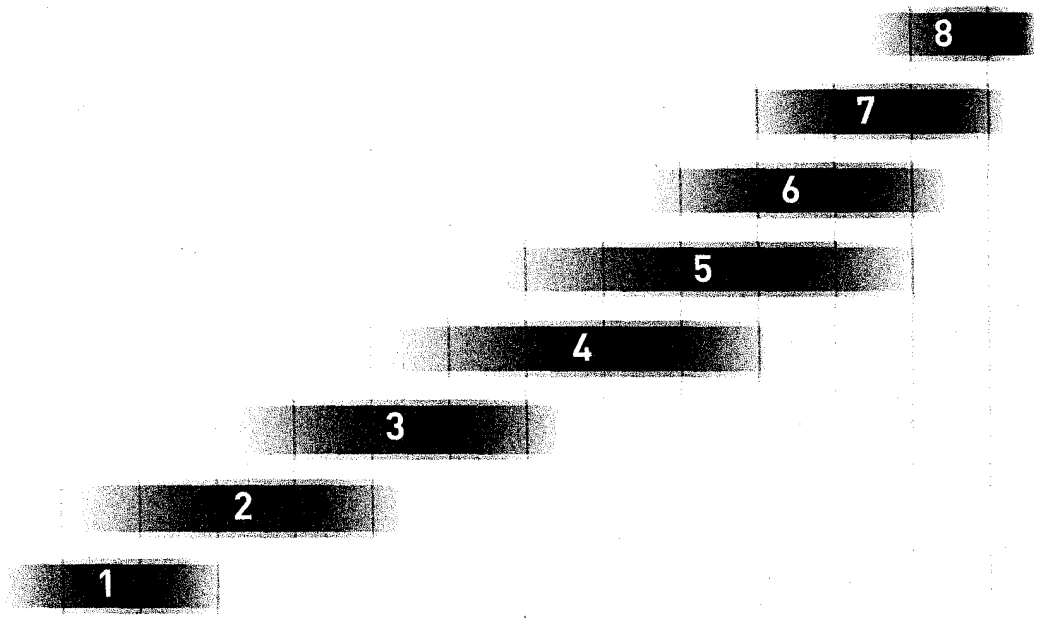
Years and Curriculum Levels



Abbreviations Used

HGL The Hitchhiker's Guide to the UEB Code Literary
HGM The Hitchhiker's Guide to the UEB Code Mathematics
BCS BLENNZ Cluster Site
TSBVI Texas School for the Blind
MME Mathematics Made Easy for Children with Visual Impairment
GTM Guidelines for Technical Material

General Notes

Symbols which have more than one meaning in print.
EACH PRINT SYMBOL HAS ONE AND ONLY ONE BRAILLE EQUIVALENT. This is regardless of the mathematical function the symbol is fulfilling.
Example:

The simple **.** can be used for: (**full stop**) The product of 2 and 3 is 6. `,! product ( #b & #c is #f4`

(**decimal point**) 1.25 `#a4be`

(**ellipsis**) (2, 4, 6, …) `"<#b1 #d1 #f1 444">`

NB When the dot is used for multiplication it is usually larger in print and so has its own related symbol

(**multiplication dot**) $3 \cdot 6 = 18$ `#c"4#f "7 #ah`

UEB Grade 1 Mode does not mean quite the same as "uncontracted". It is actually indicating a higher level of maths where there might be confusion. Grade 1 indicators are saying "No contractions are permitted".

Highlighted Items

Grade 1 indicators are highlighted throughout in yellow.
Items highlighted in turquoise indicate basic Braille or maths principles.
Items highlighted in grey draw your attention to something unusual.

Working with a Braille Student: A Handout for Maths Teachers

The handout on the following page is designed as a template. Please copy and insert your own details at the end.

BLENNZ

Blind and Low Vision Education Network NZ
Te Kōtuituinga Mātauranga Pura o Aotearoa
A National Network of Services for Children and Young People

Working with a Braille Student

You are the maths teacher. Your role is to teach the mathematical concepts to the braille student. This is not the job of the student's support person, whether this is a Resource Teacher Vision or a teacher aide.

Your student's vision team can be helpful by ensuring that all materials are available in the proper braille code and all graphics are of good quality – if you are able to supply these in print in a timely manner. You will need to give worksheets, tests, etc. to the RTV to transcribe into braille far enough in advance, that the Braille student can participate with their fellow students in class - ***not later, alone***.

- Please verbalize everything you write on the whiteboard or on an overhead.
- Be precise in the language you use, always using the correct terminology.
- If the Braille learner still has difficulty keeping up please try to have a copy available before class, if pre-prepared, or immediately after.
- Encourage your braille student to take responsibility for his/her own learning. ***Your student should be listening to you***, not relying on the support person to be a conduit for instructions, etc.
- Communicate directly to your braille student, not through the support person
- Have the same expectations from your braille student as you do from the rest of your students re behaviour, participation and completion of tasks, etc.
- The braille student should not be excused from learning a math concept. Graphing and geometric constructions for example can be done with the right tools. It is permissible however to shorten assignments, complete every second example, etc. as long as the student can demonstrate competence in the content area.
- Adapted educational aids are a necessary component of any mathematics class. They are especially needed to supplement textbooks that have omitted tactile graphics or contain poor quality ones. However, they are also needed to help in interpreting mathematical concepts - just as their sighted peers benefit from various manipulatives.
- For classroom test taking, the student should be given the test in Braille (with an option for partial oral administration). It is usual for the blind student to take the test separately due to the needed extra time, use of aids (especially those involving speech), and/or partial oral administration.

However, every teacher knows that there is always that teachable moment that cannot be anticipated. This is when it is imperative that the math teacher has some tools at his/her disposal. It is your Resource Teacher's responsibility to show you various tools and aids available to your braille student. Math teachers can be very creative, and you may well find that developing a special strategy for your braille student will benefit the sighted students as well.

Remember your Resource Teacher Vision is only a phone call (Insert) or an e-mail (Insert) away.

NUMBER AND ALGEBRA

<table>
<tr><th colspan="3">LEVEL 1</th></tr>
<tr><th>NUMBER AND ALGEBRA</th><th>BRAILLE</th><th>STRATEGIES & EQUIPMENT/ADAPTATIONS</th></tr>
<tr>
<td>Number strategies
• Use a range of counting, grouping, and equal-sharing strategies with whole numbers and fractions.
• Use skip counting on multiplication tasks.

Number Knowledge
• Know the forward and backward counting sequences of whole numbers to 100.
• Know groupings with five, within 20, and with ten.
• Know basic facts to 10; doubles to 20 and corresponding halves; “10 and” facts e.g. 10+7; multiples of 10 that add to 100 e.g. 30+70.

Equations and expressions
• Communicate and explain counting, grouping, and equal-sharing strategies, using words, numbers, and pictures.

Patterns and relationships
• Generalise that the next counting number gives the result of adding one object to a set and that counting the number of objects in a set tells how many.
• Create and continue sequential patterns.</td>
<td>Links to literacy
Knowledge of braille alphabet essential before reading and writing maths.
• The digits 1 to 9 and 0 are shown by the letters a to j preceded by the number sign
• The number sign acts as a Grade 1 indicator
• Signs of operation (+, -) are unspaced from the numbers.
• Repeat number sign after operation sign.
• Sign of comparison (=) has a space before and after.

plus + "6 (dot 5, dots 2 3 5)
minus – "– (dot 5, dots 3 6)
equals = "7 (dot 5, dots 2 3 5 6)

Ordinal numbers
1st #ast
2nd #bnd
3rd #crd
4th #dth
NB Do not worry about whether the print is superscripted or not!</td>
<td><u>Strategies</u>
1. Braille equivalent of classroom materials
2. Indicate top right corner of activity cards by cutting off corner.
3. Objects must be able to be fixed and confined.
4. Concrete experiences with real objects and situations. Real-life experiences with money. <u>Always use real money for any money-related activities.</u>
5. It is recommended that the student always use the full stop when writing the number of a question, regardless of whether the text follows this convention.

<u>Equipment/Adaptations</u>
Use regular classroom equipment.
• Non-stick mat
• Lap tray with lip, corkboard, magnetic tray, board with Velcro strips.
• Blu tack, Velcro dots, playdough, sticks.
• Kitchen timer, metronome.

<u>Strategies</u>
Vertical working form for operations is not appropriate at this level. Teach horizontal form only as this translates readily to the abacus. <u>Writing an equation is recording the real object experience at this level.</u>
Note the spacings in the equation below.
6+3 = 9 #f"6#c "7 #i
<u>Equipment/Adaptations</u>
• Braille number line.
• Braille hundreds board – portable, lapsize.
• Introduce junior abacus – begin setting and clearing numbers.**Video.
• Encourage correct abacus terminology. See Appendix A Abacus Skills.

<u>Strategies</u>
1. Define starting place against a solid object, place, edge of tray, etc. Use blu tack to fix the start.
2. Music patterns, verbal patterns
<u>Equipment/Adaptations</u>
• Play dough or blu tack strips
• Threading beads
• Tiles
• Plastic shapes – as wide a variety as necessary.</td>
</tr>
</table>

LEVEL 2		
NUMBER AND ALGEBRA	**BRAILLE**	**STRATEGIES & EQUIPMENT/ADAPTATIONS**
Number strategies • Use simple additive strategies with whole numbers and fractions. E.g. deriving from basic facts 8+7 = 8+8–1	Writing simple fractions and mixed numerals **Refer to P3 Hitchhiker's Guide to the UEB Code Mathematics!** $\frac{3}{4}$ #c/d 5½ #e#a/b **plus** + ⠼⠖ (dot 5, dots 2 3 5) **minus** – ⠼⠤ (dot 5, dots 3 6) **equals** = ⠼⠶ (dot 5, dots 2 3 5 6)	**Strategies** 1. At this level use only the **simple numeric fraction form** as shown at left. A simple numeric fraction contains only digits. The print sometimes uses the ordinary slash symbol e.g. ¾ 2. NB Mixed numbers are treated as two unspaced numeric items, as shown at left. 3. Insist on fluent recall of all basic addition/subtraction – without hesitation, instant response, with understanding. These must be secure before beginning abacus. 4. Stress the importance of the equals sign. Necessary concept for the later balancing and solving of algebraic equations. 5. Stress the need for accurate braille writing. No erasures allowed when brailling. Introduce full cell for "crossing out", and correct braille then continues without a space. 6. **Always** insert comma to indicate thousands and millions. Relate to dots on abacus. 7. Formatting – setting out a page of braille maths. Remember: runovers in Cell 3, align equals signs if equation takes more than one line. Vertical working form for operations not appropriate for student although the skill of reading this format should be developed. Suggestion: always use full stop when brailling the question number regardless of what the text has done. **Equipment/Adaptations** • Mountbatten brailler or Perkins brailler • Cranmer abacus. **See Appendix A** Abacus Skills for rules and practice examples.
Number knowledge • Know forward and backward counting sequences with whole numbers to at least 1000. • Know the basic addition and subtraction facts. • Know how many ones, tens, and hundreds are in whole numbers to at least 1000. • Know simple fractions in everyday use.	**dollar sign** $ ⠈⠎ (dot 4, **s**) **cent sign** ¢ ⠈⠉ (dot 4**, c**) (Reinforce the cent symbol even if lower case c is used in print)	**Strategies** 1. Use real money – talk fractions at the same time as decimals. E.g. 10 cents is 10 out of 100 2. Face value, place value and total value. 3. Count on the Cranmer abacus to reinforce face, place and total values. Use correct terminology with student. **See Appendix B** Voice Box**.** 4. Numerator and denominator. Use correct terminology with student. . **Numerator** / **Denominator** **Say: "**numerator over denominator**", say** "3 out of 4" but do not talk about top and bottom of the fraction**.** **Equipment/Adaptations** • Paper for simple paperfolding: paper circles and squares, A4 sheet. Fold vertically and horizontally to show ½ and ¼, etc. • Measuring cups and spoons • Fractions Board • Proportional equipment to show relative sizes of Hundreds, Tens, Ones.

LEVEL 2		
NUMBER AND ALGEBRA	**BRAILLE**	**STRATEGIES & EQUIPMENT/ADAPTATIONS**
Equations and expressions • Communicate and interpret simple additive strategies, using words, diagrams (pictures), and symbols.		**Strategies** 1. Layout **Equipment/Adaptations** • See equipment listed in previous levels.
Patterns and relationships • Generalise that whole numbers can be partitioned in many ways. • Find rules for the next member in a sequential pattern.	**Omission symbol** ⠢ (indicates a missing number) **Ellipsis …** ⠄⠄⠄ (indicates a series of numbers continues)	**Strategies** Use cards with number patterns produced in different ways e.g. 6 can be shown as ◊◊◊◊◊◊ or ◊◊◊ or ◊◊ ◊◊◊ ◊◊ ◊◊ **Equipment/Adaptations** • Selection of real objects • Beads on string • Board with 2 velcro strips for pattern matching**

<table>
<tr><th colspan="3">LEVEL 3</th></tr>
<tr><th>NUMBER AND ALGEBRA</th><th>BRAILLE</th><th>STRATEGIES & EQUIPMENT/ADAPTATIONS</th></tr>
<tr><td>Number strategies
Choose appropriately from a range of additive and simple multiplicative strategies with whole numbers, fractions, decimals, and percentages.</td><td>Decimal point ⠲ (dots 2 5 6)
NB If there is a decimal point there must be another digit following it so there should be no confusion with the full stop.
percent % ⠲⠴ (dots 4 6, dots 3 5 6)
NB This is unspaced from the number to which it refers.</td><td><u>Strategies</u>
Consolidate abacus skills. Drill for 5 minutes every day.
The abacus can be used creatively to illustrate various strategies used for addition, multiplication, etc.**
<u>Equipment/Adaptations</u>
Real objects for grouping.
Abacus</td></tr>
<tr><td rowspan="2">Number knowledge
Know basic multiplication up to 10×10 and some related division facts.
Know counting sequences for whole numbers up to 1,000,000.
Know how many tenths, tens, hundreds, and thousands are in whole numbers.
Know fractions and percentages in everyday use – halves, thirds, quarters, fifths and tenths.</td><td><u>New Signs of Operation</u>
multiply × ⠠⠦ (dot 5, dots 2 3 6)
divide ÷ ⠠⠌ (dot 5, dots 3 4)
76÷5 = 15 r1
⠼⠛⠋⠠⠌⠼⠑ ⠠⠼⠶ ⠼⠁⠑ ⠗⠼⠁</td><td><u>Strategies</u>
Fluent recall of multiplication tables should be well under way. No hesitation – up to 12×.
Remember that 3×4 means 3 groups of 4, and 4×3 means 4 groups of 3. These have the same answer but are not the same event. See Grandad's Visit story (Maths Story Box, Cluster Site).
Complete confidence in mental computation of basic facts is a vital tool for the braille student.
Begin learning multiplication on the abacus. See Appendix A Abacus Skills.</td></tr>
<tr><td><u>Equipment/Adaptations</u>
Real objects
Abacus</td></tr>
<tr><td>Equations and expressions
Record and interpret additive and simple multiplicative strategies, using, words, diagrams, and symbols, with an understanding of equality.</td><td><u>New Signs of Comparison</u>
greater than > ⠈⠕ (dot 4, dots 3 4 5)
less than < ⠈⠣ (dot 4, dots 1 2 6)
implies that → ⠳⠕ (right pointing arrow)
As signs of comparison these have space before and after. See HG P2</td><td><u>Strategies</u>
Balancing the left and right sides of an equation
Stress the difference between equivalence and equal. We call it the equals sign but in fact it is really an equivalence sign. E.g. 4+3 is equivalent to 3+4 but it is not the same event. Use maths stories to illustrate the concept of equivalence e.g. Pocket Money story (Maths Story Box, Cluster Site).
<u>Equipment/Adaptations</u>
Calculator – talking or BrailleNote calculator – see manuals for instruction. Student must become a competent and independent user of the chosen calculator.</td></tr>
<tr><td>Patterns and relationships
Generalise the properties of addition and subtraction with whole numbers.
Connect members of sequential patterns with their ordinal position and use tables, graphs, and diagrams to find relationships between successive elements of number and spatial patterns.</td><td><u>Sign of Grouping - Brackets</u>
Open (⠠⠶ (dot 5, dots 1 2 6)
Close) ⠠⠶ (dot 5, dots 3 4 5)
Brackets are unspaced from the items they enclose.
(10+3) ⠠⠶⠼⠁⠚⠬⠼⠉⠠⠶</td><td><u>Strategies</u>
Physically show (perhaps by cupping hands) how these braille brackets mimic the print brackets in the way they enclose what is inside. NB the similarity to the brailling of < and > reflects the similar print shape, but it is helpful to remember that signs of comparison are always spaced and signs of grouping are unspaced!
When teaching say "open bracket, close bracket". Although the correct term for (…) is "parentheses" the general NZ usage is to use the term "brackets" for all these grouping symbols. See Appendix B Voice Box for additional information.</td></tr>
</table>

LEVEL 4		
NUMBER AND ALGEBRA	**BRAILLE**	**STRATEGIES & EQUIPMENT/ADAPTATIONS**
Number strategies and knowledge • Use a range of multiplicative strategies when operating on whole numbers. • Understand addition and subtraction of fractions, decimals, and integers. • Find fractions, decimals, and percentages of amounts expressed as whole numbers, simple fractions, and decimals. • Apply simple linear proportions, including ordering fractions. • Know the equivalent decimal and percentage forms for everyday fractions. • Know the relative size and place value structure of positive and negative integers and decimals to three places.	Symbol for recurring decimal – 1.333… is written as 1.3 (with dot over the 3) This is brailled as #a4<c>~4 dot over previous item **Note that the 3 is enclosed in the braille brackets. The braille brackets are used to enclose items that are not bracketed in print. They define exactly what is being affected by a braille symbol e.g. the superscript indicator or the dot over symbol as above. Note the difference between the braille brackets and the braille of the print brackets.** **Braille brackets** < > **Print brackets ( )** "< "> **Negative Integers** -3 "-#c -2.75 "-#b4ge 5+-2 #e"69"-#b **Exponents** **superscript indicator** 9 (dots 3 4) 3^2 #c9#b x^2 x;9#b **Square Roots** √9 = 3 ;%#i+ "7 #c	**Strategies** (NB In fractions the bar separating numerator from denominator is also a division symbol!) 1. Additional drill with multplication tables – the answers as the set of multiples. 2. Reinforce the identity property of multiplication and division – e.g. multiplying or dividing by 1 does not change the value. Any number or letter divided by itself is a "special name" for 1. NB This excludes zero! The right "special name" for 1 allows the manipulation of an equation to reach the desired result. E.g. changing thirds to fifteenths $\frac{2}{3} \times \frac{5}{5}$ 3. Use real-life examples to illustrate how fractions, decimals and percentages are inter-related. 4. Rote learn the decimal and percentage forms for the common everyday fractions $\frac{1}{2}$ = 0.5 = 50% $\frac{1}{3}$ = 0.33 = $33\frac{1}{3}$% $\frac{1}{4}$ = 0.25 25% $\frac{1}{5}$ = 0.2 = 20% $\frac{1}{8}$ = 0.125 $12\frac{1}{2}$% $\frac{1}{10}$ = 0.1 = 1% $\frac{2}{3}$ = 0.66 = $66\frac{2}{3}$% $\frac{3}{4}$ = 0.75 = 75% 5. Use, and insist the student uses, the correct voicing of decimals e.g. 0.75 is said as "zero point seven five". Never say "zero point seventy-five". 6. Extend rote learning of tables to include all square numbers up to 15^2, and add 20^2 and 30^2. 7. Extend rote learning of tables to include basic cubes: 2^3, 3^3, 4^3 and 5^3. **Negative Integers** Note that negative integers are often written with the negative sign superscripted. Be careful with both reading and writing these. $(^-6)^2$ = $^-6 \times {}^-6$ use the voicing "negative six" not "minus six" "<;9"-#f"9#b "7 ;9"-#f"89"-#f $(-6)^2$ = -6× -6 the alternative below is easier to follow in braille but not as correct mathematically "<"-#f"9#b "7 "-#f"8-#f **Exponents** In the example to the left, 3^2 does not require a Grade 1 indicator before the superscript indicator because the number sign is itself a Grade 1 indicator. x^2 needs it before the superscript indicator because the superscript indicator is also a contraction. **Square Roots** Introduce the concept of opening and closing indicators. The expression inside the "square root" sign in print is preceded by the "open radical" sign (dots 1 4 6) and followed by the "close radical" sign (dots 3 4 6). Note that both these signs have alternative Grade 2 meanings so need Grade 1 indicators. **See Appendix B** Voice Box.

<table>
<tr><th colspan="3">LEVEL 4</th></tr>
<tr><th>NUMBER AND ALGEBRA</th><th>BRAILLE</th><th>STRATEGIES & EQUIPMENT/ADAPTATIONS</th></tr>
<tr><td>Equations and expressions
Form and solve simple linear equations.</td><td><u>New Signs of Comparison</u>
Not equal to ≠ "7@:
(dot 4, dots 1 5 6, indicate “line through”)
Approximately equal to ≈ ~9

<u>New Sign of Operation</u>
Ratio : 3 (colon)
ratio 3 : 4
ratio #c3#d

<u>New Sign of Grouping</u>
Braces
Open _< Close _>
{0, 1, 2, 3, …}
_<#j1 #a1 #b1 #c1 444_></td><td><u>Strategies</u>
1. Layout of the written form is very important. Never finish a braille line with a sign of comparison (e.g. =, ≠, <). This sign is always brought down to the next line and indented 2 spaces. E.g. 4f+p+2f+2f+3p = 8f+4p (This will not fit on one braille line.)

#d;F"6p"6#b;f"6#b;F"6#cp
"7 #h;F"6#dp
Note that “p” can follow a number without a grade 1 indictor because there is no ambiguity.

<u>New Sign of Grouping</u>
Braces (curly brackets) are used for sets of numbers. Note that the difference between the bracket and the brace is the initial braille cell sign.</td></tr>
<tr><td>Patterns and relationships
• Generalise properties of multiplication and division with whole numbers.
• Use graphs, tables, and rules to describe linear relationships found in number and spatial patterns.</td><td><u>Transcriber’s Symbols</u>
Numeric Passage Mode
##
This symbol occurs in the text to indicate that number signs have been omitted because they get in the way.
Numeric passage mode is terminated by #'
(dots 3 4 5 6, dot 3).</td><td><u>Strategies</u>
1. Numeric Passage Mode might be used in the text because numbers are displayed vertically and the number sign is intrusive, or perhaps to enable an array of numbers to fit in a wide table. It is not necessary for the student to use these symbols, only to recognise them.

<u>Equipment/Adaptations</u>
• Thermoform graph paper
• Geo board/Cork board with pins, rubber bands, string.**</td></tr>
</table>

LEVEL 5

NUMBER AND ALGEBRA	BRAILLE	STRATEGIES & EQUIPMENT/ADAPTATIONS
Number strategies and knowledge • Reason with linear proportions. • Use prime numbers, common factors and multiples, and powers (including square roots). • Understand operations on fractions, decimals, percentages, and integers. • Use rates and ratios. • Know commonly used fraction, decimal, and percentage conversions. • Know and apply standard form, significant figures, rounding, and decimal place value.	**Radicals** $\sqrt[3]{27}$;;%9#c#bg+ $\sqrt[y]{x}$;;%9yx+ Note that the superscript number or letter is written after the open radical sign and only applies to the first item following it. $r = \sqrt{x^2 + y^2}$;;;R "7 %x9#b"6y9#b+;' or ;R "7 ;%x9#b"6y9#b+ **Fractions** $\frac{2}{5} \times \frac{5}{8} = \frac{2 \times 5}{5 \times 8}$ #b/e"8#e/h "7 ;(#b"8#e./#e"8#h) Note that the right hand side is not a simple fraction so needs the fraction indicators, (and) , and the fraction line ./	**Strategies** 1. Use textbook to reinforce formatting and correct braille. 2. Operations with fractions – reinforce correct brailling of mathematical operations. Layout is very important here. Construct the equations so that the answer is reached efficiently. E.g. $\frac{2}{5} + \frac{1}{5} = \frac{2+1}{5} = \frac{3}{5}$ Continue using correct terminology. **See Appendix C** Voice Box. 3. **Do not try to "cancel";** instead, rearrange the fractions to achieve the desired result. E.g. $\frac{2}{5} \times \frac{5}{8} = \frac{2 \times 5}{5 \times 8} = \frac{5 \times 2}{5 \times 8} = \frac{5}{5} \times \frac{2}{8} = 1 \times \frac{1}{4}$ etc. 4. Rote learning of basic square and cube numbers. 2^2, 2^3, 2^4, 3^2, 3^3, 3^4, 5^2, 5^3, 10^2 , 10^3. 5. Rote learning of the basic square and cube roots i.e. undoing the above. **Equipment/Adaptations** • Small magnetic board with set of magnetised braille numbers and lines to show spatial arrangement of fractions for manipulation.**

<table>
<tr><th colspan="3">LEVEL 5</th></tr>
<tr><th>NUMBER AND ALGEBRA</th><th>BRAILLE</th><th>STRATEGIES & EQUIPMENT/ADAPTATIONS</th></tr>
<tr><td>Equations and expressions
• Form and solve linear and simple quadratic equations.</td><td>
Therefore ∴ ;,*
x+5 = 2 x"6#e "7 #b
∴ x+5–5 = 2–5 ;,* x"6#e"-#e "7 #b"-#e
∴ x = –3 ;,* ;x "7 "-#c
Note the Grade 1 indicator needed in third example above because x stands alone.
$2x^2+3x-2=0$ #bx9#b"6#cx"-#b "7 #j
(2x-1)(x+2)=0
"<#bx"-#a">"<x"6#b"> "7 #j
∴ x=½ or x=-2
;,* ;x "7 #a/b or ;x "7 "-#b
</td><td>
<u>Strategies</u>
1. When solving quadratic equations braille the brackets and the x terms first then go back and fill in . e.g. (x)(x)
2. Remember, layout is important! Check Layout Section.

<u>Equipment/Adaptations</u>
• See equipment listed in previous levels.
</td></tr>
<tr><td>Patterns and relationships
• Generalise the properties of operations with fractional numbers and integers.
• Relate tables, graphs, and equations to linear and simple quadratic relationships found in number and spatial patterns.</td><td>
Note the two types of fraction below. On the right is a simple fraction containing just numbers. The algebraic fraction on the left needs general fraction indicators and the general fraction line.
$\frac{x}{x+2} = \frac{3}{4}$
;(x./x"6#b) "7 #c/d
</td><td>
<u>Strategies</u>
1. Apply the same principles listed above to the brailling of algebraic fractions.
2. Revise and reinforce the importance of the equal sign and the fact that whatever operation is performed to one side of an equation must also be performed on the other.
3. Remember, layout is important! Check Layout Section.
<u>Equipment/Adaptations</u>
• Small magnetic board with set of magnetised braille numbers, letters and lines to show spatial arrangement of fractions for manipulation.**
</td></tr>
</table>

LEVEL 6		
NUMBER AND ALGEBRA	**BRAILLE**	**STRATEGIES & EQUIPMENT/ADAPTATIONS**
Number strategies and knowledge • Apply direct and inverse relationships with linear proportions. • Extend powers to include integers and fractions. • Apply everyday compounding rates. • Find optimal solutions, using numerical approaches.	**Complex Exponents** x^{2+3} ;;x9<#b"6#c> x^{2y} ;;x9<#by> $x^{2}y$ x;9#by	**Complex Exponents** Note the braille grouping signs in the first 2 examples at left. In braille the exponent must be enclosed in the braille grouping signs, similar to the brackets without the initial indicators. **The Superscript Indicator** Emphasise the UEB rule that the superscript indicator applies to the next "item" only. (See GTM 7.1 for formal definition of an "item".)
Equations and expressions • Form and solve linear equations and inequations, quadratic and simple exponential equations, and simultaneous equations with two unknowns.	Revise > and < symbols and introduce **greater than or equal to** ≥ _`> (dots 4 5 6, dot 4, dots 3 4 5) **less than or equal to** ≤ _` (dots 4 5 6, dot 4, dots 1 2 6) **plus or minus** ± _6 (dots 4 5 6, dots 2 3 5)	**Layout of written material** Equations will now be complex, requiring several lines of working to solve. Insist on correct layout. See Section on Layout.
Patterns and relationships • Generalise the properties of operations with rational numbers, including the properties of exponents. • Relate graphs, tables, and equations to linear, quadratic, and simple exponential relationships found in number and spatial patterns. • Relate rate of change to the gradient of a graph.		**Strategies** 1. Never forget – the brailled text is a crucial resource. 2. Your student's maths teacher is also an essential resource. Make sure you encourage the teacher to develop creative ways of teaching the student. See Handout for Maths Teacher. **Equipment/Adaptations** • Thermoform graph paper • Geo board/Cork board with pins, rubber bands, string. • Digital camera to take photo of student tactile graphs for recording (especially homework and assignments.

GEOMETRY AND MEASUREMENT

LEVEL 1		
GEOMETRY AND MEASUREMENT	**BRAILLE**	**STRATEGIES & EQUIPMENT/ADAPTATIONS**
Measurement • Order and compare objects or events by length, area, volume and capacity, weight (mass), turn (angle), temperature, and time by direct comparison and/or counting whole numbers of units.		**Strategies** • Water play/ sand play. • Household containers – plastic milk bottles, cups, measuring spoons, buckets, • Experiences in the sandpit • Real-life experiences with cooking **Equipment/Adaptations** • Nesting measuring cups, spoons
Shape • Sort objects by their appearance.		**Strategies** 1. Use a wide range of objects, plastic animals, cars, buttons, etc. to sort by feature. E.g. all objects with legs, all objects with wheels 2. Explore range of 3D objects 3. Begin using plastic shapes – circle; triangle (scalene, isosceles, equilateral, right-angled - the "threeness" concept); rectangle, square, parallelogram, kite ("fourness") **Equipment/Adaptations** • Attribute blocks
Position and orientation • Give and follow instructions for movement that involve distances, directions, and half or quarter turns. • Describe their position relative to a person or object. • Transformation • Communicate and record the results of translations, reflections, and rotations on plane shapes.		**Strategies** 1. Orientation and mobility instruction should cover much of this topic. 2. Reinforce the language and use real physical experiences. *Who is in front of you?* *Who is behind you?* *If you make a half turn from your seat where will you be facing?* 3. Real objects, real situations. **Equipment/Adaptations** • Corrugated card or paper circles and squares – cut duplicate shapes which can be flipped, rotated, translated, etc. relative to original. Use blu tack to hold in place. • Attribute blocks

LEVEL 2		
GEOMETRY AND MEASUREMENT	**BRAILLE**	**STRATEGIES & EQUIPMENT/ADAPTATIONS**
Measurement • Create and use appropriate units and devices to measure length, area, volume and capacity, weight (mass), turn (angle), temperature, and time. • Partition and/or combine like measures and communicate them, using numbers and units.	**Time:** - number sign repeated after colon or hyphen but not after full stop 5:30 pm ⠼e3⠼cj pm 5.30 pm ⠼e4cj pm 5.30 - 6 ⠼e4cj-⠼f **If written symbols are used refer to this section in Level 3.**	**Strategies** 1. Practise ruling lines with old ball point – lots and lots of practice. 2. Measuring ruled line with **end points –** start with lines of known length. 3. Student should know how to estimate measurements using body parts. e.g. width of an adult finger is about 1 cm. How can they estimate a meter? 5 cm is length of a finger, etc. 4. Time the following activities: walk 100m, run 100m, walk 1km. 5. How tall, how heavy is an average child of this age? How tall, how heavy is a man? What does a baby weigh, how long is a baby? How high is a doorway? What does a car weigh? What does a kilo feel like? – potatoes, butter, etc., (real-life kitchen examples). How much in a can of coke? Etc. **Equipment/Adaptations** • Talking scales - kitchen and bathroom. • Talking tapemeasure, braille tapemeasure, rulers, measuring metre wheel that clicks • Number track ruler with 1 cm cubes (MTA) • Talking stopwatch. • Litre bottles, measuring cups and spoons, etc.
Shape • Sort objects by their spatial features, with justification. • Identify and describe the plane shapes found in objects.		**Strategies** Take apart boxes of varying sizes and then reconstruct. Toblerone is an interesting box. **Equipment/Adaptations** • Set of geometric nets • Set of geometric solids • Plastic shapes – circle triangle – scalene, isosceles, equilateral, (the threeness concept) rectangle, square parallelogram (fourness) hexagon.
Position and orientation • Create and use simple maps to show position and direction. • Describe different views and pathways from locations on a map.	Grade 1 symbol indicator. N ⠰⠝	**Strategies** 1. Tray – show the points of the compass on the tray then use blocks to construct a known space e.g. bedroom. 2. Circle – food on a plate use 4 clock points. Can relate to points of compass with N always at 12 o'clock. 3. Understanding points of the compass – use the sun to indicate east and west. 4. Explore a known space – the child's bedroom – and then construct a simple tactile map. 5. Encourage use of board games e.g. snakes and ladders
Transformation • Predict and communicate the results of translations, reflections, and rotations on plane shapes.		**Strategies** 1. Reflection – investigate concept of mirror line and how orientation is changed. 2. Move whole body through space for simple translations and rotations. **Equipment/Adaptations** • See suggestions in Level 1.

LEVEL 3			
GEOMETRY AND MEASUREMENT	**BRAILLE**	**STRATEGIES**	**EQUIPMENT/ADAPTATIONS**
Measurement • Order and compare objects or events by length, area, volume and capacity, weight (mass), turn (angle), temperature, and time by direct comparison and/or counting whole numbers of units.	100 m #ajj ;m 25 cm #be cm 500 g #ejj ;g 1 kg #a kg 4 m^2 #d m;9#b 27 cm^3 #bg cm;9#c **Degrees** ° ~j (dots 4 5, dots 2 4 5) 18° #ah~j	**Strategies** 1. Practise ruling straight lines using stylus or ball point pen. 2. Angles – use the whole body turning through space to develop concepts of angles. Talk about different distances travelled by the various body parts during the same turn. E.g. large circle inscribed by outstretched arm, very small circle inscribed by nose, Brailling of the symbols for the following must follow the rules: • Mass • Area • Volume • Capacity (See GTM) **Equipment/Adaptations** • See list in Level 2. • Drawing kit** • Braille rulers – 15cm and 30 cm	
Shape • Classify plane shapes and prisms by their spatial features. • Represent objects with drawings and models.		**Strategies** Practise drawing around simple plane shapes with stylus or ballpoint pen. **Equipment/Adaptations** • Geometric shapes – 2-D and 3-D • Folding geometric shapes (nets). See Modern Teaching Aids catalogue.**	
Position and orientation • Use a co-ordinate system or the language of direction and distance to specify locations and describe paths.	**Co-ordinate Points** (3, 2) "<#c1 #b"> A12 ,a#ab	**Strategies** 1. Move through space. Follow a prescribed path. 2. Locate items in classroom or outside on a co-ordinate grid system.	
Transformation • Describe the transformations (reflection, rotation, translation, or enlargement) that have mapped one object onto another.		**Strategies** 1. Reflection – use squared paper and count squares **Equipment/Adaptations** • Paper or thin card shapes that can be folded and manipulated.	

LEVEL 4		
GEOMETRY AND MEASUREMENT	**BRAILLE**	**STRATEGIES & EQUIPMENT/ADAPTATIONS**
Measurement • Use appropriate scales, devices, and metric units for length, area, volume and capacity, weight (mass), temperature, angle, and time. • Convert between metric units, using whole numbers and commonly used decimals. • Use side or edge lengths to find the perimeters and areas of rectangles, parallelograms, and triangles and the volumes of cuboids. • Interpret and use scales, timetables, and charts.	**Pi** π .p **Angle sign** ∠ _{ Ĉ ,c": AĈB ,a,c":,b **Lines, Rays, Line Segments** $\overrightarrow{AB}$;;<,,ab>^: ΔABC ;$#c:,,abc (GTM 12.1, 14.1)	**Strategies** 1. Real experiences. 2. Extensive reading of charts, tables, etc. Take the time to develop braille reading skills to interpret and produce charts and tables. **NB** This will take a lot more time. **Do not waste the student's time following inappropriate class programmes.** Braille students have unique needs and cannot afford to be part of inappropriate activities. What works for sighted students often does not for a braille user, or there is a better way. **Equipment/Adaptations** • Talking Scales • Set of standard 2-D shapes. • Paper squares, triangles, circles for folding.
Shape • Identify classes of two- and three-dimensional shapes by their geometric properties. • Relate three-dimensional models to two-dimensional representations, and vice versa.	**Parallel** ‖ or // #l **Perpendicular to** ⊥ #- NB These are signs of comparison so should be spaced before and after	**Strategies** 1. Use tactile drawing tools to help the student make a 2-D picture of a simple 3-D object. 2. Look at tactile diagrams in text and relate to actual 3-D object. **This will take a lot of time – be prepared for this.** **Equipment/Adaptations** • Nets of standard 3-D shapes • Boxes of varying sizes and shapes that can be taken apart and re-formed e.g. Toblerone box is a triangular prism.
Position and orientation • Communicate and interpret locations and directions, using compass directions, distances, and grid references.	NNE SSW ,,NNE ,,SSW	**Strategies** 1. Use geo boards to set up grid system 2. Play battleships to reinforce the mapping squares concept as opposed to the co-ordinate point concept. 3. Incorporate maths concepts into O&M programme. **Equipment/Adaptations** • Talking compass.
Transformation • Use the invariant properties of figures and objects under transformations (reflection, rotation, translation, or enlargement).	**Arrows** A → A′ ;;;,a |o ,a7;' ↔ |wro (GTM 13.1)	**Strategies** 1. Reflection can be taught using body – pair with a buddy to feel the right/left transformation. 2. Paper folding. 3. Duplicate the simpler shapes used in the print text. **Equipment/Adaptations** • Use a lot of 2-D shapes that can be combined and manipulated in space. • Investigate similar triangles – same angles, different side lengths, different areas.

LEVEL 5		
Geometry and Measurement	**BRAILLE**	**STRATEGIES & EQUIPMENT/ADAPTATIONS**
Measurement • Select and use appropriate metric units for length, area, volume and capacity, weight (mass), temperature, angle, and time, with awareness that measurements are approximate. • Convert between metric units, using decimals. • Deduce and use formulae to find the perimeters and areas of polygons and the volumes of prisms. • Find the perimeters and areas of circles and composite shapes and the volumes of prisms, including cylinders.	**Angle sign** ∠ _{ Ĉ ,c": AĈB ,a,c":,b $\overrightarrow{AB}$;;<,,ab>^: ΔABC ;$#c:,,abc A = π r^2 ,a "7 .pr;9#b	**Strategies** 1. Continue to give opportunities to practise measuring using tools appropriate for the Braille student. 2. Real experiences 3. Physical movement of body through space to investigate concepts of perimeter, area, volume. 4. Student could just use the words line, ray, line segment as they are much easier to braille than attempting to duplicate the print symbols in braille e.g. ray AB ray ,a,b only requires 8 braille cells and does not need the Grade 1 indicators nor the Braille brackets. **Equipment/Adaptations** • See equipment listed in previous levels. • Nets of standard 3-D shapes. • Set of geometric solids.
Shape • Deduce the angle properties of intersecting and parallel lines and the angle properties of polygons and apply these properties. • Create accurate nets for simple polyhedra and connect three-dimensional solids with different two-dimensional representations.	**Parallel** ‖ or // #l **Perpendicular to** ⊥ #- **NB** These are signs of comparison so should be spaced before and after	**Strategies** • See strategies listed in previous levels. **Equipment/Adaptations** • Wikki stix • Nets of standard 3-D shapes • Boxes of varying sizes and shapes that can be taken apart and re-formed.
Position and orientation • Construct and describe simple loci. • Interpret points and lines on co-ordinate planes, including scales and bearings on maps.	**is an element of** ∈ ^e	**Strategies** **1.** Develop the skills of verbal description. **See Appendix D** Graphing Skills. **Equipment/Adaptations** • See equipment listed in previous levels.
Transformation • Define and use transformations and describe the invariant properties of figures and objects under these transformations. • Apply trigonometric ratios and Pythagoras' theorem in two dimensions.	Number is unspaced from function name. sin A sin,a cos θ cos.? tan 45° tan#de^j	**Strategies** **1.** Pythagoras works because the ratios between sides of a triangle are the same regardless of area, provided angles are the same. Investigate this with lots of examples. **2.** Use the basic 3,4,5 triangle and investigate it moving physically through space with string, squaring off at corner (for right angle) and pacing the short sides off. ** Double the length of the short sides and investigate what happens to length of third side. **Equipment/Adaptations** • Selection of similar triangles.

LEVEL 6		
GEOMETRY AND MEASUREMENT	**BRAILLE**	**STRATEGIES & EQUIPMENT/ADAPTATIONS**
Measurement • Measure at a level of precision appropriate to the task. • Apply the relationships between units in the metric system, including the units for measuring different attributes and derived measures. • Calculate volumes, including prisms, pyramids, cones, and spheres, using formulae.		**Strategies** 1. Develop the student's ability to efficiently direct another person to make an exact measurement. **Equipment/Adaptations** • See equipment listed in previous levels.
Shape • Deduce and apply the angle properties related to circles. • Recognise when shapes are similar and use proportional reasoning to find an unknown length. • Use trigonometric ratios and Pythagoras' theorem in two and three dimensions. • Position and orientation • Use a co-ordinate plane or map to show points in common and areas contained by two or more loci.		**Strategies** 1. Similar triangles: investigate a wide variety of similar triangles to discover that ratios remain the same if angles are the same. This makes the trigonometric ratios easy to understand. 2. See Chapter on triangles in MME **Equipment/Adaptations** • See equipment listed in previous levels.
Position and orientation • Use a co-ordinate plane or map to show points in common and areas contained by two or more loci.		
Transformation • Compare and apply single and multiple transformations. • Analyse symmetrical patterns by the transformations used to create them.		

STATISTICS

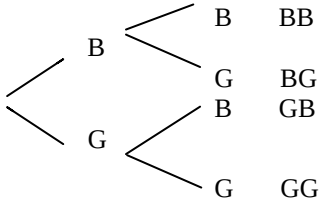
LEVEL 1		
STATISTICS	**BRAILLE**	**STRATEGIES & EQUIPMENT/ADAPTATIONS**
Statistical investigation • Conduct investigations using the statistical enquiry cycle: – posing and answering questions – gathering, sorting and counting, and displaying category data – discussing the results.		**Strategies** 1. Real experiences 2. Question of the day e.g. "How did your family get to work today?" Create pictograph. **Equipment/Strategies** • Plastic vehicles on square cards to create pictograph.** • BSM sorting and classifying materials.
Statistical literacy • Interpret statements made by others from statistical investigations and probability activities.		**Strategies** 1. Real experiences **Equipment/Strategies** • See equipment listed in previous levels.
Probability • Investigate situations that involve elements of chance, acknowledging and anticipating possible outcomes		**Strategies** 1. Real experiences – tossing a coin, throwing a die, picking a particular flavour of sweet out of a bag. **Equipment/Strategies** • Coins, large tactile die, bag of sweets, toys, etc.

** See photo on Cluster Site

LEVEL 2		
STATISTICS	**BRAILLE**	**STRATEGIES & EQUIPMENT/ADAPTATIONS**
Statistical investigation • Conduct investigations using the statistical enquiry cycle: • posing and answering questions • gathering, sorting, and displaying category and whole-number data • communicating findings based on the data.	**Tally marks** dots 456 ⠳⠳⠳ ⠇⠇⠇ two approaches (GTM p25) ⠤⠤⠤⠤⠤⠤⠤ ⠤⠤⠤⠤ ⠤⠤⠤⠤⠤⠤ 3 ⠤⠤⠤⠤ ⠤⠤⠤⠤⠤⠤⠤ ⠤⠤⠤⠤	**<u>Strategies</u>** 1. Use groups of 5 with a space between or the second option at left. 2. For Pictographs – use dots 123456 or braille lines of 3,6 and then use stickers.** 3. Beginning to describe in words – e.g. create and then describe a pictograph to a blindfolded peer. 4. Group work with sighted peers to create pictographs together. 5. Digital camera or phone camera can record student's work for assessment. **<u>Equipment/Adaptations</u>** • Tactile stickers of various shapes. Make sure they can be cut exactly in half. • Cards with velcro or felt strips in lines.** • Metal tray with sets of small magnets to create quick pictographs.** • Counting stick.
Statistical literacy • Compare statements with the features of simple data displays from statistical investigations or probability activities undertaken by others.		**<u>Strategies</u>** • See strategies listed in previous levels. **<u>Equipment/Adaptations</u>** • See equipment listed in previous levels.
Probability • Investigate simple situations that involve elements of chance, recognising equal and different likelihoods and acknowledging uncertainty.		**<u>Strategies</u>** • See strategies listed in previous levels. **<u>Equipment/Adaptations</u>** • Tactile dice – can find large die with indents that can be counted • Coins • Bags that can hold different-shaped objects (replacing colours)

LEVEL 3		
STATISTICS	**BRAILLE**	**STRATEGIES & EQUIPMENT/ADAPTATIONS**
Statistical investigation • Conduct investigations using the statistical enquiry cycle: • gathering, sorting, and displaying multivariate category and whole-number data and simple time-series data to answer questions • identifying patterns and trends in context, within and between data sets • communicating findings, using data displays.		**Strategies** 1. Pie graph – use different beads on length of string then form into circle.** 2. Circular cake board with circumference marked every 10°.** 3. Form paper circles into simple pie graphs with paperfolding. To develop planning skills and reinforce correct construction of a graph braille title and make and label tactile key first before adding extra texture. 4. Use Perkins or MB for quick bar graphs – full cell makes bars, create on lines down the page and then turn page and replace in brailler to label axes, title, etc.** 5. Single hole punch on strips of paper for environmental surveys 6. Digital camera to record student's graph. **Equipment/Adaptations** • Same size circles – paper, light card, textured wallpaper, etc. • Thermoform piegraph, linegraph masters – Homai library • Graph Board (brilliant for bar graphs) from MTA.** • Corkboard – circular cake board. • Wikki stix**
Statistical literacy • Evaluate the effectiveness of different displays in representing the findings of a statistical investigation or probability activity undertaken by others.		**Strategies** 1. Carroll Squares –braille headings appropriately on braille paper then fold a paper square into 4 equal squares and glue or staple to the braille page. Place different objects on the squares with blu tack. Photo for recording purposes. ** 2. Data squares – create with paper square and paperfolding.** 3. Form paper circles into simple pie graphs with paperfolding. **Equipment/Adaptations** • Paper squares and circles. • Selection of suitable objects.
Probability • Investigate simple situations that involve elements of chance by comparing experimental results with expectations from models of all the outcomes, acknowledging that samples vary.		**Strategies** • See strategies listed in previous levels. **Equipment/Adaptations** • Tactile dice, large dice with indents. • Coins. • Deck of braille cards. • Bag with selection of different shapes.

<table>
<tr><th colspan="3">LEVEL 4</th></tr>
<tr><th>STATISTICS</th><th>BRAILLE</th><th>STRATEGIES & EQUIPMENT/ADAPTATIONS</th></tr>
<tr>
<td>Statistical investigation
• Plan and conduct investigations using the statistical enquiry cycle:
• determining appropriate variables and data collection methods
• gathering, sorting, and displaying multivariate category, measurement, and time-series data to detect patterns, variations, relationships, and trends
• comparing distributions visually
• communicating findings, using appropriate displays.</td>
<td></td>
<td><u>Strategies</u>
1. Continue to develop student’s ability to describe a graph. A good description is accurate, efficient – i.e. aim for brevity. See Appendix D Graphing Skills.
2. Use basic pie, bar and line graphs to develop knowledge – student to create own story and braille in the relevant information on the graphs.**
3. Encourage the student to work with sighted buddy to produce appropriate displays, rather than developing reliance on the TA or RTV.
4. Spend as much time as you can practising the skills. If this means extra time then take it.
5. Digital camera can record student’s work for homework, assessment, etc. See cluster site.
<u>Equipment/Adaptations</u>
• Same size circles – paper, light card, textured wallpaper, etc.
• Thermoform piegraph, linegraph masters with a variety of axes configurations – Homai library.
• Sets of thermofrom copies of various unlabelled pie, bar and line graphs.
• Geo board., Wikki stix, rubber bands, mapping pins, wire, etc.</td>
</tr>
<tr>
<td>Statistical literacy
• Evaluate statements made by others about the findings of statistical investigations and probability activities.</td>
<td></td>
<td><u>Strategies</u>
• See strategies listed in previous levels.
<u>Equipment/Adaptations</u>
• See equipment listed in previous levels.</td>
</tr>
<tr>
<td>Probability
Investigate situations that involve elements of chance by comparing experimental distributions with expectations from models of the possible outcomes, acknowledging variation and independence. Use simple fractions and percentages to describe probabilities.</td>
<td><u>Tree Diagrams</u>
The best way to reproduce these is in braille is in horizontal rather than vertical form. E.g.

Possibilities for family with 2 children
1st Child 2nd Child Possible Outcomes
 
</td>
<td><u>Strategies</u>
1. For frequency tables set out horizontally i.e. column heading become row headings followed by colon, any runovers in cell 3.
2. Look at the brailled text and try to develop, with the student, simple, quick methods that work e.g. tree diagrams, stem and leaf, creating tabular material.
3. For recording number of successful trials use single hole punch on strip of paper.
4. Probability trees: practise reading in the text, keeping one hand at the start and following the branches. For brailling these keep as simple as possible and plan before beginning so that there is room. (Count cells needed, as in example at left.)
5. Stem and leaf - use text to find ways that work for the student.
6. Spend as much time as you can practising the skills. If this means extra time then take it.
<u>Equipment/Adaptations</u>
• Basic tree diagrams on thermoform that can be put in Perkins for the probability fractions to be brailled – Homai library.
• Tactile dice, large dice with indents
• Deck of braille cards
• Bag with selection of different shapes.</td>
</tr>
</table>

LEVEL 5		
STATISTICS	**BRAILLE**	**STRATEGIES & EQUIPMENT/ADAPTATIONS**
Statistical investigation • Plan and conduct surveys and experiments using the statistical enquiry cycle: • determining appropriate variables and measures • considering sources of variation • gathering and cleaning data • using multiple displays, and re-categorising data to find patterns, variations, relationships, and trends in multivariate data sets • comparing sample distributions visually, using measures of centre, spread, and proportion • presenting a report of findings.		**Strategies** 1. Continue to develop student's ability to describe a graph. A good description is accurate, efficient – i.e. aim for brevity. **See Appendix D** Graphing Skills 2. Spend as much time as you can practising the skills. If this means extra time then take it. **Equipment/Adaptations** • See equipment listed in previous levels.
Statistical literacy • Evaluate statistical investigations or probability activities undertaken by others, including data collection methods, choice of measures, and validity of findings.		**Strategies** • See strategies listed in previous levels. **Equipment/Adaptations** • See equipment listed in previous levels.
Probability • Compare and describe the variation between theoretical and experimental distributions in situations that involve elements of chance. • Calculate probabilities, using fractions, percentages, and ratios.		**Strategies** • See strategies listed in previous levels. **Equipment/Adaptations** • See equipment listed in previous levels.

LEVEL 6		
STATISTICS	**BRAILLE**	**STRATEGIES & EQUIPMENT/ADAPTATIONS**
Statistical investigation • Plan and conduct investigations using the statistical enquiry cycle: • justifying the variables and measures used • managing sources of variation, including through the use of random sampling • identifying and communicating features in context (trends, relationships between variables, and differences within and between distributions), using multiple displays • making informal inferences about populations from sample data • justifying findings, using displays and measures.		**Strategies** 1. Random number generator on calculator. Student must be able to direct support person in use of the calculator. 2. Remember the braille text book is a valuable resource. **Equipment/Adaptations** • See equipment listed in previous levels.
Statistical literacy • Evaluate statistical reports in the media by relating the displays, statistics, processes, and probabilities used to the claims made.		**Strategies** • See strategies listed in previous levels. **Equipment/Adaptations** • See equipment listed in previous levels.
Probability • Investigate situations that involve elements of chance: • comparing discrete theoretical distributions and experimental distributions, appreciating the role of sample size • calculating probabilities in discrete situations.		**Strategies** • See strategies listed in previous levels. **Equipment/Adaptations** • See equipment listed in previous levels.

Senior Level Mathematics

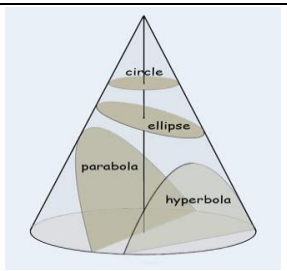
LEVEL 7		
MATHEMATICS	**BRAILLE**	**STRATEGIES & EQUIPMENT/ADAPTATIONS**
Patterns and Relationships • Apply co-ordinate geometry techniques to points and lines. • Display the graphs of linear and non-linear functions and connect the structure of the functions with their graphs. • Use arithmetic and geometric sequences and series. • Apply trigonometric relationships, including the sine and cosine rules, in two and three dimensions. • Choose appropriate networks to find optimal solutions.	Accurate brailling should be consistently expected of the student. Oral work only is not acceptable. **New Sign of Grouping** **open angle bracket** < @< (dot 4, dots 1 2 6) **close angle bracket** > @> (dot 4, dots 3 4 5) <1, 4, 7, …> @<#a1 #d1 #g1 444@>	**Strategies** 3. Always use textbook to reinforce correct brailling of the necessary symbols. There will be a number of Greek letters in use by now. Make sure that the names are learned and used accurately with the Greek letter indicator . 4. Student must become familiar with the Formula Sheet that is used in all exams and tests. Should know where to find, or direct support person to, the relevant formulae quickly. 5. By now student should be capable of accurate dictation of a graph for another to construct. E.g. **"Draw a positive parabola, with x- intercepts at -1 and +3, y-intercept at -1 and turning point at (2, -2)."** This is a complete, accurate description of the function and at this level the written description could even replace a sketch graph. **New Sign of Grouping** Angle brackets are often used for sequences. Note that these are exactly the same as when used for **less than** and **greater than** except for the spacing. Signs of grouping are unspaced. **Equipment/Adaptations** • Geo board, etc. • Graphing calculator – the preferred class model for TA or RTV support. Student will need to learn how to instruct a sighted amanuensis in the use of this. • Talking graphing calculators are presently available as software to a PC. Use of these, however, is very problematic for the braille student.
Equations and expressions • Manipulate rational, exponential, and logarithmic algebraic expressions. • Form and use linear, quadratic, and simple trigonometric equations. • Form and use pairs of simultaneous equations, one of which may be non-linear.	**Logs** 3log x #clog ;x ln e = 1 ln ;e "7 #a GTM s9.5	**Strategies** ○ Layout should make it easy for student to read back so that notes and previous work are readily accessible for study purposes. ○ Layout of simultaneous equations – space so that several lines can be looked at simultaneously. Need to do this sort of work on a manual brailler. **Equipment/Adaptations** • BrailleNote/PacMate – at this level the student may well be using this type of equipment not just for notetaking but for a lot of the working as well, provided good written maths braille skills have been developed. Assignments could then be dictated for scribing.

LEVEL 7		
CALCULUS	**BRAILLE**	**STRATEGIES & EQUIPMENT/ADAPTATIONS**
• Sketch the graphs of functions and their gradient functions and describe the relationship between these graphs. • Apply differentiation and anti-differentiation techniques to polynomials.	**Absolute value** $\lvert x \rvert$ `__|x_|` **Derivative** $\frac{dy}{dx}$ `;;(dy./dx)` **or** $f'(x)$ `;;f7"<x">` Note that the prime sign is straighter than an apostrophe in print. **Integral** $\int$ `!` $\int x^2 dx$ `;;!x9#bdx` GTM s11.5 **Infinity** ∞ `#=`	**Strategies** 1. Refer to the braille textbook in conjunction with the print for correct brailling of these symbols. 2. Note the need for the Grade 1 word indicators.

<table>
<tr><th colspan="3">LEVEL 7</th></tr>
<tr><th>STATISTICS</th><th>BRAILLE</th><th>STRATEGIES & EQUIPMENT/ADAPTATIONS</th></tr>
<tr><td rowspan="2">Statistical investigation
• Carry out investigations of phenomena, using the statistical enquiry cycle:
– conducting surveys that require random sampling techniques, conducting experiments and using existing data sets;
– evaluating the choice of measures for variables and the sampling and data collection methods used;
– using relevant contextual knowledge, exploratory data analysis, and statistical inference
• Make inferences from surveys and experiments:
– determining estimates and confidence intervals for means, proportions, and differences, recognising the relevance of the central limit theorem
– using methods such as re-sampling or randomisation to assess the strength of evidence.</td><td>$\bar{x} = \frac{\Sigma x}{n}$
;;;x:
"7 (,.sx./n);'
(GTM p56, 58)</td><td><u>Strategies</u>
1. Emphasise the correct brailling of the statistical symbols. Learn the correct terminology so that when verbalising to the student the meaning is clear.
2. Keep comparing the braille text and the print so that you understand how the print symbols have been transcribed.
3. Develop good relationships with the maths department so that specialist maths support is available to both the student and the RTV.
4. Note the need for the Grade 1 word and passage indicators.</td></tr>
<tr><td colspan="2">$\lim_{n\to\infty}$
;;lim.5<nn|o#=>
Note that .5 means "directly under."
(GTM 9.6)

sigma notation
$\sum x_i^2$
;;,.sx5i9#b
Note that the subscript indicator comes before the superscript indicator.
(GTM 7.7)
$\sum_{i=1}^{n} x_i^2$
;;,.s.5ix5i9#b
Note that .9 means "directly over."
(GTM 7.9)</td></tr>
<tr><td>Statistical literacy
• Evaluate statistically based reports:
– evaluating risk and relative risk;
– identifying, sampling and possible non-sampling errors in surveys, including polls.</td><td></td><td></td></tr>
</table>

LEVEL 7		
STATISTICS	**BRAILLE**	**STRATEGIES & EQUIPMENT/ADAPTATIONS**
Probability • Investigate situations that involve elements of chance: – comparing theoretical continuous distributions, such as the normal distribution, with experimental distributions; – calculating probabilities, using such tools as two-way tables, tree diagrams, simulations, and technology.	**Tree Diagrams** The best way to reproduce these is in braille may be in horizontal rather than vertical form. E.g. **Probability of choosing 2 beads from a bag containing 3 red and 3 blue beads** 1st 2nd 2/5 R RR ½ R 3/5 B RB 3/5 R BR ½ B 2/5 B BB	**Strategies** 1. Tree Diagrams: Student should use a system that works for him/her. Check how the textbook has dealt with this to see if that works for the student.** At this level these can be really complex – using wikki stix may work better for the lines. 2. A Year 12 student intending to study statistics in Year 13 should be developing the skills and acquiring the appropriate technology to use Excel independently. **Equipment/Adaptations** ▪ Set of basic tree diagrams

LEVEL 8		
MATHEMATICS	**BRAILLE**	**STRATEGIES & EQUIPMENT/ADAPTATIONS**
Patterns and Relationships • Apply the geometry of conic sections. • Display and interpret the graphs of functions with the graphs of their inverse and/or reciprocal functions. • Use permutations and combinations. • Use curve fitting, log modelling, and linear programming techniques. • Develop network diagrams to find optimal solutions, including critical paths.		**Strategies**[❁]  1. Construct cones and cut to show the required ellipse, parabola or hyperbola. Have student investigate the shapes, taking apart and putting together. 2. Photograph graphs for assessment purposes. 3. Student reads and interpret text's tactile graphs and verbally describes to a peer or RTV for print reproduction without peer or RTV seeing print version. The onus is on the student to describe accurately. **Equipment/Adaptations** • Set of solids which include conic sections. • Geo board, pins, string and wire. • Thermoform graph sheets with various axes, e.g. with origin in centre, bottom left, bottom central, etc. • Geometry kit – **see Appendix E** Toolkits
Equations and expressions • Manipulate trigonometric expressions. • Form and use trigonometric, polynomial, and other non-linear equations. • Form and use systems of simultaneous equations, including three linear equations and three variables, and interpret the solutions in context. • Manipulate complex numbers and present them graphically.		**Strategies** 6. Student must become familiar with the Formula Sheet that is used in all exams and tests. Student should know where to find, or direct support person to, the relevant formulae quickly. 7. Braille skills must be very accurate so that work can be revised.

[❁] http://cseligman.com/text/history/ellipses.htm

<table>
<tr><th colspan="3">LEVEL 8</th></tr>
<tr><th>CALCULUS</th><th>BRAILLE</th><th>STRATEGIES & EQUIPMENT/ADAPTATIONS</th></tr>
<tr>
<td>Calculus
• Identify discontinuities and limits of functions.
• Choose and apply a variety of differentiation, integration, and anti-differentiation techniques to functions and relations, using both analytical and numerical methods.
• Form differential equations and interpret the solutions.</td>
<td>Partial Derivative
∂ `d<br>$\frac{\partial y}{\partial x}$ ;;(`dy./`dx)
(GTM 9.6, 11.5, 11.7)

Definite Integral
$\int_a^b f(x)\,dx = \lim_{n \to \infty} \sum_{i=1}^{n} f(x_i)\,\Delta x$
;;;!5a9bf"<x">dx
  "7 lim.5<n|o#=>,.s.5<i"7#a>.9n
    f"<x5i">,.dx;'
Note that the equals sign is indented 2 spaces and the runover is indented a further 2 spaces. Note also where the break has been made in the braille [before the f(x_i)] so that mathematical groupings remain together.</td>
<td><u>Strategies</u>
1. Use textbook as resource. Student must produce accurate braille so that independent study is possible.
2. Differentiation – ensure that student has a good grasp of the relationship between derivatives and gradient. Make sure that the idea of line tangent to the curve is well understood.
3. Integration – ensure that student has a good grasp of the relationship between integrals and area. Investigate lots of tactile examples.
<u>Equipment/Adaptations</u>
• Set of thermoform examples of the various types of areas under a curve.</td>
</tr>
</table>

<table>
<tr><th colspan="4">LEVEL 8</th></tr>
<tr><th>STATISTICS</th><th>BRAILLE</th><th>STRATEGIES</th><th>EQUIPMENT/ADAPTATIONS</th></tr>
<tr><td>Statistical investigation
• Carry out investigations of phenomena, using the statistical enquiry cycle:
– conducting experiments using experimental design principles, conducting surveys, and using existing data sets
– finding, using, and assessing appropriate models (including linear regression for bivariate data and additive models for time-series data), seeking explanations, and making predictions
– using informed contextual knowledge, exploratory data analysis, and statistical inference
– communicating findings and evaluating all stages of the cycle.
• Make inferences from surveys and experiments:
– determining estimates and confidence intervals for means, proportions, and differences, recognising the relevance of the central limit theorem
– using methods such as resampling or randomisation to assess the strength of evidence.</td><td></td><td colspan="2"><u>Strategies</u>
1. Student must become familiar with the Formula Sheet that is used in all exams and tests. Should know where to find, or direct support person to, the relevant formulae quickly.

<u>Equipment/Adaptations</u>
• Graphing calculator
• Excel program
• R program (free download from http://cran.stat.auckland.ac.nz/)</td></tr>
<tr><td>Statistical literacy
• Evaluate a wide range of statistically based reports, including surveys and polls, experiments, and observational studies:
– critiquing causal-relationship claims
– interpreting margins of error.</td><td></td><td colspan="2"><u>Strategies</u>
• See strategies listed in previous levels.

<u>Equipment/Adaptations</u>
• See equipment listed in previous levels.</td></tr>
</table>

Probability • Investigate situations that involve elements of chance: – calculating probabilities of independent, combined, and conditional events – calculating and interpreting expected values and standard deviations of discrete random variables – applying distributions such as the Poisson, binomial, and normal.	**Factorials** 6! #f6 $\frac{n!}{(n-r)!}$;;(n6./"<n"-">6) P_r^n ;;,p5r9n $\binom{17}{8}$ "<#ag]#h"> (GTM 11.5)		

APPENDIX A

ABACUS BASICS

HOW MANY TOO MANY?

- Place value – ones or units, tens, hundreds, thousands … (columns from right to left)
- Face value – the digit
- Total value – combination of the digit and its place value
- Middle finger for ones column
- Hadley method – pincer with thumb for all beads below bar
- Index finger operates 10s, 100s etc
- **Set** beads (push towards bar)
- **Clear** (push away from bar)
- Setting and clearing used for all 4 operations
- Always work from left to right
- Move 5 bead first
- Use left hand to mark left of working column
- Verbalise finger movements
- Can I set directly? Can I set the 5 bead? No? Then I set 1 left!
- Verbalise and physically set zero

With the right support students can become highly competent in all four operations and should be encouraged to use the abacus to 3- and 4-digit multiplication and division before moving to calculator.

Hint: Keep an abacus near the phone to take down phone numbers.

Hadley School for the Blind offers an on-line course in Abacus Skills for teachers.
Abacus I Course ID: ABA-121
This consists of 15 lessons and covers addition, subtraction, multiplication and division of whole numbers and decimals. Prerequisite: Prior knowledge of math facts.
http://www.hadley.edu/hsps/5_a_Courses.asp#A1

Check the BLENNZ Cluster Site for a simple booklet on abacus skills available for downloading. This includes a lot of basic practice drills for the student.

APPENDIX B

VOICEBOX

THE SPOKEN VOCABULARY OF MATHEMATICS

With thanks to Dr. Abraham Nemeth, who developed the rules of MathSpeak, (a system for orally communicating mathematical text) for verbalising Nemeth-based Mathematics – the suggestions have been used as a basis for this New Zealand UEB adaptation.

Dr. Nemeth's presentation: http://people.rit.edu/easi/easisem/talkmath.htm

As Dr Nemeth notes in the above presentation "*No standard protocol exists for articulating mathematical expressions as it does for articulating the words of an English sentence. Therefore, it was necessary for my reader and me to come to some agreement as to the most efficient method for conveying mathematical text to me in an unambiguous manner*."

If you download this to have a look at it, remember that Dr Nemeth was working at a university level and we do not have to reach those rarified heights.

Teachers working with braille students need to develop, with their students, a simple, unambiguous method for oral dictation of written mathematical expressions. While individual teachers and students will use what works best for them it is suggested that some general principles be adhered to. The following suggestions are offered as a beginning.

- Always use correct mathematical terminology, appropriate to the age of the student. Do not compromise correct terminology in an attempt to simplify things for the student and do not allow the student to use incorrect terminology either.

- Use the Braille textbook to practise reading examples together. Both student and teacher need to become familiar with the Braille symbols and the rules governing their use.

- Numerals. Actually speaking the whole number in words rather than digits reinforces the place values of our decimal system. However, for older students, in the interests of speed of dictation, you may choose to just say the digits in some situations and that is a judgement call (but do read out digits after a decimal point: e.g. 24.15 is never *twenty-four point fifteen*).

- Lowercase letters are just named. Upper case letters are commonly verbalised as capitals or "cap" e.g. **A** verbalised as "*cap A"*.

- When the student has reached Level 3-4 explain why Grade 1 indicators are sometimes necessary and practise using them. Voice as "*Grade 1 indicator*", "*Grade 1 word indicator*", "*Grade 1 passage indicator*".

- Negative numbers integers are often written with the negative sign superscripted. Be careful with voicing these – say "*negative six*" not "*minus six*". Minus is the operation of

subtraction whereas a negative integer indicates a distance to the left (or down) along a number line.

- The ellipsis. Possibly the easiest way to voice this is just to say "*dot, dot, dot."* Remember the ellipsis is just three dots and no more. (If you ever see four dots then one of them is a full stop.)

The concept of opening and closing indicators. This concept will occur in a number of cases and is the simplest way of conveying the idea of enclosure.

Brackets ( ), [ ], { }

- When voicing say "*open bracket, close bracket*".
- Although the correct term for (…) is "parentheses", the general NZ usage is to use the term "brackets" for all these grouping symbols.
- If using […], say "*open square bracket, close square bracket*".
- If using { … } say "*open curly bracket, close curly bracket*", although you may choose to call these braces.
- The Braille brackets are a special case – used to show enclosed items that are not actually bracketed in the print. May occur in fractions, exponents, etc.

Fractions

For simple fractions it may be easiest at first just to say the fraction e.g. *three quarters*, *two thirds*, etc. or *three over four*, *two over three*, etc. Remember that as fractions become more complex the brailling of them changes, with the necessary inclusion of Grade 1 indicators or braille brackets, etc. You will want to devise a system of voicing fractions that allows your student to braille them quickly and accurately.

Superscripts and Subscripts

- For simple exponents it is usual in the classroom to just say *"x squared", "four cubed", "ten to the power 6"* when voicing x^2, 4^3, 10^6 respectively. However the Braille student needs to learn when to use the Grade 1 indicators from quite an early level and so you will need to work out a system that works for the two of you. Usually just use *super* and *sub* for superscript and subscript so that x^2 becomes something like *"x, Grade 1 indicator, super, two".* To be sure that you are enforcing the correct brailling keep checking the transcribed material in the textbook.

Radicals $\sqrt{9}$, $\sqrt[3]{27}$

- For simple radicals it is easiest at first just to say *"square root of 9"* for $\sqrt{9}$, *"cube root of 27"* for $\sqrt[3]{27}$; remember the need for the Grade 1 indicator.
- At higher levels you will need to devise a more rigorous way of voicing these so that they may be brailled quickly and accurately, remembering that there is a closing indicator for radicals as well as the opening indicator and the Grade 1 word indicator is probably required. At this level of maths you will usually, but not always, have a student with years of practice at brailling maths.

Greek Letters:

- Relevant Greek letters are included in this document – for the full list refer to UEB Hitchhiker's Guide.

- Encourage the student to use the correct names, *alpha, beta, pi,* etc. At the beginning say "*Greek letter alpha", "capital Greek letter Delta"* to ensure the correct symbol precedes the letter. At higher levels just saying "*sigma"*or *"cap sigma"* should be sufficient.
- Do not spell out *sin, cos,* and *tan* as the word form is the common way of referring to these functions in NZ schools.
- Factorial symbol ! e.g. 3!8! This is usually voiced as "*three factorial, eight factorial"* ***but*** please feel free to use Dr Nemeth's preferred verbalisation "shriek" for the exclamation mark as it will often be a valued source of light relief.

Complex Algebraic Expressions

Remember there are two levels of verbalisation as in the example below.

(x+3)(x-2)

1. Verbalising print examples (whiteboard or unbrailled handouts) for immediate brailling by the student needs to be clear and accurate for instant transcription. E.g. Say "*open bracket x plus 3 close bracket, open bracket x minus 2 close bracket*".
2. Verbalising print examples to emphasise the mathematical meaning of the expression: **Say** "*The product of the sum x+3 and the difference x-2*" **or** "*The sum x+3 multiplied by the difference x-2*."
   You would not say this for copying purposes as it would slow your student down.

When verbalising mathematics to a Braille student it is important to use the standard vocabulary used in the classroom – this will foster the student's independence. Then, where necessary, the student will be able to cope with a peer's or the class teacher's dictation of whiteboard material.

APPENDIX C

STUDENT LAYOUT

- From as early as possible encourage good recording habits in the student. Even before the student is working from a textbook written work should be dated and tasks numbered so that work can be marked and filed for later reference. To develop independence make sure the student plays an active part in the filing process.

- It is important that the student practises reading as well as writing maths so copying examples from the textbook is a useful task. While the student does not have to be as precise a formatter as the transcriber, reading correctly formatted braille can only benefit the student.

- Erasures are not permitted although a missing dot can be inserted. Over time erased dots will spring back up and then meaning is compromised. Teach the student to "cross out" by brailling the full cell over the mistake. The exercise can then be continued without a space.

- Task numbers should be left-justified and include a full stop so that it is very clear what the written answer is. At the early levels most answers can be accommodated on one line. Remember vertical working of problems involving the four basic operations is not recommended – use the abacus for the working and just braille the equation with the answer.

- When worked examples use more than one line make sure that the equals sign begins the second line and is indented two spaces. Subsequent lines will have the equals sign aligned vertically as the indenting is repeated. This indenting is important as it leaves the task numbers sitting out to the left where they are easily located. At secondary level this is particularly important as there is a huge volume of work required and effective study requires easy finding of previously-worked examples.

  e.g. Factorise

  1. $4x^2 + 9xy - 7y^2 + 16 + 5x^2 - 2y^2 + xy + 4$
     $= 9x^2 + 10xy - 7y^2 + 20$
     $= 9(x^2 - y^2) + 10(xy + 2)$

- The long-term goal is that the student develops effective methods of recording and presenting braille maths that will allow fully independent revision.

APPENDIX D

GRAPHING SKILLS

*Just like a machine which must have all of its parts to work properly, a **graph** must also have all of its parts to be complete. When you are drawing or describing a graph you must include everything.*

A bar graph uses a bar to show data. Four parts of the bar graph must be present for the graph to be complete: title, labels, scales, bars. The bars of a bar graph do not touch.

A histogram is a special kind of bar graph that uses continuous data shown as numbers in order. Four parts of the histogram must be present for the graph to be complete: title, scales, labels, bars. The bars of a bar graph touch each other.

A pictograph uses pictures or symbols to show data. Four parts of the pictograph must be present for the graph to be complete: title, symbols, labels, key.

A line graph uses points connected by a line to show data. Five parts of the line graph must be present for the graph to be complete: Title, scale, labels, points, line.

A pie graph uses a divided circle to show data. Three parts of the pie graph must be present for the graph to be complete: title, key, circle. However, a key may not be necessary if the segments can be labelled.

REMEMBER:

Tools - ruler, pen, grid paper or thermoform grid, pin-board, wikki stix, push-pins, rubber bands, cotton or string, compass, Perkins brailler.

Practise, Practise, Practise!

Using graphs in the maths textbook that is in use in the classroom -

1. **Investigate a graph**. What kind of a graph is it? How would you describe it? Look for the title, the key (if there is one), any labels (what is labelled and why), any numbers (why are they on the graph, what do they tell you and is there a pattern to how they are set out).

2. **This will take time – don't begrudge the time spent!** Graphing is a complex tool which is done to make understanding easier for people with sight! Usually it is not easier for a student with very low vision but the skills must still be learnt and can be learnt very successfully.

3. **Spend as much time as you can practising the skills**. If this means extra time then take it. Often, time in the maths class is not used to best effect for the blind or low-vision student so be brave and "do your own thing"! Discuss this with the class teacher – he or she is usually very receptive to the particular needs when you take the trouble to demonstrate.

4. **In a test situation no student with low-vision should be expected to produce a graph!** However, if the student has had plenty of experience exploring tactile graphs, creating his or her own graphs and describing graphs, then a teacher or teacher aide can be given very clear verbal instructions by the student so that a suitable graph can be produced.

Create your own graph

1. A quick bar graph can be done with your Perkins brailler. Use the "for" contraction to create the bars and make sure you label the axes appropriately. Keep it simple!

2. Co-ordinate Graphs:

   a. Use a corkboard mounted with a rubber mat which has been embossed with a grid or raised line graph paper on a corkboard.
   b. Use two perpendicular rubber bands held down by thumbtacks for the x- and y-axes.
   c. The points are plotted with pushpins at the appropriate coordinates. Points are connected with rubber bands or thin string.

3. Inequalities:

   a. **To represent inequalities that require a solid line or a dotted line on the graph:** Use pushpins to plot points. Connect the points with a rubber band when the boundary line is to be included in the solution (solid line in print), and leave off the rubber band when the boundary line is not included in the solution (dotted or dashed line).
   b. **To show shaded parts on the graph:** When graphing one inequality in two variables, simply place a hand over the shaded side. When graphing a system of two inequalities, place one hand on the shaded side of the first inequality. Then place the other hand on the shaded side of the second inequality. Where the two hands overlap (including the boundary lines where appropriate) is the solution.

4. Pie graph:

   a. Use corkboard and sheet with embossed circle marked in 5 or 10 degree intervals. There are thermoform sheets available marked in this way.
   b. Use large rubber bands or string to show circle and segments.
   c. Use wikki stix in various patterns to show different segments.

5. If you have a digital camera, take a photo of your graph for your teacher's information and for your records.

6. Practise, practise, practise, until you are confident.

7. Discuss how you will describe the graph as you work on it. Then, when you are in a test situation you, and your student, know exactly how to work together.

Good graph-drawing rules

1. Plan ahead – with your student! Note the largest value number to be plotted on each axis and make sure your scale is large enough so that you use up at least half of the paper in both directions.
2. A graph should always have a title, telling the reader what it is about. A good title that always works is "y" as a function of "x". The independent variable is usually plotted on the horizontal (x) axis. "Distance as a Function of Time" is an example of a good title.
3. When a scale has axes, they should be labelled, e.g. frequency graphs; give units to those labels: e.g. Distance (cm).
4. The scale on an axis should be uniform, meaning it goes up in constant steps. If measurements do not start at zero there may be necessary to insert a "scale break" as shown below.
5. Most co-ordinate graphs should start at the origin (x = 0, y = 0). There are exceptions like graphing temp. If your lowest temperature is 51^{o} C start at 50^{o} C.
6. Scales should begin at 0. If not indicate there is a break in the graph with a zigzag.
7. Pick a logical scale, counting by 0.1, 1, 2, 5, or 10 etc., not 3, 5, 7, 9, etc.
8. Look at your points. Draw the best straight line or smooth curve that goes through as many points as possible. Point to point connections are usually not used in science but are quite valid for plotting irregular data which does NOT display any regularity - like gold prices. Try to miss as many points above the line as you draw as below.
9. If 2 or more lines are plotted on a graph a key is needed. It should be placed on the right side and toward the top if possible. Tell your teacher or teacher aide that a different colour ink must be used for each line.
10. A graph such as a pie graph should have a key, explaining what lies in each sector.
11. A graph should be appropriate – suitable to display the type of data given.

Here is a quick check list: TITLE, LABELS and UNITS, KEY (if needed).

APPENDIX E

STUDENT TOOLKIT

A Pencil case for Braille learners
A pencil case is a very normal part of a student's school kit – our Braille learners need the following items, particularly for maths but also for science and technology, so get them used to having it, using it and taking personal responsibility for the kit at an early age.

- abacus – available from APH or RVIB
- single hole punch – available from stationery store
- small Braille-marked ruler – available from APH , RNIB or RNZFB
- stylus or used ballpoint pen
- spur wheel – available from craft/sewing store
- French curves (secondary) – available from stationery store
- Braille eraser – available from RNZFB or APH
- Braille protractor (Year 7 on) – available from APH (basic)
- compass with pen (or ideally the old metal one) (year 7 on) – available from APH – check out the RNIB option of a Circle Mate also, for use with a Piaf.
- scissors

Other essential items stored in a convenient location:

- Mapping pins, rubber bands, Wikki Stix
- Tactile dice (2)
- Thermoform graph sheets – various
- Cake boards – circle and square
- Geometry mat – available from RNIB or RVIB
- Calculator – onboard BrailleNote or Pacmate or talking scientific calculator; also at Levels 7-8 consider graphing scientific calculator options.
- Piaf machine and capsule paper based where the teacher aide can use it easily.

TEACHER'S TOOLKIT

Apart from the usual pens, pencils, etc, consider including the following:

- 2 or 3 different-shaped punches (e.g. circle, triangle, star)
- Tactile tape measure
- Stylus
- Spur wheel
- 15cm tactile ruler
- 30cm tactile ruler – RVIB
- Small screwdriver (ideal for fixing braillers!)
- Black whiteboard pens, especially for learners with a little vision
- French curves (secondary – ideal for drawing curves, parabolas, etc.)
- Scissors
- Fineline black Sharpie
- Stiff paper suitable for folding - large supply of
    - Circles 25cm diameter
    - Squares
    - Useful additions could be triangles, hexagons, octagons
- Abacus and manual
- Post-it pen

VISUAL RESOURCE CENTRE'S TOOLKIT

Also consider having the following available for occasional use.

- Talking scales
- Talking compass
- Talking tape measure (5 metres minimum)
- Measuring cups, spoons

Useful URLs
http://www.aph.org/catalogs
http://onlineshop.rnib.org.uk
https://secure.visionaustralia.org/visionaustralia/onlineshop

APPENDIX F

GREEK LETTERS COMMONLY USED IN MATHEMATICS

Used most usually in geometry

a alpha }
β beta } usually labelling angles
θ theta }

π pi

Used in statistics

Σ sigma (capital) used for "the sum of"
σ sigma used for standard deviation of a population
μ mu used for mean of a population
λ lambda

Used in calculus
Δ delta (capital)
δ delta

See The Hitchhiker's Guide for the complete list.