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Helping Children With Dyscalculia: A Teaching Programme With Three Primary School Children

Esmeralda Zerafa [a*]

[a] *University of Malta, Msida MSD 2080, Malta*

Abstract

Dyscalculia is a specific learning difficulty which hinders learners from developing the basic number concepts which are needed for the acquisition of mathematics. The aim of this study was to explore strategies which would help children with dyscalculia overcome some of their barriers. After initial assessment of 15 children using the *Dyscalculia Screener* (Butterworth, 2003), three children were identified with dyscalculia. These children, two 10-year-olds and one 7-year-old, were selected as the participants for the study. Their parents were questioned to confirm the *Screener*'s assessment. Consequently, the children were formatively assessed using the *Catch Up*[†] *Numeracy* (2009) assessment tools. Twenty 15-minute sessions were carried out with each child, using the *Catch Up Numeracy* programme. Post-assessment was then carried out. Results suggested that appropriate intervention can allow dyscalculic learners to succeed at acquiring the basic number concepts needed for mathematics learning. Additionally, it was noted that such intervention could greatly impact the affective domain of children, raising self-esteem and developing a more positive attitude to the learning of mathematics.

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Keywords: dyscalculia; dyscalculia screener; primary mathematics; learning difficulties; numeracy; mathematics education

1. Introduction

Teaching mathematics to mainstream classes in primary school can be a challenging endeavour. One challenge can be catering for pupils who would have yet not grasped the basic skills and concepts usually acquired in the

* Esmeralda Zerafa. Tel.: +0035699854860
E-mail address: esmeralda.zerafa@hotmail.com

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lower grades. This research therefore aimed at studying learning difficulties associated with mathematics specifically dyscalculia and seeking effective strategies to support these struggling learners. Dyscalculia is a specific learning difficulty which affects an individual's acquisition of basic number concepts and hinders the understanding and application of number facts and procedures. Studies have reported that 5–8% of school-aged children experience difficulties that interfere with their grasp of mathematical concepts or procedures (Geary, 2004; Fuchs & Fuchs, 2002). Hence the importance of research about mathematics learning difficulties has increased substantially in recent years.

2. Defining Mathematics, Mathematics Learning Difficulties (MLD) and Dyscalculia

Mathematics is a symbolic language which encompasses numbers, form, chance, algorithm and change (Van De Walle, 2004). Since quantitative information exists in every natural environment it needs to be meaningful to all. Humans are born with the ability to "respond to the numerical properties of their visual world" (Butterworth, 2005, p.5). Various researches have shown how babies seem sensitive to numerosity (Starkey & Cooper, 1980; Brannon, 2002). Divergent research has illustrated how they are born with a sense of approximate numerosities on which exact numerosities are later formed through the use of language (Lemer et al., 2003). Numerosity is thus the foundation of numeracy and mathematics. Different authors have used the latter two terms differently. Sousa (2008) for example places concepts like counting and performing simple addition operations under the title of mathematics. Contrarily Dowker (2004) suggests that they should be placed under the numeracy heading explaining that mathematics comprises of more abstract and complex concepts and skills like data handling, geometry and algebra. My own perspective of the relationship between numerosity, numeracy and mathematics is that numerosity which is innate, leads to numeracy which in turn leads to the development of mathematics. Throughout this paper I shall use each term intentionally to signify any one or more of these stages. Defining MLD begins with an understanding of what in particular learners with such difficulties usually find difficulty with. Dowker (2004) illustrates how learners struggling with mathematics would have probably not grasped one or more of the components of numeracy. Limited research has so far indicated areas which are usually problematic for these learners. Since some learners find difficulty with all numerical tasks (Landerl et al., 2004) and others experience difficulties with specific concepts and procedures (Temple, 1991), it is crucial that learners are assessed formatively to identify specific areas needing intervention. As studies about MLD increased, a wide repertoire of terms were attributed to developmental mathematics difficulties for example: *Developmental Dyscalculia* (Butterworth, 2003), *Dyscalculia* (Emerson & Babtie, 2010) and *Mathematics Learning Difficulties (MLD)* (Hopkins & Egeberg, 2009). Most of these terms have been used to illustrate the same condition (Geary, 1993; Geary & Hoard, 2001). For this paper the term dyscalculia will be used because of its literal meaning (*counting badly*), its prevalence in current literature and because it refers to a specific learning difficulty in mathematics as will be outlined in the following sub-section.

2.1. The Characteristics of a Dyscalculic Learner

Dyscalculic learners may exhibit different traits. However as Bird (2009) indicates they usually have 'no feel for numbers', poor ability to estimate and cannot understand whether an answer to a mathematical task is reasonable or not. The difficulties experienced by dyscalculic learners include: subitising, estimating, recalling number facts, counting backwards, understanding and applying the concept of time, understanding money, sequencing, direction (left/right), noticing number patterns and understanding and applying mathematics language (Bird, 2009; Dowker, 2004; Geary, 2004). Mathematics Anxiety may also have a key role in the way these learners perform because it may block their ability to engage in mathematics tasks (Emerson & Babtie, 2010). Such negative feelings may hinder dyscalculic learners from reaching their full potential.

3. Method

3.1 Participants

To find participants with dyscalculia, I began by selecting the children having MLD within a cohort of 83 girls whom I taught mathematics. The children were at Grade 6 level (10 to 11 years old). A total of 15 students were identified as struggling with mathematics. The Dyscalculia Screener (Butterworth, 2003) was administered to all these 15 students. Two out of the 15 pupils were assessed with a profile of dyscalculia. Finding another student with a profile of dyscalculia was problematic so I asked my colleagues whether they had particular concerns about their students. Another student who was currently at Grade 3 level (7 to 8 years old) was referred to me. The Screener was administered and assessed a profile of dyscalculia so she was selected as the third participant. Following the initial screening I interviewed the children's parents separately to see whether their views of their child's mathematical ability confirmed the Screener's report. Interviews lasted approximately 20 minutes and took the form of semi-structured interviews. Semi-structured interviews were used to avoid the rigidity of structured interviews whilst still ensuring that the parents provided answers to the questions I had in mind.

3.2 Assessments and Intervention

Once the participants' learning difficulties were confirmed, the Basic Number Screening Test (Gillham & Hesse, 2001) was carried out with the pupils to ensure that their number age was significantly below their chronological age thus confirming their difficulties. This standardised test was also administered so that the participants' number age before the intervention programme could be compared to their number age after the programme to assess any possible progress. Additionally the children did the formative assessment proposed by *Catch Up Numeracy* (2009) which allowed the assessment of the strengths and weaknesses of each child within the components of numeracy. Every assessment lasted approximately one hour and a half. Once the assessments were ready the intervention programme was carried out with each child individually. The intervention sessions were 15 minutes long and were carried out by myself twice weekly. Each session was kept short so that learners did not lose their attention thus maintaining their focus and effectiveness. The children participated in a total of 20 sessions each spread over 10 weeks. As prescribed by *Catch Up Numeracy*, the targeted components were those in which each child was weakest. Each session was divided into three parts and each section was dedicated a prescribed number of minutes: reviewing previous session (3 minutes), introducing new number skill (6 minutes) and reviewing skills learnt (6 minutes). All sessions were tape recorded and during each session I took note of the following: the component and number range worked upon; any misconceptions the child had shown to have; other components targeted indirectly through the session; the open-ended questions asked to the pupil; my comments and the pupil's comments about their performance; follow-up tasks to be carried out in future sessions.

4. Discussion

4.1 Reflections on Definitions

The initial difficulty encountered in identifying three children with dyscalculia made me question how effective the Dyscalculia Screener (Butterworth, 2003) was in identifying children with dyscalculia when used as the only form of assessment. This thought reflected the concerns put forward by other researchers (Gifford & Rockecliffe, 2008; Messenger et al., 2007). For example with one of the pupils I had to use my own form of additional assessment to find out whether she could carry out simple operations for addition and subtraction as the Screener had first concluded that she guessed the answers on the test and then when re-administered concluded she could do them whilst my own formative test indicated that the child could not do either operation. If the rest of the children (not assessed with dyscalculia) were performing so poorly in mathematics but did not have dyscalculia, as the Screener concluded, what therefore could be the underlying causes for this low attainment in mathematics? Could it be that they had not been taught in a way that fits their learning styles? Is there actually a distinction between mathematics learning difficulties and dyscalculia? The latter conclusion would challenge the fact that these two terms have been used interchangeably in various literature and would support emergent literature using the term

'dyscalculia' to refer to a specific learning difficulty with numeracy (Chinn, 2004; Bird, 2009). This research project showed that there may be a difference between MLD and dyscalculia. One possible difference is that dyscalculia is a severe difficulty with grasping the underlying concepts and skills of numeracy and therefore it may be said that it is a difficulty with numerosity as well. Diversely the title of MLD can describe those pupils who are finding it difficult to cope with the mathematics covered by their peers but have managed to grasp the basic skills. Additionally, I believe that whereas mathematics difficulties may be related to external factors such as irregular attendance at school, dyscalculia may be related to a difference in the formation of the brain (Sousa, 2008; Lemer et al., 2003).

4.2 Positive Impacts of the Intervention Phase

By the end of the intervention phase post-assessments illustrated that all the children had made significant improvement in the numeracy components as assessed by *Catch Up'*s (2009) formative assessment. Moreover two out of three students, one in Grade 3 (P3) and the other in Grade 6 P2, had increased their number age by six months and 18 months respectively. Other important observations were also made. The children were less reliant on finger counting to work out even simple sums. It is not unusual that children with dyscalculia use this strategy to compensate for their inability to work out sums mentally (Geary, 2004; Hopkins & Lawson, 2006). After the programme the children were more efficient at working out simple addition and subtraction sums mentally after new strategies were introduced through the 'remembered facts' component of the *Catch Up Numeracy* (2009) programme. One of the children specifically mentioned this new ability she gained by saying *"but now I am much faster at working out sums mentally so I* [with emphasis] *can do them."* (P1) Another significant gain was that through the metacognitive questioning technique suggested by the programme, the children learnt how to reflect about their learning, comment on what they had previously learnt and ensure that they had understood a newly learnt skill by explaining it back to me. Another important impact of the programme was that on the children's affective domain. Whereas before the programme the children had admitted to disliking mathematics, throughout the programme the children passed on comments like "*this is a real lot of fun, can we do this again?"* (P1) and *"Oh no! Is the session over already?"* (P3). It was also observed that the children's self-confidence in mathematics was also increased. The children would comment on their achievements for each session helping them to see their strengths in mathematics. They realised that they were not failures in all areas of mathematics as they had believed earlier. The focus placed on mathematics vocabulary through the programme was also effective because the children learnt the meaning of this vocabulary and also used it themselves correctly when explaining to me what we had covered during the previous session. Throughout the sessions I had noticed that the Pupils 2 and 3 confused the direction of the numbers and inverted some numbers. These are common characteristics of dyscalculic learners (Bird, 2009; Ott, 1997). By the end of the sessions P2 would notice that she had written the numbers incorrectly without me prompting her and P3 rarely made such mistakes anymore. The use of visual aids and tangible resources such as the Cuisenaire rods made it possible to help the children create mental representations of the numbers and their value.

5. Conclusion

I believe that one of the main conclusions of this research is that with an appropriate intervention programme, learners with dyscalculia can make substantial improvement. *Catch Up Numeracy's* (2009) intervention programme had two major positive outcomes. Primarily the children did acquire the fundamental skills and concepts in numeracy which had not yet been developed. Additionally there was a shift in their attitudes towards mathematics from negative ones to more positive ones. These results corroborate other research both using the *Catch Up Numeracy* programme (Evans 2007, 2008) and another programme which focuses on similar numerical and conceptual knowledge (Kaufmann et al., 2003). Further research on such intervention strategies is undoubtedly crucial but it seems that through the right intervention strategies encouraging results may be noted.

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