Screening for dyscalculia: development and delivery

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Introduction

DysCalculiUM is a new first-line screening tool to identify students who may be at risk of dyscalculia. The name and capitalisation derives from the key focus of the tool, that of understanding mathematics (UM). It has been developed over a number of years by Trott and Beacham at Loughborough University and follows extensive research and development.

Background

The conceptual understanding of number is one of the main features in the definition of dyscalculia from The National Numeracy Strategy (DfES, 2001, page 2): "Dyscalculia is a condition that affects the ability to acquire arithmetical skills. Dyscalculic learners may have difficulty understanding simple number concepts, lack an intuitive grasp of numbers, and have problems learning number facts and procedures. Even if they produce a correct answer or use a correct method, they may do so mechanically and without confidence." Understanding is also emphasised by Chinn (2006, page 16): “A lack of a true comprehension or understanding of maths will be a key characteristic of dyscalculic people”. Furthermore, the primary statement in The National Numeracy Strategy definition is ‘the ability to acquire arithmetical skills’, which serves to highlight acquisition rather than the mechanical procedures of arithmetic. Butterworth (1999) contends that numbers are conceived as a numerosity or a collection of items. “An intuitive grasp of number” would imply comparisons of these quantities and therefore an understanding of the inter-relationships between numbers. These, together with possible inferences, are also central to screening for dyscalculia.

There are various reasons why mathematical difficulties occur: dyscalculia, knowledge gaps, poor teaching or long periods of absence as well as other neurodiversities. “It is important to make a clear distinction between students whose mathematical difficulties are due to dyslexia or other neurodiversities and those who struggle with mathematics as a result of dyscalculia (Trott, 2010, page 19)”. The learning of number facts and procedures, as specified in the National Numeracy Strategy definition above, involves rote learning and recall and is known to be an ‘at risk’ area for those with dyslexia and other neurodiverse profiles.

The Model

The model that was developed, in parallel with the screener, is given in figure 1.

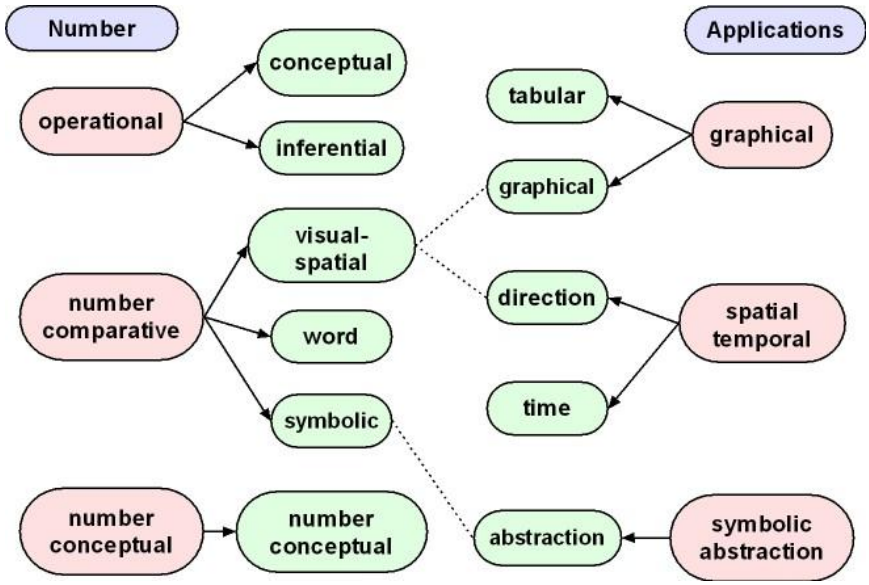

Figure 1: The model for DysCalculiUM: a first-line screening tool

It is built on the three key areas essential to understanding number: number concepts, quantitative comparisons (subdivided into items that employ words, symbols and visual spatial representations) and operations. The latter being further split into conceptual understanding of operations and the making of inferences from given results, as illustrated by the exemplar item in figure 2:

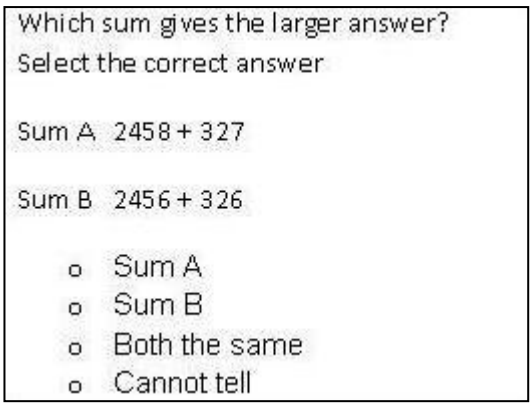

Figure 2: an exemplar item from DysCalculiUM

“The screening tool also includes several applications of these key elements, thus helping to identify what is conceptually understood and what can be effectively applied “ Trott (2010). These applications focus on understanding graphs and tables, directions, time and symbolic notation. Numerical understanding incorporates inductive reasoning, visualisation and quantitative skill. It is a logical analysis of visual symbolic information. These elements are blended together within the core elements of the screening tool.

Development

Very encouraging results were obtained from the early trials of DysCalculiUM (Beacham and Trott, 2005, 2006). From the outset, the appearance of the

screening tool and the use of language were key considerations. There is no set time limit within which the student is required to complete the test. This is designed to reduce the pressure it causes and thereby the implicit anxiety. For those who struggle with understanding mathematics, there is frequently a severe attendant issue of mathematical confidence. Without the timing, it is possible to establish what the participant understands, rather than what can be achieved under the pressure of time constraints. However, participants are encouraged to move forward through the items in the screener and not to dwell on them for too long. Following the early trials, modifications were made to both the items in the screener and its appearance. All of the items had to fit in one screen shot so that scrolling is not necessary. Consideration was also given to the background colour in order to reduce the visual stress.

As noted earlier, mathematical difficulties can be a consequence of many factors, including dyslexia or other neurodiversities such as dyspraxia, particularly with regard to working memory, processing speed and language. Thus, it has always been a priority for the screener to differentiate the dyscalculic student from the dyslexic student. Throughout the development and trials, measures of sensitivity and specificity were used to compare three groups. These were a dyscalculic group (those with a recognised assessment of dyscalculia) with a dyslexic group (those with a recognised assessment of dyslexia) and a control group (those with no known neurodiverse profile). It was important to effectively distinguish the dyscalculic group from the other two groups. An exemplar item will serve to illustrate this: Figures 3 and 4 show the items together with the percentage of each group achieving the correct response. These results are taken from one of the trials. The items ask participants to select the larger of two given numbers. The first shows good discrimination between the dyscalculic group and the other two groups, as required for successful screening. In order to answer this item correctly, the participant must understand the concept of decimal place value. The second does not show the required differentiation and a correct response can be obtained without understanding decimal place value. The reversal in the digits appears to have presented difficulties for the dyslexic group. This second item was therefore removed from the screener.

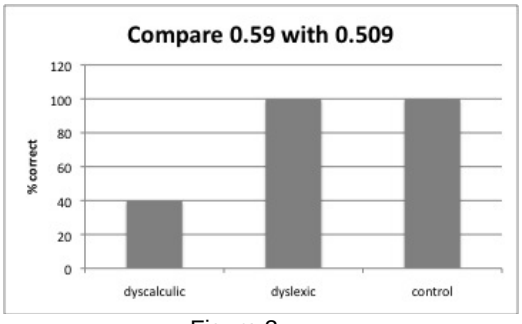

Figure 3

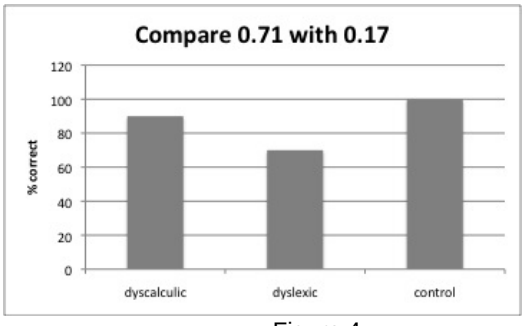

Figure 4

Development of the screener continued through further trials and modifications, including trials on a much larger scale that collected general data for the Further and Higher Education population (n=504) so that

'severely at risk' and 'at risk' thresholds could be established. These were accordingly set at the 2nd and 8th percentile ranks. Furthermore, the screener was trialled on a number of students who had already been identified as dyscalculic through recognised assessments. "The overall picture of results gives substantial evidence in support of the effectiveness of the DysCalculiUM screening tool, not least in the substantial agreement between the appropriate indicators of 'at risk' performance on the screener and those individual students who have already been identified as dyscalculic through recognised assessments" (Trott, 2009, page 134).

DysCalculiUM: the profiler

The 11 sub-categories from the model given in figure 1, provides the basis for an individual profile that shows the areas of relative strength and weakness, in addition to an overall 'at risk' indicator. The profile report from the DysCalculiUM screening profile can act as a useful starting point for subsequent one-to-one learning support. An exemplar profile is given in figure 5. This shows an overall score that indicated 'severely at risk of dyscalculia'. The profile provides further evidence for this, with 7 highlighted categories. The profile suggested a difficulty in understanding number concepts and making numerical comparisons between numbers. This is likely to impact upon understanding the concept of number operations and in making inferences from them. However, no difficulties with graphical and tabular information, time and spatial directions were apparent. These are more visual areas and suggest a visual learner.

	Severely at risk	At risk	Not at risk
OVERALL SCORE	■		
No. Conceptual		■	
No. Comparative: Word		■	
No. Comparative: Symbol	■		
No. Comparative: Vis-Sp	■		
Graphical			■
Tabular			■
Symbolic Abstraction	■		
Spatial Direction			■
Time			■
Operational: Conceptual	■		
Operational: Inferential	■		

Figure 5: Profile from DysCalcuiUM

Delivery

DysCalculiUM will be an online screener for dyscalculia. The learner accesses the DysCalculiUM portal and completes the screener. The results are automatically analysed. The tutor can then access the portal, review the

results and profiles, and identify those who are ‘at risk’ and require further investigation.

Conclusion

Our understanding of dyscalculia is many years behind that of dyslexia. However, by building on our growing knowledge of how mathematics is conceived and understood, it is hoped the DysCalculiUM first-line screening tool will provide a much needed step in the identification process and a platform for subsequent learning support for those who struggle at the conceptual level of mathematical thinking.

DysCalculiUM: a first-line screening tool for dyscalculia will be available from Iansyst Ltd., Cambridge in Autumn 2010

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