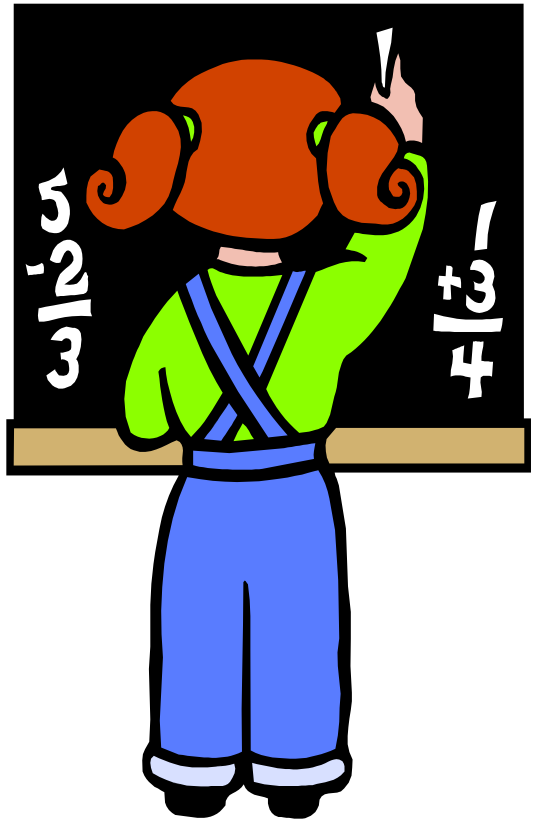

Mathematical Connections:

Making it happen for students with vision impairment in inclusive classrooms

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Current thinking

- Numeracy, or the ability to use mathematical concepts in everyday life is a basic necessity for all learners.
- Some learners with vision impairment may lag behind their sighted peers in numeracy because their impairment impacts on their ability to learn and understand mathematical concepts
- This in turn inhibits their ability to use those concepts in everyday life.

Overview

- This presentation reports two case studies that examined the ways numeracy is learnt by young people with vision impairment in inclusive classrooms:
  - one student with low vision
  - one functionally blind
- Results indicated that the two students were achieving at the same level as their peers in mathematics and they were succeeding in learning numeracy

Introduction

- *...all students can learn mathematics if given high-quality instruction, challenging content, and appropriate accommodations, and well-prepared, knowledgeable teachers must have adequate resources and support to deliver high-quality instruction* (United States National Council of Teachers of Mathematics [NCTM], n.d.).

The Literature

- Numeracy is an important educational priority in our complex technological society.

Mathematical Understanding

- Mathematical understanding is “essential for full participation in society” (Kapperman, Heinze & Sticken, 2000, p. 370).

Critical numeracy

- In societies where mathematics plays a significant role, it is important to develop “critical numeracy” (Stoessiger, 2002, cited in Hawera & Taylor, 2011, p. 3).

Foundational

- If young people with vision impairment have a solid educational foundation in mathematics they are able to solve the simple arithmetic problems that arise in their daily life (Rosenblum &Herzberg, 2011)

The real issues

- The real issues are:
  - the complex, visual nature of mathematics
  - the impact of severe vision impairment on numeracy learning.
- It is **not** about whether students with vision impairment can succeed in developing mathematical understanding, but **rather, how skilled teachers enable this learning to occur**.
- Developing students' understanding and competence in working mathematically should be at the forefront of sound educational practice.
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The problem

- Severe vision impairment has the potential to impact strongly on a student's ability to understand mathematical concepts.
- **These students have**:
  - fewer cognitive resources available for problem solving,
  - incomplete conceptual understanding of mathematical information and
  - materials that are not fully accessible to them (Beal, Rosenblum, & Smith, 2011)
- **Regular classroom teachers**
  - are not always aware of the nature of the student's vision loss
  - the limitations this imposes in relation to learning mathematics.
  - the need to re-evaluate their approaches to teaching,
  - the value of support from Specialist Vision Support Teachers
  - the need for appropriate modifications, equipment and materials.

Aim and Research Questions

- To describe the ways numeracy is acquired and developed by two students with vision impairment.

The Research Questions

1. *How is numeracy acquired by two students with vision impairment, one with low vision and one who requires braille for reading and writing?*
   a) In what ways do their teachers develop numeracy learning with these two students with vision impairment?
   b) What teaching practices do teachers engage in when working with these two students?
   c) How do teachers assess and report the progress of these two students in numeracy?

Methodology and Procedure

- **Qualitative methodology**: a case study approach
- **Data collection involved -** Three days in each school.
  - interviews, (structured: Principal, teachers, and support staff
  - observation of the students in class,
  - informal discussions with students and teachers
  - analysis of school documents.
- **The researcher observed:**
  - teaching practices and student participation,
  - methods of providing access to the curriculum,
  - the use of technology
  - the equipment, resources and materials used.

The student participants

1. David (Pseudonym)

- nine-year-old boy, Year 4 at his local Primary School.
- **Eye condition:** widespread atrophy (degeneration) of his retina
- **Characteristics:** nystagmus, eccentric viewing and difficulty in fixating on an object of regard
- **Vision:** David was not totally blind, but his central vision loss and other vision problems meant that his residual vision was too poor to be of use for academic tasks. His major learning senses were hearing and touch.

2. Jarrad (pseudonym)

- eight-year-old boy; Year 2 at his local Primary school.
- **Eye condition** Marfan Syndrome.
- **Characteristics:** abnormally long, slender fingers, toes and other bones, congenital heart problems and general muscular underdevelopment.
- **Vision:** corrected to 6/9 right eye and 6/18 left and dislocated lenses. Blurred distance vision and lack of depth perception.

Purpose

- **Case Study 1: David:** to examine the ways David learned mathematical concepts with no useful vision, and the approaches to teaching and the accommodations and modifications that were in place to facilitate his learning.
- **Case Study 1: Jarrad:** to examine the ways Jarrad acquired numeracy learning with his severe vision loss, and the approaches to teaching, accommodations and modifications that were in place to facilitate his learning.

Findings

- The findings are presented under the following headings:
  - *The program*,
  - *Approaches and curricula*
  - *Teaching strategies*
  - *Assessment,*
  - *Technology and equipment*
  - *Support*.

The Mathematics Program

David: Case study 1

- **Aim:** To make mathematical learning positive and relevant to the individual by providing the students with appropriate concrete experiences relevant to six strands:
- space, measurement, chance and data, number, algebra, and working mathematically.
- The program was based on a belief that Mathematics involved:
  - investigating patterns,
  - understanding relationships,
  - observing and
  - using mathematical objects.

Jarrad: Case Study 2

Aim: To give all students the best opportunity to develop an understanding of mathematical processes.

The program was based on a problem solving approach to numeracy.

The teachers believed mathematics was about real life problem solving not just about exercises in a maths text,

Focus: children's ability to use mathematical knowledge in working out everyday situations.

- They challenged students' thinking and encouraged them to discover mathematical relationships.

Approaches & Curricula

David - worked on the same mathematics curriculum as his classmates

- problem-based approach using “real, relevant and realistic” life activities
- emphasis on the use of mathematical concepts in daily life.
- **David’s teacher:**
- developed many “real” maths situations.
- argued that students need to be guided to think and reason
- designed her own work sheets rather than using a text.
- diversified instruction to meet the various learning styles and disparate needs of her students
- believed in “outcomes-based education” and child-focused curriculum driven by students’ interests.

David needed

- print material and diagrams transcribed into Braille and tactile format.
- a Perkins brailler
- Technology to translate braille into text
- audio materials when braille was unavailable

Teaching Strategies: David

- Content was integrated across curricula
- Emphasis was placed on working in groups and pairs
- Games were devised develop students' skills in addition, subtraction, division and multiplication (regular tables challenge)
- Teacher used voice and verbalised as she wrote on the board
- Time was spent working with David individually
- Specific modifications and specialised equipment were used
- Block time was set aside each day, for students to work on various curriculum areas – working alone or in groups
- Students had clear areas to be covered and tasks to complete, but could do the work in the order they wished.

Example: Class activity

- Students were asked to write down a question that he or she wished to investigate .
- David's question was, "How tall would they be if we stacked all of the planets on top of each other?"
- Appropriate books were borrowed from the library.
- Braille books were provided by the Specialist Vision Impairment Service so that he could work independently.
- Class time was set aside for the research.

Approaches and Strategies: Jarrad

- **Jarrad's teacher**
- modified his approach to teaching, and gave clear instructions
- **Jarrad's teacher believed**
- in an open-ended task approach using concrete materials to develop concepts, impart mathematical knowledge and teach skills.
- this approach would enable students to draw on appropriate knowledge and skills to problem solve.
- she needed to assist students to be selective about how to problem solve and what materials to use.
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Jarrad needed:

- to wear his glasses at all times
- bold clear print and illustrations.
- verbal cues -he missed the subtlety of facial expressions.
- extra time on some tasks,
- books with dark lines, dark black pens or pencils
- borders around the edge of white paper when on a white surface.
- special maths equipment.
- clear, strongly contrasting concrete materials,
- to work from concrete to abstract.

Teaching strategies: Jarrad

- No particular programs were used for mathematics teaching
- The teacher used clear, strongly contrasting materials, modified his approach to teaching, and gave clear instructions
- The teacher engaged all students in activities and group problem solving, discussions and questioning
- Planned open-ended activities were designed to cater for the range of abilities in the class and this benefitted Jarrad.
- The teacher used a direct teaching approach to introduce new concepts
- Made sure that Jarrad sat at the front so that he could see the board, manipulate materials and see demonstrations.

Class Activity

- Students were asked:
- to compile a list of six things they would like for Christmas.
- estimate how much each would cost.
- They were told they only had $50 to spend, so they had to check to see if they were within budget and if not they had to calculate how much they were over or under.
- They were then given toy catalogues and told to check the prices and compare them with their estimations.
- This exercise involved estimation, addition and subtraction of money, and prioritising.

Assessment

David's teacher used

- Formal and informal procedures to monitor progress
- Observation, worksheets, oral and written number computation tests.
- detailed records to ensure she was aware of problem areas to follow up.
- Formal tests in braille to enable independence.
- Oral when braille unavailable; answers produced on a brailler linked to a printer
- Not given extra time in brailled tests but 15 minutes extra in oral tests

Jarrad's teacher used

- the same assessments for all students
- Formal and informal procedures to monitor progress
- observation, questioning, work sheets, tests and anecdotal records.
- He planned learning outcomes and measured the students' progress against them.
- He emphasised the importance of assessment, and its link to teaching.
- informed parents of their child's progress on a regular basis.

Technology and equipment

- **David used:**
- Perkins Brailler, computerised Brailler, talking calculator
- Equipment modified with Braille or tactual markings (rulers, set squares, mathematical cork board [with tactile overlays], fraction kits, raised line drawing kit.
- Concrete materials: blocks, metric trundle wheel, Cuisenaire rods with tactual markings, real money, and three dimensional shapes and blocks

Jarrad used:

- A calculator to check his work when appropriate.
- He calculated answers first then verified them so his teacher could monitor his understanding of the processes
- A sloping desk top that could be set on top of his desk.
- Dark lined paper and soft black pens and pencils.
- Maths equipment with strongly contrasted markings.

Support Staff

David

- Specialist Vision Support Teacher
  - **Aim:** to ensure that mathematical concepts were understood
  - **Role:** to establish what was needed to maximise David's success in learning, to communicate with his class teacher to ascertain areas of difficulty and concepts needing work
  - To maintain and update David's Braille skills, and provide specialised equipment and materials in Braille and tactile formats.

Jarrad

- Specialist Vision Support Teacher
  - **Aim:** To support the class teacher's work in numeracy
  - **Role:** advise on the nature of Jarrad's vision loss
  - highlight aspects of the Maths program that could cause difficulties
  - recommended approaches to teaching mathematical concepts
  - advise on seating, lighting, glare, print size, teaching approaches and concept understanding
  - provide materials in appropriate formats

Discussion: Key points

- **Students with vision impairment:**
  - accessed the same curriculum as their sighted peers,
  - clearly needed specific modifications and accommodations to facilitate their learning.
- **Factors that impacted on the achievement of both learners**
  - the nature of the students' vision impairment,
  - the complexity and visual nature of mathematics,
  - the assessment tools,
  - the skill and strategies implemented by teachers and the support provided by the Specialist Vision Support Teachers.
  - the physical environment, pedagogy, learning materials, time, technology and assessment.
  - Use of suitable media and resources

Summary

Both students followed the same numeracy curriculum as classmates

- expectation that they would achieve learning outcomes consistent with their classmates.
- No variations to content, but variations occurred in how these students demonstrated their knowledge and skills, in terms of communication modes (Braille/large print) and the use of technology.

The teachers in the study believed:

- in a child-focused curriculum driven by the students' interests.
- students with vision impairment needed skilled direct teaching, guided discovery, and experiential learning.
- they needed to encourage independence and assist their students to develop self-sufficiency

Conclusions: What Works: What can be Achieved?

- This study provided a tiny snapshot of numeracy learning for students with vision impairment. The findings emphasised that learners with severe vision impairment need to be exposed to creative approaches to numeracy learning, diversified teaching, specialist equipment, materials in appropriate media and extra support to ensure that they are able to learn and apply mathematical skills in a range of situations both familiar and unfamiliar.
- **What works?**
  - A collaborative team
  - Books and materials in appropriate media
  - specialist equipment and technology
  - Real experiences, using concrete materials.
  - Adapted teaching approaches that meet students' individual learning needs.

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Numeracy

What is Numeracy?

- The use of numbers in daily life,
- The ability to think in quantitative terms in order to complete tasks
- The inclination to solve problems using number (Munn, 2005, p. 62).
- “Students become numerate as they develop the skills and confidence to use mathematics at school and in their lives beyond school”.

Numeracy Involves

- Students in recognising and understanding the role of mathematics in the world and having the dispositions and capacities to use mathematical knowledge and skills purposefully” (ACARA, 2012, p. 1).
- “In the context of schooling, numeracy involves students recognising and engaging with whatever mathematical knowledge and skills are needed for understanding in all learning areas” (ACARA, 2012, p. 1).

The Visual Nature of Mathematics

- Mathematics depends on visual knowledge
- Visualising abstract mathematical concepts allows individuals to understand both what is within sight and what is not within sight
- Vision enables individuals to process pieces of information simultaneously (Rosenblum & Herzberg, 2011, pp. 404-5)
- The eye can more quickly and efficiently take in pieces of information simultaneously than can the fingers (Kamei-Hannan, 2009).
- Students with vision impairment "need to be able to integrate individual units of information mentally into an abstract whole" (Kapperman et al., 2000, p. 371).

Mathematics: Students with Vision Impairment

- **Vision** plays a critical role in the development of mathematical cocepts (Cavenaugh, 2006; McDonnall, Geison, & Cavenaugh, 2009; National Science Foundation, 2009)
- **Visual nature** reduces access to important information that underpins the development of conceptual understanding so important in numeracy.
- **Students with vision impairment**
  - Can gain an understanding of mathematical concepts "through the use of real objects and manipulatives" (Ahlberg &Csocsán, 1999, p. 549)
  - potentially have the ability to develop the same range of mathematical skills as their peers,
  - often do not have the opportunity to develop these skills.

The student participants

- **Case Study 1**
- **David** (Pseudonym), a nine-year-old boy, who was fully included in a Year 4 class at his local Primary School. David used his peripheral vision because of a significant central field loss, which was due to widespread atrophy (degeneration) of his retina
- **David** presented with nystagmus, eccentric viewing and had difficulty in fixating on an object of regard.
- **David** was not totally blind, but his central vision loss and other vision problems meant that his residual vision was too poor to be of use for academic tasks and so his major learning senses were hearing and touch.
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The student participants

- **Case Study 2**
- **Jarrad** (pseudonym) an eight-year-old boy who was fully included a Year 2 at his local Primary school.
- **Jarrad** had Marfan Syndrome.
- This inherited condition resulted in severe vision impairment, accelerated growth with resultant weakening of the tissues of the body.
- **Characteristics:** abnormally long, slender fingers, toes and other bones, congenital heart problems and general muscular underdevelopment.
- **Vision**
- corrected to 6/9 in the right eye and 6/18 in the left and dislocated lenses. Blurred distance vision and lack of depth perception. Even after correction he still needed to sit close to any visual source.

The Mathematics Program

- **David: Case study 1**
- The Mathematics program at the school aimed at making Mathematical learning positive and relevant to the individual by providing the students with appropriate concrete experiences relevant to six strands: space, measurement, chance and data, number, algebra, and working mathematically. The program was based on a belief that Mathematics involved investigating patterns, understanding relationships, observing and using mathematical objects.