diagnostic and formative assessment with teacher observation.	After six months one quarter of students moved into mainstream classes. Graham, Bellert, Thomas & Pegg, (2007). Byers (2009).

Mathematical Assessments

Researchers use a variety of measurements and apply a wide range of criteria to define students with mathematical difficulties (Murphy, Mazzocco, Hanich & Early, 2007). The range of definitions used in research applied to students experiencing difficulties in mathematics combined with the development of a variety of diagnostic instruments leads to different research samples (Micallef, 2009). Assessing what students know and how they process their thoughts when solving mathematical problems assists teachers develop lessons within student's capabilities. Stiggins and Chappuis (2005) outlined assessment options as, selected response, (multiple choice); extended written response, (observation and judgement); and personal communication with the student. The challenge for teachers is matching the assessment to the intended target with problems arising when the written text places reading demands on students, reducing their level of performance.

Stiggins and Chappuis (2005) defined diagnostic assessment as assessment for learning which includes frequent feedback from which information is obtained to make decisions about future learning. Diagnostic tests are not as broad as achievement tests and are designed to locate students' strengths and weaknesses in specific areas (Mercer & Mercer, 2005). Herman and Baker (2005) stated a test with high diagnostic value is able to provide information on why students are performing at their current level and what to do about it by incorporating multiple choice questions with purposefully designed incorrect answers. Information gathered from a student's choice of a common misunderstanding can allow for instruction to improve the mathematical outcomes of the student.

Doig (2005) advocated an initial diagnosis of a student's mathematical skills is necessary to identify which students require a place in a support program. Sherman et al. (2005), declared that "for learners to succeed, teachers must assess students' individual abilities and characteristics and choose appropriate and effective instructional strategies accordingly" (p. 1). Individual assessment interviews are time consuming but provide an understanding of students' thought processes and the pace of the assessment can be adapted for each

student. Visual clues can be observed such as finger counting or counting all, which may not be witnessed with a written assessment. Individual assessments were incorporated into the study with the Schedule for Early Number Assessment 1 (SENA) used as a measure of mathematical understanding prior to the commencement of the support program and again at the conclusion. During the individual assessments students demonstrated an understanding of mathematical concepts not evident in the Diagnostic Mathematical Tasks 1 (DMT) and this assisted in the creation of more in-depth individual profiles than would have been obtained from a pencil and paper assessment alone. These assessments accurately identified the participants' areas of difficulty and enabled the mathematics lessons to be planned to meet student needs. Focussing the development of numeracy skills around each students' ZPD enabled them to actively participate in lessons which focused on relevant skill development.

During formative assessment, teachers observe and interact with children while learning takes place which allows for re-teaching of concepts not mastered by the student. Ruiz-Primo (2011) defined informal assessment as small scale, frequent opportunities teachers have for collecting information about their students' progress carried out through observation and interaction with the students and used to shape future learning. This method is particularly relevant in the Early Childhood years prior to the introduction of formal state and national testing which is implemented from Year Three. Informal assessment allows the teacher to monitor student development. An accurate level of proficiency can be gained without formal assessments by allowing students to give verbal explanations that demonstrate their understanding (Reig, 2007).

Summative assessment is a formal method of testing and measures students' knowledge at the end of a unit of work taught over a longer period of time and whether the concepts taught have been retained by the students (MacMillan, 2006). Formal or summative assessments can be either constructed by the teacher or a published test.

Each mode of assessment has strengths and a combination of both formal and informal provides a meaningful and authentic evaluation of student achievement as recommended by Hong and Enrensberger (2007). Formal and informal assessments were incorporated into the study, with formal assessments including an analysis of the PIPS held in 2008, and the SENA and DMT prior to and at the conclusion of the program. Informal assessments included observation of students as they participated in lessons, evidence obtained from work samples and teacher observations which were recorded in individual student files.

Summary

Terminology applied to students experiencing difficulties or disabilities in mathematics provided a classification for students deemed to be at risk in this case study. The challenges experienced by classroom teachers such as providing adequate instruction in a limited time frame emphasised the need for an intervention program for at risk students. The consequences of failing to provide appropriate support for students after they had been recognised as being ‘at risk’ included developing the Matthew Effect, continuing to fall further behind their peers. The relationship between literacy and mathematics, with the cognitive process required to commit alphanumeric symbols to memory reflected the influence that reading ability has on mathematical achievement. Other factors contributing to student performance included individual student behaviour and the method of teaching utilised in a classroom environment. A review of numeracy intervention programs implemented in Australian schools and the target audience for each preceded a review of assessments used to measure students’ mathematical ability. Examples of diagnostic and formative assessments and examples of each closed the chapter.

CHAPTER THREE

RESEARCH DESIGN

Introduction

This chapter begins by introducing the research design and explaining the rationale for selecting a case study approach in which both qualitative and quantitative data were collected. The chapter goes on to look at participant selection, data collection, assessment, and measuring student achievement. The flow chart at the beginning of the chapter illustrates the process by which data was collected and how the information obtained was used to create student profiles from which an analysis of the program was made. An analysis of pre-assessment results and how these aligned to the First Steps in Mathematics diagnostic maps to set goals for the students is followed by a description of the processes used to monitor student achievement, including the journal kept throughout the intervention program.

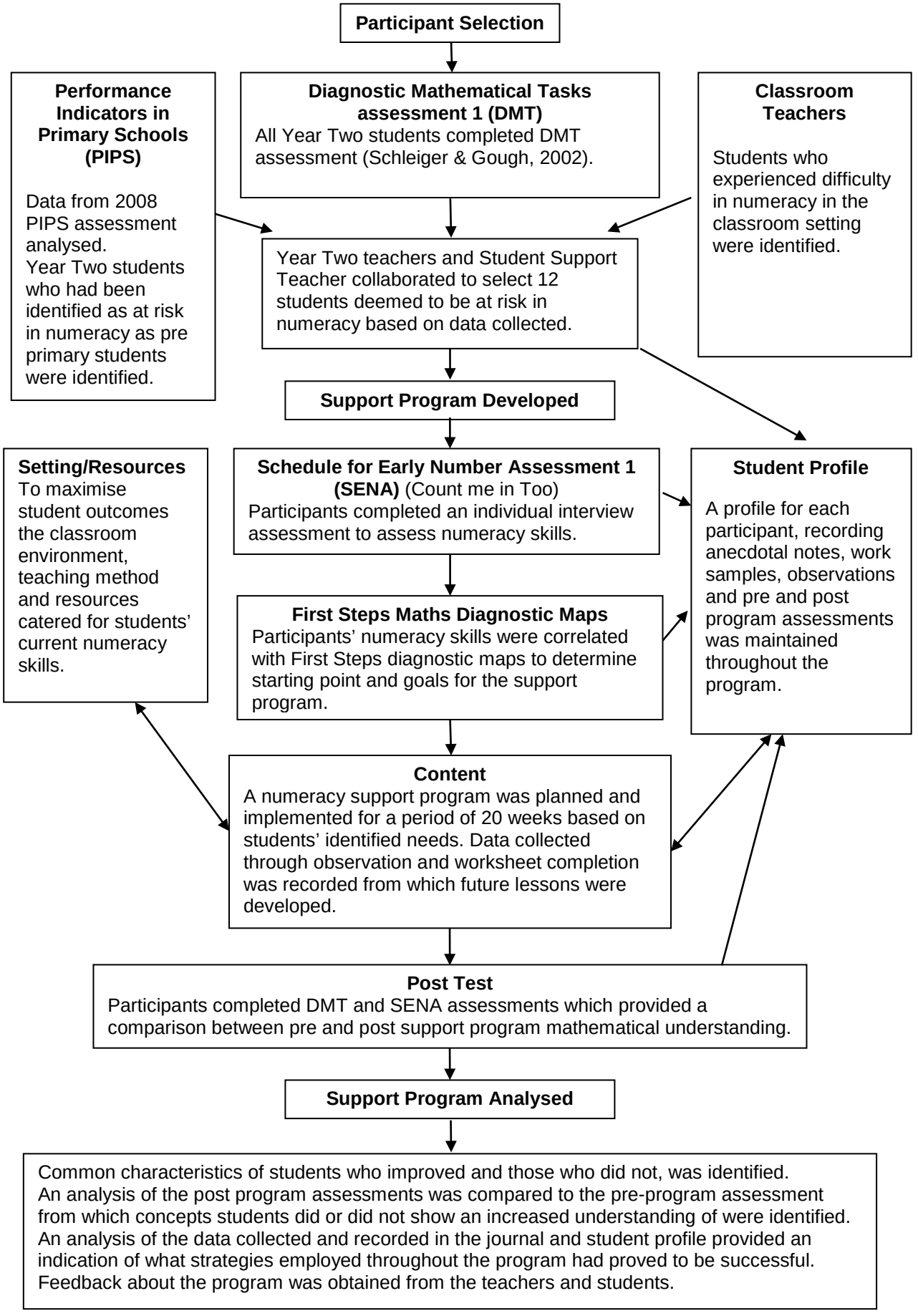


Figure 1. Research design

Research Design

The flow chart (figure 1) illustrates the course of the support program beginning with participant selection based on the results of summative and formative assessments combined with anecdotal evidence from classroom teachers. The creation and maintenance of student profiles throughout the program enabled ongoing monitoring of student progress, and the analysis of post-assessment results underpinned the evaluation of the intervention.

Case Study

Woodside (2010) defined a case study as research which goes beyond description and explanation in an attempt to answer who, what, where, when and how questions. Cohen, Manion and Morrison (2007) recommended the use of case studies which employ real people in real situations to penetrate in ways numerical analysis cannot, resulting in theory which is able to be applied to similar situations. The aim of the research was to use a case study approach to identify how a small group setting impacted on the mathematical achievement of 12 students identified as being at risk in numeracy. The study took place in the context of the participants' normal school day as the students participated in regular timetabled mathematics lessons. Woodside (2010) explained that the use of mixed methods of data collection used in case studies increases the accuracy due to information being collected through different methods but in the same context, therefore providing opportunities for all information gathered to be clarified by another means. Bailey (1982) supported the use of observations over an extended period as applied in a case study because it enables researchers to take appropriate and detailed notes.

Throughout this study qualitative data were gathered via observation of student participation in each lesson and this was recorded in journal entries. Evidence of how the students interacted with one another, used mathematical equipment, applied strategies such as talking aloud, and sought help, or not, was noted. Cohen, Manion and Morrison (2007) reported that case studies provide opportunities for observation of occurrences which may not be frequent but are nonetheless significant and provide the researcher with an insight into the dynamics of the situation. An example of such an insight occurred in the

intervention during discussion among the students about what salt and pepper shakers were together with confusion as to how to which side was left or right. Through listening as the children participated in their discussion I became aware of the cause of students' difficulty. Although Lincoln and Guba (1985) defined the collection of data by observation as obtrusive, I was the teacher, observer and an agent in the design, implementation and evaluation of the program and the students had familiarity with the classroom therefore the observation was not considered to be intrusive.

Observations recorded during the course of this research study provided detailed notes which were included in each student's individual profile. Woodside (2010) promoted the use of case studies as providing opportunities for the researchers to achieve deep understanding by directly observing in real time. Real time questions which can be posed by the researcher or to the participants include:

> "What exactly is happening right now?"
>
> "What were the events leading up to what just happened?"
>
> "What is the meaning of what just happened?"
>
> "What is going to happen next because of what just happened?" (p. 9)

Quantitative data was collected during the course of the study from the students' pre and post-program numeracy assessments and from worksheets completed during mathematics lessons. The two forms of data collection were used to establish a record of the participants' learning journey in individual profiles created for each student.

Cook and Rumrill (2005) discussed the importance of the interval between pre-test and post-test assessments to the internal validity of the research. A short interval risks students remembering the test items, while maturation over time can affect the validity when there is a long interval. In this instance the 20 week interval was unlikely to have provided sufficient time for maturation to be a key factor and, while some learning may have taken place as a direct result of

administering the pre-test, the students' memory difficulties and low scores in the initial assessment suggest that this would not have had a significant impact on student achievement. Diverse forms of data contributed to an analysis of each student's individual improvement following their participation in the program. Individual profiles contained a substantial volume of data including ESL and learning disabilities or difficulties such as dyslexia, which provided for a cross-case analysis and allowed for the identification of common factors which may have influenced student achievement.

Data Collection and Participant Selection

Performance Indicators in Primary Schools (PIPS)

Students who participated in the study had been assessed at five years of age by means of PIPS, a baseline one-on-one computerised assessment of early reading, mathematics and phonological skills. The assessment takes approximately 15 to 20 minutes with questions progressively becoming more difficult as in the number recognition section which begins with numbers below ten and continues to high three digit numbers. When students continue to provide correct answers the difficulty increases but when students begin to falter the test automatically moves onto the next section. Lembke and Foegen (2009) reported basic number skills such as number identification, quantity discrimination and missing number are promising early indicators of later mathematics success. PIPS is a standardised test; it is not designed to measure against any set curriculum objectives but to assess fundamental mathematical concepts of basic counting, addition and subtraction with and without symbols, shape, size and capacity.

Specialised analysis software is used to measure student achievement and identify areas in which students are achieving or underachieving. Standardised scores are presented in graphical reports which assist schools to predict students who might benefit from early intervention. A score below 40 indicates the student is in the bottom 16% of the sample, with scores below 30 representing 2% to 3% of students. The administrators of PIPS recommend close monitoring of the progress of students who achieve below 40 as these students are in the bottom 2.5% of their cohort. Six of the 12 participants had

scored below 40 when assessed in PIPS, one student below 30, 4 below 45 and only one achieved above 50. Information provided in 2008 indicated these students would benefit from an early intervention program (figure, 2). The twelfth participant enrolled at the school during Year One and, therefore, was not present during the PIPS assessments.

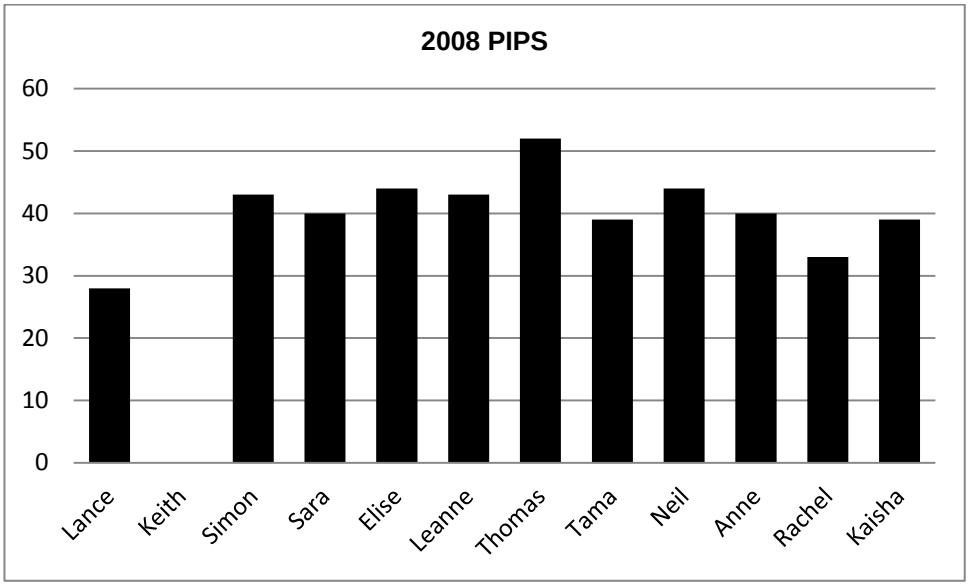


Figure 2. PIPS 2008

Bull, Espy and Wiebe (2008) used PIPS assessment data to correlate and predict student mathematical achievement in relation to working memory and executive functioning. Results of their research indicated short-term working memory was able to successfully predict students' later mathematical achievement. Stock, Desoete and Roeyers (2010) adopted PIPS as a diagnostic tool and predictor of student achievement. They found seven out of eight children aged 7 to 8 years were able to be classified into mathematical ability groupings based on PIPS assessment conducted two years earlier. Hojnoski, Silberglitt and Floyd (2009) purported the early practice of measuring mathematical competency over time assists in the identification of students for intervention programs through the evidence gathered on students' growth.

Diagnostic Mathematical Tasks (DMT)

The Diagnostic Mathematical Tasks were written to provide assessment material for Victorian primary teachers to assess students' understanding of basic numeracy concepts at each year level. Although originally for the Victorian curriculum, DMT retains validity in other education systems as it is a diagnostic test not an achievement test (Schleiger & Gough, 2001). Each DMT assessment identifies students who have or have not mastered the basic concepts at that year level. The DMT was selected as a reliable indicator of difficulties because questions and instructions were read to the students therefore the focus was on mathematical skills and not reading ability. The test was not timed, but administered in a lock step method with each question read aloud by the teacher and all students progressed through the assessment at the same time. Questions were short, able to be repeated, required a response of drawing on a visual diagram, writing a numeral or written text of numbers to twenty (figure 3). Students with working memory deficits should not have been disadvantaged as the written text and illustrations on the answer sheet provided students with additional visual clues.

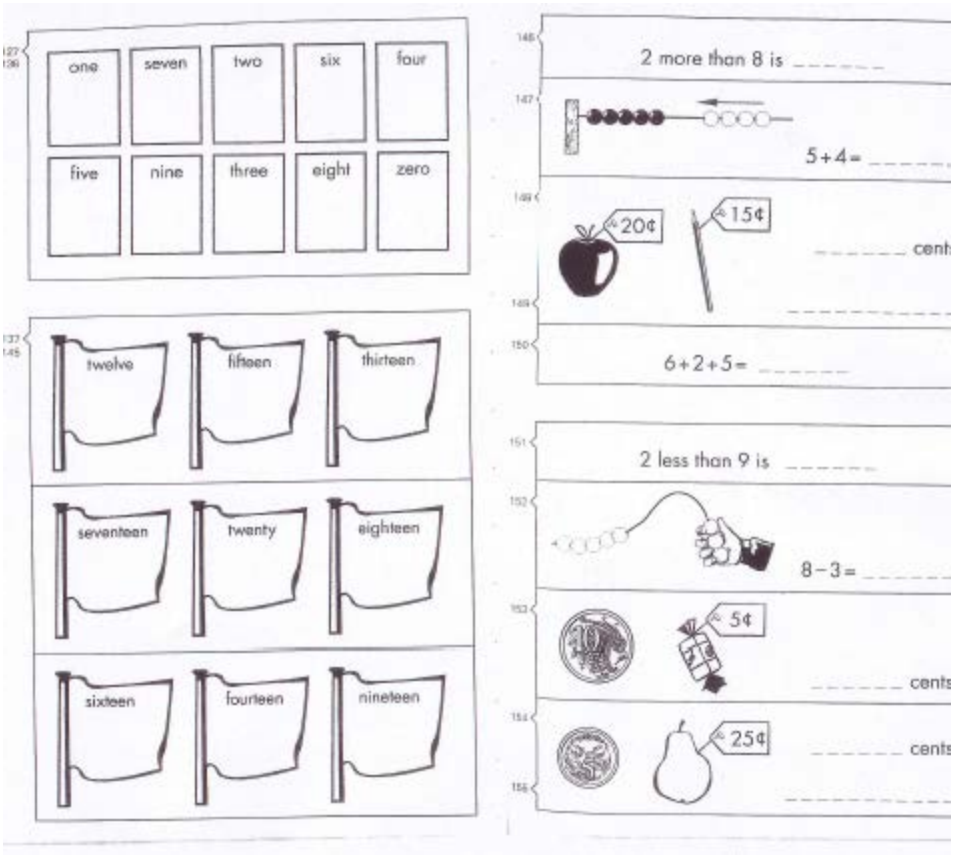


Figure 3. Example of DMT answer sheet

Sixty of the Year Two students completed a DMT assessment (Appendix C). The purpose was to identify students achieving below their age level and therefore having difficulty understanding the Year One concepts. DMT 1 was chosen in preference to DMT 2 as it was designed for Year One students and at the date of assessment all Year Two concepts had not been taught.

A correlation of data from 2008 PIPS and the 2010 DMT was expected to indicate students with difficulties in mathematics which had not been overcome through maturity and learning experiences in Year One. Aubrey, Dahl and Godfrey (2006) stated “without active intervention it seems likely that children with little mathematical knowledge at the beginning of formal schooling will remain low achievers throughout their primary years and probably beyond” (p. 44). Incorporating data from PIPS in the selection of participants added valuable identified students experiencing long term difficulties in numeracy.

Classroom Teachers

Teachers are often the initiators of assessments undertaken to identity learning difficulties (Van Kraayenoord & Elkins, 2004) and are in a position to directly observe students' learning activities and to provide a depth of information not available through assessments (Dettori & Ott, 2006), including students' attitudes toward mathematics. Results of the DMT assessment and analysis of the PIPS assessment were discussed with Year Two classroom teachers who stated that they were surprised to learn Neil had recorded a low score. They confirmed that results from the DMT had identified all other students experiencing difficulty exactly as they would have themselves based on results and behaviours during class lessons. Fletcher, Denton and Francis (2005) reported students around a cut off point will fluctuate in and out with repeated testing. Mazzacco (2005) emphasised that the idiosyncrasies of each assessment influence scores and students may perform within an average range on one test and not another. A decision was made to follow the results of the assessment as Neil was the only student whom teachers had not predicted as a potential participant.

Triangulation

Lincoln and Guba (1985) ascertained that a triangulation of sources bestow credibility to inquiry research with independent measures supporting the same finding. This is supported by Drew, Hardman and Hosp (2008) who advised that applying a mixed-method approach provides substantial strength to an investigation, often with one approach capitalising on the strengths of the other. A triangulation of data was achieved with three sources used to select the student participants by combining the quantitative data from PIPS and DMT together with qualitative data obtained through discussions with the Year Two teachers. Cohen, Manion and Morrison (2007) suggested multi-method approaches applied in social science allowed contrast between methods used to collect data and increased researchers' confidence in the results of the study. In addition to the assessment results, character profiles of individual students' created throughout the program were combined to add complexity, depth and meaning to the quantitative measurements. Applying a triangulation of methods in the study allowed for inferences to be drawn that would have not been possible using a single method.

Participant Selection

Data from PIPS assessment and the DMT assessments were analysed to locate students who may have been identified as being at risk during their Pre-primary year and continued to be at risk in Year Two. Teachers were able to provide up to date checklists and reports on students who were experiencing difficulty understanding new concepts due to not having the prerequisite numeracy skills. The professional judgment of the class teachers provided depth to the overall selection process with descriptions of characteristics displayed by students experiencing numeracy difficulty including off-task behaviour, anxiety, and incomplete work during mathematics lessons. Twelve students were selected from the school's total population of 62 Year Two students. The number of students represented approximately 18% of the Year Two cohort which was within the estimated range of 10-30% of Australian students found to be at risk in numeracy in research conducted by Rohl and Milton (2002).

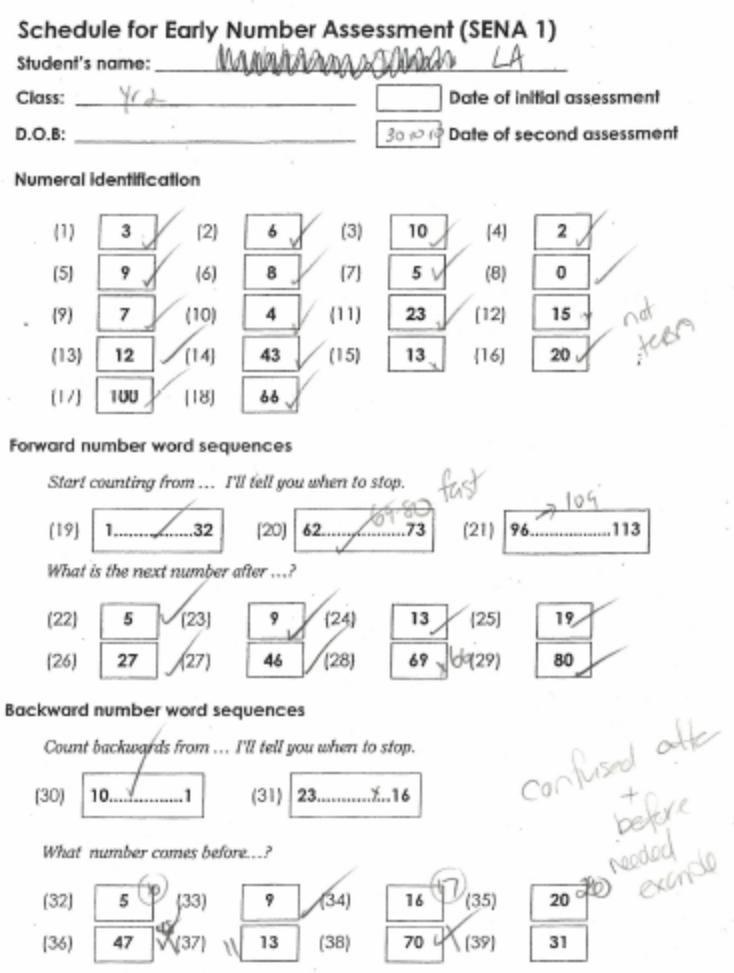
Parental/Guardian Permission

Following the selection of students, a letter requesting permission and promising confidentiality was sought from their parents or guardians for children to be participants in the support program (Appendix A). Parents of the student who scored the third highest number of errors requested their daughter not participate. Consequently she was excluded resulting in the thirteenth placed student accepting a position in the program. Anonymity was ensured in the recording and documenting of results with the use of aliases applied to each of the participants.

Schedule for Early Numbers Assessment 1 (SENA)

Immediately following the granting of permission students were individually assessed using the SENA interview from the 'Count Me In Too' program (NSW Department of Education) (Appendix E). Although students had been selected based on the outcomes of a mathematical diagnostic assessment, individual SENA interviews allowed student responses to be heard and seen by the teacher. Skills assessed in the SENA included numeral identification to 100,

forward number and backward sequencing, subitising, counting and early addition, subtraction number skills, and grouping and sharing. An example of the marking sheet completed during the individual SENA assessments provides an overview of concepts covered in figure 4. During interviews the teacher was alert for mistakes and was able to seek immediate clarification from the student about the cause of the confusion or misunderstanding, such as a reading, comprehension, transformation or process skill problem.


Schedule for Early Number Assessment (SENA 1)

Student's name: [redacted] LA

Class: Yr 2 — Date of initial assessment

D.O.B: — 30 10 19 Date of second assessment

Numeral identification

(1) 3 (2) 6 (3) 10 (4) 2

(5) 9 (6) 8 (7) 5 (8) 0

(9) 7 (10) 4 (11) 23 (12) 15

(13) 12 (14) 43 (15) 13 (16) 20

(17) 100 (18) 66

Forward number word sequences

Start counting from … I'll tell you when to stop.

(19) 1.....32 (20) 62.....73 (21) 96.....113

What is the next number after …?

(22) 5 (23) 9 (24) 13 (25) 19

(26) 27 (27) 46 (28) 69 (29) 80

Backward number word sequences

Count backwards from … I'll tell you when to stop.

(30) 10.....1 (31) 23.....16

What number comes before…?

(32) 5 (33) 9 (34) 16 (35) 20

(36) 47 (37) 13 (38) 70 (39) 31

Figure 4. SENA 1 Answer sheet

An analysis of the DMT and SENA assessments provided the focus for the support program based on numeracy skills deficits. In order to design a suitable program based on their current level of understanding areas in which the students demonstrated limited understanding were mapped to the First Steps Developmental Continuum (Department of Education and Training, 2004). Although students demonstrated difficulty in both multiplication and division sections, these concepts are in a higher phase of development. The numeracy

skills of reading, writing and sequencing numerals are lower order skills which need be understood by students prior to the introduction of more complex concepts. Rousselle and Noel (2008) reported being able to understand numbers, count and calculate are fundamental mathematical skills and each level of ability requires an understanding of lower level interrelated skills. The program planned to ensure students were able to master basic numeracy skills on which they could build higher level numeracy skills.

First Steps in Mathematics Diagnostic Map of Student Development (Western Australian Department of Education and Training, 2004)

Ketterlin-Geller et al. (2008) recommended that scaffolding learning experiences in support programs allows students to experience success and develop a positive attitude toward mathematics. The support program provided numeracy lessons at the students' current level of understanding and within their ZPD and did not replicate lessons which were being taught in the mainstream class at slower pace. The First Steps continuum was used as a starting point from which suitable learning activities were developed for the students.

Burns, Codding, Boice, and Lukito (2010) found that students pass through four phases during their development of mathematical skills; acquisition, fluency, generalisation and application with appropriate intervention dependent upon students' current phase of development. The First Steps in Mathematics diagnostic maps describe characteristics of learners through phases which are developmental rather than age specific. Each stage has been designed to map anticipated progress of learning and assists teachers to guide students in their learning. First Steps was an important and relevant resource to incorporate into the program because professional development in First Steps Number for all the primary staff in the school was held in 2008 with the aim of creating consistency across the year levels. The First Steps diagnostic map assists teachers to recognise common patterns of thinking and to anticipate student responses to activities, the difficulty they may be experiencing, and how to provide learning opportunities to move students' thinking forward to achieve mathematics outcomes.

Herman and Baker (2005) suggested the value of diagnostic tests is in the provision of information on each student's level of understanding, why they are achieving at a particular level and what to do about it. MacMillan (2009) explained that curriculum documents help inform teachers about how to plan for the needs and interests of their own group of children by providing direction with what to teach and in what order. Analysis of DMT and SENA results highlighted the need for students to master and consolidate concepts at the end of the First Steps matching phase, which most students move through between the ages of 5 and 6 years after which they enter the quantifying phase. At the time of the program students ranged in age from 7 years to 8 years, with an average age of 7.8 years and were demonstrating evidence of mathematical understanding 1 to 2 years behind their peers. To be able to achieve success when participating in mathematics lessons in the mainstream class students needed to be competent in basic number skills covered in the matching phase. The Year Two mathematics program provided reinforcement and consolidation of concepts from the quantifying phase and new concepts within the partitioning phase which students generally enter between the ages of 6 and 9. Participants in the support program were unable to keep up with their peers in the learning of new concepts due to not having mastered the necessary prerequisite numeracy skills.

Measurement of Student Achievement

The Western Australian Department of Education and Training (2001) suggested students' mathematical understanding should be based on evidence over time and include a range of mathematical ideas and techniques not a single test. Pre-testing students' numeracy skills prior to the program was followed by a second test repeating the identical assessment at the conclusion. The SENA and DMT assessments were reliable measurement instruments as both included explicit instructions on the delivery and provided a level of consistency without assessor bias.

A comparison was made between results of the pre-program and post-program assessments to measure the growth of individual students. Repeating the same

assessment after a period of 20 weeks provided a more accurate measurement of change in student achievement levels than would be obtained by using a similar test measuring the same concepts. The internal validity of study results should not be affected due to the 20 week period between the assessments and the reliability of two pre and post tests. In addition, the results of the pre-assessment were not reviewed or discussed with participants, allowing the post-assessment to be an accurate measurement of improvement.

Journal (Appendix F)

Jackson, Pretti-Frontczak, Harjusola-Webb, Grisham-Brown and Romani (2009) recommended collecting formative data and recording students' progress daily or weekly during the course of an intervention program. A journal was kept in which anecdotal notes recorded students' participation and progress during each of the lessons together with other incidental events that occurred over the course of the program. In the publication, 'The Reflective Teacher', targeted at practising teachers by the Western Australian Department of Education and Training (2001), the recommendation is made to use a journal to document events and discussions and as a tool to record student behaviour and achievement, and to plan future lessons.

Bobis et al. (2004) recommended teachers use observation, listening, questioning, analysis of work samples and discussions with students to interpret children's understanding and to plan what mathematical concepts to introduce next. Ross and Kurtz (1993) advised teachers to listen to students talking during mathematics lessons and observe as they work mathematically to evaluate student progress. During the support program listening to and observing students as they worked was used to evaluate student understanding of concepts and provided timely feedback on whether further teaching on each concept was required. The Western Australian Department of Education and Training (2001) stated that good teachers are highly skilled observers of students and are able to profile students by studying their behaviour patterns from which they are able to provide the most effective teaching strategy for each student. Strategies implemented as a result of observation included selecting groups according to the students' ability to work together and

providing direct one on one assistance when students began to exhibit signs of lowered confidence or anxiety.

Table 2. Example journal entry

	Used Arrows	Used Numerals	Comments
Neil	√	√	Excellent diagrams. Whole story completed.
Rachel	√	√	Excellent diagrams. Whole story completed.
Keith	√ **some**	√ **some**	Difficulty listening and following instructions.
Leanne	**absent**		
Sara	√	√	Excellent diagrams. Whole story completed.
Tama	√	√	Worked well, able to follow instructions demonstrated understanding.
Elise	X	√	Worked well, able to follow instructions demonstrated understanding.
Lance	X	X	Completed pictures, did not show halving using arrows for direction.
Anne	√	√	Excellent effort, good pictures, and followed instructions.
Simon	X	X	Very difficult to remain focused and on task, little completed.
Thomas	X	X	Completed pictures did not use arrows.
Kashia	√	X	Little completed, used arrows.

Summary

The Case study developed from a triangulation of three sources of data, PIPS, DMT assessments and teacher recommendation to select participants of the intervention program. This mixed method approach assisted in the creation of a thorough profile for each student. After permission to participate was granted students completed an individual assessment which provided greater depth to the areas of strength and weakness. These were then cross referenced with the First Steps in Mathematics Diagnostic Map of Student Development for planning of lessons. An example of an entry from the journal maintained throughout the course of the program concluded the chapter.

CHAPTER FOUR

THE PROGRAM

Introduction

This chapter comprises of a synopsis of the most suitable classroom environment to maximise the learning opportunities for SAER and how the support classroom provided features to meet these conditions. The student support teacher's timetable identifies when lessons were held throughout the week and is followed by an explanation of the teaching approach used to deliver the program. The mathematical concepts taught during the 20 week program and how these correlated to the students' level of understanding are outlined. The chapter concludes with description of the hands-on activities and games students participated in throughout the program.

Environment

Students who participate in interventions which incorporate a withdrawal method and effective teaching techniques are able to master a number of strategies and skills in a short time (Chan & Dally, 2001). In a withdrawal model students receive part-time intensive tuition by highly-trained teachers in a designated resource room. Success is achieved when students are actively engaged in applying a range of strategies, including oral discussions, to solve meaningful problems. The low student to teacher ratio found in withdrawal models provides increased opportunities for interactions with teachers able to provide timely feedback and adjust content according to individual students' needs (Woodward & Baxter, 1997). Withdrawal models are viewed as a temporary program after which time it is anticipated students will return to work independently in the mainstream classroom.

Coordination between the regular classroom program and what was taught in the intervention ensured that students who participated in the withdrawal-model intervention were not disadvantaged. In this study the student support room was part of the participants' everyday environment as it was situated adjacent to the Year Two classroom and nine of the twelve participants also attended literacy lessons in the room. The range of strategies and activities able to be implemented is restricted when support for SAER takes place the mainstream

classroom. Students playing games and talking aloud can be a distraction for students working on dissimilar activities and is, therefore, not encouraged when SAER are supported within the mainstream classroom. In contrast, students in the support program were encouraged to talk aloud and participated in mathematical games and interactive activities which were considered essential for both motivation and to accelerate improvement.

The significance an acoustic environment has on the impact of student academic achievement was stressed by Choi and McPherson (2005). They stated that in order for student learning to occur accurate speech recognition was necessary. Reece (2008) reported that causes of an unfavourable listening environment in a classroom included the distraction of the background noise of students' voices due to the similarity of sound frequency between the children's and teacher's voices. Inability to accurately hear clearly can negatively impact on students particularly those with auditory processing difficulties (Crandell & Smaldino, 2000; Nelson & Soli, 2000). The harsh auditory and busy visual elements found in a typical classroom environment can have a powerful impact on the students, resulting in a place of frustration (Notbohm & Nomura, 2008). Both the Year Two classes shared one large, open plan room which resulted in an environment with poor acoustics and many distractions, even more than a typical classroom. Zigmond and Baker (1996) expressed their concern that student progress was inhibited in an environment of distractions and students who remained in full inclusion models were still in need of intensive targeted instruction. In comparison to the Year Two classroom the support room provided an excellent auditory setting where students could hear the teacher's and each others' voices without distracting noises.

Hong and Enrensberger (2007) found that proximity to the teacher, noise, ventilation, lighting and comfort were critical aspects of a students' ability to learn mathematics and they recommended these features need to be considered together with individual students' needs to maximise learning outcomes. Students deemed to be at risk may have auditory processing difficulties and one of the commonly applied strategies to assist students experiencing auditory problems is to place them at the front of the class where

they are able to see and hear the teacher with limited distractions. The smaller size of the student support classroom and lower number of students allowed for all to be seated close to the teacher and whiteboard when explicit teaching occurred as recommended by Wadlington and Wadlington (2008).

The physical layout of the classroom was designed to promote co-operative learning with the desks arranged in groups and adequate free floor space which allowed for range of settings and a level of comfort for students whether participating in structured learning tasks or playing games. Bobis, Mulligan and Lowrie (2004) reported children often made better choices when selecting the working space themselves and developed a sense of responsibility through taking ownership of the physical environment. During the support program students were given responsibility for the mathematical resources which were stored in clearly labelled trays for easy access and this contributed to the students demonstrating a greater interest in the lessons and increased ownership of their learning.

Timetable

The timing of lessons aimed to maximise the time available for the withdrawal group lessons while causing the least disruption to the Year Two classroom timetable. Final arrangement allowed two 85 minute and one 40 minute lesson each week over a 20 week period (Table 3). In contrast to the standard 45 minutes lesson which Ketterlin-Geller et al. (2008) believe does not provide sufficient time for students at risk to master new concepts, the longer 85 minute lessons provided time for explicit teaching, whole group interaction, independent skill application and reinforcement of concepts. Neither the students nor the teacher were pressured to complete tasks because of time constraints as the focus of each lesson was on students developing their skills and understanding. Elkins (2002) accentuated the importance of SAER mastering the basic mathematical skills of addition, subtraction, multiplication, division and an understanding of place value. The longer lessons provided time for students to apply repeated practice to strengthen their understanding of basic number skills. The location of the support classroom in the adjoining room

to the Year Two classrooms negated any potential negative effects of movement to another class necessary in withdrawal programs.

Table 3. Support timetable 2010

GILLIAN HURLE - SUPPORT

	TIME	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
1	8.45-9.05	DOTT	DUTY DOTT	DOTT	DOTT	DOTT
2	9.05-9.25am	Year 2 Literacy	Year 2 Literacy	ASSEMBLY CHAPEL	Year 2 Literacy	Yr 1 Literacy
3	9.25-9.45am					
4	9.45-10.05am			Yr 1 Literacy		
5	10.05-10.25am					
6	10.25-10.45am					
7	10.45-11.05am	RECESS	RECESS	RECESS	RECESS	RECESS DUTY SM OVAL
8	11.05-11.25am	Yr 3 Literacy	Yr 2 Numeracy	Yr 3 Literacy	Yr 2 Numeracy	PPLJ
9	11.25-11.45am					
10	11.45-12.05pm					PPSW
11	12.05-12.25pm					
12	12.25-12.45pm	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
13	12.45-1.05pm	LUNCH	LUNCH	LUNCH	LUN CH Duty Inside	LUNCH
14	1.05-1.25pm	Yr 6 Literacy	Yr 6 Numeracy	DOTT	Yr 6 Literacy	DOTT
15	1.25-1.45pm			Yr 5 Literacy		Year 2 Numeracy
16	1.45-2.05pm	PPSW	Yr 4 Literacy		Year 4 MD Numeracy	
17	2.05-2.25pm					
18	2.25-2.45pm	PPLJ	IEPS		Year 4 CM Numeracy	DOTT
19	2.45-3.05pm			CHAPEL – DOTT		
20	3.05-3.25pm	DOTT			DOTT	

Content

Common difficulties revealed from results of the SENA and DMT assessments indicated students were working within the matching phase of the First Steps Diagnostic Map. The program aimed to consolidate concepts within this phase and to introduce more difficult concepts from the quantifying phase. The development of the students' abilities to think mathematically focused on applying logic and reasoning to solve problems which also required the application of the basic numeracy skills addition, subtraction, multiplication, division, and reading and writing of numbers. The students participated in activities designed to develop their basic numeracy skills while developing connections between mathematics and their own everyday lives. Verbal

communication between the students and with the teacher was promoted to facilitate the students' abilities to use mathematical language across a variety of activities.

The following table provides an example of the mathematical concepts within the matching and quantifying phases of the First Steps Diagnostic Map corresponding with matching examples of the participating students' level of understanding gathered from the pre-assessments and journal entries.

Table 4. Concepts introduced from the First Steps matching phase (Department of Education and Training, 2008).

Matching Phase (5 to 6 years) **Students:**	**Example** **(Journal, Appendix F)**
May 'skip count' but do not realise it gives the same answer as counting by ones.	When asked 'If I count by 2's will I get the same number?', the greater part of the group said "No". There was some hesitation but no-one was confident enough to go against the majority and say "Yes".
May lay out groups to represent a multiplicative situation but do not use the groups to find out how many altogether, counting by ones instead.	While counting in 2's or 5's if not enough counters to complete a whole set of 2 or 5, lost focus and started again reverting to counting by 1's instead.
Often can only solve addition and subtraction problems when there is a specific action or relationship suggested in the problem situation which they can directly represent or imagine.	Confusion developed with the students adding the numbers such as 6 + 4 = 10 rather than how many altogether. Another error was using the first counter as a marker for the group and then including this in the total number.
Have difficulty linking their ideas about addition and subtraction to situations involving the comparison of collections.	The challenge of estimating how many counters there would be when another group of 20 counters were added to the first set resulted in a range of answers from 24 to 200.
May represent division type situations by sharing out or forming equal groups but become confused about what to count to solve the problem often choosing to count all the items.	Students struggled with the concept of multiplication and division even when direct teaching, modelling, counters and diagrams were used.
May deal out an equal number of items or portions in order to share but do not use up the whole quantity or attend to equality of the size of portions.	Children could identify half or quarter of an object but not of a group of objects.
Often do not realise that if they have shared a quantity then counting one share will also tell them how many are in the other shares.	Students demonstrated difficulty sharing counters into groups and needed to count the number in each group to explain how many were in each.
May split things into two portions and call them halves but associate the word 'half' with the process of cutting or splitting and do not attend to equality of parts.	Most students were able to divide a given object into half or quarter but colouring in half or quarter of a given number of objects proved challenging and indicated the need for further practise in order to master the concept.
Understand that the more portions to be made from a quantity the smaller the size of each portion.	Students were able to realise that with each new visitor everyone's share got less. Pictures and stories were understood by most of the students, however when asked to draw a tray of something and share between varying numbers of their family or friends confusion was noted.

Table 5. Concepts introduced from the First Steps quantifying phase (Department of Education and Training, 2008).

Quantifying Phase (6 to 9 years) **Students:**	**Example** **(Journal, Appendix F)**
Use materials or visualise to decompose small numbers into parts empirically eg. 8 is the same as 5 with 3.	Students were able to locate and give answers to missing numbers when working with concrete objects and together as a whole group, including writing the matching number sentences on the white board. However with the exception of Simon all experienced difficulty writing number sentences to match the bonds created from their teddy bears or counters when working with one partner.
Make sense of the notion that there are basic facts e.g. 4 + 5 is always 9 no matter how they work it out or in what arrangement.	The aim of the lesson was to consolidate and develop further the patterns found in decomposition and number bonds as most students had not been able to transfer the concrete manipulation to written number sentences.
Write number sentences that match how they think about the story line (semantic structure) for small number addition and subtraction problems.	Students experienced difficulty writing number sentences to match the bonds created with concrete objects.
Select either counting on or counting back for subtraction problems depending on which strategy best matches the situation.	Eight students had difficulty naming the number after and six with the number after during the pre-test and with the counting on or back strategy.
Find it obvious that when combining or joining collections counting on will give the same answer as starting at the beginning and counting the lot.	Students had difficulty holding a number in their head, returning to counting from one and counting the groups together.
Can think of addition and subtraction situations in terms of the whole and the two parts and which is missing.	The concept of number bonds was demonstrated to students on the white board using different colours for each number from which students provided the missing number by recognising the pattern. Two of the 12 students, Rachel and Elise were able to confidently provide the correct answers.
Realise that repeated addition or skip counting will give the same result as counting by ones.	Questioning revealed students believed counting in 2's had to begin at 2, and could only be even numbers. This was the same understanding for 5's and 10's.
Realise that if they share a collection into a number of portions by dealing out or continuous halving and use up the whole quantity then the portions must be equal regardless of how they look.	Number stories were discussed and demonstrated on the white board using picture diagrams and number sentences, with the focus was on 'sharing' and 'groups of'. Students created their own story; however when this proved too difficult for most, the activity was stopped. A story was told to the students who then drew a matching picture diagram and wrote a number sentence.

Teaching Approach

All children are capable of learning and the teacher is responsible for providing appropriate opportunities (Reig, 2007). Serin, Serin, Yavuz and Munahhedzade

(2009) suggested teachers should be more concerned about how they teach than the curriculum content. During the intervention it was hoped that the teaching method implemented would be a significant contributor to student success in combination with appropriated based and level content. Sherman, Richardson and Yard (2005) stated that no one tool would be effective in every circumstance or environment and Munn (2005) recommended that teachers should focus more on student learning and use observation to facilitate future planning. Providing mathematics lessons in a small group provided an opportunity for the teacher to vary the teaching approach spontaneously and include a wider range of tools than practical in the mainstream setting. The low student to teacher ratio allowed for observation to be utilised as a tool for assessing each students' numeracy skill development. The low student to teacher ratio provided opportunities for timely feedback which resulted in less disruptive or off task behaviours and the teaching methods applied in the study balanced the teaching method and content.

Children with mathematical learning difficulties do not develop computational fluency and rely on slow counting-based actions such as counting all, counting on using their fingers and rarely using direct retrieval to solve problems (Geary, 2004; Micallef, 2009). Fuchs et al. (2008) emphasised the importance of integrating number knowledge with the relationship between subtraction and addition as fundamental for an intervention program. Results of numeracy assessments held prior to the implementation of the support program highlighted the limited knowledge of basic number skills and strategies each of the selected students possessed. Bryant et al. (2008) found students' mathematical achievement improved after students developed fluency with counting strategies and mastery of number combinations through repeated practice. The support program was designed to incorporate repeated practise of basic numeracy skills, with participants encouraged to apply counting on and back strategies rather than reverting to counting all, and to develop students' automatic retrieval of basic facts.

Children may take many years to move into abstract thinking and the use of games is recommended by Meyerhot (2004) to assist students to understand

the relationship between concrete and abstract. Concrete materials or manipulatives are objects that can be handled whereas abstract thinking involves conceptual reasoning together with the signs and symbols of mathematics. Burns, Codding, Boice, and Lukito (2010) found the use of manipulatives as students progressed through the acquisition and fluency phases of development had a positive effect on achievement. Wadlington and Wadlington (2008) recommended the initial use of concrete objects, pictures and diagrams to assist students to master prerequisite numeracy skills prior to the introduction of abstract concepts. An essential element of the program was the students active participation in a range of mathematical games and hands-on activities. Wade-Woolley (2007) explained that children with learning difficulties experience problems in consolidating, retaining and transferring newly learned information and skills and this was supported by Wright, Martland and Stafford (2000) who endorsed a combination of concrete objects, counting skills and abstract thinking for students in numeracy support programs. The inclusion of multi-sensory activities incorporating manipulatives such Cuisenaire rods and counters helped students progress through the developmental phase of working with manipulatives to abstract thinking.

Creative thinking was promoted by Starko (2009) as one of the key strategies to help students obtain deeper understanding by allowing them to construct ideas based on their unique personal experience from which content learning is enhanced. During the support program, in preference to completing pre-made worksheets, students were encouraged to think creatively by matching number sentences to pictures they drew on blank paper to solve mathematical problems. Results of research conducted by Ozdemir, Guneysu and Tekkaya (2006) found that implementing a teaching strategy which included activities such as drawing, viewing performances, dramatising and completing puzzles resulted in a higher level and retention of knowledge. They recommended teachers develop meaningful and relevant learning experiences which engage students' intelligences based on Gardner's theory of multiple intelligences (table, 6). Gardner (1983) profiled seven intelligences with each person stronger in some and weaker in others. To promote the numeracy achievement of students the intelligences defined by Gardner were included in the

mathematical activities students participated in during the program. Verbal intelligence was promoted with students encouraged to talk aloud as they worked together to solve numeracy problems. Students participated in dramatisation to define positions such as in front of and behind, to incorporate kinaesthetic intelligence. Visual and spatial intelligence was promoted throughout the program with manipulation of concrete materials such as counters and Cuisenaire rods. Students developed their logical intelligence as they discovered mathematical patterns in Cuisenaire rods, and counting in multiples. Students were encouraged to develop their interpersonal skills as they worked together in small groups or with a partner. Wadlington and Wadlington (2008) recommended teachers help students to see the relationship between facts using multisensory strategies such as writing and speaking aloud. A multisensory approach was incorporated into the program to assist students to master foundation numeracy skills by physically touching and moving concrete objects, viewing patterns and colours while being encouraged to speak aloud.

Table 6. Gardner's Multiple Intelligences, Gardner (1983)

Intelligence	
visual/spatial	Ability to manipulate and create mental images – Remember facts, recognise and use patterns of space
verbal/linguistic	Strength in language and words
musical/rhythmic	Ability to recognise non-verbal sounds
logical/mathematical	Ability to observe patterns, carry out mathematical operations and investigate issues scientifically.
bodily/kinaesthetic	Ability to express physically
interpersonal	Ability to relate to understand and relate to others
intrapersonal	Ability to relate to understand oneself

The use of mathematical games in the support program allowed for repetition and application of the same concepts in different activities which enabled the students to consolidate their basic numeracy skills and understanding. Rieg (2007) reported that students at risk learn from their peers in cooperative group situations and Young-Loveridge (2004) stated that "Playing games and reading number stories with a specialist teacher is an effective way to enhance numeracy skills in young children" (p. 90). To assist in the development of

addition and subtraction skills a variety of mathematical games were used throughout the program. Bragg (2003) stated the advantage of using games as an instructional tool was they were both highly motivating and social. He reported that when games are used in classrooms a positive attitude toward mathematics develops particularly for early finishers and are preferred over more repetitive practice. Using games as a reward had been common practice not only in the Year Two classroom but the Year One and Pre-primary classrooms of the school. In contrast the program provided opportunities for the students to participate in fun-based learning activities during lessons as a learning tool and not as an incentive for completing work. The participants were students experiencing difficulty with mathematics and as such were unlikely to have been among the 'early finishers' typically experiencing the reward of playing games in the classroom after completing set work in less than the allocated time. Sherman et al. (2005) established the repetitive feature of games assisted students with memory difficulties and this finding supported the value of including games in the program. To maximise the outcomes for the participating students the addition of an aspect of fun to the lessons aimed to increase retention in both their long term and short term memory. Games provided opportunities for interaction between participants and supported the development of mathematical language and fostered a positive attitude toward mathematics. While the students played the games they were able to apply adding and subtracting strategies, write numbers sentences and develop mental problem solving strategies.

Play Based Activities

The effective teaching of mathematics involves students in lively interaction and discussion (Sulaiman, Abdurahman & Rahim, 2010). The inclusion of play based activities aimed to build a positive attitude through students developing an enjoyment of mathematics because they were experiencing success. Students were also increasing fluency and understanding in the areas of number recognition, addition, subtraction, counting on, counting back. The activities used into the program incorporated auditory, visual and kinaesthetic modes of learning. Mathematical games and activities students played included

Mushroom House, Mousetrap Maths, Koala Tree, Number Fun, In the Window, Toss and Add, Toss and Subtract and the Function Box.

Mushroom House

Each player in the group had a card on which was a mushroom shape containing numbers to 20. Students took turns to roll two dice after which they added the two numbers together. If the sum of the two digits was in their mushroom it was covered with a counter. Students were able to use a range of addition strategies such as number lines, rulers or counting on to arrive at their answer. The other members of the group observed as each student completed the calculation checking the accuracy of the addition (School made resource - origin unknown).

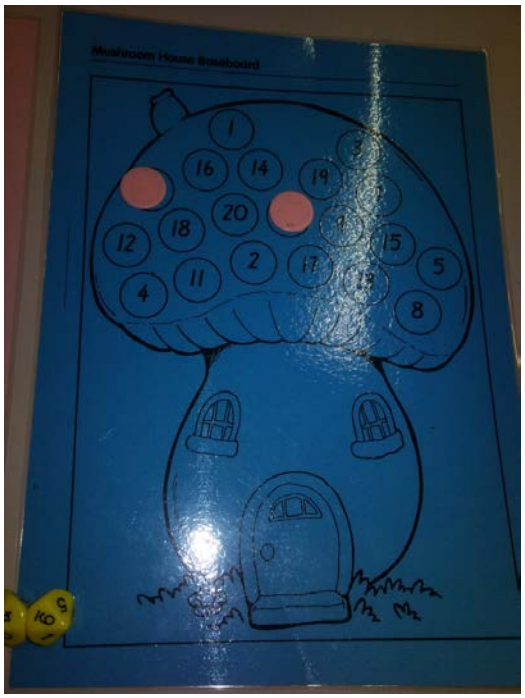


Figure 5. Mushroom House

Mousetrap Maths

Students selected an instruction card from a pile on the board and moved their counter around the board following the instructions on the card. One side of the board contained an addition game and the reverse subtraction. *(Learning Ladder)*

Figure 6. Mousetrap Maths

Koala Tree

A wooden board with koalas clipped on both edges and an addition sign on one side and subtraction sign on the reverse. A pile of laminated numbers were placed face down on each edge of the board. One student took a card from each pile and clipped it under one koala on that edge of the board. The two numbers are added or subtracted according to the sign. Students used number lines, rulers and counting on or back strategies to solve their problem while the other player checked the calculation for accuracy.

Figure 7. Koala Fun

Number Fun

Number Fun consisted of a set of picture cards with addition and subtraction problems and a set of answer cards. The original instructions suggested two variations to play, however these brightly coloured cards provide many creative adaptations. In one activity the sum cards were hidden and students wrote their own number sentence to match the picture and in another students drew their own picture to match the sum cards and. It was also played with one student 'reading' the problem and the other working out the answer either using counting on or a number line and both checking the accuracy of the answer (Smith, Jewitt & Paris, 2004).

Figure 8. Number Fun

In the Window

Students took turns to place window over numbers on their card which contained randomly placed numbers to 20. The ‘window’ was either placed horizontally or vertically and the student selected to add or subtract the numbers using number lines, rulers and counting on or back strategies to solve their problem which was written as a number sentence. The calculation was checked by other group members for accuracy (School made resource - origin unknown).

Figure 9. In the Window

Toss and Add / Subtract

Each player had an A4 size card containing numbers to 20. Each took turns to roll two dice, which included a choice of multiple sided die. They selected to add or subtract the numbers and if the answer was on their card they covered it with a counter. Students wrote their calculation as a number sentence which the other members of the group checked for accuracy. Students used number lines, rulers or counting on or back strategies to solve their problem (School made resource - origin unknown).

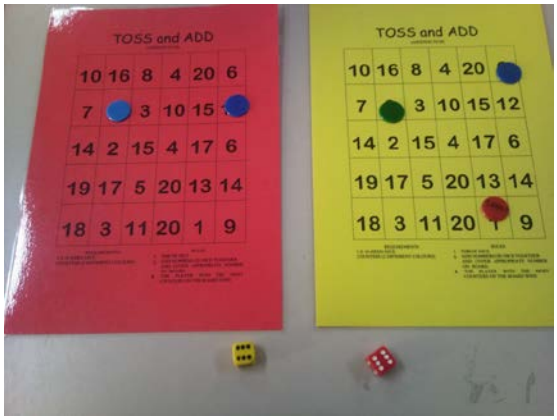


Figure 10. Toss and Add/Subtract game

Function Box

One player had a box containing cards with instructions such as ‘add two’ or ‘subtract five’. Another player selected a random number of counters which he or she placed on the desk. Without looking the student with the box selected an instruction and directed the other student to add or subtract that amount to the original set of counters. The student completing the problem wrote a number sentence which was checked by the other player after which exchanged roles and continued to play (Self made activity).

Thinking Aloud

Active listening, observation, analysing and interpreting were promoted as necessary strategies for communication by MacMillan (2009). Intentionally listening to students as they worked together provided information not available from marking worksheets after students had left the room and could not explain how they obtained their answers. Hearing students talk to one another as they participated in activities allowed for timely feedback to be provided. Misunderstandings were able to be clarified with students encouraged to explain their understanding of the processes using concrete materials in combination with abstract signs and symbols. Drew, Hardman and Hosp (2008) explained

> A design that allows the children to talk about what they are thinking and doing as they work on a math problem gives the researcher a view about what the children are doing, choices they make as they seek to solve a problem and their rationales for making these choices. (p. 187)

Reading and Writing Numerals and Words

An activity included in the program required students to order and match numerals to words for numbers to 20. A common error noted among the children during pre-assessments was the mispronunciation of the teen and ty numbers such as reading 15 as 50. Students were encouraged to look for smaller words within larger ones such as nine in nineteen and how to recognise and pronounce the teen and ty numbers correctly. Nine of the twelve students were members of the literacy support group and improving their ability read and

write numbers was an important element of both their literacy and numeracy development.

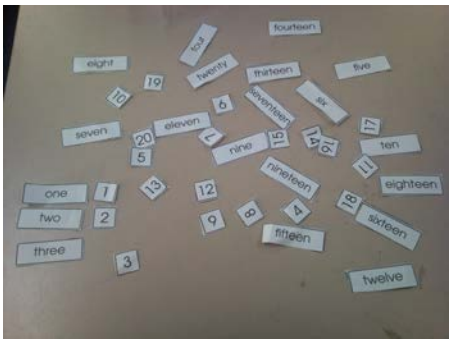


Figure 11. Matching words with numerals

Manipulatives

Cuisenaire rods

Scaffolding students' learning through the manipulation of objects to pictorial representation and finally the development of abstract symbols is recommended by Ketterlin-Geller et al. (2008). Cuisenaire rods were introduced as resource to help students understand the concept of partitioning numbers into part-part-whole, the inverse relationship of addition and subtraction and fluency of knowing the number bonds for ten. The coloured wooden Cuisenaire rods were included in the games rotation and were a popular activity as these had not been used in their classrooms previously. As students built up their block pattern they were able to recognise and say the numbers associated with each rod and write a number sentence to match the number bond they had created.

Figure 12. Cuisenaire rods

Counters

To help students develop their understanding of the relationship between multiplication and division and an ability to skip count counters were used as a visual representation to demonstrate the total quantity not changing. Initially many students were disorganised and lacked coordination when manipulating the counters in particular the ability to one finger touch which resulted in the need to start again as they lost track of which counters had been counted.

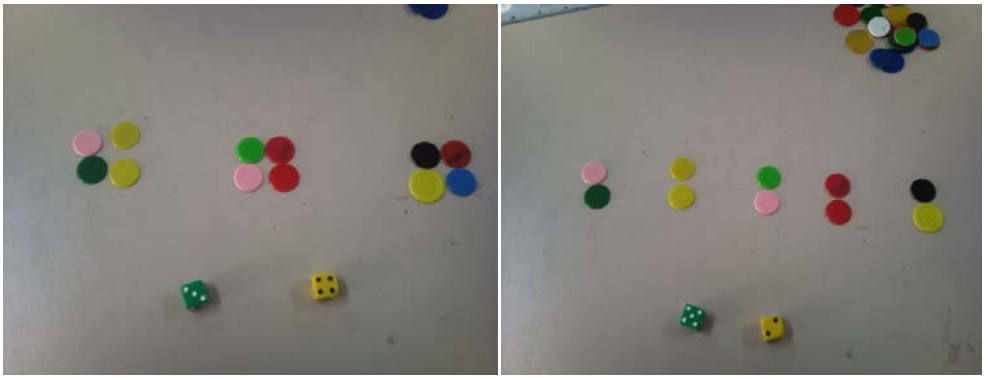


Figure 13. Example activity requiring the movement of counters.

Visual Patterns

Number Chart

To assist students understand the concept of counting in twos, fives and tens a number chart was displayed during whole group sessions and a smaller copy for individual work. The chart provided students with a visual aid while they counted aloud and located patterns within the chart. All students originally stated it was impossible to count in twos unless counting an even number, however the number chart assisted their comprehension that is was possible to start at any number including odd numbers and count in twos. Prior to the introduction of the number chart students believed counting in tens involved only numbers ending in a zero. Using a number chart was easy for the students to follow a visually demonstration of counting in tens from a number between decades which led to students being able to count in tens between decades without the use of the number chart (figure 14).

Figure 14. Hundreds chart

Creative thinking

Number Stories

Think boards were introduced to help the students develop their ability to solve story problems involving addition, subtraction, multiplication and division. Wiggins and McTighe (2006) recommended in order for students to obtain long term retention of any new learning they should be provided opportunities to solve problems related to real life. Using think boards students created their own word problems bringing together diagrams, number sentences and mathematical symbols. By varying the starting point students developed an understanding of the links between each concept and how each provided a part in solving the problem (figure 15).

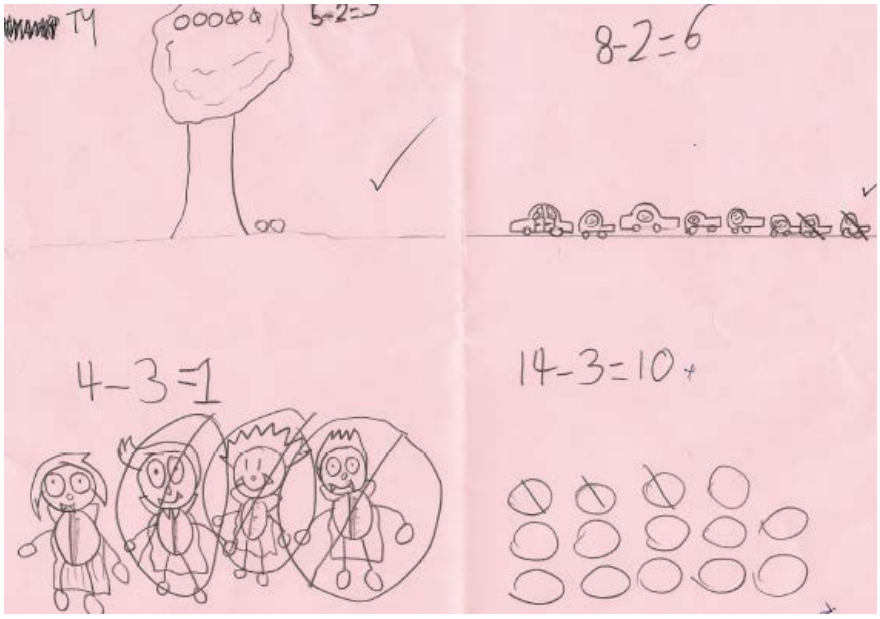


Figure 15. Number stories

Ordinal Numbers and Location

Analysis of the DMT assessment indicated students were not competent in the reading and placement of ordinal numbers. The concept of ordinal numbers was introduced to the group with the leading question, “Where have you heard or used this type of measurement?”

“Birthdays”, “winning a race” and “behaviour warnings” were examples given (Journal, Appendix F). Following the introduction students drew a picture of a race in which positions were defined by set colours but the objects racing were their own free choice with people and cars were the common subjects selected. In another lesson the concept of location was introduced and used together with ordinal numbers (figure 16). Students physically took part in the lesson and became the manipulatives themselves. They moved to stand beside, in front, next to objects and people or stood in a set position in a line such as 5th or 1st place as instructed by the teacher. This activity was repeated with students taking turns to instruct each other to move into set positions and answer questions about who was beside, next to or in front of. Students enjoyed the physical aspect of moving about the room and moving each other rather than a counter.

Figure 16. Race: Tama

A subsequent lesson involved the use of a photograph of each of the Year Two classes with the students answering and constructed their own questions based on location and position of students. The students were very excited and enthusiastic to be using a photograph which included a picture of themselves and their friends in a mathematics lesson.

Books

Linking literature to mathematics was reported by Bull, Espy and Weibe (2008) to assist students to think and reason by using spatial concepts as they created mental pictures. The Doorbell Rang (Hutchins, 1986) was read to students and combined the concepts of sharing, repeated addition, skip counting, continued addition and subtraction focusing on the 'missing' or unknown' quantity. Students were provided with a sheet of coloured A4 paper which became the tray and counters which became the cookies to be shared. The book was re-read students with their suggestion of baking more cookies incorporated into the story with the larger number given by the students replacing that in the text. As the book was read students used their tray of cookies to find the answer to the number of cookies each person would receive. To conclude the lesson students drew an example of their own story which involved sharing the cookies and included the family pets (figure 17).

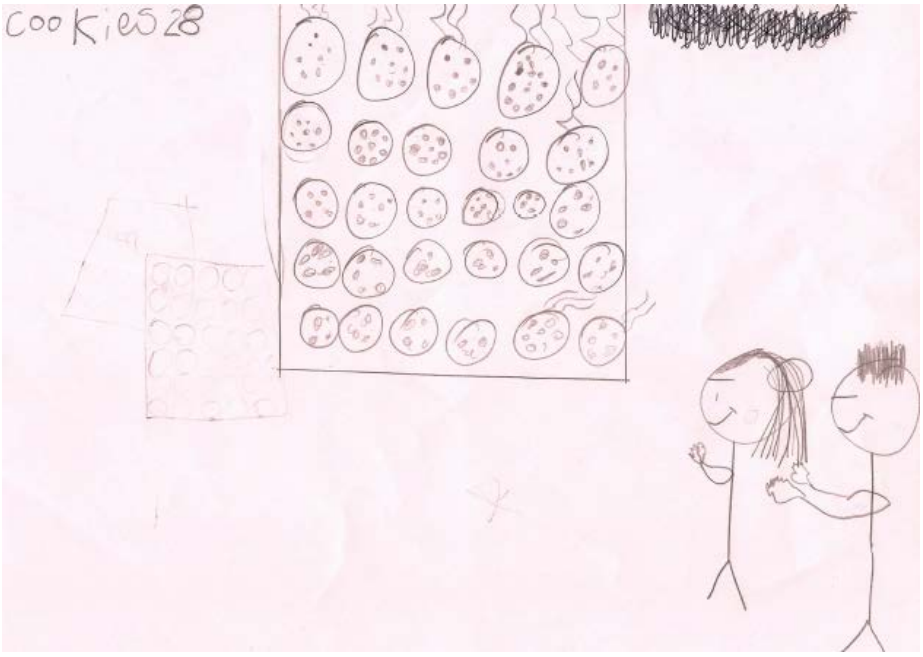


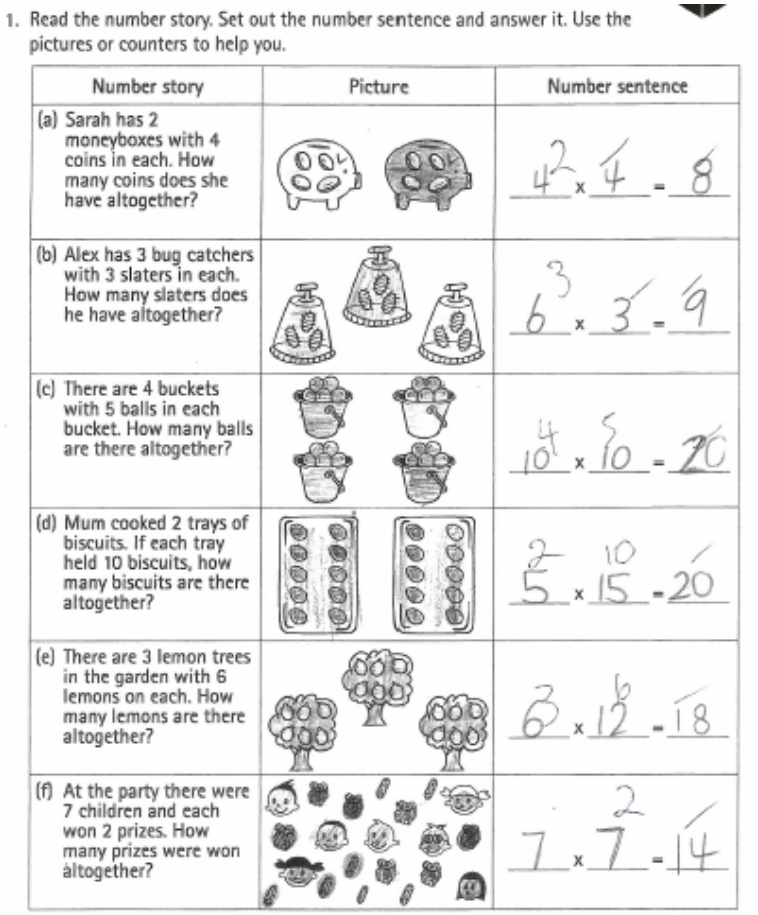
Figure 17. Cookie sharing

The book The Great Divide (Dodds, 2000) was read to students to introduce the concept of how halving large numbers was based on the same principle as halving small numbers. Students were able to use their mathematical knowledge to halve 2, 4, 6, 8 and 10, and after a demonstration on the whiteboard adding a zero to 2 and repeating with 4 students halved the larger numbers 60, 80 and 100. Students created their own edition of the story by filling in the unknown such as ‘what happened to the competitor who came second?’ The key focus for the lesson was the concept that half is two groups of equal size and students were encouraged to draw arrows as indicators of sharing, a strategy previously implemented in think boards (figure 18). Developing the ability to use arrows to show direction assisted students to develop a conceptual understanding for higher orders abstract problems involving multiplication and division.

Figure 18. Halving story: Anne

Worksheets

Worksheets photocopied from published books often contain problems which have only one possible answer and MacMillan (2009) alleged this leads students to focus on ‘getting it right’ whereas providing open-ended tasks reduces the students’ focus solely on the answer. Photocopied worksheets were used in the program predominately when requested by the classroom teachers for reporting or portfolio purposes. Instructions and questions needed to be read to Lance and Keith due to their limited reading ability and other students frequently requested assistance with written text. It was in the most part reading and comprehension of the instructions and the amount of text on the page which caused the students difficulty and anxiety and not the actual mathematical task (figure 19). At other times assistance was sought by students who were reluctant to continue without reassurance that they were on the right path and had understood the task. The observation of students as they individually completed worksheets provided understanding of their ability to apply previously learnt skills and where further teaching was required.



1. Read the number story. Set out the number sentence and answer it. Use the pictures or counters to help you.

Number story	Picture	Number sentence
(a) Sarah has 2 moneyboxes with 4 coins in each. How many coins does she have altogether?		4 x 4 = 8
(b) Alex has 3 bug catchers with 3 slaters in each. How many slaters does he have altogether?		6 x 3 = 9
(c) There are 4 buckets with 5 balls in each bucket. How many balls are there altogether?		10 x 10 = 20
(d) Mum cooked 2 trays of biscuits. If each tray held 10 biscuits, how many biscuits are there altogether?		5 x 15 = 20
(e) There are 3 lemon trees in the garden with 6 lemons on each. How many lemons are there altogether?		6 x 12 = 18
(f) At the party there were 7 children and each won 2 prizes. How many prizes were won altogether?		7 x 7 = 14

Figure 19. Multiplication story problem worksheet

At the request of the Year Two class teachers after a review of the topic students completed a worksheet on the concept of half and a quarter. During the discussion students were asked what they understood about the terms half and a quarter and what items could be halved and quartered. Students took turns to draw their object on the white board prior to dividing it. Demonstrations also incorporated groups of magnetic counters with students suggesting ways to share out the counters into half and a quarter. Students took turns to group the counters before completing dividing a set counters into half and a quarter individually on their desk. After the practical hands-on activities students completed a worksheet as requested by the classroom teachers (figure 20).

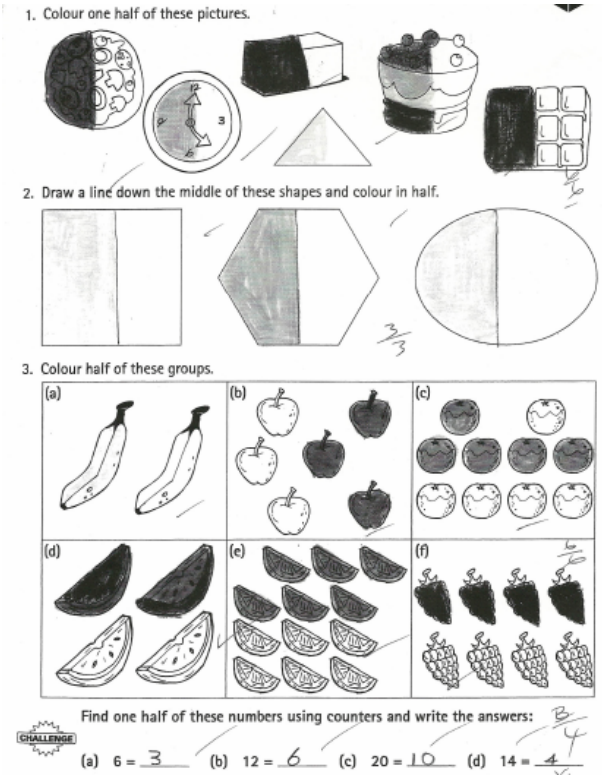


Figure 20. Halving worksheet: Leanne

In another lesson covering the concept of half required students to draw a shape on 1cm square grid paper, count the number of squares inside their shape and using either counters or pencil and paper as strategies find out half the number of squares within the shape. Although students enjoyed this activity their ability to rule straight lines even with the lined paper caused problems and resulted in incorrect answers.

Summary

The provision of an environment which provided a low student to teacher ratio was deemed to be a valuable component of the program. Reducing distractions and improving the classroom acoustics increased the potential for students to maximise learning opportunities. The longer length of the lessons provided time for repeated practice which promoted consolidation of new concepts and basic skills. Lessons were built around the students' level of understanding and new concepts added within their ZPD. This was achieved by merging the level of understanding demonstrated by students in pre-program assessments with phases of development in the First Steps Diagnostic Map. The content of each

lesson ensured students were active participants in mathematical lessons, which focused on including a multisensory approach based on Gardner's definition of multiple intelligences and incorporated direct instruction in combination with practical, hands-on activities. A journal recording the outcomes of each lesson, student behaviour and characteristics together with their numeracy achievement facilitated the creation of in-depth student profiles from which individual progress was measured.

CHAPTER FIVE

RESULTS

Introduction

One of the methods used to select participants for the support program involved all Year Two students completing the Diagnostic Mathematical Tasks 1 Assessment (DMT) (Schleiger & Gough, 2001). Repetition of the same test at the conclusion of the support program was used to ascertain the level of student improvement. Students also completed the Schedule for Early Number Assessment 1 (SENA) (NSW Department of Education, 2009) prior to beginning the support program and again at the conclusion of the program. A summary of the overall results of the DMT and SENA assessments prior to the implementation of the support program begins the chapter followed by a correlation of results of the two assessments. A comparison of the pre-program and the post-program results provide a focus from which selected students' progress and characteristics are discussed.

DMT Assessment Results

An analysis of the number of errors made by all students in the DMT accentuated the students who were demonstrating a lower level of mathematical understanding than their peers (figure 21).

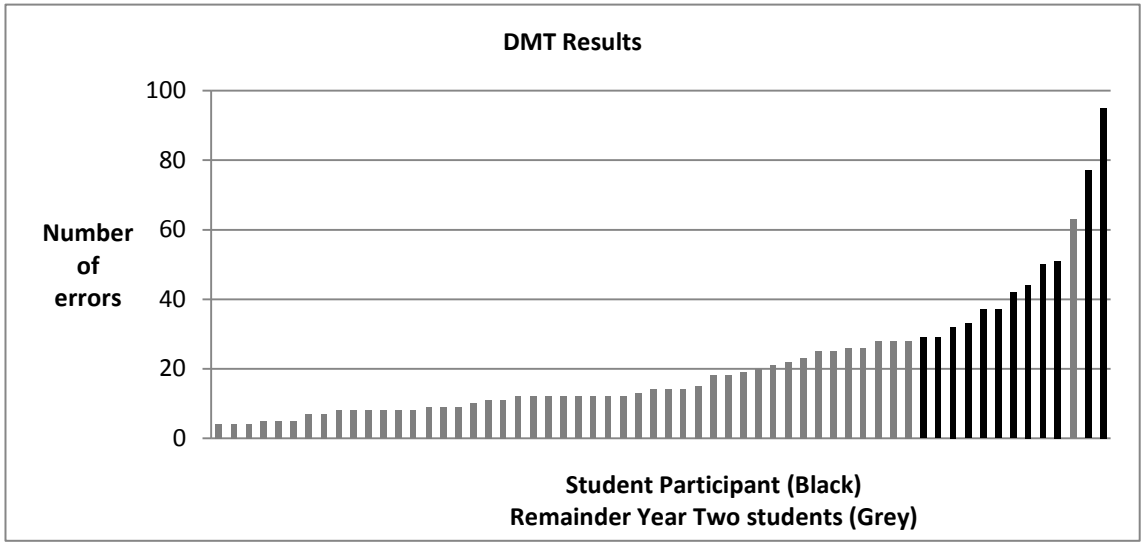


Figure 21. DMT: Year Two students number of errors

The average number of errors made by the whole Year Two cohort was 21. The 12 students who made the highest number of errors and were selected to participate in the program achieved an average of 46 errors in comparison to the remaining students who achieved an average of 13 errors. This indicated a considerable difference between the mathematical understanding of students selected to participate in the program and their peers. The number of errors of the students who participated in the program ranged between 29 and 95, and the remaining Year Two students between 4 and 38. Only two students selected for the program made less than 30 errors in the pre-program assessment.

The mathematical concepts of multiplication and division were the two concept areas in which students demonstrated the least understanding, where the skills assessed focused on the sharing and grouping of up to 12 objects. Addition and subtraction were the next two concept areas in order of difficulty experienced by the students and questions involved a combination of pictorial images and written equations to solve total, difference and more than problems involving numbers to 20 (figure 22).

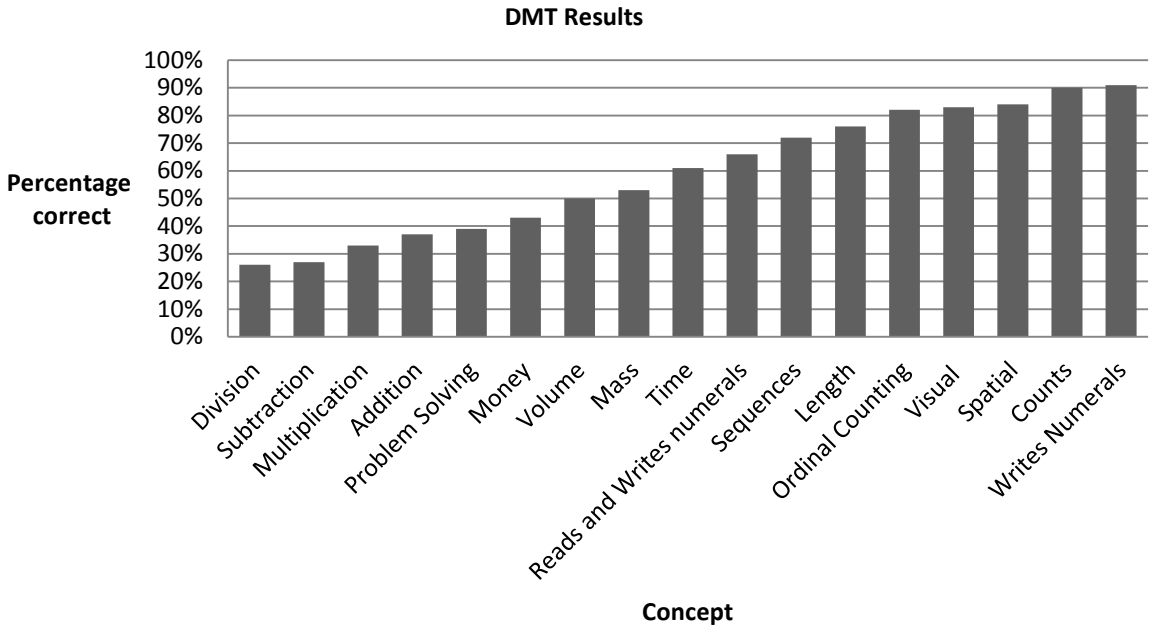


Figure 22. DMT: Participants' average achievement

Although money, mass, volume and problem solving were other concepts in which students demonstrated limited proficiency a prior knowledge of basic number skills is required in order to build higher levels of mathematical understanding. In the reading and writing of numbers section of the DMT, students were required to read words one to nineteen and write the matching numeral, correctly count and write how many in a group of up to 17 objects, and write the digits 12 through to 15 when read aloud by the teacher.

Low scores in the basic numeracy skill of reading and writing numbers to 20 and addition and subtraction indicated basic mathematical concepts had not been mastered by the students and needed to become a priority teaching focus in the support program. Basic numeracy skills are the foundation on which higher order skills are built and used to solve mathematical problems in all concept areas. It was evident that an improvement in the students' fundamental numeracy skills should lead to an improvement in their level of achievement in other concepts not specifically targeted during the support program.

SENA 1 Assessment Results

The individual interview format of the SENA assessment provided opportunities for observations of student behaviour as they answered each question. Common behaviours noted among the group of students included slow responses to questions with an accompanying lack of confidence to provide an answer or to have a go, instead saying "It's too hard" or "I don't know". A limited application of the counting on strategy was apparent with students selecting to recount all objects instead of counting on from the group of objects they had just counted when finding the total number of two groups of counters. Other observations made during the SENA interview which would not have been noticeable from the marking of the pen and paper DMT assessment included: mispronunciation of numbers such as reading and saying 15 as 50, and reading or writing numbers incorrectly for example reading 15 as 51 whilst knowing it was 15. Due to the interview style of the assessment student understanding was able to be clarified at the time the error was made and provided an indication of the cause of a student's mistake. Another difficulty observed was a limited ability of the students to physically manipulate objects systematically as

they counted and not matching the number recited with the object counted leading to errors in counting. SENA provided valuable additional information not available from the DMT, not only on what concepts students had difficulty with but why. Results of the SENA assessment indicated multiplication and division concepts were the areas in which students demonstrated the lowest level of understanding followed by subtraction. Students were not demonstrating consistency in the sequencing of numbers including number before or counting backwards and addition concepts.

Comparison between SENA and DMT

The DMT assessment covered a broader range of concepts than the SENA but both assessed basic numeracy skills and allowed a correlation to be made between the two sets of results. Utilising two forms of assessment provided students with an increased opportunity to demonstrate their understanding due to the wider variety of questions and allowed individual students' strengths and weaknesses to be determined with increased accuracy. Merging the results from the two assessments emphasised areas in which the majority of students were experiencing difficulty and provided information on the key skills to address in the support program. Mazzocco (2005) reported seriation, classification, procedural and conceptual counting, and magnitude comparison, skills have been found to successfully identify children experiencing mathematical difficulty. This was evident in the results of the pre-assessments in which the basic numeracy skills of reading and writing numbers; adding, subtracting and applying counting strategies; seriation and multiplication and division all found to be areas students experienced difficulty. Table 7 shows the correlation of concepts covered in both the DMT and SENA assessments in order of difficulty.

Table 7. Concepts in order of difficulty revealed by each assessment

DMT	SENA
Division	Multiplication and Division
Subtraction	Subtraction
Multiplication	Number Before
Addition	Sequencing
Reads and Writes numerals	Addition
Sequencing	Counting Backwards
Ordinal Counting	Subitising
Counting	Next Number
Writes Numerals	Counting
	Numeral Identification

Post-Program

DMT

At the conclusion of the program students demonstrated an overall improvement in all concepts assessed in the DMT. The largest gains were found to be in the basic numeracy skills which had been the main foci of the program: reading and writing of numbers, addition and subtraction, multiplication and division, and problem solving. These were the concept areas in which students had demonstrated the lowest level of understanding prior to the program (figure 23).

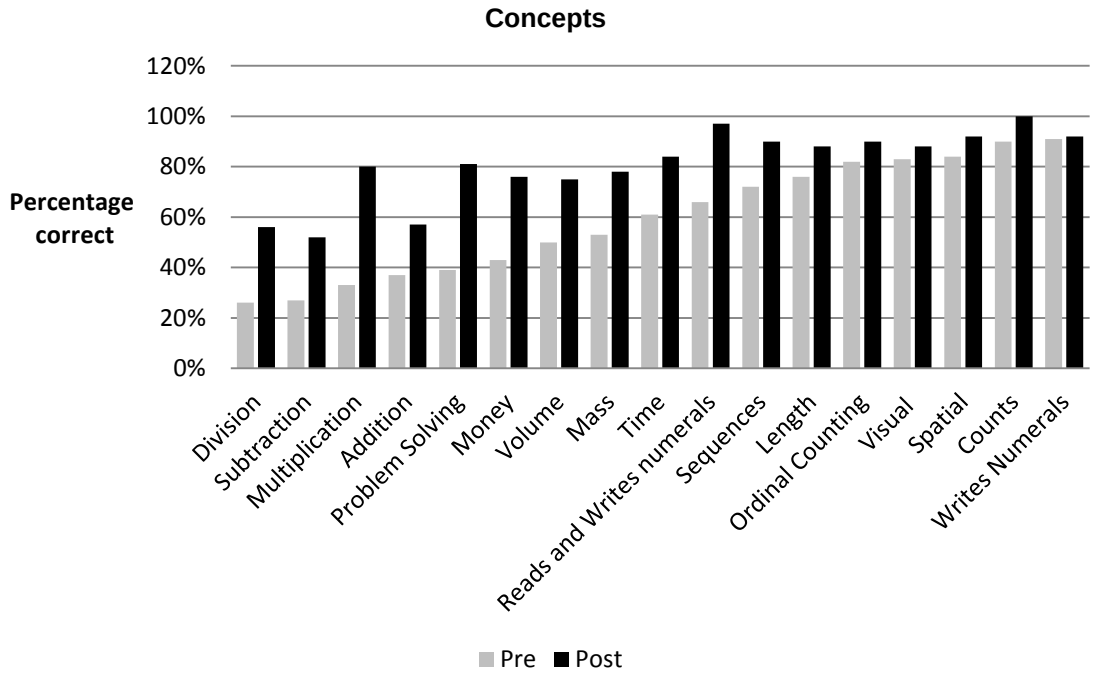


Figure 23. DMT: Concepts – percentage of correct answers pre and post program

In comparison to an average of 46 errors made in the DMT pre-assessment, the average number of errors in the post-program assessment was reduced to 18, which was lower than the average of 21 errors made by whole Year Two cohort in the pre-test (figure 24). At the conclusion of the program students who participated in the program demonstrated considerable improvement in their basic numeracy skills and were working at the achievement level of their peers 20 weeks earlier.

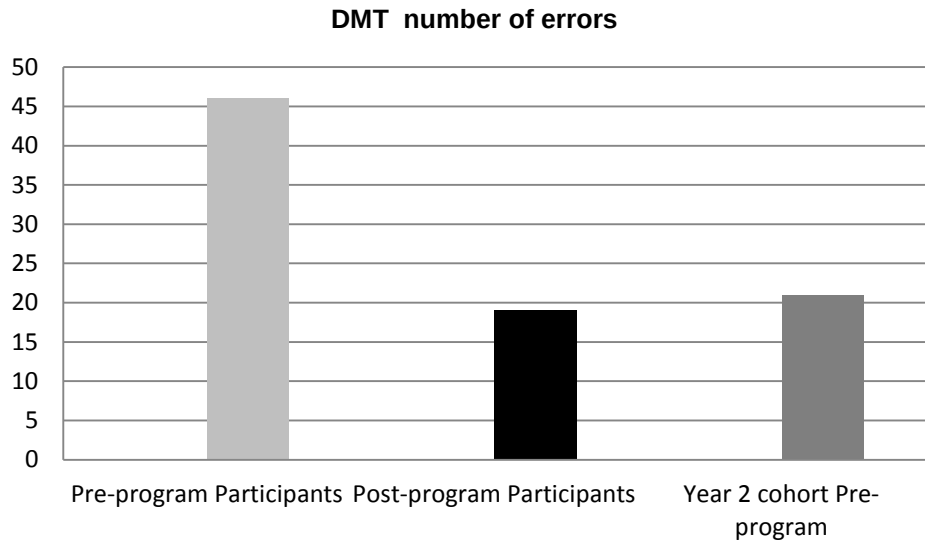


Figure 24. DMT: Number of errors pre and post program

SENA

Participating students' numeracy skills were reassessed at the conclusion of the support program using the SENA assessment with comparisons made between the pre and post scores to determine student progress. An analysis of results showed an improvement in all areas with addition, subtraction, multiplication and division, sequencing and number before, concepts in which students demonstrated the most improvement. These were the areas in which students had demonstrated the lowest levels of achievement in the pre-program assessment and were the concepts teaching predominately focused on during the 20 week program (figure 25).

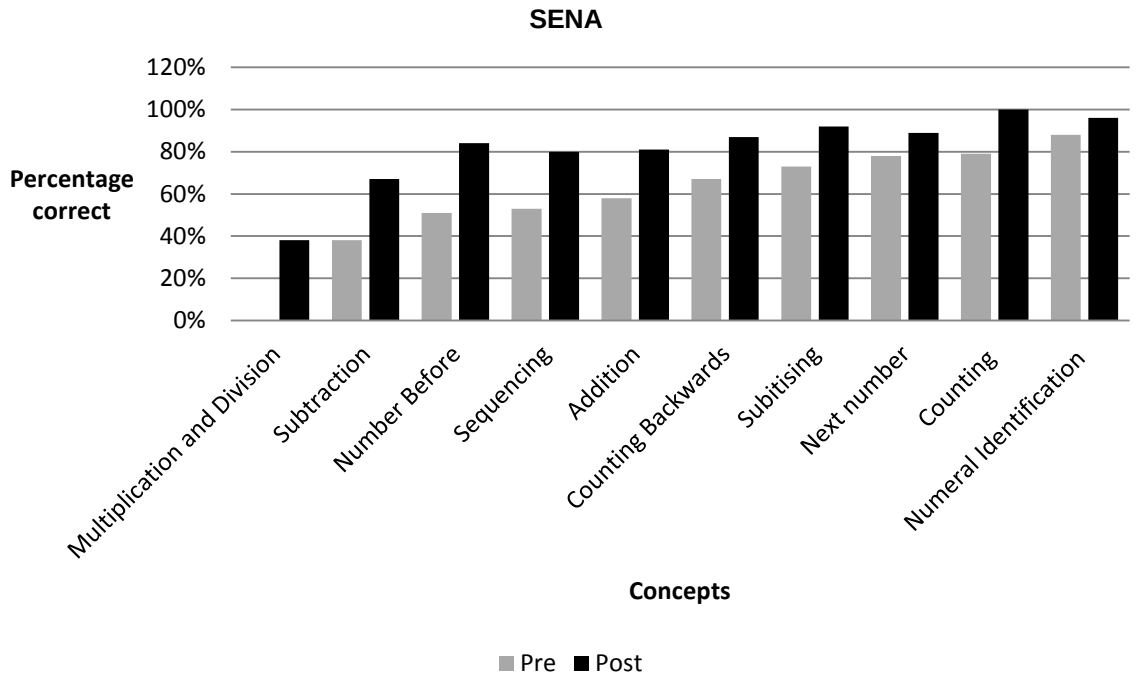


Figure 25. SENA: Concepts – percentage of correct answers pre and post program

Student Achievement

An improvement in numeracy understanding was demonstrated by all participants as evidenced in the DMT and SENA results recorded at the conclusion of the program. In both the DMT and SENA assessments the areas in which students made the most progress were the same areas in which students demonstrated the lowest levels of competence prior to the program. A review of the data collected from pre and post-assessments was undertaken to determine the students' individual progress (figure 26).

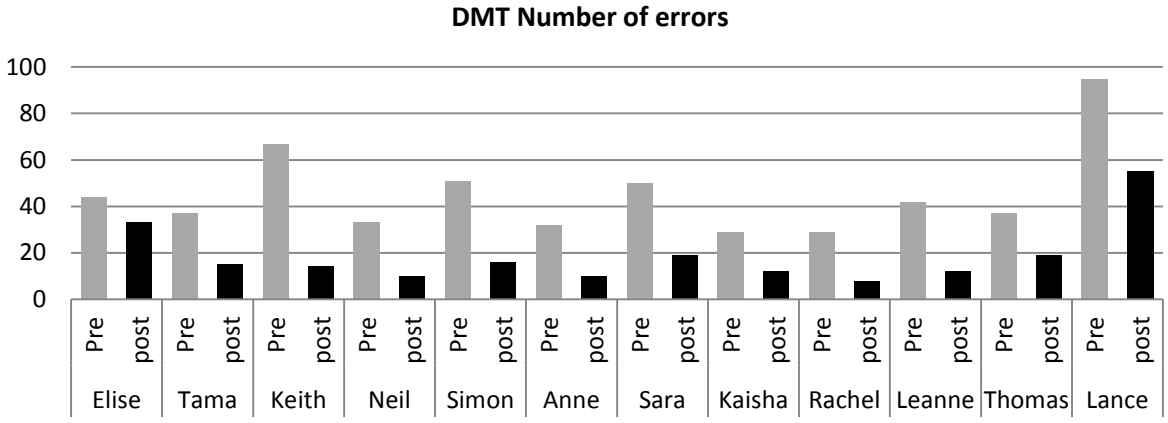


Figure 26. Comparison of pre and post DMT assessment results for individual students

A journal maintained throughout the study documented the learning journey of each student, recording their academic progress, behaviour and personal characteristics. The information collected was used to compile individual student profiles which were compared in a cross-case analysis to locate common elements from which inferences and conclusions were drawn.

Student Profiles

Three lowest scoring students: DMT pre-assessment

Lance

Lance's parents initially expressed apprehension about his hearing development at eight months of age and he experienced problems with glue ear during his early childhood. Results of 2008 PIPS testing indicated Lance was experiencing difficulty in both literacy and numeracy and concern was expressed by this Pre-primary teacher regarding his limited progress and level of development. This led to Lance being diagnosed with Dyspraxia after which he attended Speech and Occupational Therapy. Matthews (2006a) explained children with Developmental Motor Dyspraxia are clumsy due to their inability to exhibit spatial awareness and to coordinate body movements with messages from the brain. Lance was a very friendly boy and he conversed easily with adults, had excellent recall and could orally retell past events in detail but difficulty arose when tasks involved reading and writing. He was a member of both the literacy and numeracy support classes for Year Two students.

Prior to participating in the support program Lance became anxious when faced with a task he perceived as too difficult or challenging and he would automatically state, "I can't," when asked a mathematical question or to complete a written activity. It was particularly stressful for him when he could see his peers already working independently or quietly. During these times Lance required direct one to one assistance or alternatively he found he was able to concentrate more and with less anxiety when seated away from the other students. When Lance began to recognise his own developing stress levels he would request to move himself away from other students.

Lance frequently complained of tiredness and had difficulty maintaining an appropriate posture when seated. His awareness of the space around him was low and he frequently moved into others' personal space spreading himself across more than his half of a shared desk. Lance was extremely disorganised and constantly dropped or misplaced his equipment and during these times his behaviour was disruptive to other students particularly those seated in close proximity to him. These behaviours which resulted from dyspraxia inhibited his ability to focus on set tasks which required even small periods of concentration. Although Lance continued to experience anxiety attacks during the support program the level and frequency of these were reduced and only developed when tasks involved pre-made worksheet activities. Lance was observed participating fully and showing enjoyment during the mathematics lessons when he worked in a small group and his peers were able to assist him.

Lance had the habit of frequently 'thinking aloud' and although this was discouraged in a classroom due to the distraction it caused other children it was welcomed in the support room. Lance was able to hear others being encouraged to do the same as they participated in a variety of activities and this appeared to have a positive effect on his level of self confidence. Lance was able to maintain his level of concentration for longer periods of time when he was thinking aloud. Lance tried his best at all times and the small successes he experienced gradually built his confidence which eventually led to a willingness to have a go and answer questions, whether he knew the answer or not. Lance reversed the digits writing 51 for 15 and had difficulty pronouncing the teen numbers saying 50 when he meant 15. His basic numeracy skills improved throughout the support period, but he remained reliant on the use of concrete objects because abstract ideas were too challenging. Lance's thought processes were slower than his peers and he was often left behind during class discussions. Deliberate attempts to involve him in whole group discussions were needed to ensure he was included and participated as much as possible. When students worked in pairs the choice of a suitable partner needed to be taken into consideration if the students were to work together successfully.

Results of the DMT assessment held prior to the start of the program indicated Lance experienced difficulty in most mathematical concepts including sequencing, reading and writing numbers 1 to 20, addition, subtraction, multiplication, division, ordinal counting, time, volume and capacity, visual representation and problem solving. Lance's 95 errors was the highest number of errors of all the Year Two students.

Lance's results in the post-program DMT demonstrated his improvement in basic numeracy skills particularly in ordinal counting, reading, writing and sequencing numbers. During completion of the SENA assessment at the conclusion of the program Lance's level of confidence was high. He enthusiastically provided answers and stated, "This is fun," which is something he was never heard to say prior to the program. Lance had difficulty reading the teen numbers and although he was fast counting forwards he could not count beyond 109. Lance fluently counted backwards from 10 but he was unable to count backwards from 23 and became confused when he needed to state the number that came before a given number. Lance made errors in the counting, addition and subtraction sections but he gave answers fluently and with confidence. He was only one number out in some of his answers and although incorrect was close and demonstrated he had gained an understanding of what to do and the process involved. These attributes are unable to be measured in a pencil and paper test and highlighted the value of individual interview assessments. In the DMT assessment Lance made 55 errors in the post-assessment compared to 95 in the pre-assessment. In the SENA assessment Lance achieved mastered 3 of the concepts and in the final assessment 6.

During the course of the program Lance became anxious when faced with a worksheet which required the completion of before and after questions. He stated, "I can't do it!" before he had attempted any questions, automatically reacting negatively as soon as he saw the worksheet (figure 27).

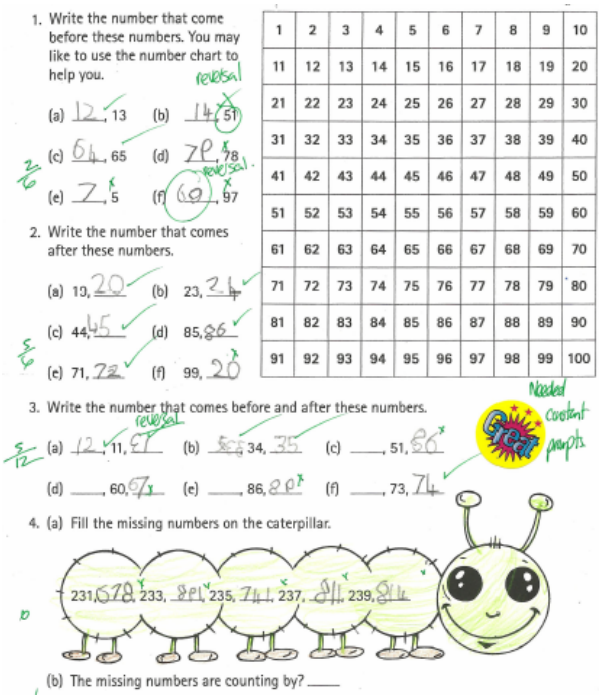


Figure 27. Before and after worksheet: Lance

Encouragement and support were given by helping Lance focus on completing one answer at a time and view only one line at a time. He was encouraged to recognise patterns himself rather than be told the answer or allowed to give up. A blank sheet of paper was used to cover up all questions other than the line he was currently working on and he was provided with a high level of support and encouraged to take small steps. Lance was able to complete the activity and his anxiety was immediately lowered due to the altered visual image. The high level of support was able to be provided in the small group setting but it is understandably much more difficult to accomplish in a mainstream classroom due to the higher student to teacher ratio.

Keith

Keith began at the school in 2009 as a Year One student and therefore did not participate in the PIPS assessments held in 2008. He came from a non-English speaking background, had low level literacy skills and demonstrated problems with reading, writing and comprehension. Keith demonstrated difficulty concentrating and easily became involved in off task behaviour. He did not speak clearly or participate in classroom discussions and constantly required prompting to provide more than a one word answer or shoulder shrug. Keith

needed to be encouraged to speak audibly and clearly in order for others to hear him as he tended to mumble or not speak at all. Keith demonstrated more confidence in numeracy than literacy and although his results in the numeracy assessments indicated low level skills he showed an enjoyment of and enthusiasm for mathematics. Keith had a good pencil grip and excellent fine motor skills which enabled him to participate fully in lessons using his strengths when provided with opportunities. Keith was a member of both the Year Two literacy and numeracy support programs.

Keith frequently displayed inappropriate classroom behaviours, such as sitting awkwardly on his chair constantly moving, fiddling with pencils and wriggling and he was unable to maintain his focus on task for long without reminders to listen or participate. Although he enjoyed the mathematical games he tended to become over excited such as throwing dice much further than needed. Keith was quick to gain an understanding of the concept of reoccurring digits and completed the number grid into the 200s. He was able to apply the counting on strategy however after identifying the larger number he used his fingers to count on.

Results of the DMT assessment held prior to the program indicated sequencing, reading and writing numbers 1 to 20, addition, subtraction, multiplication and division, ordinal counting, time, volume and capacity, visual representation and problem solving were all areas in which Keith demonstrated limited understanding. In the pre-program DMT assessment Keith made 67 errors and in the final assessment he made 14 demonstrating considerable improvement in numeracy understanding across the range of concepts assessed. Although Keith made the second highest number of errors in the DMT pre-assessment he was the student who showed the most improvement.

During the SENA interview Keith was restless, did not sit still and constantly wriggled in his seat. He was slow to state the numbers that come before and after a given number but when completing addition and subtraction problems he was very quick to provide the correct answer. Keith recorded one of the lowest number of errors in both the pre and post SENA assessments which was in

contrast to his DMT assessment. The individual interview format of the SENA assessment which required limited reading and writing skills suited Keith and he was able to demonstrate higher numeracy knowledge orally.

Keith's limited literacy skills hindered his ability to complete pre-made worksheets as he required all questions to be read to him and due to his limited recall he needed constant support because he was unable to complete written activities independently. During lessons that required completing pre-made worksheets with any form of instructions in written text Keith needed to wait for assistance so the text could be read to him which even in a small group of 12 students was frustrating for him. When the instructions or questions were longer than one step Keith had difficulty, however when the instructions were easily followed Keith completed activities independently. Games and activities which required no reading of text enabled Keith to participate fully and demonstrate his numeracy understanding and participate fully with his peers (figure 28). Keith demonstrated his improved numeracy skills by progressing from 11th position in the DMT assessment held prior to the program to equal 5th place. The focus on numeracy skills in combination with reduced literacy demands enabled Keith to participate fully in mathematics lessons and limited off task behaviour.

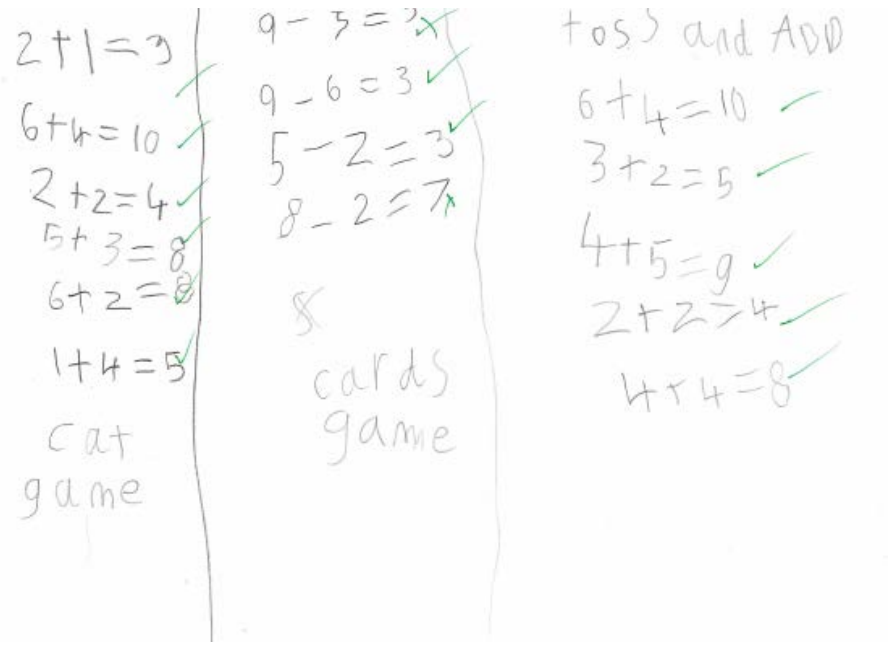


Figure 28. Games, number sentences: Keith

Simon

Simon was assessed by the school psychologist in May after his classroom teacher had expressed her concern to his parents regarding his difficulty concentrating. Simon had a very low level of work output and the quality of his written work lacked legibility and basic conventions of print such as size, shape and spacing of letters. Results of the professional assessment indicated Simon possessed an average cognitive ability and strength in visual spatial manipulation, his processing speed was strong but verbal comprehension weak for his age. The outcome of further professional assessments recommended by the school psychologist resulted in Simon being diagnosed with Irlen Syndrome, a visual perception problem affecting his reading and learning causing eye strain, frowning and the need to move printed text close to his eyes.

Simon was a small boy for his age, the youngest student in his class and a member of both the Year Two numeracy and literacy support groups. Simon was constantly very restless preferring to perch inappropriately on his chair and he found it difficult to remain focused for any length of time. Printing and handwriting were laborious and tiring activities for Simon resulting in him having difficulty putting his thoughts on paper or copying accurately, particularly if time limits were set. However when the pen and paper work involved diagrams and not words Simon participated enthusiastically and managed to complete tasks.

Simon displayed immature behaviours frequently calling out to tell completely random stories during classroom lessons, providing further evidence of his off task daydreaming thoughts and lack of focus on the topic. During the times when Simon lost concentration he was not a distraction to others but he needed a review of what he was supposed to be doing to refresh his thoughts in order for him to continue on with the set task. Simon was able to maintain a higher level of focus during hands-on activities such as games and measuring tasks.

Although Simon was a quiet student who was frequently off task he willingly attempted all tasks and accepted assistance from the teacher and his peers but he never actively sought help of his own accord. Simon demonstrated a preference for visual learning and needed to be encouraged to speak and to

participate verbally in small group and whole class lessons. He seldom completed written activities without extra time or continuous prompts and required high levels of supervision, however when he participated in an activity he enjoyed or one that provided him with an opportunity to apply his own creativity he did not require any prompting. When working with the Cuisenaire rods Simon was quick to recognise the repeated pattern, “It’s a pattern,” he stated eagerly as the reverse side was built up (Journal, Appendix F). Simon demonstrated a high level of concentration and was able to maintain focus for greater periods of time when he enjoyed the lesson content and was able to draw illustrations and orally explain his understanding (figure 29).

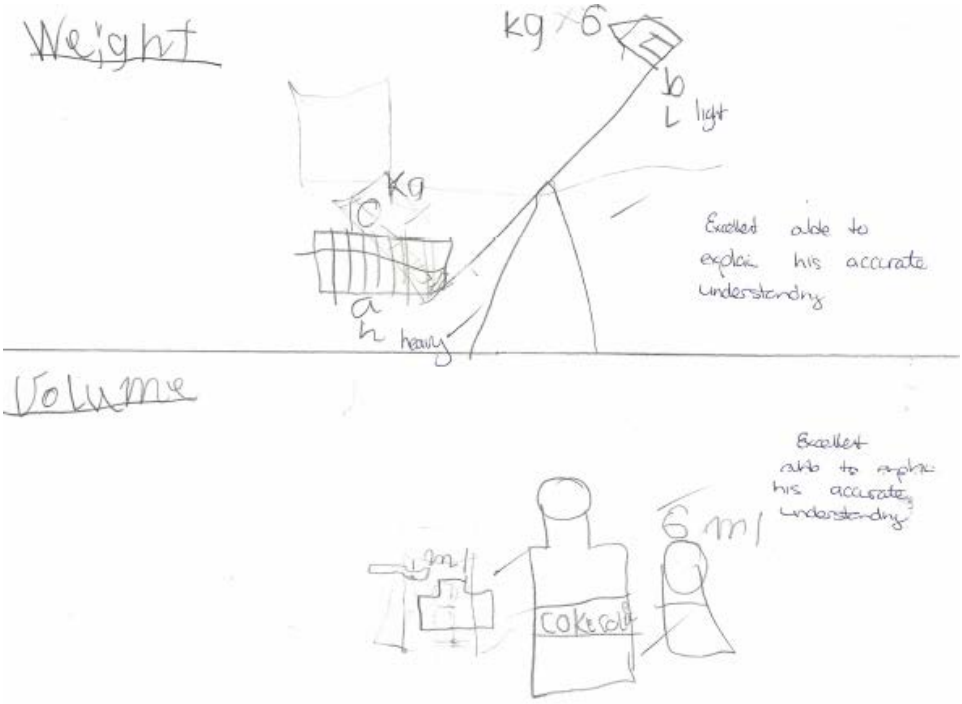


Figure 29. Recording measurement activities: Simon

In the first DMT assessment Simon had the most difficulty in the concepts of money, reading and writing numbers, addition, subtraction, multiplication and division. He was competent in the areas of counting, length and visual and spatial concepts. Results of assessments held at the end of the program indicated that Simon had improved in all areas particularly reading and writing of numbers, money and multiplication. He increased his understanding of addition and subtraction but still did not demonstrate a sound level of

confidence. Simon made 51 errors in the first DMT assessment held prior to the start of the program and in the final assessment only 16 errors suggesting considerable growth in his understanding of the numeracy concepts with which he had struggled previously.

During the SENA assessment it was observed that Simon's counting speed was slow and he was extremely hesitant when counting forward particularly beyond 109 although he was able to successfully do this. Simon found counting backwards easy and was faster at stating the number that came before a given number than stating the number that came after a given number. He was very fast at manipulating the counters into groups during the multiplication and division problems demonstrating a high level of confidence when working with objects he could touch.

Simon correctly answered all ten sections of the assessment an improvement on the first assessment when he achieved only three correct sections. During one lesson students were asked to draw a race following a given set of instructions to place coloured ordinal positions. Students drew their race with the starting line reversed to that demonstrated on the whiteboard which was interesting as they produced work from their perspective and did not rely on copying. Simon's drawing was even more unusual as he drew his cars lined up in two rows. I had assumed students would draw one line as had been demonstrated in all previous examples with ordinal numbers. When questioned about why he had drawn his two lines of cars he replied; "You see cars lined up to race like this, in rows" (figure 30). Simon applied these to his already developed view of the world when learning new mathematical concepts.

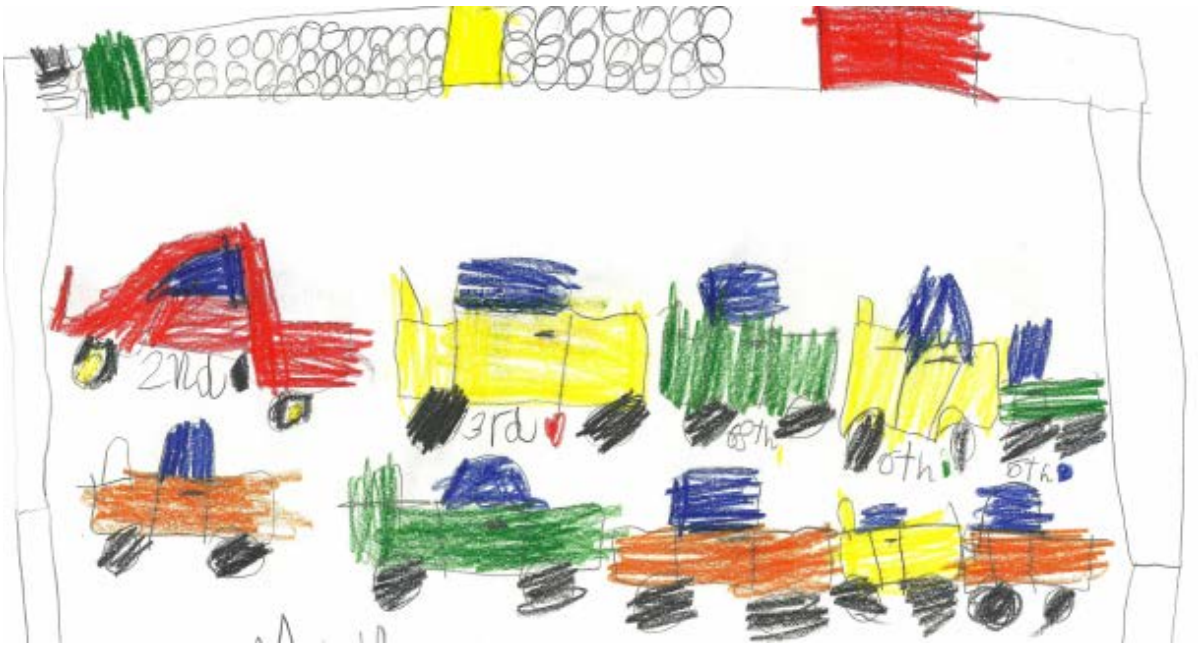


Figure 30. Car race: Simon

When interviewed at the conclusion of the program Simon observed he enjoyed being a member of the mathematics support group and stated he liked playing games the best. Simon believed he was able to work better in the smaller room because it was quieter and he was confident that he had improved his numeracy skills at the conclusion of the program.

Three highest scoring students: DMT pre-assessment

Kaisha

Kaisha experienced difficulty in both literacy and numeracy and was a member of both the Year Two numeracy and literacy support groups. She was well behaved and able to maintain focus on her work and completed set activities in the allocated time. Kaisha however, had difficulty interacting with her peers as she tended to be bossy and appeared to be unaware of how her behaviour affected her ability to make and maintain good relationships with her peers. During small group activities Kaisha attempted to dominate others in her group and had a difficult time being a member of a team preferring to work independently.

Results of PIPS assessments in 2008 indicated Kaisha had difficulty in literacy but her numeracy understanding was not a concern. Kaisha was a member of both the literacy and numeracy support programs for Year Two students having been assessed as at risk in 2010. Kaisha tried hard and enjoyed the hands-on activities and games, although she found interacting in a group difficult. Kaisha was very quiet and needed to be encouraged to talk aloud when applying the mathematical concepts which made it more difficult to follow her thought process and understanding in comparison to the other students in the group.

Kashia scored one of the higher marks in the DMT assessment of the students selected for the program and at the completion of the program her results showed improvements in most concepts. Her largest gains were in the areas of reading and writing numbers, addition and problem solving but her score in division and time was lower than in the pre-test and remained the same in volume. The concept areas in which Kaisha demonstrated an improvement were those focused on during the course of the program and the concepts in which she did not improve had not been specifically taught.

At the beginning of the program Kaisha's results in the SENA assessment indicated she was unable to count beyond 109 but she was very quick at counting backwards and stating the number that came before or after a given number. In the assessment completed at the conclusion of the program Kaisha had only one incorrect section and she had improved in the concepts of numeral identification, sequencing, counting backwards, number before, subitising, addition, subtraction, and multiplication and division.

When interviewed following the program Kaisha said she enjoyed being a part of the support group and thought using counters was the best part. She said mathematics in the mainstream class was harder than in the support class because in the Year Two classroom counters were not used. She commented on the difference in noise level between the two classrooms with the support room not as noisy as the Year Two classroom. Kaisha believed she was much better at maths at the end of the program than she was at the beginning.

Rachel

Rachel was a student of African heritage and English was her second language. Although she had an excellent use of spoken language her reading and comprehension were of a lower standard than the majority of Year Two students. Rachel's difficulty in both literacy and numeracy were identified following the PIPS assessment in 2008 and her at-risk status was maintained in 2010 when she was a member of the Year Two literacy and numeracy support programs. Rachel had a friendly personality and she was popular with her peers. Rachel was an enthusiastic participant in all lessons and an excellent worker who was proud of her effort; however she demonstrated a low level of confidence and constantly sought reassurance. Rachel had a need to have the correct answer and was reluctant to make an attempt without knowing that her answers would be correct. Rachel never hesitated to assist or encourage others and she was equally effective as a group leader or member. Although Rachel lacked confidence she always attempted tasks, and her willingness to seek clarification and assistance was a good model for her peers. Rachel was right-handed, used a correct pencil grip and presented neat written work.

Results of the DMT assessment held prior to the support program indicated Rachel's areas of limited numeracy understanding were the concepts of sequencing, reading and writing numbers 1 to 20, addition, subtraction, multiplication, division, ordinal counting, time, volume and capacity, visual representation and problem solving. In the results of the post-program DMT assessment Rachel demonstrated competence in most areas excluding addition with the number of errors in this concept remaining the same as in the initial assessment. The concepts of multiplication, division, addition, counting backward and forward were concepts Rachel had not mastered in the SENA assessment prior to the support program but in the post-program assessment Rachel demonstrated her competence in all areas.

When interviewed at the conclusion of the program Rachel stated she enjoyed being a member of the numeracy support group and liked free play and free drawing the best. Rachel stated she liked working in the quieter environment of the support room with easier work. Rachel believed she was much better at

mathematics at the end of the program than she had been previously and that she now enjoyed mathematics lessons.

Anne

Anne was of Asian descent with English as her second language. Both her literacy and numeracy skills were recognised as weak in the 2008 PIPS assessment and again in 2010 when Anne was a member of the both the Year Two literacy and numeracy support programs. Although Anne tried her best at all times was well behaved and positive she did not converse easily and frequently failed to gain understanding even after additional one to one assistance.

Anne was a serious girl. She was very well mannered and although she generally remained on task she often did not participate fully preferring to sit back and watch others. Anne pressed very hard with her pencil and produced large print resulting in written text being quite an effort for her and she seldom completed written activities. Anne was slow at processing her thoughts and in line with her written work her speech was also slow. She performed better when completing pre-made worksheets than she did when creating her own examples due to the time needed for her to write and draw illustrations (figure 31). This difference noted between the students highlighted the importance of allowing students to demonstrate their understanding orally and not to rely on worksheets marked after the lessons are completed.

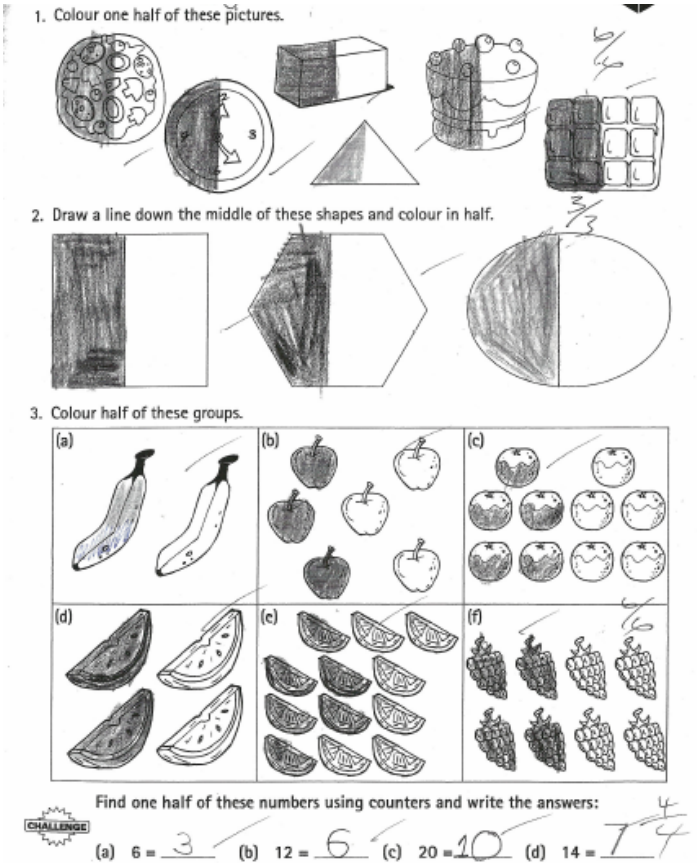


Figure 31 Halving worksheet: Anne

Anne improved in the areas of reading and writing of numbers, addition and subtraction all concepts which were a focus throughout the support program. She made considerable progress in both time and multiplication but she did not achieve as well in the second assessment in the areas of ordinal numbers, division and area.

In the initial SENA assessment Anne misread 20 for 12 and was unable to count above 109. She was very confident when providing both the next number and the number that came before a given number; however she was slow counting backwards from 23. Anne made only one error in the subtraction section and was confident sorting counters into groups. In the SENA assessment held at the conclusion to the program Anne demonstrated her improvement in the areas of number sequencing, both before and after, counting, subtraction, multiplication and division but was still not able to demonstrate an understanding of forward counting beyond 109.

Anne always tried hard but required the use of resources she could physically manipulate to solve problems. She demonstrated difficulty understanding abstract problems and in activities which involved participating in whole group discussions. Anne showed a strong preference for lessons which involved visual stimuli and manipulative objects. During game playing when students applied their counting on and counting back skills Anne appeared to begin to develop an understanding and applied strategies successfully although she remained a very quiet participant, preferring to watch and was reluctant to verbalise.

When interviewed at the conclusion of the support program Anne stated she enjoyed mathematics and liked being part of the support group and the part she liked the most was being able to count in a variety of ways. She said she learned about the many different signs used in mathematics and that the biggest distinction between the Year Two classroom and the support room was the quietness of the support room. Anne believed she was much better at mathematics at the end of the program compared to at the beginning.

Other Students

Elise

Elise was a happy girl who enjoyed participating in all the activities. She was popular with her peers and although she struggled academically in literacy and numeracy she was very talented musically. At least once each week Elise left the classroom for a violin lesson however on her return she settled back into the activities quickly without creating any fuss and completed all tasks willingly. Elise always appeared to listen to instructions, be on task and to understand the concepts covered in each of the lessons when these were discussed prior to students completing tasks independently. Evidence gained from marking her work showed Elise had not understood and the causes of her misunderstanding were not obvious as her errors were inconsistent. Extra help was provided to reduce the difficulty she had following instructions and she was encouraged to repeat the instructions in her own words. Elise did not seek help or volunteer to contribute during group discussions, however she would join in when called upon and worked well with a partner or in small group activities.

Elise was experiencing difficulty in all academic areas in the Year Two classroom and because of the effort she made in comparison to the outcomes achieved Elise was recommended for further assessment by professionals outside the school environment. During the course of the support program Elise was diagnosed with dyslexia which helped explain her ability to participate in the hands-on, practical activities in the classroom and the lower or inconsistent results demonstrated in the written activities and assessments. Elise was left-handed and the size, spacing and shape of her written characters indicated a difficulty with spacial awareness. She had to put extra effort into her writing to improve the legibility but she still found explaining or reading back her own work a challenge, particularly if not attempted straight away (figure 32).

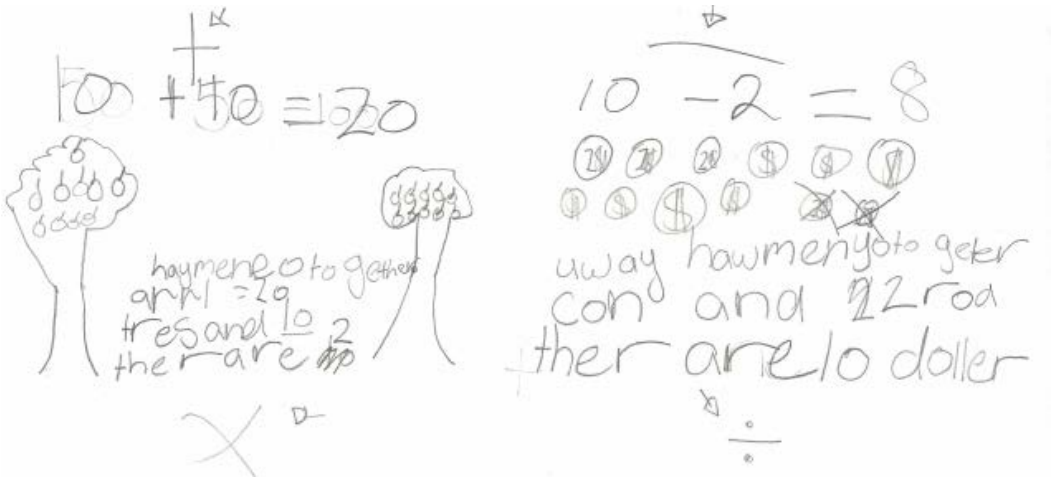


Figure 32. Number stories: Elise

Elise was the student with the lowest level of improvement in both the DMT and SENA assessments. Although Elise demonstrated a small improvement in the DMT concepts of sequencing, reading and writing numbers, subtraction and multiplication, her largest increases were in the areas money and mass which were not focused on in the program. Elise achieved higher scores in her original DMT assessment in the areas of ordinal counting, measurement, visual and division and in the remaining concepts she neither made an improvement or a regression.

In the post-program SENA assessment Elise improved in the areas of sequencing, number before, addition and multiplication and as with the results

of her DMT assessment Elise's results in the SENA were lower in the areas of next number, and counting backwards. She also made no improvement in the concepts of numeral identification, subitising, and counting but her addition skills improved across both the assessments. Elise improved her marks in the SENA multiplication tasks although this was reversed in the DMT assessment. In the SENA assessment held prior to the support group Elise counted in sequence to 109 but then jumped to 1000. She did not use a counting on strategy when adding one group of counters to another group she had just counted. Instead, she returned to one and counted all. Elise had difficulty stating what number came before and after a given number. At the conclusion of the program Elise was still unable to count beyond 109 and remained confused with the number that comes before a given number but she was able to count backwards with fluency. Elise was able to complete the addition problems and counting activities successfully and was beginning to apply the counting on strategy but she could not count on or back when completing subtraction problems.

When interviewed at the conclusion of the support program Elise said she enjoyed being part of the numeracy support group. Elise said the biggest difference she noticed between mathematics lessons in the mainstream classroom and in the support program was "Miss C (classroom teacher) tells us the answers but Mrs H doesn't, she lets us figure it out". Elise believed she was better at mathematics at the end of the program.

Neil

Neil was selected to be a member of the numeracy support group but he was not a member of the literacy support group for Year Two students. Neil was acknowledged as experiencing difficulty in both reading and mathematics in the 2008 PIPS assessment. Although one of the weaker students in numeracy from the Year Two cohort he did show strengths in some areas and at first was not considered to be a priority for placement in the support program.

In the Year Two classroom Neil's behaviour had caused concern as he frequently lost concentration and did not complete tasks he was believed

capable of finishing. Neil was a friendly happy student who was popular with his peers, well behaved and well organised. He was right handed and had a correct pencil grip. Neil was able to complete most tasks set during the intervention program.

Neil improved from having the fourth lowest number of errors in the DMT pre-assessment to the second lowest in the post-assessment. When interviewed followed the conclusion of the intervention program Neil stated he liked free drawing activities most and maths was sometimes more difficult in the mainstream class. He believed he was much better at mathematics than he had been prior to the program.

Summary

All students recorded improvements in their numeracy skills over the 20 week program, this was demonstrated in their application of basic numeracy skills shown in both the SENA oral assessment and the DMT written assessment. Elise was the only student who had limited levels of improvement in comparison to her peers. Fletcher, Denton and Francis (2005) suggested unexpected underachievement may indicate an inability to learn from instruction that is effective for most students. Therefore, although the majority of participants improved their numeracy skills, Elise's results could signify a need for a different type, a greater intensity or longer duration intervention.

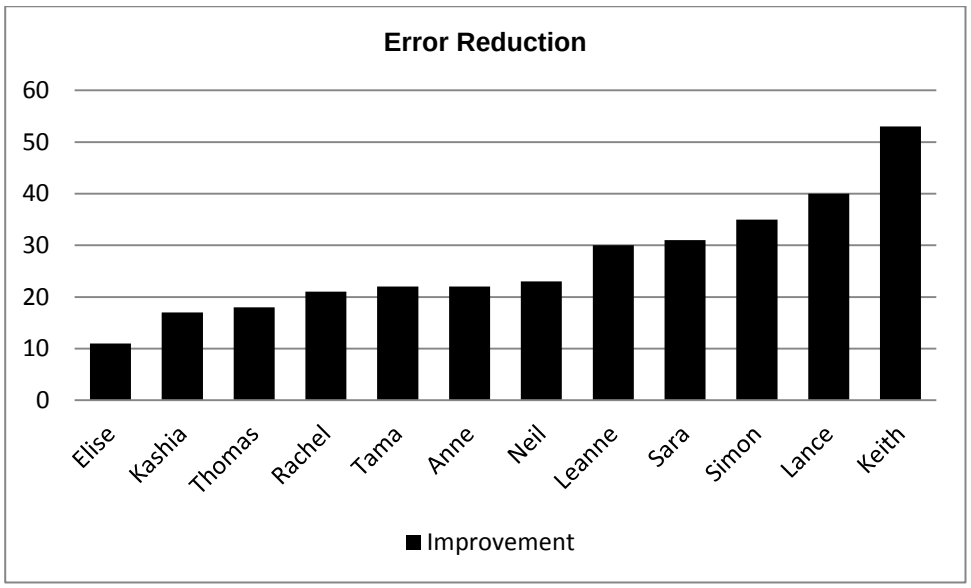


Figure 33. DMT: Reduction in number of errors

The activities in the program were designed to support numeracy concepts and strategies in addition and subtraction and the reading and writing of numbers with multiplication and division introduced using the process of grouping and sharing objects. Results of the post-program DMT assessment indicated an improvement in all the areas assessed with the concepts in which the students demonstrated the most progress were reading and writing of numbers, multiplication, division, money, time and clocks and problem solving. Although money and time were not specifically taught in the numeracy support program as anticipated students' improved basic numeracy skills enhanced their skills other areas of mathematics.

CHAPTER SIX

DISCUSSION OF RESULTS

Introduction

An analysis of the pre and post-program diagnostic assessments examines the impact the support of the program had on the students' numeracy skills. The progress of the three students who demonstrated the lowest numeracy understanding in the pre-assessment together with the three students who were the highest performers is appraised. As recommended by Hong and Enrensberg (2007) both formal and informal methods of assessment were adopted to create student profiles from which information was compared in order to evaluate student progress. The effect the many features incorporated into the program had on the students' academic achievement and their attitudes towards mathematics are gauged. These features included the numeracy concepts, environmental features, behaviour, learning difficulties and disabilities.

Diagnostic Assessments

The accuracy of the Diagnostic Mathematical Task (DMT) assessment in the identification of students at risk in numeracy and their areas of difficulty was supported by the outcomes of the Schedule for Early Numbers Assessment (SENA). Observations made during the verbal SENA assessment revealed information about how students answered the questions rather than relying on written answers provided in the DMT. A lack of confidence in their own mathematical ability was demonstrated by the students with responses given such as "Don't know", or "It's too hard" instead of attempting to provide an answer. These comments made by the students supported finding of Torbeyns, Verschaffel and Ghesquiere (2004) who reported a cause of students' inability to solve problems stems from a limited knowledge of strategies to apply.

The DMT assessment proved to be a reliable diagnostic test with all students identified as at risk previously being identified by the PIPS assessment in 2008. Herman and Baker (2005) recommended the use of diagnostic assessments to plan appropriate programs for students and the results of both DMT and SENA enabled the support program to be planned around the students' level of

mathematical development. In a written DMT assessment the students knew they could select an answer from one of the choices provided, but in the spoken SENA assessment a lack of understanding resulted in the student not knowing what to say. The SENA assessment utilised hands-on activities students were accustomed to participating in during routine classroom lessons and therefore rendered a realistic appraisal of their ability.

The correlation of the DMT and SENA assessments contributed information on each individual student's numeracy strengths and weaknesses and defined where teaching should begin in order to commence at the students' current level of understanding and stage of mathematical development. Powell and Kalina (2009) recommended locating each student's Zone of Proximal Development (ZPD) in order to maximise student learning. Lessons were based on the findings and enabled the establishment of an environment that optimised learning opportunities for the participating students.

Students were guided through scaffolded lessons advancing from their current level of understanding to the next. A selection of games allowed for repeated practice of the fundamental concepts of addition, subtraction, multiplication and division. Repeated practice to assist students develop their working memory was promoted by McGlaughlin, Knoop and Holliday (2005) as an important feature of numeracy support programs. This method of teaching had a positive effect on student achievement with the students demonstrating higher levels of numeracy understanding at the conclusion of the program.

Learning Environment

Doll, Spies, LeClair, Kurien and Foley (2010) suggested features which affect student academic performance include a supportive environment, the degree of autonomy and student self belief. Pianta and Stuhlman (2004) deemed the relationship developed between students and the teacher directly influenced students' behaviour. The students who participated in the intervention enjoyed being members of the support group, eagerly attended lessons and expressed their disappointment when classes did not take place. During the individual interviews held at the conclusion of the program Thomas, Rachel, Kaisha,

Anne, Elise and Sara stated they liked being a member of the support group and believed they had improved their numeracy skills. Simon, Lance and Neil were very confident they were much better at mathematics after the program and also enjoyed being members of the small group. Keith said he loved being in the small support group where the work was easy and he was decisive he was much better at the end of the program than he had been previously. Although they both demonstrated an improvement in their numeracy skills said they enjoyed participating in the program Tama and Leanne did not consider themselves any better at mathematics following their participation in the lessons. The students in the support group had the same learning difficulties throughout the program with the environment and program content being the influencing factors on student achievement. Results of the intervention concur with the findings of Cuttance (1998) that the external environmental influenced student achievement more than internal factors.

Lesson Content

To foster involvement and academic performance the students were encouraged to speak aloud while they participated in activities. These features are advocated by Choi and McPherson (2005) who contended that speaking while learning has a positive effect on numeracy achievement. At first some students were reluctant to apply this method but most quickly incorporated this strategy into their activities. One exception was Kaisha; she did not easily take part in group exercises and she did not achieve the improvement levels of the other students. In contrast Elise was an enthusiastic participant who actively contributed fully in all lessons but she made the lowest improvement between her pre and post-assessments.

Sherman, Richardson and Yard (2005) expressed their surmise that the content of mathematics lessons for students at risk should ultimately be aimed at their current level of understanding and Ketterlin-Geller Chard and Fien (2008) encouraged the use of scaffolding experiences in intervention programs to equip students for success. Incorporating these strategies into the program with the content of lessons specific to the students' needs and not merely a

modification of the classroom program resulted in all participants successfully improving their mathematical understanding.

A dislike of pages of text or numbers resulted in an immediate negative “Can’t do it” reaction from Lance. His anxiety prevented any positive action or behaviour without individual adult intervention. Lance found tasks more challenging than his peers and his slow processing speed hindered his ability to complete tasks even when he was provided with individual assistance. No other students in the group exhibited anxiety during mathematics lessons although they did experience difficulty with the reading text in worksheets. Regardless of their ability students completed written tasks and activities to the best of their ability applying a range of strategies including asking a peer or teacher for assistance. Compared to early stages in the program when Lance displayed a dislike of written text both words and numerals he demonstrated increased confidence during assessments held after the 20 week period. Although he did not always select the correct answers he believed he had and stated ‘This is easy’ signifying his attitude towards mathematics had become more positive. Schunk and Pajares (2005) reported student success is strongly influenced by their belief in what they can achieve and their experiences of success. Lance experienced success through his participation in mathematics lessons which were within his ZPD and as a result he developed a positive attitude towards mathematics.

Mann (2006) recommended that mathematics should not focus on the correct writing or answering of algorithms in order to develop thinking and problem solving skills but encourage students to create and answer their own problems. Students were not pressured to complete a worksheet photocopied from a published book in a given period of time or to copy from the board but were provided with opportunities to think mathematically and creatively. By obtaining and maintaining their interest through the use of tasks which allowed them to apply their creativity Lance, Simon and Keith displayed less off-task behaviour and as a result they completed a greater volume of work than when completing worksheets.

Kaisha was a reluctant participant and contributor during small group activities and therefore may have not maximised the learning opportunities captured by other students, possibly causing her not to attain the levels of improvement achieved by her peers. Although Kaisha enjoyed being a member of the group she did not mix easily with the other students which may have been a result of relationships outside the support classroom. Similarly Anne did not communicate freely with other students and she found the sharing activities difficult. Anne worked slowly and methodically and did not like to talk aloud and she was one of only four students who requested assistance when experiencing difficulty. Anne was able to maintain her focus and work independently ignoring distractions occurring in close proximity to her. Both Anne and Kaisha possessed very dissimilar personalities with Kaisha being dominant while Anne was reserved. In comparison Rachel worked as well in a small group as she did independently and was able to spend more time on task than in the mainstream class due to the lower student to teacher ratio. All three of the girls were among the students who achieved the lowest number of errors in the assessments completed prior to beginning the program but also the least improvement at the conclusion. These results suggest the teaching method and group activities did not impact on the three girls to the same extent as the lower achieving students. Evans (2007) found that students experiencing mathematical difficulties required explicit or direct teaching because they were unable to grasp new concepts or develop new strategies in constructivist style lessons which resulted in a reliance on inefficient strategies. In the intervention program constructivist style lessons in a small group with a low student to teacher ratio the weakest students achieved the greatest gains in numeracy skills. In support of Evans research the highest performing students in the pre-assessment did not achieve the same degree of improvement as the lower students and appeared to prefer more structured and directed lessons.

The low student teacher ratio ensured Keith was well-supervised throughout each lesson and the variety of hands-on activities ensured that he was constantly kept engaged. A combination of the high visual content of the lessons and hands-on activities helped Keith to successfully develop a sound understanding of basic numeracy concepts. At the conclusion of the program

Keith's numeracy skills had improved however, his behaviour had not changed and he remained in need of close supervision and encouragement during mathematics lessons.

Written worksheets proved to be unappealing to Simon and when they were included in the program he showed his tendency to daydream, but during interactive activities in which he could participate physically or orally he maintained his focus. Simon did not become anxious but the lack of appeal failed to stimulate his interest resulting in the need to provide frequent prompts. Mathews (2006) reported students with dyslexia will have more success when they experience and discover things for themselves and lists of facts are not easily retained in the memory. The use of manipulatives and illustrations in the program assisted Simon to gain and retain an understanding of the mathematical concepts covered during the course of the program. When interviewed at the conclusion of the program Simon said he enjoyed drawing his own illustrations and maths problems the most. Simon's pleasing improvement may have been mastered from the opportunity to be creative during the program which supported Starko's (2009) view that the use of creative thinking is a key strategy to help students learn.

Encouraging talking aloud is supported by MacMillan (2009) who promoted the use of language as central to both teaching and learning and that by listening to students talk teachers are able to gain access to children's thinking processes. This technique was successfully applied during the program and provided invaluable knowledge of students' development. While students were completing what appeared to be a basic worksheet a group were discussing what salt and pepper shakers were with the answer provided from one "You see them at Sizzler". Students also discussed which was left and right, their left or right or of the person or object in the picture. Following this incident I paid more attention to the worksheets being given to students than I had previously. Additionally, observation of the students' answers highlighted a large amount of confusion over positions which were dependent upon students' individual perspective. The concept of drawing a glass of water above each placemat also depended upon one's perspective and highlighted the need to listen to a

student's explanation of their answer and not merely mark a worksheet as correct or incorrect (figure 34).

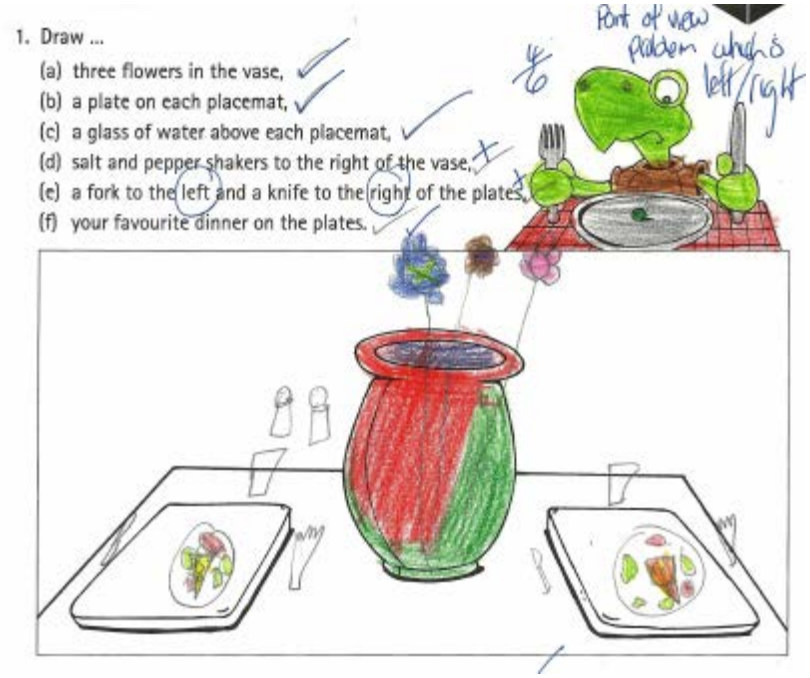


Figure 34. Position worksheet

In contrast to Elise other students who shared a specific learning difficulty similar to her attained excellent improvement and made the most improvement of all the participants. Elise demonstrated an enjoyment of mathematics and she actively participated and maintained excellent on-task behaviour throughout the program. An unreliable assessment due to randomly guessing the answers correctly may have provided a higher score in her pre-test. Elise's lack of progress was not caused by off task behaviour, lack of concentration or effort. Wade-Woolley (2007) reported that even with high quality instruction some students will not progress and will require highly specialised and intensive small group remediation.

Results of research conducted by Naglieri and Johnson (2000) found the effect of mathematics instruction on students varied according to the student's cognitive profile. Students who did not have a weakness in planning did not make the same level of improvement after participating in the same group instruction as those who had a profile that included a weakness in planning. The

research of Naglieri and Johnson posed additional questions about the possible reasons for the large improvement made by some students and the low improvement demonstrated by others such as exhibited by Elise. Research by Kroesbergen, Van Luit and Naglieri (2003) found students with mathematics difficulties also had cognitive processing difficulties which are important skills in both reading and mathematics and are required for solving word problems which require the automatic recall of basic facts. The students who participated in the study did not participate in any cognitive assessments prior to the program but an analysis of their cognitive skills may have assisted in an explanation of why students responded differently to the intervention.

Learning Difficulties

During the course of the program Elise was diagnosed with dyslexia, Simon was diagnosed Irlen Syndrome and Lance had been diagnosed with dyspraxia in 2008. Matthews (2006) reported that students with auditory memory problems predominately found in dyslexia, dyspraxia and Irlen Syndrome have extreme difficulty remembering sequences of numbers, including simple number bonds, days of the week, and months of the year. Lucangeli and Cabriele (2006) proposed inattentive children appear to overload their working memory with irrelevant information particularly in problem solving which left limited space for decision making. Students experiencing literacy and mathematics difficulties are also affected by working memory problems (Jordan et al. 2002; McGlaughlin, Knoop & Holliday, 2005; Swanson & Jerman, 2006). Ketterlin-Geller et al. (2008) expressed concern that there is insufficient time in a traditional classroom mathematics lesson for students with low memory to consolidate their learning. The extended lessons which consisted of two 85 minute and one 40 minute lesson provided time for students to develop mathematical strategies and recall of number facts.

Wadlington and Wadlington (2008) suggested that understanding the variety of signs, symbols and words used in mathematics are some of the problems students with learning difficulties encounter. Matthews (2006) reported students with learning difficulties become confused with left and right, following specific directions, writing teen numbers and completing algorithms from the right to left.

These difficulties were observed during the program not only by the students with a diagnosed learning difficulty but among other members of the group.

Due to the time spent listening to students while they completed worksheets and when working together during mathematics lessons the cause of their errors could be identified and as a result students did not receive crosses for wrong answers. Adjustments were made as the students worked and by not marking answers incorrect but helping the student work through the problems and encouraging them to locate their mistake and to talk aloud assisted to create a positive attitude. Overcoming difficulties in mathematics associated with dyslexia-type learning difficulties requires considerable more time than available in 20 week program. Developing a positive attitude towards mathematics lessons was the first step and this was achieved within the intervention period. The additional assistance provided in the support room with the low student to teacher ratio and ability to talk aloud had a positive influence on students' numeracy understanding.

Lance and Simon achieved exceptional growth in their numeracy understanding after participating in the support program where they were involved in lessons which were matched to their current ZPD. Although Elise shared a diagnosed learning difficulty along with the Lance and Simon she did not have the same level of distractibility. Elise enjoyed the group work, actively participating in all activities where her confidence provided the impression of competence. However, marking written tasks and results of the final assessments contradicted this as Elise made the least improvement of all students in the group. The support program did not influence all students with learning difficulties to the same extent.

The common factors found in the students who demonstrated the most improvement were off-task behaviour and low levels of concentration. Kaisha did not have the learning difficulties, behaviour or concentration problems of the members of the support group who made the largest improvements. She did not demonstrate the levels of active participation during small group activities that

other students did and therefore may have missed out on maximising the learning opportunities taken by other participants.

Literacy

Nine of the 12 students who participated in the program were members of both the literacy and numeracy support programs for Year Two students in 2010. The number of students with both literacy and numeracy difficulties supports Geary's (2004) finding that the memory required for numeracy facts is the same as needed for phonological decoding and this is linked to a student's ability to recall number combinations. The assessments and lessons were designed to limit the influence literacy ability had on students' numeracy success. Anne required extra assistance due to her low comprehension and extra time to complete tasks due to her slow processing and writing. The area in which Anne made the most improvement was problem solving which requires knowledge of the language of mathematics in addition to numeracy skills. Removing the challenge of reading from numeracy tasks assisted the students with literacy difficulties considerably. Their anxiety was reduced by eliminating the effort and concentration needed to decode words as they struggled to read text. This allowed the students to focus on their numeracy skill development and not their literacy difficulties and contributed to an improved positive attitude towards mathematics. Five students had an ESL background but this did not appear to correlate with mathematical achievement attained in the program. Of the ESL students Rachel and Anne achieved the lowest number of errors in the DMT assessment and Keith achieved one of the most improved scores.

Behaviour

Research by Maher (2007) found students with low aptitude tended to play with mathematics equipment rather than use it mathematically. The students' limited ability combined with their distractibility resulted in a constant need of adult supervision and interaction. This was evident in the support group with students, particularly Lance, Keith and Simon who received the highest number of errors in the pre-test also having exceptionally low levels of concentration. All three had a tendency to play with equipment and Keith would throw dice in an inappropriate manner if he thought I was occupied elsewhere and not directly

watching him. When partnered with students who were sensible he demonstrated more appropriate behaviour and followed their lead. During classroom discussions or direct instruction both Keith and Simon could not listen without fiddling with objects, building towers from their rulers, pencils and rubbers. Simon needed to be physically involved in an activity to maintain concentration. Despite their off-task behaviour the three boys were also the students who achieved the largest improvement over the course of the program. The low student teacher ratio helped ensure students were able to be supported and encouraged during the lessons and combined with active participation prevented inappropriate behaviours. These results reflect the finding of Lee and Zentall (2002) who suggested by increasing the level of active involvement student behaviour improves. During the program keeping the students actively engaged in physical tasks was a main priority. Sherman et al. (2005) purported that easily distracted students stay on task better if working in pairs or drawing. Throughout the program this concept was implemented with time spent waiting for a turn, listening to, or watching others kept to a bare minimum. The students worked mainly in pairs or a group of three. A range of activities which kept the students fully occupied required them to draw diagrams or illustrate their problems: a task they enjoyed. Increasing participation resulted in a significant reduction in off task behaviour and the increased time spent on task resulted in higher achievement by the students who previously had difficulty remaining focused. Liaupsin, Umbreit, Ferro, Urso and Upreti (2006) reported students displayed less off task behaviour and participated by asking and answering questions when they were academically engaged. This was found to be true of the participants in this intervention program.

Keith's behaviour reflected research by Maher (2007) who reported students with low aptitude would play with equipment unless under constant adult supervision. Keith had difficulty concentrating however, when provided with direct supervision he was able to concentrate and complete the tasks. This was also evident in the results of SENA assessment during which, under close supervision, he was able to produce higher results than in the DMT assessment. Classroom teachers reported that during whole class lessons they had difficulty providing the necessary levels of support for the students who

participated in the program. Encouraging students to apply a thinking aloud strategy and verbalise their thoughts and actions as they solved problems or moved counters assisted their level of concentration and improved on task behaviour because waiting time was reduced. Although students were constantly talking with only 12 students in a small room the noise level was low enough for the environment to be considered quiet. This feature of the program was one of the biggest differences the students noted between the student support room and their Year Two classroom.

Summary

The purpose of the study was to develop a support program which would result in an improvement in the numeracy achievement levels of Year Two students at risk of developing mathematical difficulties. Shinn (2004) suggested the key to preventing difficulties and later failure in mathematics is through early identification of students who may be at risk and providing appropriate intervention. Fuchs (2005) and Templeton, Neel and Blood (2008) reported that without additional support students experiencing difficulties will fall further behind their peers. A reduction of the gap between the numeracy achievement levels of students at risk and their peers and the development of a positive attitude towards mathematics by the participants were envisaged outcomes of the program. Sherman et al. (2005) defined mathematics achievement in terms of skill level, a positive attitude toward learning and the ability to reason and solve problems. These definitions were used during the course of the support program to determine student achievement.

The students demonstrated an enjoyment of mathematics and their understanding of the numeracy concepts and ability to apply basic numeracy skills improved as evidenced in the mathematical assessments and interview. The students' ability to reason and solve problems was still developing but should continue to improve as they gain more experience in the problem solving process. Results of the support program were positive and the goal of students increased their level of numeracy understanding during the 20 week program was achieved.

CHAPTER SEVEN

IMPLICATIONS

Introduction

The implications for mathematics teaching established from the outcomes of the 20 week support program are outlined. This begins with an explanation on the need for early intervention based on initial diagnostic assessment, followed by a section focusing on the content and frequency of lessons. Strategies that were deemed to be successfully applied in the program and how they influenced student achievement are reviewed with recommendations about how these may be incorporated in a classroom setting. Factors found to influence student success included creativity, play-based activities and classroom environment. A review of other factors of the program such as student behaviour in addition to the effects of the program on student achievement emulates Garcia, Sanchez and Escudero's (2006) recommendation that reflection of events that occur in the classroom improves future action. In view of MacMillan's (2009) notion that a challenge of teaching is a willingness to reflect critically, a reflection of my experiences during the program is presented. The chapter concludes with recommendations for best teaching practice to support students experiencing difficulties in numeracy.

Early Intervention

Ten of the students who participated in the program were identified as being at risk in numeracy during their Pre-primary year from the results of their PIPS assessment. Additional instruction beyond the standard classroom lessons was not provided for these students until the introduction of the Year Two numeracy support group in 2010 when they were identified as at risk in numeracy as a result of the Diagnostic Mathematical Task (DMT) assessment. Students determined to be at risk in numeracy in 2008 continued to be at risk in 2010. The identification of the same students after a two year period emphasised the importance of establishing an early intervention program specifically targeted at the students' level of understanding to prevent continued barriers to learning. Intervention should not be delayed until the students have fallen further behind their peers and are causing elevated levels of concern. Stanovich (1986)

described what is known as the Matthew Effect when students continue to fall further behind their peers, which is the likely outcome of not implementing an intervention program for identified students. Research by Hamlett (2005) ascertained that tutoring small groups of two to three students improved their mathematics skills more than would otherwise have occurred although additional support may need to be continued in the subsequent years. Although students who participated in the support group demonstrated an improvement in their enjoyment of mathematics and numeracy skills they may not continue to build on their knowledge at the same rate as their peers without some form of supplementary instruction.

Program Content

The practice in the school was for teachers to plan and publish mathematics teaching programs prior to the commencement of each of the three learning phases, consequently the focus was on the teacher teaching set concepts and not addressing the students' learning needs. Although the programs catered for the Year Two curriculum content the students with low numeracy skills were unable to demonstrate the pre-requisite foundation level numeracy skills and as a result continued to fall further behind their peers. The amount of time allocated to the teaching of each concept had not been sufficient for students at risk to acquire satisfactory understanding. This supports the research of Evans (2007) and Ketterlin-Geller et al. (2008) who reported on the difficulties teachers encounter providing appropriately paced instruction for students at risk. The ensuing progression to new concepts taught in the mainstream class which required knowledge of the basic skills of addition, subtraction, reading and writing of numerals were outside the understandings of the members of the support group. It is difficult for teachers of classes with over 30 children to provide content directed at each student's level of understanding or to allow the additional time needed for repeated practice because each lesson has been carefully planned in advance to follow a prescribed syllabus. The DMT assessment established each student's level of mathematical understanding from which the support program was developed based on the concepts which are the foundation on which sequential mathematical skills are built.

The National Mathematics Advisory Panel (2009) acknowledged the existence of pressure to move on to the next topic before the students had mastered the current material and accentuated the need for reducing the pressure by combining topics. This may still not provide the time necessary for the repeated practice needed by students at risk. The support program consisted of two 85 minute lessons each week, 40 minutes longer than the standard 45 minute lesson and one 40 minute lesson, thus providing students with the extra time they required for repeated practice in order to successfully master the vital basic concepts. Schools must establish additional teaching sessions for students at risk in numeracy in junior primary. The time invested should reduce the extent of numeracy difficulties in the higher grades and associated student anxiety and negative attitudes toward mathematics.

Creativity

At the conclusion of the program students completed an oral questionnaire during which their comments were scribed to remove the requirement of reading or writing their response. Students provided direct simple answers and tended not to want to elaborate on their reply. When asked what they enjoyed most about the support group answers included, “Free drawing”, “Drawing my own pictures”, and “Drawing the sums”. The students did not participate in free drawing activities during lessons but their interpretation of the use of blank paper on which they were able to demonstrate their understanding of numeracy concepts was that it was free drawing. This reinforced Matthews (2006) deduction that many children with learning difficulties need to be creative. Park and Seung (2008) supported the use of creativity to enhance the learning of mathematics. The advantage of using blank paper allowed the students who were predominately visual learners with low literacy levels the flexibility to demonstrate their numeracy skills creatively. This strategy also supplied the teacher with greater insight into each student’s prevalent difficulties and thought processes than could be concluded from the marking of a published worksheet, where the focus is usually right or wrong answers and not why or how the students answered or solved the problem.

Students were often able to demonstrate correct understanding when working in a practical capacity but answering questions on worksheets copied from published books proved difficult for most of the participants of the support group. When not daunted by the worksheets full of numbers and words to complete the students' confidence and enjoyment of mathematics noticeably increased. When completing worksheets copied from published books students focused on receiving 'ticks', did not want to 'get it wrong' and were reluctant to have a go or apply new strategies. In contrast, while completing tasks on a blank sheet of paper students eagerly applied their knowledge to provide evidence of their understanding, without the fear of getting it wrong. The use of photocopied worksheets creates a busy classroom but not an interactive learning environment. Many worksheets produced for mathematics lessons have large volumes of text on a page, lack clarity and focus on the student's literacy skills. It is essential teachers carefully consider the purpose, relevance and content of worksheets copied from published books given to students and instead present blank or grid paper to enable students to creatively demonstrate their understanding.

Play Based Activities

Foster (2008) encouraged the use of games and simulations as effective tools in mathematics education. Throughout the support program games were carefully and deliberately included and were not employed to keep students busy or as a reward. Repetitive practice of the basic numeracy skills of addition, subtraction, and number recognition were core skills of the games which enabled the students to increase their proficiency in these concepts. Students did not perceive playing games as work and if a dice, counters or movable objects were involved enjoyment was evident with no apprehension present. An additional benefit of incorporating games into the program was that students were able to develop their understanding of the relationship between concrete and abstract. The importance of including games into a support program is supported by Dowker's (2003) finding that translation between concrete, verbal and numerical formats is a crucial area in children's mathematical development. Classroom teachers should incorporate mathematical games constructively in their numeracy lessons as an opportunity for repetitive practice and

consolidation of basic facts and not for as a time filler or as a reward for early finishers.

Generating time to observe and listen as students talk will provide teachers with a much deeper awareness of each student's ability than marking completed worksheets especially after they have left the room. Games help students to experience enjoyment during mathematics lessons which is extremely important for students who have been struggling to achieve basic numeracy skills and are at risk of developing a negative attitude towards mathematics due to their lack of success. A highlight of the program was the positive and enthusiastic attitude demonstrated daily by the students who eagerly rushed into the support room asking, "Is it a maths day today?"

Environment

When interviewed at the conclusion of the program students stated that one of the most noticeable differences between mathematics lessons in the support class and in their own Year Two classroom was the noise level. Thomas, Lance and Tama all stated the biggest difference was the size of the room and the quietness. Sara reported she noted the lower number of children, less noise and the different activities were the major differences. Simon declared he felt he was able to work better in the smaller room because it was quieter and Rachel reported she liked working in the less noisy room with 'easier' work. Kaisha and Anne also stated they liked the quietness of the support room. Providing support for a small group of children within a mainstream classroom limits the range of strategies which can be implemented, such as playing games and talking aloud as claimed by Notbohm and Nomura (2008). The large open plan classroom environment did not have the visual or auditory elements necessary to maximise the learning potential of students at risk. The location of the support classroom next door to the Year Two rooms aided the perception of the room being an extension to the Year Two room and diminished any negative associations typically associated with 'withdrawal' programs. The influence the environment had on student achievement follows the findings of Cuttance (1998) who found the environment had a 60% influence on student achievement. Numeracy intervention programs should be provided in an area

where students can have as close to an optimal learning environment as possible to maximise student achievement. The support room became an extension of the students' classroom and provided an environment with limited distractions.

Behaviour

The low teacher student ratio ensured students were less inclined to become distracted or to participate in off-task behaviour yet on their return to their classroom they reverted to these behaviours. "I am not able to provide the support that you give them. I cannot constantly be there for him all the time," reported one teacher. The students were mastering basic numeracy skills in the support class but not gaining the ability to work independently or to concentrate in the larger classroom. This indicated that following the implementation of an intervention program an integration period during which additional support is provided in the classroom would be beneficial. The program aimed to improve the numeracy skills of the participants and the low student teacher ratio helped students stay on task nevertheless there was not the intention to successfully achieve long term behaviour modification. It was assumed behaviour would improve simultaneously with ability but this did not transpire on students' return to their classroom. Hamlett (2005) advised a possible cause of off task behaviour is a mismatch between the instruction given and that needed by students. To reduce problem behaviour in the classroom teachers may need to modify their teaching style and alter their program content to match the needs of students, particularly those identified as being at risk. During the support group lessons when the content was at students' level of understanding off-task behaviour was rarely witnessed. The Year Two classroom teachers commented on the positive attitude all participants exhibited, their enthusiasm to attend classes, disappointment when the numeracy support group did not take place and that other students requested to attend the intervention.

Assessment

Elise, Anne and Rachel registered a higher number of errors in their post DMT assessment than they had prior to beginning the support program. Of the three students Elise was the only one who also made more errors in the SENA

with Anne and Rachel improving in all concepts assessed in the SENA. Anne and Rachel were among the students who achieved the lowest number of errors in the pre-assessment. One possibility may be that due to the multi-choice format of the DMT assessment students had a chance of guessing correctly and therefore provided a false impression that the concept was understood. If understanding still had not been mastered by the time of the second assessment when the answer was guessed again and a different answer was selected the result could be a negative movement. Another possibility is copying from each other may have occurred due to the number of students assessed at one time with 32 students in one large group for the DMT pre-assessment. Although the students were closely monitored during the assessment, students were clustered extremely closely in the Year Two classroom with up to six students at one table. The possibility of copying was reduced during the second assessment as only the 12 members of the support group were assessed at the one time. The seating arrangements were significantly more spacious with children seated two to a desk with ample personal space. It is recommended assessments of students be in groups of 10 to 12 to minimise discrepancies. The use of two forms of assessment such as the DMT and SENA provided a valuable correlation between student's achievements.

Reflection

Ginsburg and Golbeck (2004) questioned the evaluation of support programs which are traditionally measured by student achievement and suggested the quality of the program and the effectiveness of the teacher are also vital components. Hattie (2005) recommended teachers use student achievement to analyse their own teaching and although the focus of the program was on the student's learning, in line with Hattie's suggestion I reflected on my own teaching skills and beliefs about students and how they learn. As I observed, monitored and interacted with students throughout the 20 week program I believe I transformed as a teacher. With an emphasis on students working together in small groups while developing a thinking aloud strategy under my observation I realised I was able discover with greater accuracy each student's specific areas of strength and weakness. I now believe that in the past I was too intent on constantly working with children and felt guilty if not busily interacting,

whereas during the program I was able to intervene in a timely fashion. I aim to increase my observations of students working in the future, to listen more to the students and to have them listen less to me. One recommendation for classroom teachers that I found invaluable during the study, which should positively affect their teaching, is to stop being so busy working hands-on with a student and to stand back, watch and listen.

Another discovery I made while working with the students was although I had previously not liked using photocopied worksheets, by working with the students and paying more attention to reading and explaining concepts to students I realised how confusing the language can be. Any teacher marking worksheets following the completion of a lesson and not listening to students explaining their reasons for obtaining their answers is not procuring an understanding of their students' mathematical thinking. I recommend the use of photocopied worksheets should not be a routine, everyday practice but kept to a minimum and if used they need to be studied first and not haphazardly distributed.

Prior to the numeracy program I had been a reluctant user of mathematical games based on my experience of student behaviour in a mainstream classroom when the opportunity to play or work in small groups without direct supervision often resulted in appropriate activity. Nonetheless I found the games were incredibly successful in an environment with a low student to teacher ratio and based on the impact the games had on student achievement I will definitely include games regularly when teaching in the future.

Unfortunately PIPS testing, incursions, excursions, illness and unforeseen circumstances interrupted the planned 20 week program. Although the number of teaching days was significantly reduced students did demonstrate a pleasing growth in their numeracy skills. Of the maximum possible 60 lessons over 20 weeks only 37 were achieved. Although the study was intended to cover terms two and three, unplanned delays resulted in the program extending across two holiday periods and three terms. In hindsight, an earlier start date and a shorter length, possibly fifteen weeks with an additional period for those students who had not mastered specific concepts may be a better alternative. The study took

place in a typical school environment and the program incurred all the natural disruptions that transpire during a school year and as such the intervention program was conducted in a realistic setting.

Best Teaching Practice

As a result of this research study I believe it is extremely important for the mathematical achievement of all students that:

- Diagnostic assessments are undertaken and immediately followed by the implementation of an intervention program for students identified as at risk.
- Mathematics lessons focus on the student ability and are tailored around their Zone of Proximal Development (ZPD) and not pre-planned to suit a set curriculum.
- A classroom environment be created that maximises learning by limiting distraction and off-task behaviour including the provision of a suitable acoustic setting.
- Explicit teaching of concepts with immediate feedback is followed by activities that incorporate multisensory, hands-on, play-based activities and thinking aloud.
- Creativity is promoted through the use of blank paper to allow students to demonstrate their understanding and not the completion of fill-in-the-gap worksheets or published year level workbooks.
- The teacher to student ratio promotes learning while providing time for teachers to observe and listen in order to provide timely intervention.
- Teachers become observers to facilitate student learning and not markers.

Students identified as being at risk in numeracy in 2008 continued to be at risk after a two year period emphasising the importance of early intervention to prevent continued low performance and spiralling deficits.

The inclusion of play-based activities in the program provided opportunities for students to gain confidence in the basic skills needed for higher order concepts and introduced an element of fun into the lessons. Removal of the focus on achieving correct answers as required in the completion of pre-made worksheets provided opportunities for students to demonstrate their understanding creatively. Tasks that were centred on students' creative input increased their enjoyment in mathematics lessons and provided a greater depth to their understanding and level of achievement. A low student-teacher ratio combined with activities set within the students' ZPD had the positive effect of reducing off-task behaviour because students were not challenged with tasks beyond their current level of understanding.

The students who participated increased their basic numeracy skills and enjoyed the activities during the program, however when faced with a higher student to teacher ratio and mainstream lessons they may struggle to continue to demonstrate similar levels of achievement. The pace of instruction necessary to complete prescribed year-level curriculum does not allow the time required by students at risk to obtain understanding through repeated practice and the research raises the question of how teachers can maintain the balance of keeping pace with the curriculum while meeting the needs of all students.

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APPENDIX A Parent and Principal Consent Forms

Numeracy Support for Year Two Students

Principal

17 May 2010

Dear

I request permission to conduct a research study as part of my Masters of Research (Education).

I have completed the proposal stage of the research and would like to begin the data collection phase in term 2, 2010.

The purpose of the project is to plan, implement and evaluate a numeracy program for a group of twelve Year Two students diagnosed as requiring extra support.

Students will be asked to:

Complete an individual diagnostic assessment before and after completion of the program. This is to provide the researcher with a depth of understanding of areas of difficulty not obtainable from a pencil and paper test.

Participate in a program providing intensive numeracy development for three or four, 30-40 minute lessons each week over a period of 20 weeks. These small group sessions will be held in the student support room, adjacent to the Year Two classroom. Lessons are based on the use of hands-on activities and games combined with the encouragement to talk aloud as they develop their mathematical skills.

This study will have a completion date of no later than December 2010. It is anticipated students will increase the rate of their mathematical skill development during their participation in the program and gain an increased confidence and enjoyment of mathematics.

I request permission to incorporate the data from the 2008 Performance Indicators in Primary Schools (PIPS) and information from the students' personal files relating to educational development into this research study. This will assist in creating a profile of each student and in the analysis of the program using a Case Study approach.

The information will be used to complete the requirements for the research study mentioned above. Any information or details given for this study will be kept confidential and will only be used for the purposes of this project. No student or the school concerned will be identified in any written assignment or presentation of the results of this project and all data obtained during the course of this research study will be kept securely locked at the school premises for a period of five years, after which time it will be destroyed.

Participation in this project is voluntary and students are able to withdraw from further participation at any time without giving a reason and with no negative consequence.
I look forward to discussing any aspect of this program with you.

If you have any questions or require any further information about the research project, please contact:

Gillian Hurle	Dr. Jenny Jay	Dr. Fiona Budgen
Student Support Teacher	Supervisor	Supervisor
	Edith Cowan University	Edith Cowan University
GHurle@jsracs.edu.au	j.jay@ecu.edu.au	f.budgen@ecu.edu.au

If you have any concerns or complaints about the research project and wish to talk to an independent person, you may contact:

Research Ethics Officer
Edith Cowan University
270 Joondalup Drive
JOONDALUP WA 6027
Phone: (08) 6304 2170
Email: research.ethics@ecu.edu.au

Gillian Hurle

Numeracy Support for Year Two Students

17 May 2010

Dear……..

Your child ……has been are invited to participate in this the above named project, which is being conducted as part of a Masters of Research (Education) by Gillian Hurle.

The purpose of the project is to plan, implement and evaluate a numeracy program for a group of twelve Year Two students requiring extra support. Students have been selected from a combination of diagnostic assessment and teacher observation.

If your child participates in this project they will be asked to:

- Complete an individual diagnostic assessment before and after completion of the program. This is to provide the researcher with a depth of understanding of areas of difficulty not obtainable from a pencil and paper test.
- Participate in a program providing intensive numeracy development for three or four, 30-40 minute lessons each week over a period of 20 weeks. These small group sessions will be held in the student support room, adjacent to the Year Two classroom. Lessons are based on the use of hands-on activities and games combined with the encouragement to talk aloud as they develop their mathematical skills.

This study will have a completion date of no later than October 2010. It is anticipated students will increase the rate of their mathematical skill development during their participation in the program and gain an increased confidence and enjoyment of mathematics.

I request permission to incorporate the data from the 2008 PIPS and information from the students' personal files relating to educational development into this research study. This will assist in creating a profile of each student and in the analysis of the program using a Case Study approach.

The information will be used to complete the requirements for the research study mentioned above. Any information or details given for this study will be kept confidential and will only be used for the purposes of this project. No student or the school concerned will be identified in any written assignment or presentation of the results of this project and all data obtained

during the course of this research study will be kept securely locked at the school premises for a period of five years, after which time it will be destroyed.

Participation in this project is voluntary. If you choose to allow your child to participate, you are free to withdraw him/her from further participation at any time without giving a reason and with no negative consequence and at that time you are able to request for any information relating to your child to be withdrawn from the study. I look forward to discussing any aspect of this program with you.

If you have any questions or require any further information about the research project, please contact:

Gillian Hurle	Dr. Jenny Jay	Dr. Fiona Budgen
Student Support Teacher	Supervisor	Supervisor
John Septimus Roe ACS	Edith Cowan University	Edith Cowan University
GHurle@jsracs.edu.au	j.jay@ecu.edu.au	f.budgen@ecu.edu.au

If you have any concerns or complaints about the research project and wish to talk to an independent person, you may contact:

Research Ethics Officer
Edith Cowan University
270 Joondalup Drive
JOONDALUP WA 6027
Phone: (08) 6304 2170
EMAIL: research.ethics@ecu.edu.au

CONSENT DOCUMENT

Numeracy Support for Year Two Students

I have been provided with a copy of the Information Letter, explaining the project.

I have been given the opportunity to ask questions and any questions have been answered to my satisfaction.

I understand that participation in the research project will involve:

- Completion of a pre and post intervention diagnostic assessment.
- Participation in a program providing intensive numeracy development in specific areas of identified need.
- Inclusion of data obtained from 2008 PIPS and personal information from student files regarding educational development.

I understand that the information provided will be kept confidential, will only be used for the purposes of this research study and my child will not be identified in any way in the results of this study. I understand that I am free to withdraw my child at any time during the course of the intervention, from further participation at any time, without explanation or penalty.

I freely agree to allow my child to participate in the above named research study.

……

Name

……

Signature

……

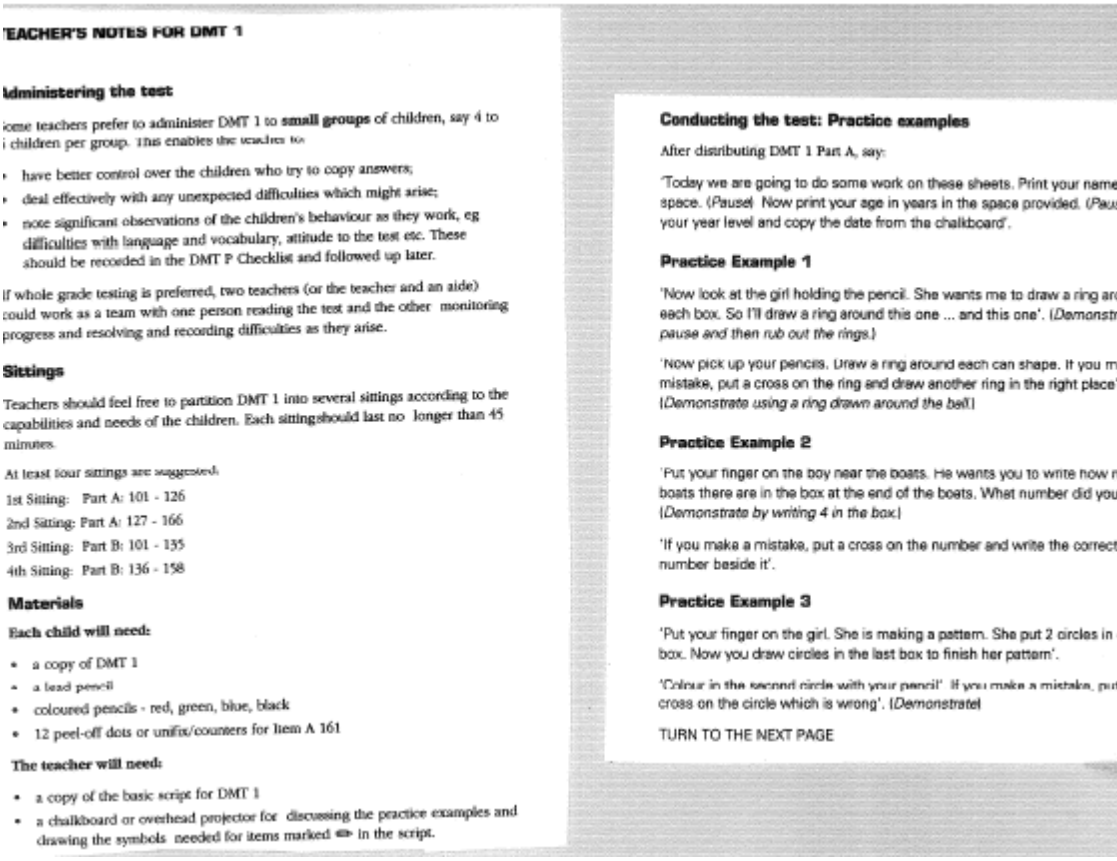
Date

Appendix B Ethical Issues

A prior relationship existed between the participants in the study and the researcher and this is recognised as providing greater knowledge of the students than that which is being used during the research. This includes family background, specialist reports, and other external factors that are not measured for the purpose of the research.

Participation in the research study was voluntary and informed written consent obtained prior to implementation of the project. Withdrawal from the research project was an option on request but not actioned. All data obtained during the research was confidential, with no participants identified or the subject school identified in any reports resulting from the research. The protocols required for completing research in a West Australian Anglican School were followed. An Ethics clearance was granted from Edith Cowan University via the University Human Research Ethics Committee.

Appendix C Numeracy Assessments



TEACHER'S NOTES FOR DMT 1

Administering the test

Some teachers prefer to administer DMT 1 to **small groups** of children, say 4 to 6 children per group. This enables the teacher to:

- have better control over the children who try to copy answers;
- deal effectively with any unexpected difficulties which might arise;
- note significant observations of the children's behaviour as they work, eg difficulties with language and vocabulary, attitude to the test etc. These should be recorded in the DMT P Checklist and followed up later.

If whole grade testing is preferred, two teachers (or the teacher and an aide) could work as a team with one person reading the test and the other monitoring progress and resolving and recording difficulties as they arise.

Sittings

Teachers should feel free to partition DMT 1 into several sittings according to the capabilities and needs of the children. Each sittingshould last no longer than 45 minutes.

At least four sittings are suggested:

1st Sitting: Part A: 101 - 126
2nd Sitting: Part A: 127 - 166
3rd Sitting: Part B: 101 - 135
4th Sitting: Part B: 136 - 158

Materials

Each child will need:

- a copy of DMT 1
- a lead pencil
- coloured pencils - red, green, blue, black
- 12 peel-off dots or unifix/counters for Item A 161

The teacher will need:

- a copy of the basic script for DMT 1
- a chalkboard or overhead projector for discussing the practice examples and drawing the symbols needed for items marked ✏ in the script.

Conducting the test: Practice examples

After distributing DMT 1 Part A, say:

'Today we are going to do some work on these sheets. Print your name space. (Pause) Now print your age in years in the space provided. (Pau your year level and copy the date from the chalkboard'.

Practice Example 1

'Now look at the girl holding the pencil. She wants me to draw a ring ar each box. So I'll draw a ring around this one ... and this one'. (*Demonstr pause and then rub out the rings.*)

'Now pick up your pencils. Draw a ring around each can shape. If you m mistake, put a cross on the ring and draw another ring in the right place' (*Demonstrate using a ring drawn around the ball.*)

Practice Example 2

'Put your finger on the boy near the boats. He wants you to write how m boats there are in the box at the end of the boats. What number did you (*Demonstrate by writing 4 in the box.*)

'If you make a mistake, put a cross on the number and write the correct number beside it'.

Practice Example 3

'Put your finger on the girl. She is making a pattern. She put 2 circles in box. Now you draw circles in the last box to finish her pattern'.

'Colour in the second circle with your pencil'. If you make a mistake, pu cross on the circle which is wrong'. (*Demonstrate*)

TURN TO THE NEXT PAGE

DMT 1: PART A

Oral Instructions

(Repeat the words in bold to ensure clarity)

✏ 101 Look at the rows of empty boxes. Put your finger on the triangle (*Demonstrate* ▼)
Write the figure 10 in that box. **Now finish writing the numbers** from 10 to 20. Put a number in each box.

102 –105 Look at the groups of things and numbers. **Count how many things there are in each group. Draw a line from each group to the number telling how many things there are.**

106 &107 Look at the things in each picture. **Count how many things there are in each picture and put that number in the box.**

TURN TO THE NEXT PAGE

Look at the empty windows. **You are going to write a number in FIGURES (as a NUMERAL) in each window when I say it.** Put your finger on the **arrow**.

108 **In that window, write in figures the number FIFTEEN.**

109 **In the next window, write in figures the number TWELVE.**

110 **In the next window write in figures the number NINETEEN.**

111 **In the last window. write in figures the number THIRTEEN.**

112 Look at the numbers and the apples. **Colour in red THAT NUMBER of apples.**

113 Look at the number and the bird under it. **Draw THAT NUMBER of birds in the space.**

114 Look at the book of numbers and the blank page. **Write on the blank page, the number that comes JUST AFTER this number.**

115 Look at the other book numbers. **Write on the blank page the number that comes JUST BEFORE this number.**

116 Look at the balloons with numbers in order. **Some of the numbers are missing. Write the numbers which are left out, IN ORDER .**

117 Look at the carriages with numbers in order, starting at 20. Again, **some numbers are missing. Put the next 3 numbers in order on the carriages.**

118 Look at the two dollar and one dollar coins. **How much money is this? Put your answer in the box.**

119 Look at the two dollar coins. **Count how much money is here. Put your answer in the box.**

120 Look at the five cent coins. **Count how many cents there are altogether. Put your answer in the box.**

121 Look at Freddo the Frog and the rocks with numbers in order. **With each jump, Freddo leaps over a black rock. Put the numbers in order on the rocks that Freddo lands on.**

122 Look at the counting pattern of the letter boxes. **Write the next three numbers in this pattern on the letter boxes.**

123 Look at the counting pattern on the shapes. **Write the next three numbers in this pattern on the shapes.**

124 Look at the balloons with numbers on them. **Colour the balloon with the BIGGEST number on it.**

125 **Circle the balloon with the SMALLEST number on it.**

126 Look at the flags with numbers on them. **Write these numbers in order, starting with the SMALLEST and ending with the BIGGEST .**

127 –136 Look at the doors with numbers on them. **Write each number in FIGURES (as a numeral) on ALL the doors.**

137 –145 Look at the flags with numbers on them. **Write each number in FIGURES (as a numeral) on ALL the flags.**

146 **What number is 2 more than 8? Put your answer in the space.**

147 Look at the 5 black beads. **4 more beads have been put onto the string. Finish the NUMBER SENTENCE (or equation) about ALL the beads.**

148 Look at the apple, pencil and prices in cents. **How much would it cost to buy an apple and a pear?**

149 **In the next space, write the NUMBER SENTENCE (or equation) to show how you did it.**

150 **Finish this number sentence (or equation): 6 ÷ 2 ÷ 5 =** (*Provide concrete aids if needed and note who use them in the checklist.*)

151 **What number is 2 less than 9? Put your answer in the space.**

152 Look at the beads being taken off the string. **Finish the NUMBER SENTENCE (or equation) about the beads left on the string.**

153 Look at my 10 cent coin and the lolly I bought for 6 cents. **How much change did I receive? Put your answer in the space.**

154 Look at Jason's 5 cent coin and the pear costing 25 cents. **How much more money does Jason need to buy the pear? Put your answer in the space.**

155 **In the next space, write the NUMBER SENTENCE (or equation) to show how you did it.**

TURN TO THE NEXT PAGE

156 Look at the cherries in groups of 3. **Count the groups of 3 and all the cherries. Finish the number sentence: ' ... groups of 3 equals ...'**

✏ 157 **In the next space draw 2 groups of 5 balls. Be sure to ring the group.**

158 Finish the number sentence: **'2 groups of 5 balls equals ....'**

159 Look at the groups of stars. **Finish the number sentence (or equation) about these stars.**

160 **In the next space, draw a picture to show 2 x 3 = 6.**

(Items 159 and 160 introduce the '**x**' sign. This may be postponed for many children until Year 2, if '+' and '-' are introduced in Year 1.)

TURN TO THE NEXT PAGE

✏ 161 Look at the 12 lollies and the 2 children's tables. **Share the lollies** fairly between the two children.
(Provide 12 peel-off dots or 12 unifix/counters for each child.)

162 Finish the number sentence (or equation): **12 shared between 2 people makes ..... each.**

163 Look at the 8 lollypops. **Ring groups of 2 lollypops.**

164 Finish the number sentence (or equations): **8, how many 2s makes .... groups?**

165 Look at the peanuts. **Ring groups of 4 peanuts.**

166 Finish the number sentence: **11, how many 4s, makes ..... and ..... left over.**

(Items 165 and 166 introduce remainders. This topic, and the sign '–' may be postponed until Year 2 for most children.)

Oral Instruction

(Repeat the words in bold to ensure clarity)

Materials:

- Rod or straw 5 cm long, for Item 117
- Coloured pencils (red, green, blue, black) for Items 124-127

After distributing DMT 1 Part B, direct the children to write their name, age, year and date at the top of the sheet, and then proceed with these oral instructions:

✏ 101 Look at the line of people waiting for a bus. **Draw a star over the THIRD person from the bus stop.**

102 **Colour the LAST person from the bust stop.**

103 **Draw a ring around the person in the MIDDLE.**

104 Look at the brick wall and the trees. **Draw a line from the wall to the NINTH tree.**

105 Look at the dotted tree. **What is its number order from the wall? Write your answer in WORDS under the DOTTED tree.**

106 Look at the black tree. **What is its number order from the wall? Write your answer in FIGURES under the BLACK tree.**

107 Look at the coins we use for shopping. **Colour the coin which buys the MOST.**

108 **Ring the coin which buys the LEAST.**

TURN TO THE NEXT PAGE

Look at the money in boxes and the loose coins. How much money is there in the top box $2, so I join that to the box worth as much, the $2 coin.

109 Look at the money box with 20¢, 20¢ and 10¢ in it. **Count how much money there is in the box and draw a line to the money worth as much.**

110 &111 Finish the next two questions. **Count the money in boxes and then match with a coin.**

112 Look at the purse with money in it. **How much money is this? Put your answer in the space.**

113 Look at the straw. **Draw a line AS LONG AS the straw.**

114 Look at the leaves. **Colour the LONGEST leaf.**

115 **Draw a ring around the shortest leaf.**

116 Look at the toothbrush and the line of paper clips. **How many paper clips are needed to make a line AS LONG AS the toothbrush? Put your answer in the space.**

✏ 117 (Provide a rod or a straw for this item). Look at the key, pencil, leaf, feather, screwdriver and zip. **Use the rod (or straw) to find which things are AS LONG AS the rod/straw. Ring ALL of these things.**

118 Look at the shoe and the peg. **About how many pegs would make a line AS LONG AS this shoe? Write the number of pegs in the space.**

119 Look at my picture and picture frame of matches. **How many matches did I use for the picture frame? Write the number of matches in the space.**

120 Look at the two mats. **Colour the mat which covers MORE floor.**

✏ 121 Look at the shapes cut into parts. **Put a cross on ALL shapes with two EQUAL parts.**

122 Look at these shapes cut into parts. **Colour one-half of all the shapes with two EQUAL parts.**

123 Look at these shapes. **Put a cross on the shape that does NOT belong.**

124 **Find the RECTANGLE .... put a RED spot on it.**

125 **Find the DIAMOND .... put a BLACK spot on it.**

126 **Find the HEXAGON .... put a BLUE spot on it.**

127 **Find the OVAL .... put a GREEN spot on it.**

128 Look at the pictures of the tree and kite. **Ring the picture where the kite is on the RIGHT of the tree.**

129 Look at the pictures of the table and box. **Ring the picture of the box in the CENTRE of the table.**

130 Look at the pictures of the coffee table and ball. **Ring the picture of the ball at the CORNER of the table.**

131 Look at the pictures of the tree trunk and football. **Ring the picture where the football is on the LEFT of the tree.**

132 Look at the pictures of a car going over a cliff. **Ring the picture of the car going BACKWARDS over the cliff.**

133 Look at the lines. **Ring the picture of the CURVED line.**

134 Look at the football and the book. **Ring the picture showing a FLAT surface.**

135 Look at the blocks. **Ring the THIN block.**

136 Look at the pan balance with things in each pan. **Ring the thing which has MORE mass.**

137 Look at the pan balance with two blocks balncing a ball. **Which has LESS mass - a block or a ball? Ring the one that has LESS mass.**

138 Look at the apple in the cloud and the other things - a pencil, a full school bag, a balloon, a handkerchief and a soccer ball. **Ring ALL the things that have a GREATER mass than the apple.**

139 Look at the clock face. **Fill in all the numbers on this clockface so that it can tell me the time.**

140 Look at the two clocks. **Read the first clock and write the time under it.**

141 **Read the second clock and write the time under it.**

142 Look at the two clocks with no hands. **Put hands on the first clock to show 2 o'clock.**

143 **Write numbers on the second clock to show 7 o'clock.**

(Expect correct answers for all of 140-143 for mastery.)

144 Look at the days of the week. They are NOT in order. **Ring the school days.**

145 Finish these sentences. **Today is .....**

146 **Yesterday was .....**

147 **Tomorrow will be .....**

TURN TO THE NEXT PAGE

148 Look at the 3 pictures of the can and the bottle. The first one shows th full can and empty bottle. The next picture shows water being poured from the full can into the bottle. **In the last picture, ring the one which holds MORE water.**

149 Look at the 3 pictures of the bottle and a bowl. The first one shows the full bottle and empty bowl. The next picture shows water being poured from the full bottle into the bowl. **In the last picture, ring the one which holds LESS water.**

150 Look at the litre carton of milk in the cloud and the other containers: a tray, bowl, glass and jug. **Ring the containers which hold LESS than the carton of milk.**

151 Look at the number of icy-poles eaten by four children at a birthday party. **Ring the name of the child who ate the LEAST icy-poles.**

152 **Write the name of the child who ate TWO more icy-poles than TOM.**

TURN TO THE NEXT PAGE

153 Put your finger on the arrow and look at the pattern of blocks. **Use your black pencil to draw the next THREE shapes of this pattern on the string.**

154 Put your finger on the star and look at the beads threaded on the string. **Use your black pencil to draw the next THREE shapes of the pattern on the string.**

(Insist that the children do not say the answers to the next four questions aloud.)

155 **I am a number less than 20, but I am more than 10. I end in 3. What number am I. Put your answer in the box.**

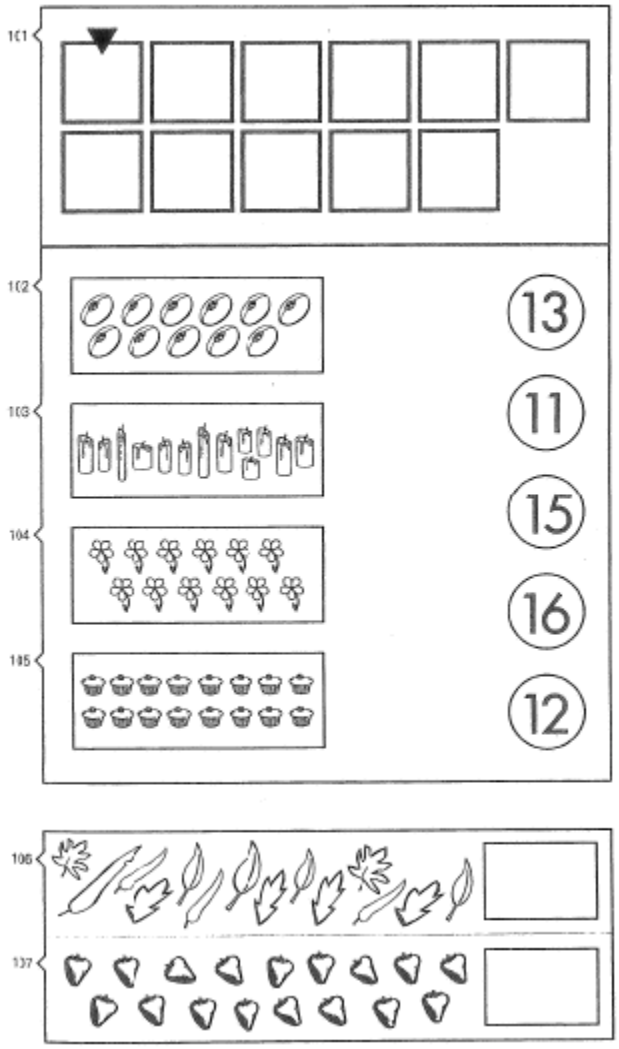
156 Look at the hand and the counters. **There are three more counters hidden underneath the hand. How many counters are there altogether? Put your answer on the dotted line.**

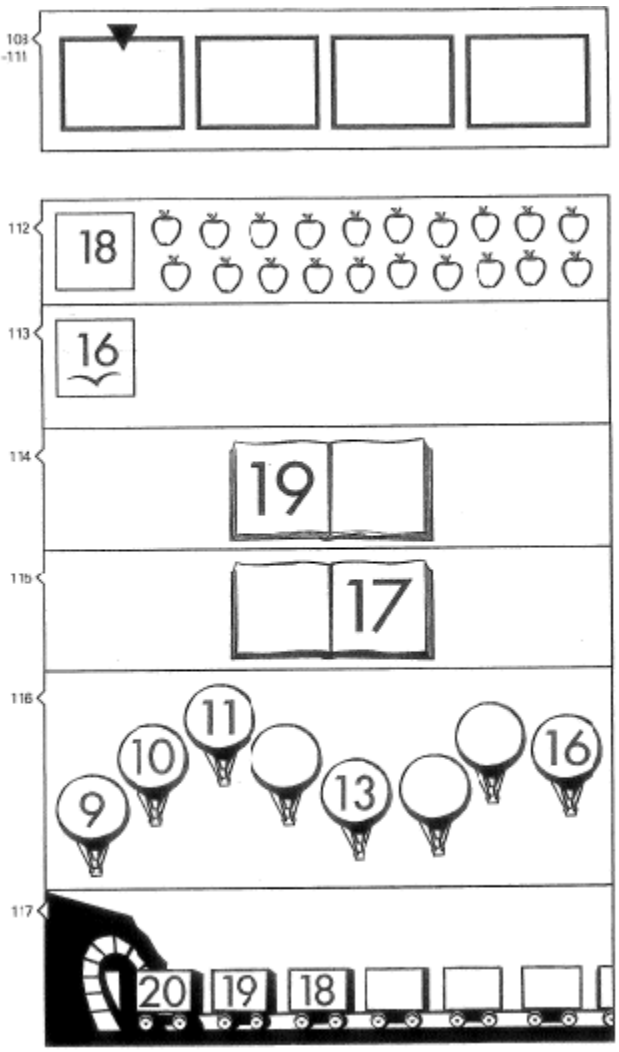
157 **Paul had 7 rabbits. He sold 3 of them. How many did he have left? Put your answer on the dotted line.**

158 This question is about a make-believe animal called a dub. **A dub has 2 heads. How many heads would you see if there were 4 dubs? Put your answer on the dotted line.**

END OF PART B

DMT **1** – Part A

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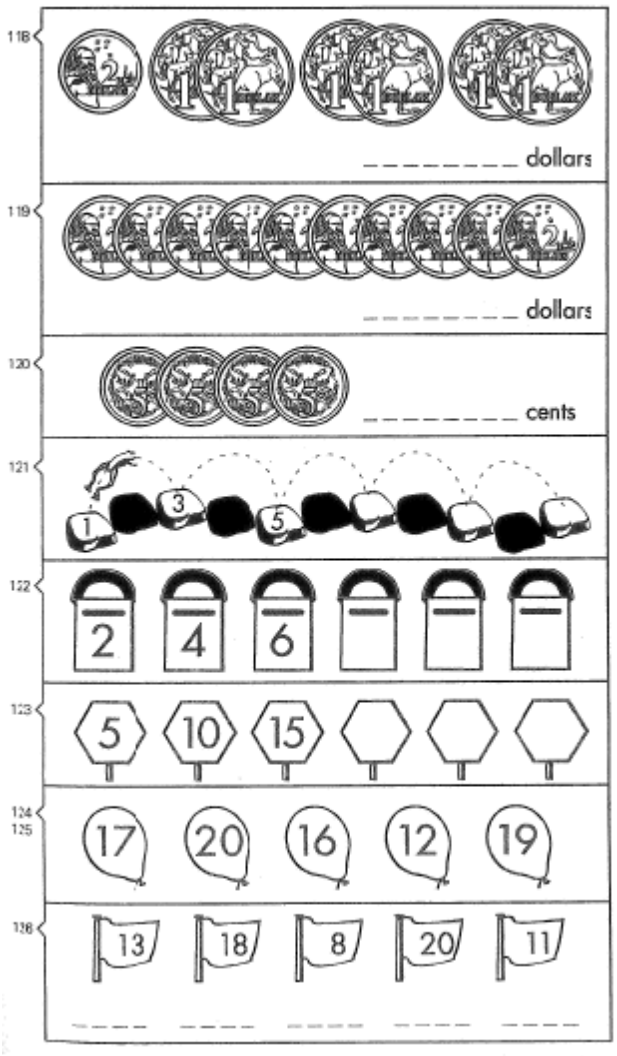
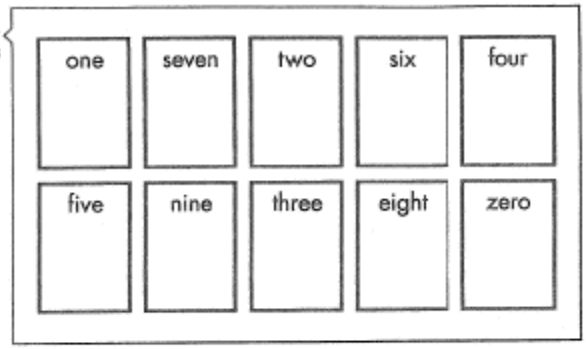
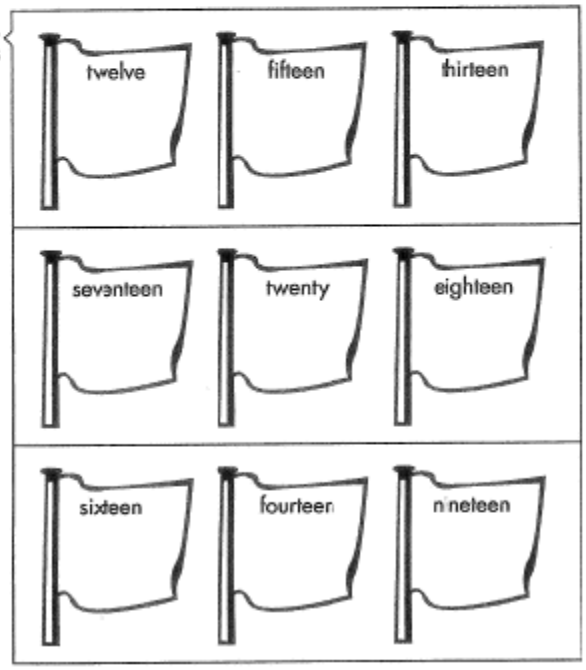

118
dollars
119
dollars
120
cents
121
1
3
5
122
2
4
6
123
5
10
15
124
125
17
20
16
12
19
126
13
18
8
20
11

127
–136



137
–145



146 2 more than 8 is _____

147  5+4= _____

148 

_____ cents

149 _____

150 6+2+5= _____

151 2 less than 9 is _____

152  8−3= _____

153 


_____ cents

154 


_____ cents

155 _____

153

_____ groups of 3 equals _____

157

168

2 groups of 5 equals _____

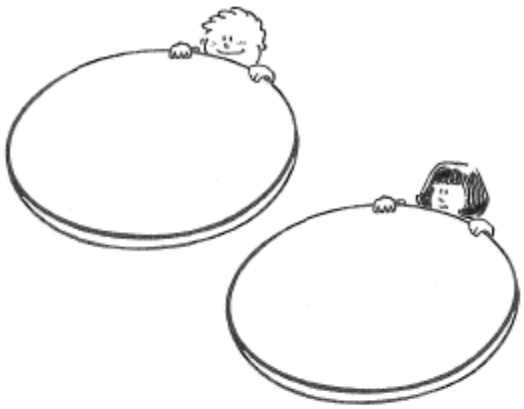
159

6 x 2 = _____

160

show 2x3=6

161



162 12 shared between 2 makes _____ each.

163

164 8 ,how many twos, makes _____ groups.

165

11 ,how many fours, makes _____

166 and _____ left over.

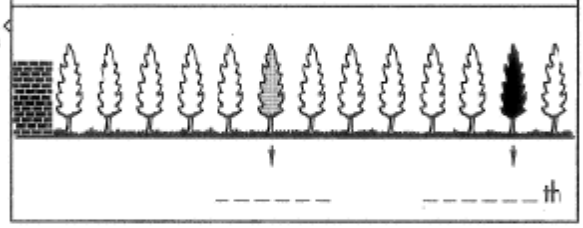
DMT **1** – Part B

Name: _____ Age: _____

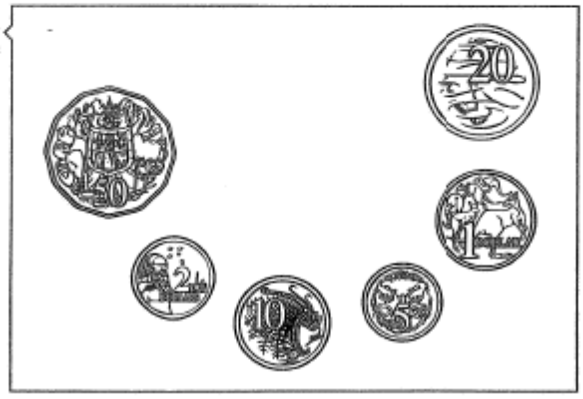
Year: _____ Date: _____

101
–103

104
–106



107
108

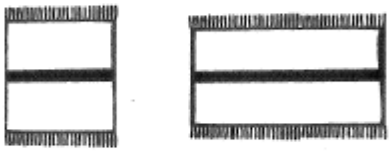



109
110
111
112
cents
113

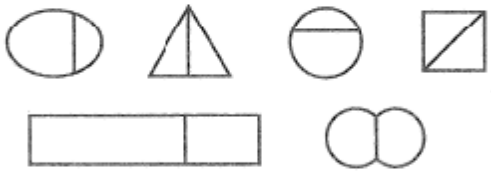
119

_____ matches.

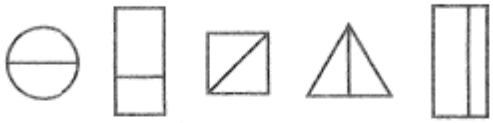
120



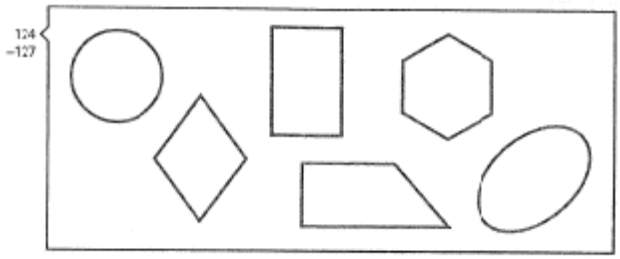
121

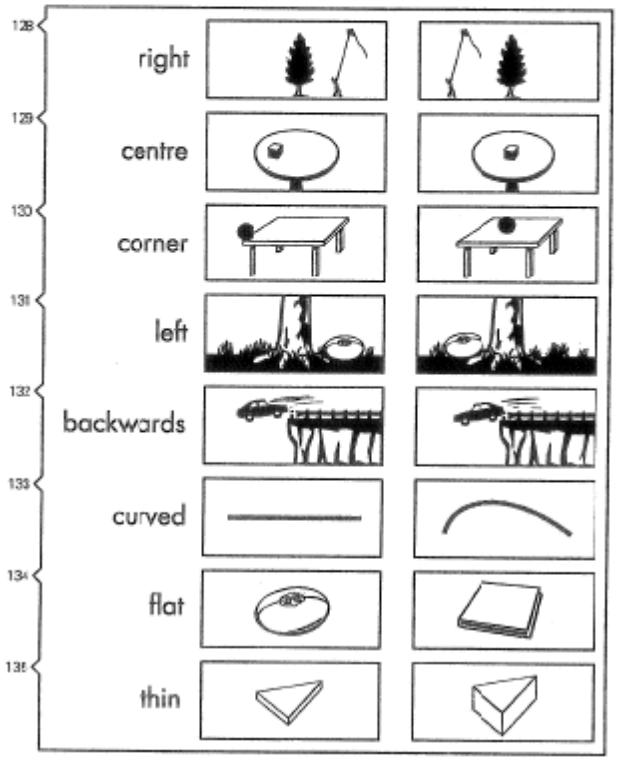


122



123




right
centre
corner
left
backwards
curved
flat
thin

136

137

Which has less mass?

138

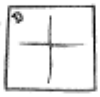
school bag

balloon

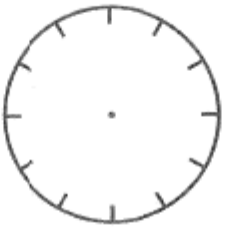
soccer ball

pencil

hanky



139



140
141

_____ o'clock

_____ o'clock

142
143

show 2 o'clock

show 7 o'clock

144

Wednesday Sunday

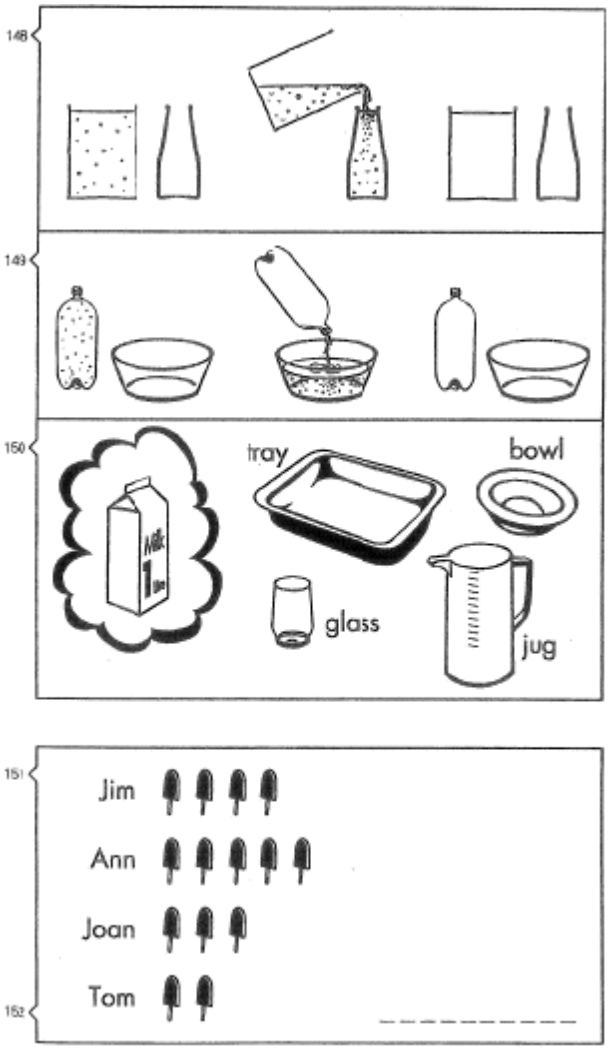
Thursday Monday Saturday

Tuesday Friday

145 Today is _____

146 Yesterday was _____

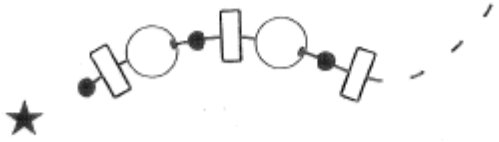
147 Tomorrow will be _____


148
149
150
tray
bowl
glass
jug

151
Jim
Ann
Joan
Tom
152

153

154



155

The number is ☐

156

_____ counters

157

_____ rabbits

158

dub

4 dubs have _____ heads

APPENDIX D **SENA Assessment**

Schedule for Early Number Assessment 1

Interview guidelines

General

- Have an assessment sheet for each student being interviewed.
- Place the assessment sheet to the side of the work space and, if possible, out of the student's view. (A small screen is useful for this purpose.)
- Note incorrect responses and any useful comments on the assessment sheet.
- Where useful, ask students *how* they solved the tasks.
- The interviewer should decide if it is necessary to give additional tasks or to abandon some of the set tasks.

Numeral identification (Tasks 1 – 18)

- Show the numeral cards in the order indicated.

Forward number word sequence (Tasks 19 – 29)

Tasks 19 – 21

- Stop if the student encounters difficulties.

Tasks 22 – 29

- For these "number after" tasks, the interviewer needs to decide if the student finds the "number after" by counting from one or can give the answer immediately.
- If necessary, give additional tasks (e.g. the number after 4, after 7, etc.)

Backward number word sequence (Tasks 30 – 39)

Tasks 30 & 31

- Don't give Task 31 if the student has difficulty with Task 30.

Tasks 32 – 39

- For these "number before" tasks, the interviewer needs to decide if the student finds the "number before" by counting from one or can give the answer immediately.

Subitising (Tasks 40 – 46)

Task 40

- Place the set of "display" dot pattern cards on the table face up in front of the student. (Use the dot pattern cards on page 10.)
- Briefly "flash" the "random pattern" card for "4" for approximately one second.
- The student points to the corresponding card from the "display" set.

Tasks 41 – 46

- Each of the domino patterns appears on a separate card.
- Display each card for approximately one second.

Counting (Tasks 47 – 49)

Task 47

- Place the group of five blue counters in a random group (i.e. not in line or in the dice pattern of five).
- Don't count the counters when placing them on the work space.
- When this task is completed, put the five counters to one side (to be used again in Task 49).

Task 48

- Place a collection of red counters (more than eight) on the work space.

Task 49

- If the student was successful with Tasks 47 and 48, place the eight red counters and the five counters in separate groups and ask: *How many are there altogether?*
- If the student was unsuccessful with Tasks 47 and 48, place 13 counters of the same colour in one group and ask: *How many counters are there?*

Addition (Tasks 50 – 52)

- Pay close attention to *how* the student solves these tasks.
- The interviewer is seeking to determine the student's counting stage and will need to ask what the student did to achieve the answer.
- Specifically, the interviewer is seeking to see if the student:
  - can't count visible items (stage 0 – emergent)

- can't solve hidden tasks (stage 1 – perceptual)
- solves hidden task by counting from one (stage 2 – figurative)
- counts-on (stage 3 – counting-on-and-back)
- uses a more advanced strategy, e.g. making the ten and adding 3 (stage 4 – facile)

Subtraction (Tasks 53 – 55)

- Task 53 is verbal – no counters.

Tasks 54 – 55

- Present the counters as a group. Do not count them out in front of the student.
- These tasks are designed to elicit at least figurative counting strategies.

Multiplication and division (Task 56)

Present more than 12 counters, randomly placed, to the student. The first instruction is designed to indicate if the student is able to form equal groups. Note how the student forms the groups. Does he or she drag the counters one at a time or many at a time to form a group? The follow-up question is intended to show the counting strategy which the student uses to find the total. A student using a less sophisticated strategy will count by ones, ignoring the structure of the groups. A more advanced strategy would be to use skip counting or repeated addition.

Schedule for Early Number Assessment (SENA 1)

Student's name: _____

Class: _____ ☐ Date of initial assessment

D.O.B: _____ ☐ Date of second assessment

Numeral identification

(1)	3	(2)	6	(3)	10	(4)	2
(5)	9	(6)	8	(7)	5	(8)	0
(9)	7	(10)	4	(11)	23	(12)	15
(13)	12	(14)	43	(15)	13	(16)	20
(17)	100	(18)	66				

Forward number word sequences

Start counting from … I'll tell you when to stop.

(19) 1.....32 (20) 62.....73 (21) 96.....113

What is the next number after …?

(22)	5	(23)	9	(24)	13	(25)	19
(26)	27	(27)	46	(28)	69	(29)	80

Backward number word sequences

Count backwards from … I'll tell you when to stop.

(30) 10.....1 (31) 23.....16

What number comes before…?

(32)	5	(33)	9	(34)	16	(35)	20
(36)	47	(37)	13	(38)	70	(39)	31

Schedule for Early Number Assessment (SENA 1)

Subitising

(40) *I am going to show you a card very quickly and I want you to point to the card on the table that has the same number of dots as the one I show you.*

How many dots are there?

(41) 4 (42) 6 (43) 5 (44) 3

(45) 4 + 4 (46) 4 + 5

Counting

(47) Put out 5 blue counters. *How many blue counters are there?*

(48) Put out a pile of red counters. *Get me 8 red counters.*

(49) Put out 8 red counters and 5 blue counters in two groups. *How many counters altogether?*

Addition

(50) **4 + 3** *Here are four counters.* (Briefly display, then screen.) *Here are three more counters.* (Briefly display, then screen.) *How many counters are there altogether?*

(51) *I have seven apples and I get another two apples. How many apples do I have altogether?*

(52) **9 + 4** *Here are nine counters.* (Briefly display, then screen.) *Here are four counters.* (Briefly display, and then screen.) *How many counters are there altogether?*

Subtraction

(53) *I have 7 bananas and I eat 2. How many bananas do I have left?*

(54) **12 remove 3** *I have 12 counters.* (Briefly display, then screen.) *I'm taking away 3 counters.* (Remove 3.) *How many are left?*

(55) **11 remove... = 7** *I have 11 counters.* (Briefly display, then screen.) *I'm taking away some counters and there are 7 left.* (Remove 4 counters.) *How many did I take away?*

Multiplication and division

(56) Present a pile of counters, more than 12, to the student. (Randomly spaced, not in a line. Do not count them out.) *Using these counters, make three groups with four in each group. How many counters are there altogether?*

APPENDIX E **PIPS Assessment Record**

Stucent Name: _____

Date: ___/___/___ Time: ___:___

Maths Assessment

Early maths				
☐ longest	☐ inside	☐ on		
☐ triangle	☐ circle	☐ square	☐ triangle	
Notes:				

Ideas about maths						
☐ biggest	☐ smallest	☐ more	☐ most	☐ least	☐ tallest	☐ shortest
Notes:						

Counting	
☐ How many apples **are** here (4)	☐ How many apples **were** there (4)
☐ How many fish **are** there (7)	☐ How many fish **were** there (7)
Notes:	

Sums A *(Do not provide concrete aids)*							
☐ 3-1=	☐ 4-1=	☐ 6-3=	☐ 2+1=	☐ 3+1=	☐ 2+2=	☐ 3+2=	☐ 4+3=
Notes:							

Numbers									
☐ 4	☐ 1	☐ 3	☐ 2	☐ 5	☐ 7	☐ 6	☐ 9	☐ 8	☐ 0
☐ 2 digit numbers *(note and tick in boxes)*				☐	☐	☐	☐	☐	☐
☐ 3 digit numbers *(note and tick in boxes)*				☐	☐	☐	☐	☐	
Notes:									

Shapes				
☐ star	☐ circle	☐ square	☐ triangle	☐ hexagon
Notes:				

Maths 1 *(Do not provide concrete aids)*				
☐ 1 more than 5	☐ 3 less than 7	☐ 2 more than 6	☐ 3 more than 8	☐ 6 less than 15
☐ 8 more than 13	☐ 10 less than 25	☐ 21 more than 32		
Notes:				

Maths 1 *(Do not provide concrete aids)*			
☐ circle 3/4 coloured in	☐ buy apple (10c)	☐ cover 1/2 the bikes	☐ 7+3=
☐ 10, 20, 30, 40, **50**	☐ 2, 4, 6, 8, 10, 12	☐ half of 5	☐ 4+11=
☐ 9-6=	☐ buy orange (50c + 10c)	☐ 15-4=	☐ 15+21=
☐ 42-17=	☐ Quarter of 8	☐ twice 3 doubled	☐ 105+302=

APPENDIX F

JOURNAL

Week 1

Tuesday

Analysis of the students SENA assessment indicated a weakness in their reading and saying numbers between 10 and 20 with some students mixing teens and ty's. Another common area where limited understanding was demonstrated was the concept of numbers beyond 109. Using the basic digits one to nine, students were encouraged to recognise the patterns in numbers, and how the pattern repeated with the use of only these digits to create new numbers. A variety of coloured markers were used to highlight the patterns in numbers on the whiteboard with students were encouraged to talk aloud as they added numerals which they did with increasing confidence and enthusiasm. A demonstration of 'thinking aloud' was given to assist students with their own thought process and to encourage 'thinking aloud' by the students when participating in mathematics activities in the support room. Following the whole class activity students were provided with an opportunity to consolidate their understanding by individually completing number grids using coloured pencils counting aloud was not discouraged. Emphasis was placed on the teens to help students hear and see the difference between teens and ty's.

Students appeared to be confident completing their own chart with the exception of Lance who became anxious when faced with 'counting to 100', saying "I can't do it" before making any attempt to start. A task involving a large amount of numbers particularly an A4 page fill of numbers and words, combined with the need to write caused Lance to become stressed. He did try once he had been calmed down and was provided with additional support, working one line at a time with the remainder of the page covered by another sheet of paper. Encouragement was given by supporting him providing close reassurance to help Lance to think aloud as he wrote one number at a time, looking back to see if he could recognise the pattern both vertically and horizontally.

Students easily became distracted stopping their own work to listen and watch whenever a child near them received assistance and even though talking aloud was encouraged as a positive it does have its downside, particularly for students who have low level of concentration. Lance frequently reversed numerals and numbers. Neil and Keith were very quick to grasp the pattern and apply it completing the number chart easily continuing to 200, with Neil going beyond. Sara, Anne, Simon, Leanne, Kashia, and Elise, were able to complete the chart to 109 or 119 but became confused after these numbers. Thomas and Rachel wrote numbers into the mid hundreds with some one on one assistance and reminders about what the pattern was.

Thursday

To become more aware of students' number sense and ability to estimate, students were encouraged to count by 2's, 5's and 10's. Discussions using magnetic counters on the white board began with questions 'What is skip counting?' 'Can you give some examples?' 'Why do we skip count? In answer to the question 'when and why we would skip count?' Rachel suggested 'To find how many we have like computers that need repairing' and Neil, 'To count money'. Elise applied the concept to counting counters. After demonstrating counting a set of counters by ones the question was asked 'If I count by 2's will I get the same number?' The majority of the group said "No", although there was some hesitation no-one was confident enough to go against the majority and say "Yes". The knowledge that students were not one hundred percent sure that once they had counted a group of counters, it would stay at that number regardless of the way it is counted indicated their level of mathematical understanding in the pre-program assessment was accurate and they were within the phase of development indicated earlier. The idea of starting counting at the opposite end did not deceive the students as they were quite aware that counting would result in the same number as previously.

The challenge of estimating how many counters there would be when another group of 20 counters were added to the first set resulted in a range of answers, from 24 to 200. Viewing the group of 20 in comparison to the size of a new group now directed students to what could be a realistic number. In pairs with a

random number of counters students took turns to count in 1's, 2's, 5's and 10's, making sure to clearly set counters out to ease counting. The use of a counting finger and talking aloud was encouraged as was the importance of accuracy not speed. Students were noticeably disorganised, not structured, did not naturally line up counters, or move them to count. Lance was clumsy and found it hard to keep one finger for counting. Students appeared to have developed a desire to 'finish first' early during their time at school which can be detrimental to their learning. Students enjoyed this activity and the lesson was a good time length, with active learning occurring continuously throughout. It was noted while counting in 2's or 5's and there were not enough counters to complete a whole set of 2 or 5, students found it extremely difficult to stop and add one when in a rhythm counting and this resulted in the need to 'start again' and revert to counting by 1's instead.

Friday

Results of the DMT assessment indicated a need for further teaching of ordinal numbers. The language of place and position was introduced with students providing information on where they have used this type of measurement. Classification of time – birthdays; position - in a race; counting – how many have been used (tissue boxes and behaviour warnings were given as examples. Coloured counters on the white board provided concrete objects with questions posed such as; 'What colour counter is in 5th place?'; 'What colour counter is before the 3rd counter and what one comes after the 6th counter?'

Students were set a task to draw a 'race' of 10 objects, people, or cars etc and to colour positions as defined on the white board. Coloured magnetic counters were used to assist students who may have had difficulty reading therefore reducing the effect language difficulties had on their understanding of mathematical concepts. Thomas asked for clarification of the concept of before and after, while he was completing the drawing activity after which he let out a sigh of relief 'AHH, I get it!', indicating he understood. The high standard of presentation of the students work was impressive. During the lesson all were busy with no one off task. Following the ease at which students answered questions during the demonstration and whole group participation I was

surprised by the number of incorrect answers in their independent work. Another revelation was my assumption students would follow the examples that had been demonstrated on the board. However all students do not use the starting line position as had been demonstrated. Although the instructions included the need to fit all the objects in one line and all should be of a similar size, Simon drew his cars as in two rows. When questioned why he did his cars in two lines, he replied, “You see cars lined up to race like this in rows”, it was his interpretation and made complete sense to him. Had I marked his work following the lesson without speaking to Simon I question whether I would have just marked his work incorrect for not following instructions, rather than appreciating his ability to draw from his sense of logic and allow him the opportunity to explain his reasoning. Overall the quality of the presentation was above the standard usually presented in class by the students and although their work may not have been correct, their active participation and pride in their work was impressive.

	2nd	**3rd**	**5th**	**Before 9th**	**After 6th**	**Last**	**%**	**Comment**
Neil	√	√	√	√	√	√	100	Excellent
Rachel	x	x	x	x	x	√	17	Missed the first, positioned 5th in 8th place.
Keith	√	√	√	√	x	√	83	Completed, high quality presentation
Sara	√	x	x	x	x	√	33	Started at opposite end. Did not seek clarification while completing the activity.
Lance	x	x	x	x	x	x	0	Excellent presentation. Attempted to follow multi step instructions.
Tama	√	√	√	x	x	√	67	Started at wrong end marked according to her processing.
Elise	x	x	x	x	x	x	0	Difficult to follow her thought processing.
Leanne	√	x	x	√	x	x	33	Incomplete but good quality of presentation. First position was forgotten.
Anne	√	√	√	x	√	√	83	Did not draw 1st. Good results.
Simon	x	x	x	x	x	x	0	Did not follow instructions drew lines of cars, little use of colour to indicate position, however completed more work than usual.
Thomas	√	√	√	√	√	x	83	Neat work excellent illustration but incomplete.

Week 2

Tuesday

Students had previously been introduced to a variety of maths games and play based activities, and following a reminder of how to play each game, provided by the students themselves, working in pairs they rotated through the activities in a twenty minute cycle. While playing students were encouraged to 'think aloud' as they applied the mathematical terms of add, plus and altogether, and to use concrete materials or number lines to assist in their calculations or to check answers. Sara was particularly verbal and enjoyed ensuring others were 'talking aloud'. Keith was not at all interested in speaking but he enjoyed participating in the range of play based activities.

For the final ten minutes of the lesson a quieter period followed the previously 'busy' and excited environment. The concept of number bonds was demonstrated to students on the white board using different colours for each number from which students provided the missing number by recognising the pattern. Two of the 12 students, Rachel and Elise were able to confidently provide the correct answers.

Thursday

Students used counters, teddy bears and drawings to represent number bonds to 10. They challenged each other to provide the missing number and wrote their own individual number sentences to match the action with the concrete objects.

The classroom was busy and it was difficult to oversee students who needed additional assistance while ensuring the dominating behaviour of some students in a partnership did not result in conflict and all students participated and remained on focussed on the task and not 'playing' with the equipment. Sara appeared very confident, and was keen to talk with volume demonstrating her understanding of 'what to do'. Simon finished first with a high standard of presentation which was surprising due to his usual lack of concentration and low level of work completion. Rachel had difficulty and was confused, her lack

of ability to verbalise her understanding or misunderstanding made assisting her difficult. This was surprising as during the whole class activity prior to breaking into small groups she was able to provide correct answer confidently. Students automatically wanted to 'play' with the bears or counters matching colours or sizes, things an adult may find irrelevant and not important. This behaviour was evident in all the students, not only those who displayed a low level of concentration. Students were particular and seldom selected manipulatives randomly, but made selections based one colour or size. Students were able to locate and give answers to missing numbers when working with concrete objects and together as a whole group, including writing the matching number sentences on the white board. However with the exception of Simon all experienced difficulty writing number sentences to match the bonds created from manipulatives when working with one partner.

	1/9	**2/8**	**3/7**	**4/6**	**5/5**	**Comment**
Neil						ABSENT
Rachel Addition	√	x	x	x	x	Needed a lot of assistance during the written activity. Could see the pattern and give correct answers when working with whole class.
Subtraction	x	x	x	x	x	
Keith Addition	√	√	x	x	x	Slow, off task, played with equipment. Did not show understanding of the patterns
Subtraction	x	x	x	x	x	
Sara Addition	√	x	x	x	x	Understood the principle but did not complete only number bonds for 10. Very quick and confident sharing during whole class activity.
Subtraction	x	x	x	x	x	
Lance Addition	x	x	x	x	x	No understanding, even when assisted one on one with concrete objects provided random guesses.
Subtraction	x	x	x	x	x	
Tama Addition	√	x	x	x	x	Completed first one but did not stick to number bonds for 10. Contributed during whole class discussions.
Subtraction	x	x	x	x	x	
Elise Addition						ABSENT
Subtraction						
Leanne Addition	√	√	x	x	x	Excellent contribution during whole class activity.
Subtraction	x	x	x	x	x	
Anne Addition	x	x	x	x	x	Confused with subtraction. Contributed after prompting during whole class lesson.
Subtraction	x	x	x	x	x	
Simon Addition	√	√	√	√	√	Excellent understanding, however needed prompting to contribute during whole class discussions.
Subtraction	√	√	√	√	√	
Thomas Addition	x	x	x	x	x	Went off track, did not write number bonds. Contributed willing when asked during classroom discussions but not with confidence.
Subtraction	x	x	x	x	x	

Kaisha Addition	√	x	x	√	√	Neat and appeared to understand. Errors were in the subtraction with repeating same number sentence.
Subtraction	√	√	x	√	√	

Friday

The aim of the lesson was to consolidate and develop further the patterns found in decomposition and number bonds as most students had not been able to transfer the number bonds to written number sentences.

Students they were given number and symbols written in a range of colours on flashcards. One child was responsible for demonstrating the ‘sum’ on the board using magnetic coloured counters. He or she ‘read’ out the number sentence and student holding the appropriate card came to the front of the room to form the number sentence. The students holding the cards changed positions and the first student manipulated the counters to match. All students were given the opportunity to actively participate, checking and correcting one another as necessary. Each number bond was completed using coloured markers on the whiteboard. Students completed the lesson by writing number bonds on paper using coloured pencils. Kashia was particularly animated and excited during the whole class activity and achieved a good result in her written work. She often found it difficult working in small groups, however she enjoyed the whole class activity and her role playing.

	1/9	2/8	3/7	4/6	5/5	Comment
Neil Addition	√	√	√	√	√	Completed to a high standard of neatness,
Subtraction	√	√	√	√	√	
Rachel Addition	√	√	√	√	√	Required reassurance prior to starting. Completed addition, set work out correctly and correctly wrote one of each pair of the subtraction.
Subtraction	x	x	x	x	x	
Keith Addition	√	√	x	x	√	Off task, did not complete the activity as required or follow examples given.
Subtraction	x	x	x	x	x	
Sara	x	x	x	x	x	Accurate answers during whole class lesson however written work did not support understanding, little completed.
	x	x	x	x	x	
Lance Addition	x	x	x	x	x	Wrote sums that had =10 however the addends did not equal 10.
Subtraction	x	x	x	x	x	
Tama Addition	√	√	√	√	√	Completed addition, used digits in the subtraction, reversed the two digits correctly but misplaced the 10.
Subtraction	x	x	x	x	x	
Elise Addition	√	√	√	√	√	Completed the addition sums but not the subtraction. Not set out as demonstrated.
Subtraction	x	x	x	x	x	
Leanne Addition	√	√	√	√	√	Completed activity setting out as demonstrated. Accurately completed addition but mixed the placement of the 10 in all the subtraction, was aware the other two digits moved positions.
Subtraction	x	x	x	x	x	
Anne Addition	√	√	√	√	√	Completed the addition correctly in pairs, did not demonstrate an understanding of the concept of the subtraction.
Subtraction	x	x	x	x	x	
Simon Addition	√	√	√	√	√	Completed correctly and quickly.
Subtraction	√	√	√	√	√	
Thomas Addition	x	x	x	x	x	Off task, difficult to get him to focus Gained limited understanding and did not follow examples.
Subtraction	x	x	x	x	x	
Kaisha Addition	√	√	√	√	√	Completed this activity correctly, she was animated during the hands-on, whole-class activity.
Subtraction	√	√	√	√	√	

Week 3

Tuesday

Students participated in play based activities and mathematical games as used previously. The focus was on slowing the ‘playing’ down with each student orally expressing what was happening, to ‘think aloud’. The concept of counting on and counting back to find the ‘missing number’ was encouraged.

After moving around the room, closely watching and listening to each small group as they played, I stood back observed and listened, focusing on who needed assistance. Although the activities were simple, it was the development

of the thought processing, strategies and visualising of patterns and development of fluency and confidence were being developed, skills which could be transferred to larger numbers and more complex problems.

The lesson was more successful than the previous week, as purposefully selecting members of each of the groups improved the dynamics and outcomes significantly. Students were heard speaking aloud with an informal leader developing in each group who encouraged others. Sara spoke loudly and clearly understood the concept of counting on and demonstrated this by ensuring others in her group followed her lead.

Thursday

Students were introduced to the concept of 'doubles' and how this knowledge could help solve unknown addition and subtraction problems using the strategy of counting on and back, with one more or one less. This concept was being taught in the Year Two classroom and it was able to be timely included in the support program. Rather than predetermining that the students could not understand this concept as too above their ZPD it was decided the knowledge would be beneficial for the students and the use of patterns could assist students to able this skill.

Numbers up to and including 10 were the initial focus with a demonstration using coloured magnetic counters and the number sentence written on the whiteboard together while 'thinking aloud'. Students took turns to demonstrate their understanding writing and moving counters on the whiteboard as they were challenged with questions from the other students to complete a sum involving one more or less. In small groups students used counters and completed doubling and doubling plus and takeaway one together. The use of fingers was encouraged too as this is a known strategy they were familiar with and it was able to be used to develop their fluency and automatic recognition, with the eventual goal for students to not need to count all.

Students enjoyed working with counters and most understood that doubles result is the similar to counting in 2's (recognition of patterns and even

numbers) and were able to add one more. Sara stated, “We are counting by 2’s.” A short review of odd and even numbers was given to ensure all students were able to recognise these term. Although unplanned it was decided to introduce the 2 times tables it related well to what the students were doing and children already had 2 groups of equal numbers of counters

The lesson ended with students matching pre cut words to the correct numeral 1 to 20. The students enjoyed this activity and needed a quiet, but hands-on activity as they were becoming quite ‘tired’ and reading and writing numerals was an area on which they needed to focus.

Friday

Due to a change of arrangements within the school for an incursion the planned lesson time was reduced. Students participated in playing mathematical games other activities were played again in groups of two and three. The lesson began with a review of the concept of holding larger number in their head and the use of a ruler for a number line. The correlation between addition and subtraction, more and less were reviewed. The concept of all games needing to have a winner is one that is difficult to remove from the children’s mind set.

Week 4

Tuesday

In the classrooms students were being introduced to the measurement of area. In order to not miss out on what is being covered in the class students completed a worksheet as requested by classroom teachers involving measurement using 1cm cubes. While the cubes were out Cuisenaire rods were introduced and the concept of the different sized rods representing numbers and adding two rods (numbers) equalled another rod (number). Manipulating the rods created ‘family of facts’, or ‘number bonds’ in patterns of colour the students could see. I built the rods very carefully vertically, the possibility of them falling added to some excitement for the students (unintentionally). Students contributed by suggesting which rod to place where involving them in the demonstration developing their estimation skills. Number sentences were written on the white board by students, ‘dictated’ by other

students. The class was divided into two groups due to limited number of Cuisenaire rods and while one group made their number bond pattern to 10 and wrote the matching number sentence the others matched words to numerals for numbers 1 to 20.

Thursday

The concept of counting in 2's 5's and 10's with the understanding that odd numbers are able to be counted in 2's not only the even numbers and that is it still counting in 10's when starting between the decades was introduced. A large 100 grid was used for demonstration, in conjunction with a large number line (metre ruler). Questioning revealed students believed counting in 2's had to begin at 2, and could only be even numbers. Their understanding was similar for 5's and 10's. A number chart helped the students see and hear that it was possible to count in 2's starting at any number including odd numbers. Counting in 10's from a number between decades was much easier for the students to follow visually and they were soon able to do this themselves. A discussion was held on the purpose of being able to count in this way when it would be used and by whom.

Keith had difficulty concentrating and not fiddling with rubbers or anything that is close to him. When provided with direct supervision he was able to concentrate and completed the written sample quickly. Lance did his best but became upset when he found something challenging or lots of numerals on a page and needed to be provided with individual assistance. Anne, Elise, Rachel and Neil completed their work independently**.**

Friday

The lesson began by using coloured counters lined up in a row on the white board and a range of questions asked of the students relating to before and after. Start and finish lines were added followed by questions relating to ordinal numbers, in combination with before and after. A set of simple direct instructions were written on the board for the students to follow. Students decided their own positioning of the start and finish lines but were directed to draw coloured stick figures and not to focus on elaborate drawing. The time

allocated to complete this activity was 20 minutes, which appeared long enough and encouraged students to focus on the task. Exact colours had been previously sorted to reduce the need to search for colours in a pencil case, therefore eliminating a time wasting and distracting task.

Instructions: Red 1st, Blue 3rd, Yellow 4th, Black 6th, After Red, After Green, Before Black, Before Orange. Students produced a high standard of work, no-one was off task and the lesson was only 30 minutes long. Their understanding of ordinal numbers and position showed significant improvement on the previous lesson covering the same concept. Classroom teachers reported all students returned to the class excitedly saying they had fun.

	1st	2nd	3rd	4th	5th	6th	Start Finish	Comment
Neil	√	√	√	√	√	√	√	Confident, worked quickly to complete activity.
Rachel	√	√	√	√	√	√	√	Set her race opposite to that demonstrated, worked quickly and confidently.
Keith	√	√	√	√	√	√	x	Worked quickly neatly presented, did not label start and finish lines.
Sara	√	√	√	√	√	√	x	Actively participated in class, start and finish did not match the positions of the runners.
Lance	x	x	x	x	x	x	x	Did not follow any of the instructions apart from drawing runners in a race.
Tama	√	x	x	x	√	√	√	Completed the 1st place and 6th place first followed by one before black, but in drawing in red and 4th omitted 2nd. Drew facial expressions but kept to stick figures.
Elise	x	x	x	√	x	x	x	Drew race opposite to demonstrated and 1st person facing the correct way, had her start been the finish. The other runners were drawn facing the finish 6th in black with a number 1 attached. Limited following of other instructions was evident.
Leanne	√	√	√	√	√	√	√	Followed all instruction, neat tidy stick figures with the addition of breathing.
Anne	√	√	√	√	√	x	√	Completed activity neatly with stick figures. Only error was misplacing the orange runner, added breathing and hair.
Simon	√	√	√	√	√	√	√	Completed activity independently and accurately. Race was the opposite way to that demonstrated. Drew stick figures with the addition of faces and hair.
Thomas	√	x	√	√	x	√	√	'The artist' focused more on drawing cartoon characters with speech bubbles than completing the activity. He left room to draw the second placed runner and only needed to colour the 5th runner but he did not complete the activity.
Kaisha	√	√	x	x	x	x	√	Drew in the start and finish lines positioning first and second accurately. Placement of the remaining runners was seemingly without reason and inconsistent. Work was neat with runners having faces and hair

Week 5

Tuesday

A review of Cuisenaire rods was followed by the playing of mathematical games which included a rotation with the rods. The focus was building and recognising the patterns found in number bonds, while developing an association between written number sentences. The use of repeated colour and repeated patterns with basic addition and subtraction skills was within the scope of the other activities and building students concrete to abstract.

Students were placed into groups of three or two, with a more confident student in each. The Cuisenaire Rods provided the most challenge although students were able to build their number bonds recording as number sentences on paper while saying aloud what they represented proved to be a challenge. Elise was once again withdrawn for violin lessons during this lesson.

Thursday *(Founders Day Activities)*

Friday

The lesson involved writing numbers that are less or more than a given number. Students used of a number chart to help solve a range of problems such as five more than or 10 less than. Students were asked to colour in even numbers and outline numbers counting in 5's on the number chart provided.

Rachel continued to use her fingers to count on rather than use the number grid. All students needed to have the directions read to them each time they moved onto a new section. The use of a number grid appeared to cause confusion for the students who were beginning to develop confidence using a number line. Simon worked steadily but was still slower than the other students.

	10's	1 after	2 more	4 more	5 more	10 more	Even	5's	Comments
Neil	100%	83%	67%	83%	83%	80%	√	√	confident
Rachel	100%	83%	100%	100%	100%	100%	√	x	Steady
Keith	100%	100%	83%	0	0	60%	√	x	Inconsistent.
Sara	100%	33%	50%	67%	0	0	√	x	Very weak.
Lance	Absent								
Tama	100%	50%	17%	17%	100%	100%	√	√	not confident
Elise	Absent								
Leanne	100%	67%	83%	67%	100%	40%	√	√	Steady work
Anne	100%	100%	100%	83%	83%	100%	√	√	Good result
Simon	100%	100%	83%	83%	83%	80%	√	√	steady work
Thomas	100%	100%	100%	83%	100%	80%	√	x	Confident
Kaisha	100%	100%	100%	17%	83%	100%	√	x	independent

Week 6

Tuesday

Students continued with the activities from the previous week as they had not rotated around all activities and I wanted them to have a turn with the Cuisenaire rods and matching the written word with the numeral.

Keith was able to quickly match the digits 1 to 20 with the words only mixing twelve and twenty. I found this interesting due to his very limited phonological knowledge, he was not doing it by sounding out but may have been developed sight word knowledge of numbers. Neil and Tama worked quietly together creating the Cuisenaire rod pattern but had some difficulty writing up the number sentences. Elise was quite animated playing the mouse trap game but had to go to violin lessons and did not get to complete the activity although she constructed her pattern successfully.

Thursday

Last day of term, students were too busy in their own class to attend support group lessons.

Week 7

Tuesday

The book ‘The Doorbell Rang’ (Hutchins, P. 1986), was read to students to combine the concepts of sharing, repeated addition and skip counting together with continued addition and subtraction focusing on the ‘missing’ or unknown’ quantity. The knowledge that as the same number is shared among more each portion becomes less was developed through the use of realistic number examples. These skills are important prior to the introduction of multiplication as students move through the quantifying phase of development.

Students suggested baking more and the story was re-read and the larger number shared. Another suggestion from the students was adding more visitors or giving the dog some. Students were given some counters and a coloured sheet of paper, which became a tray of biscuits which were shared as each visitor arrived. This was an activity they enjoyed, and they remained focused and on task. Lance required some assistance to manipulate his counters and prompts to assist him to remember exactly what he was doing.

Thursday

The book ‘The Great Divide’ (Dodds, 2000) was read to students who were shown how halving large numbers could be easy by applying their knowledge of halving small numbers. Students created their own edition of the story filling in the unknown such as what happened to the competitor who came second. The key focus was the concept half is two groups of equal size. Arrows were used as indicators of direction an important strategy for students to implement when solving story problems using story boards.

Beginning the mathematics lesson with a story was a good start with the students enjoying the story line. The visual halving of the given number of characters in the pictures in the book demonstrated in diagram form on the board appeared to consolidate comprehension of the topic for the students. Many hands went up to give the answer for half of each of the given numbers during the re-reading of the book with the correct answer provided. Students

worked enthusiastically to complete their book while developing skills to ‘draw’ to represent without too much detail.

	Used Arrows	Used Numerals	Comments
Neil	√	√	Excellent diagrams. Whole story completed.
Rachel	√	√	Excellent diagrams. Whole story completed.
Keith	√ **some**	√ **some**	Difficulty listening and following instructions.
Leanne	**absent**		
Sara	√	√	Excellent diagrams. Whole story completed.
Tama	√	√	Worked well, able to follow instructions demonstrated understanding
Elise	X	√	Worked well, able to follow instructions demonstrated understanding
Lance	X	X	Completed pictures, did not show halving using arrows for direction.
Anne	√	√	Excellent effort, good pictures, and followed instructions.
Simon	X	X	Very difficult to remain focused and on task, little completed.
Thomas	X	X	Completed pictures did not use arrows.
Kaisha	√	X	Little completed, Used arrows

Friday

The mathematical focus for students in the Year Two classroom was measurement, in order to consolidate concepts covered in the classroom, the concept was included in the support program. The lesson began with a brainstorm of ideas about measurement and when each could be applied in a real life situation. Students knew terms but were unsure of when to use each one but could provide a range of places they had seen measuring devices. The importance of starting at the same point in order to obtain a fair and accurate measurement was given along with the language of comparative terms and units of measurement for length, height, weight and volume. Sara, Rachel and Neil became quite competent at predicting the smallest measurement by recognising the common term ‘milli’ although this was hinted towards but they were able to recognise the pattern.

Students displayed confidence sharing ideas during group discussions, but were often unable to demonstrate this when applying the concepts covered in written or drawn examples.

	Diagrams Shows difference				Terminology	Unit of	Comments
	H	L	W	V			
Neil	√	√	√	√	√	√	Used fat and skinny rather than heavy and light
Rachel	√	√	√	X	√	X	Confused units of measurement good diagrams understanding of size difference
Keith	X	X	X	X	X	X	Limited understanding. Copied others rather than applying own thoughts.
Sara	√	X	X	X	X	X	Not confident.
Leanne	**Absent**						
Tama	√	√	√	√	√	√	Confident excellent diagrams.
Elise	√	X	X	X	X	X	Good diagram and understanding for height but other units mixed.
Lance	X	X	X	X	X	X	Did not understand.
Anne	√	√	X	X	√	√	Excellent but incomplete.
Simon	√	√	√	√	√	√	Confident excellent diagrams all work completed.
Thomas	√	√	X	X	X	X	Excellent diagrams, has difficulty focusing and including only the relevant points
Kaisha	√	√	√	√	X	X	Used taller and shorter only

Week 8

Tuesday

'When the Doorbell Rang' was re-read to students' who discussed similar situations involving sharing objects and the portion attributed to each became less. Students were set the task of creating a story of their own when a similar event could have or had occurred. Students wrote a number sentence to match their illustrations.

Students were able to realise that with each new visitor everyone's share got less. The division symbol was used to represent 'sharing' and the equal sign 'the share' each person received. Pictures and stories were understood by most of the students, however when asked to draw a tray of something and share between varying numbers of their family or friends some became confused. At

first they wanted to fill their tray, so were reminded how it was easy to count how many when drawn neatly in rows and columns. A total of 20 items was suggested as the most to draw. Rachel became 'stressed' not knowing what to do, wanting significant reassurance; she was quite competent and provided answers during the brainstorming prior to the students completing their own diagram. Students enjoyed making up a story, Neil had dogs coming to eat the biscuits.

	Diagram	Shows sharing of items	Correct notation	Comments
Neil	√	√	√	Could not share 20 by 3 but others correct
Rachel	√	√	√	Demonstrated a high level of competence in her diagrams.
Keith	√	√	√	Drew 20 items on tray but did not use columns. Correct notation but answers incorrect.
Sara	X	X	X	Tried to do columns but too many biscuits to share
Leanne	√	√	X	Draw characters and tray of biscuits but difficulty sharing.
Tama	√	√	√	Drew biscuits on a tray and appropriate characters. Used correct notation but answers incorrect.
Elise	√	X	X	Did not keep to rows and columns but neat diagram.
Lance	√	√	√	Produced the correct written notation but no answers.
Anne	√	√	√	Excellent work, with diagrams and numerical notation.
Simon	√	√	√	Neat numerical notation did not complete any of the sharing.
Thomas	√	√	√	Completed the activity with a high level of presentation and mathematical concepts.
Kaisha	√	√	√	Excellent diagrams, did not have correct numeration.

Thursday

Students worked in pairs to think of an addition or subtraction problem where one of the parts was unknown or 'missing'. One of each pair wrote the number sentence and the other solved the problem. Students were encouraged to draw diagrams to assist them. Terms such as total number, altogether, more, less, and difference were encouraged to be used.

When students had opportunities to work on blank paper they demonstrated creativity and their work provides a greater insight into their achievement level

and understanding than when completing a worksheet copied from a published book. Listening to the children sharing problems was interesting, the range of stories intriguing. Lance and Simon got carried away with their pictures and stories saying “Once upon a time, in a haunted house”.

Friday

Measurement of height and length was the concept of the lesson. Students made comparisons between two objects measuring and recording each measurement while using comparative language and drawing a diagram. Students worked in pairs to measure object choices in and outside the classroom.

A terrible lesson! (well I thought so the children loved it)

After a short discussion and brainstorm the children measured items using a tape measure and recorded their measurements in columns for mm, cm and m proved to be very chaotic particularly for a Friday afternoon. Students were observed enjoying themselves, maybe it was just me who didn’t enjoy it at all, as I wondered if they were actually getting anything out of the lesson. I did observe students using a correct starting point and reading the measurements correctly. Most items were in cm with items of using m and mm difficult to find. To conclude the lesson students compared the objects that were longer or shorter.

Week 9

Tuesday

Number stories were discussed and demonstrated on the white board using picture diagrams and number sentences, with the focus was on ‘sharing’ and ‘groups of’. Student created their own story however when this was proved too difficult for most, the activity was stopped and instead I told a number story to the students who then drew a matching picture diagram and write a number sentence.

After the lesson had been altered the students were able to complete the task with more success. The writing of number sentences still proved problematic for

many, particularly sharing or division. When talked through the problems on a one to one basis with direct questioning students were able to complete the problems individually. Classroom teachers had sent in 'times tables booklets' but the students did not understand the concept of tables and I prefer to teach the family of facts method to develop an understanding of the relationship between multiplication and division and not rote learned. Sara picked up on this during the demonstration on the white board, saying "this is like when we found the missing numbers". A common area causing misunderstanding appeared to be when to use the multiplication and the division symbols.

Thursday

Using counters children found how many different ways they could share the counters and how many different ways they could record this in writing. A demonstration on the whiteboard using a group of magnetic counters was given with suggestions on how to share provided by the students.

Most appeared to struggle to complete the task without individual assistance Lance needed to count every counter each time.

	2 x 10	**10 x 2**	**4x5**	**5x4**	**Division**	**Comments**
Neil	√	√	√	√	√	Slow to complete work but with individual assistance completed the task.
Rachel	√	√	x	√	x	Little confused, required assistance
Keith	√	√	√	√	x	Had difficulty following directions.
Sara	√	x	√	√	x	Confused used both 12 and 20 counters.
Leanne	Absent					
Tama	√	√	√	√	x	Individual assistance to group objects.
Elise	√	√	√	√	x	Completed grouping of objects after individual assistance.
Lance	√	√	√	√	x	Needed individual assistance. Counted from one each time.
Anne	√	√	√	√	x	Confident but not with the sharing and division part.
Simon	√	√	√	√	x	Understood and completed multiplication but not the division.
Thomas	x	x	√	√	√	Required explicit one on one teaching.
Kaisha	√	√	√	√	√	Completed all sharing and grouping activities without assistance.

Friday

Students had a multiplication and division worksheet to complete for their portfolio, provided by the classroom teachers. Questions were read to students as I believe language was not part of the assessment task only the math skills and assistance was given to endure literacy did not impact completion of the task.

	Multiplication	**Division**	**Comments**
Neil	√ 5/6	With assistance	Confident with multiplication, required individual assistance to complete the tasks in division.
Rachel	√ 6/6	√ 5/6	Competent with multiplication and division, simple counting error only mistake.
Keith	X 3/6	X 0/6	Inconsistent, mixed results not competent.
Sara	X 1/6	X 0/6	Inconsistent, mixed results not competent.
Leanne	X 3/6	X 2/6	Inconsistent, mixed results not competent.
Tama	X 2/6	X 1/6	Developing skills but not competent.
Elise	X 1/6	X 0/6	Little sense obtained with irrelevant numbers used.
Lance	Absent		
Anne	X 2/6	X 0/6	Inconsistent, numbers used but in the wrong positions.
Simon	√ 4/6	X 0/6	Competent with multiplication, addition errors. Division not completed with little understanding demonstrated.
Thomas	X 0/6	X 0/6	Inconsistent, mixed results not competent.
Kaisha	√ 4/6	X 1/6	Inconsistent in multiplication, developing skills with division but not yet competent.

Even using the ‘I do, We do, You do’ approach combined with the use of counters and diagrams, students still struggled with the concept of multiplication and division. Although the terms sharing and grouping were used to assist develop understanding and reduce the fear associated with the terms multiplication and division the majority of students required further one on one direct instruction, however this was still not totally successful.

Week 10

Tuesday

Following the observations and results of students' ability to group and share combined with understanding the relationship of this to multiplication and division and the need to provide a portfolio sample for their classroom teachers I worked with pairs of students as they focused on multiplication and division questions using concrete objects, while also revisiting addition and subtraction problems developing their counting on and counting back strategies.

Completing addition and subtraction activities resulted in silly errors mainly due to not looking at the changing sign, with most problems being hidden numbers. Lance and Simon struggled to remain on task however most others were able to complete the activities. Working with the students in pairs as they completed grouping and sharing problems with counters proved rewarding. Lance struggled but with persistence and individual attention was able to work through some problems. Elise needed help to separate the groups of counters and prompts to complete the number sums.

Thursday

Continuing from the previous lessons students worked in small groups with one telling a number story involving groups while the others in the group used counters to represent the story and recorded it as a multiplication number sentence. The students were then challenged to come up with the reversal as a division and write it down as a number sentence and check each others work.

Most children had difficulty writing the division and a common problem telling a story that involved grouping of objects and therefore multiplication and not addition.

	Multiplication	Division	Comments
Neil	√	√	Good story was able to both group his counters and write his number sentence.
Rachel	√	√	Had problems coming up with a multiplication story and not addition.
Keith	√	√	Required prompts made counting errors due to his untidy presentation.
Sara	√	√	Difficulty with a multiplication story and not addition
Leanne	√	√	Errors counting total number of counters and trouble creating a multiplication story.
Tama	Absent		
Elise	X	X	Had trouble setting out counters and needed prompts to write a number sentence.
Lance	X	X	No understanding, became upset but happier when others did it for him.
Anne	√	√	Needed help to place counters according to story was able to write number sentence with prompts.
Simon	Absent		
Thomas	X	X	Did not follow instructions. When prompted able to give answers.
Kaisha	√	√	Wrote the correct number sentence, trouble sorting counters into number of groups.

Friday

The lesson began with students brainstorming words that can be used for position and direction before completing two activities. After a discussion the students completed a listening activity requiring the placements of given objects, followed by a second activity which required them to follow written instructions. (However students were able to have this read to them) Both space activities focused on following directions and placing given objects in set positions.

During the discussion the ability to correctly place objects proved difficult due to students' point of view. For what seemed like an easy activity above and left and right proved difficult. This was especially the case as the picture was only one dimensional. The instruction to place a glass of water above each placemat is not really an accurate instruction considering the meaning of above. In order to follow the instruction to place a fork to the left and knife to the right of each plate required students to visualise the person sitting at the table. This concept was discussed prior to starting however proved the main cause of errors.

During brainstorming it was amazing to find students did not know what salt and pepper shakers were. Suggestions included ‘You see them at Sizzler’. What seemed to be a simple instruction did not cater for the vocabulary of the students I assumed all students would know exactly what salt and pepper shakers were. It was noted further lessons would need to focus on the concepts of left and right.

	Auditory	**Written**	**Comments**
Neil	10/10	4/6	Salt and pepper **(right/left)** Knife and fork **(left/right)**
Rachel	10/10	4/6	Salt and pepper **(right/left)** Knife and fork **(left/right)**
Keith	7/10	4/6	Not in middle, size, shape, and stick lines, ball in correct hand. Salt and pepper **(right/left)** Knife and fork **(left/right)**
Sara	7/10	5/6	Ball in wrong hand **(left/right)** Salt and pepper **(right/left)**
Leanne	9/10	5/6	Ball in wrong hand **(left/right)** Salt and pepper **(right/left)**
Tama	Absent		
Elise	6/10	5/6	Confused, odd pictures included ball in wrong hand **(left/right)** Glass of water **above**
Lance	3/10	4/6	Each instruction is drawn with no connection to one another. Salt and pepper **(right/left)** Knife and fork **(left/right)**
Anne	9/10	5/6	Ball in wrong hand **(left/right)** Salt and pepper **(left/right)**
Simon	9/10	6/6	Ball in wrong hand **(left/right)**
Thomas	9/10	4/6	Ball in wrong hand **(left/right)** Salt and pepper **(right/left)** Knife and fork **(left/right)**
Kaisha	8/10	5/6	Ball in wrong hand **(left/right)** Salt and pepper **(right/left)**

Week 11 -MADD WEEK

Tuesday: *timetable clash*

Thursday: *timetable clash*

Friday: *timetable clash*

Week 12

Tuesday Gillian sick

Thursday Gillian sick

Friday Gillian sick

Week 13

Tuesday

In pairs students rolled a dice twice and used the first roll to determine the number of groups and the second how many in each group. Confusion developed with the students adding the numbers such as 6 + 4 = 10 rather than how many altogether. Another error was using the first counter as a marker for the group and then including this in the total number. Keith had extreme difficulty staying on task, wanting to play with counters. Working individually with students helped considerably, Lance showed more confidence using the mathematical symbols and language. At the end of the lesson I rolled the dice and the students took turns to use the coloured magnetic counters to make the groups and write the number sentences on the whiteboard. An error with my instruction appeared to be not drawing circles or a defining object in which students can place their group of objects, with confusion over marking the group and objects within it.

	Comments
Neil	absent
Rachel	Lacked confidence but was able to complete both the grouping of objects and writing of correct number sentence when one to one assistance.
Keith	Required constant reminders to stay on task and individual assistance, understands the writing of number sentences and that division is opposite of multiplication.
Sara	Sara had difficulty adding and subtracting not multiplying. She was able to work through an example on the board with prompts.
Leanne	Not confident, added extra counters as a marker for the group and included these in her total. She began to demonstrate some understanding but not competence.
Tama	Had difficulty setting the counters out in groups using a counter as a marker for the group, adding the appropriate number of counters and then counting all.
Elise	Gained some understanding after 1-1 assistance prior to this she was adding an extra one to each group.
Lance	Able to work when given 1- 1 assistance prior was adding numbers together and becoming confused. Lances understanding of terminology is improving.
Anne	absent
Simon	Demonstrated confusion at the start but gained confidence after 1-1 assistance and working in a group of 3 with Thomas
Thomas	Although he had difficulty at first but gained confidence after 1 -1 assistance and was able to successfully complete a number of groupings and was able to assist Lance.
Kaisha	Very competent with all tasks.

Thursday

Year Two excursion - No class

Friday

Continued with multiplication (grouping of objects), division (sharing), addition and subtraction concepts. A variety of story problems were orally presented from which students decided how to represent each on the whiteboard using both pictures and a number sentence. Students were encouraged to listen for the clues of the key information and completed a number stories activity where they had to complete the number sentence based on the diagrams and story provided. Most students were happy to read the sentence themselves although Lance and Keith had each problem read to them. After completing the sheet, students were given a blank A4 sheet folded into 4. The challenge was to write a simple problem and draw a matching picture and number sentence. Students completed one for each of the four symbols, multiplication, division, addition and subtraction and enjoyed creating their own maths worksheets.

Results of the activity show a variety of understanding still existed within the group. When working through problems in a strong supportive environment one step at a time understanding was obtained, however without assistance the success was not demonstrated.

Week 14

Tuesday

The lesson began discussing perspective, using a range of examples such as students sitting at the desk what was left to some people and right to others. Where was the front? What was next to, in front of and behind? This was followed by students completing worksheets copied from published books and drawing their own diagrams to indicate position.

Although during whole class activities students began to demonstrate understanding of the concepts this was not reflected in individual work, with correct and incorrect answers within the same diagram in the written activities, not pointing to a single cause for the errors. At times errors could be classed as

an inability to place oneself in the position of the ‘character’ but this would be followed by a correct answer which required the same viewpoint. Errors were made with people sitting in all positions on the table, both in student drawn diagrams and pre set diagrams.

	Boy		**House**		**Table**			**Own Group setting**
	Right (3)	**Left (4)**	**Right (1)**	**Left (1)**	**Right (2)**	**Left (3)**	**Opposite (3)**	**Picture & 3 statements**
Neil	3	4	1	1	0	2	3	Good diagram, 1 statement
Rachel	2	3	1	1	2	0	3	Good diagram, 2 statements
Keith	3	2	1	0	0	1	0	Good diagram 2 statements
Sara	0	0	1	1	0	3	3	Good diagram, 2 statements
Lance	0	1	1	1	0	3	3	Drew a diagram not labelled
Tama	0	0	1	1	2	2	2	Good diagram and 2 statements
Elise	1	0	1	1	2	1	2	Diagram of table at home not of group of students at school, no statements
Leanne	1	0	1	1	0	3	3	Good diagram, 3 statements
Anne	0	0	1	1	0	2	3	Good diagram, 3 statements
Simon	0	0	1	1	1	1	3	Good diagram, 3 statements.
Thomas	0	0	1	1	1	3	3	Good diagram, 0 statements
Kaisha	2	4	0	0	0	2	3	Good diagram, 3 statements

	Next to	left	Behind	In front of	Comment
	(2)	(4)	(1)	(4)	
Neil	2	2	1	3	Confused with left and right and placed teacher next to, not in front.
Rachel	2	2	1	2	Initially had front and back mixed but answerd a later question with the correct direction. Accurate placement of her own drawn objects
Keith	2	2	0	1	Confused left and right and behind and in front of also mixed.
Sara	1	3	1	4	Mixed in front of and used next to.
Lance	1	2	1	4	Good effort, appeared confident when completing this activity.
Tama	1	2	1	3	Greater accuracy demonstrated when drawing own objects.
Elise	2	2	0	2	Confusion with left and right used to answer questions involving the same side.
Leanne	2	2	1	3	Confusion with left and right, next to and in front of it.
Anne	2	4	1	4	Confident good answers, including drawing in own objects.
Simon	2	4	0	2	Confusion with in front of and behind.
Thomas	2	2	1	4	Confusion with left and right.
Kaisha	1	4	1	3	Next to and in front of mixed,

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Thursday

Students were introduced to the concept of half and a quarter, in line with the current Year Two topic. Demonstrations using groups of objects and counters on the white board were used to separate or group into half or quarter. Mathematical notation for both was introduced along with the written word. Students made suggestions as to when they would share an object or a group of objects and ways they could divide, cut, count, sort each. It was noted that Tama, did not appear to understand, and tended to wait and copy off others, lacking confidence to have a go herself. Students completed a worksheet on half and a quarter, as requested by the classroom teachers. Most students were able to divide a given object into half or quarter but colouring in half or quarter of a given number of objects proved challenging, and indicated a need of further learning in order to master the concept.

	Divide in half (9)	Divide in Quarters (9)	Share Half (6)	Share Quarter (6)	Comment
Neil	9	8	6	0	
Rachel	9	9	6	5	Competent
Keith	3	9	2	0	Unusual to solve ¼ but not ½
Sara	9	9	0	4	
Lance	9	0	2	0	
Tama	9	9	1	3	Did not understand tending to wait and copy. Lacked confidence to have a go. Messy work.
Elise	9	9	3	0	Coloured in too many ¼'s but accurately divided. Only coloured 1 for each ¼ sharing.
Leanne	9	6	9	0	Coloured in too many ¼'s but accurately divided
Anne	9	9	6	0	
Simon	9	9	6	0	Coloured in too many ¼'s but accurately divided
Thomas	9	6	6	0	
Kaisha	9	0	9	5	Incomplete, had difficulty following instructions

Friday, 17 September:

Students demonstrated their understanding of dividing objects and groups of counters into halves and quarters on the whiteboard, drawing diagrams and manipulating magnetic counters. Following the whole class activity students drew four shapes on grid paper, counted the number of squares enclosed in the shape, counted out the same number of counters which was 'halved' or divided into 2 equal groups. Most problems were caused by presentation, the ability to rule along a straight line and accurately count squares or counters. Sharing the counters into two or four equal groups was achieved by most students, however most demonstrated difficulty having sorted the counters into groups they needed to count each group separately to explain how many were in each group.

Week 15

Tuesday

A review of the previous lesson included a demonstration of how to draw shapes on grid paper and the process of sharing/dividing using counters and tally's. Enthusiasm throughout this lesson was high, children enjoyed creating their own shapes and working with counters. A range of abilities was evident in the class with four students requiring individual assistance while four worked independently with speed and accuracy.

	Find Whole	Find Half	Comment
Neil	√	√	Competent, completed small volume of work. Reluctant to seek assistance, but keen to assist others.
Rachel	√	√	Independent, used tally and counters. A neat, accurate and fast worker. Competent but not confident.
Keith	√	√	Untidy work. Was able to complete tasks with counters and tallys.
Sara	√	√	Developing ability to locate half but not competent. Slow worker, learning to used counters and tallys.
Lance	X	X	Lacks confidence, able to find ½ with 1-1 assistance and prompts.
Tama	√	X	Not confident, lacks ability to work independently.
Elise	√	X	Ability to find the whole number but not half. Tries hard needs after 1 -1 assistance.
Leanne	√	√	Gaining ability but requires further practice. Used counters, slow at processing.
Anne	√	√	Independent worker, used tally and counters, neat and accurate.
Simon	√	√	Excellent independent worker used tally and counters, neat, accurate and fast work.
Thomas	√	√	Reluctant to seek assistance, tendency to choose off task. When given 1 -1 assistance able to grasp concept. Able to use counters and tally's to find half.

Thursday: Last day of term

Friday: School Holidays

Week 16 PIPS TESTING

Week 17 PIPS TESTING

Week, 18 Gill Absent

Week 19 Revision concepts covered

Thursday,

The lesson involved a review of addition, subtraction and counting on strategies. A review of the four basic mathematical symbols with examples of situations when each is used and the key words to associated with each such as difference and altogether. Students were encouraged to write number sentences on paper in order to bridge the gap between concrete and abstract. Groups were based on where the students sat on their arrival in class and not manipulated by the teacher. Elise used all her fingers and did not grasp the concept of counting on kept starting at one repeatedly returning to one and counting all. With encouragement she began to attempt counting on after individual demonstrations and assistance from teachers and peers.

To conclude the lesson students were encouraged to use number lines or rulers to answer problems involving addition and subtraction. Word problems were given from which they needed to decide which symbol was relevant for each of the terms more, altogether, less, or left.

	problems
Neil	Recorded very little of the problems he completed, off task and chatty rather than participating.
Rachel	A large number of number sums recorded with accuracy.
Keith	Competence adding and subtracting demonstrated.
Sara	A large number of number sums recorded with accuracy, set out neatly according to game played.
Lance	Required assistance from his partner to record his number sentences, Not accurate in answers. Lack of confidence demonstrated.
Tama	absent
Elise	Number sentences recorded accurately but presentation was limited
Leanne	absent
Anne	A large number of number sums recorded with accuracy, set out neatly according to game played.
Simon	Left early for appointment, little completed.
Thomas	A large number of number sums recorded with accuracy, set out neatly according to game played.
Kaisha	A large number of number sums recorded with accuracy, set out neatly.

Friday

No lesson due to voting for positions of responsibility for 2011.

Week 20

Tuesday

The current class photographs were used to review terms in front, behind, middle, left, right etc. One class photograph was used during the whole group demonstration and the other when students worked in pairs asking and answering their own questions. Students enjoyed the use of photographs of themselves and their friends. Lance could complete the activity with ease when working directly with the teacher but when other students were working together and individually he became anxious.

	Set	**Own**	**Comments**
Neil	8/9	0	Very slow at completing task and required extra time. An error with the right and left of one row.
Rachel	9/9	0	Excellent neat and accurate work, completed in time.
Keith	6/9	0	Slow at completion, error with right and who was behind.
Sara	9/9	5/5	Excellent competent worker. Completed set questions and her own within the time. Neat work.
Lance	9/9	0	Accurate when questions read to him, after a very anxious start where he said he didn't understand and couldn't do it!
Tama	9/9	0	Slow completion. Neat accurate work.
Elise	absent		
Leanne	absent		
Anne	4/9	0	Extra time required with confusion with left and right positions, and middle.
Simon	absent		
Thomas	4/9	0	Did not listen or follow instructions, was confused with left and right.
Kaisha	9/9	0	Extra time needed for completion. Neat accurate work.

Thursday

Students completed a worksheet reviewing their understanding of before and after, counting forwards and backwards and three digit numbers. Lance became agitated stating "I can't find it, I am skipping it" without trying. He calmed down when stepped through some problems before continuing on his own with a

frequent support. Thomas stated “I forgot what before means”. The example of what had he did before coming into the classroom, before coming to school, and what he would do after school. “Oh, I know what you mean”. Simon worked quietly and independently commenting aloud “this last one is real tricky” but he gave it a go. Keith had each question read to him.

	1 before (6)	**1 after (6)**	**1 before & 1 after (12)**	**1 after 3 digits (5)**	**1 before & 1 after 3 digits (6)**	**Comments**
Neil	6	6	12	5	6	100% Excellent confident work.
Rachel	5	6	12	6	5	No obvious cause of errors. Confident and accurate.
Keith	6	6	12	5	6	Instructions were read following this worked independently.
Sara	5	6	11	4	0	Demonstrated understanding. Did not complete last 3 digit question.
Lance	2	5	5	0	0	Sometimes used number grid and other times ‘knew’ the answer. Problems with reversals, reading 51 as 15.
Tama	4	6	12	3	6	Error reading reversal 51 for 15 and writing 300 as following 239.
Elise	5	6	8	0	0	Reversal reading 51 as 15 lead to 3 errors. Limited idea past 100.
Leanne	6	6	12	5	6	100% confident independent work.
Anne	absent					
Simon	5	6	10	4	6	Worked quickly and independently. Read 51 as 15. Competent with 3 digit numbers.
Thomas	6	6	11	5	6	Competent one simple error.
Kaisha	5	6	11	6	6	Confident

Friday

Revision Number stories

Students were reluctant to work with multiplication and division signs individually although they provided answers during whole class activities on the whiteboard. Lance was despondent stating, “I am never going to get this”, he refused to try after one attempt. Elise said “I don’t know my times table” upon which the class was reminded it didn’t matter because they were drawing diagrams to match which would allow them to ‘count’ the total. This had been demonstrated on the whiteboard using both pictures and magnetic counters.

Elise had three groups and counted the correct number of objects however she did not have the same number of objects in each group. A number of factors must be considered and comprehended in order for the concept of multiplication and division to be understood.

	Addition	Subtraction	Multiplication	Division	Comments
Neil	x	x	x	x	Did not follow instructions writing one number sentence without the matching picture.
Rachel	√	√	√	√	Excellent understanding of all concepts
Keith	√	x	x		No understanding of grouping for multiplication confused division and subtraction
Sara	√ but under 10	√	√ but wrong answer	X some idea	Incorrect answer for multiplication but correct number Good diagram and answer for division but written incorrectly
Leanne	√	√	√	x	Matching diagrams and number sentences for multiplication only.
Elise	√ but under 10	x	√ with assistance	x	Assisted to match diagram and number sentence with multiplication
Tama	absent				
Lance	x	√ but under 10	x	x	Understood concept of word problem with number sentence and diagram.
Anne	x	x	x	x some understanding	Confused x with + sign but correct diagram for addition Good diagram for division but had number sentence incorrect.
Thomas	√	√	X	X	Correct concept of multiplication but not illustration to match. Good illustration for division but not number sentence.
Simon	√	√ not correct answer	√ not correct answer	√ not correct answer	Excellent diagrams but incorrect answers
Kaisha	√	√	√	√	Excellent diagrams and matching number sentences.