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Mata sa Rang Co-teaching: Inclusive Support for Numeracy

This article reports the findings from one section of a small-scale research study in a rural mainstream school in Ireland. The study focused on enhancing the numeracy skills of all pupils in a multi-grade First & Second Class (aged 6 – 8) through the implementation of *Mata sa Rang* (Maths Recovery) approaches in a co-teaching model for inclusive early intervention in mathematics. The pupils' needs in numeracy were identified, class-based support was developed and targeted to meet their needs; their progress was monitored and reviewed. The findings indicate that using *Mata sa Rang* approaches in co-teaching can be an effective early intervention to develop key competencies in numeracy.

Keywords: *Co-teaching, numeracy, maths, multi-grade, inclusion, early intervention*

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INTRODUCTION

This paper explores one element of a research project which took place in a rural mainstream primary school in Ireland. The project was grounded in the school's Improvement Plan for Numeracy as part of the School Self-Evaluation process (Department of Education & Skills, (DES), 2012) where the school sought to improve current practice in inclusive numeracy teaching and learning. Through the Continuum of Support (National Educational Psychological Service (NEPS), 2007) the school wished to target the enhancement of numeracy skills for all students in a multi-grade class, including a number of students with low achievement in numeracy and/or Special Educational Needs (SEN).

In the previous school year *Mata sa Rang*/Maths Recovery (Maths Recovery Ireland, 2010) had been piloted by the school's Learning Support/Resource Teachers (now Special Education Teachers) and the class teacher in a mixed First and Second Class (aged 6 – 8). The pilot operated daily for six weeks. *Mata sa Rang* is an in-class approach to numeracy using Maths Recovery teaching approaches and assessment tasks, as group or whole-class implementations (O'Loughlin, 2012). The school trialled *Mata sa Rang* in a Station Teaching format, and established that it had a positive impact on the numeracy performance of the students on the *Mata sa Rang* assessment tasks and their attitudes towards numeracy. The class teacher was positive in her praise for the programme and observed that it had affected the pedagogic practice of a number of teachers in the school. Based on these findings *Mata sa Rang* continued in First and Second class in the following year (i.e. October 2013 to March 2014) becoming the 'intervention' outlined below and comprising three sessions per week.

LITERATURE REVIEW

Nationally and internationally, mathematics achievement has been a concern for a number of years with many countries publishing national strategies aimed at improving outcomes in Literacy and Numeracy. Ireland's "poor PISA results in 2009 were treated as a catastrophe" (Kirwan & Hall, 2015, p.11). PISA is the Programme for International Student Assessment which takes place on a triennial basis. It tests the skills and knowledge of 15 year old students. In 2009 Ireland placed 26th out of 34 OECD countries and was below the OECD average. Approximately one fifth of Irish students were considered not to have sufficient mathematical skills for daily life. Irish students' performance was particularly weak in problem solving and measures. A relatively low percentage of pupils performed at the higher level of the assessment.

This was followed by Ireland's publication of *Literacy and Numeracy for Learning and Life: The National Strategy to improve Literacy and Numeracy among Children and Young People, 2011-2020* where numeracy is defined as "the ability to use mathematics to solve problems and meet the demands of day-to-day living" (p.8).

In the 2012 PISA study, the performance of Irish students in Print Mathematics improved significantly to 13th of the 34 OECD countries. PISA 2015 tells a similar story with Irish students ranked at 13th out of 35 OECD countries. To date, PISA targets from the National Literacy and Numeracy Strategy have been met for high achievers but not for lower achievers (Shiel et al. 2016).

Underachievement in mathematics continues to be a serious concern as competence in mathematics is an important goal for all students. International researchers such as Fuchs et al. (2013, p.58) have suggested that "functional innumeracy is more common among adults than reading problems due in part to stronger early intervention for reading".

In the literature there is a myriad of definitions of "mathematics difficulties". The DES (2000, p.57) states that pupils with low achievement are those who are at or below the 10th percentile on a standardised test. Gersten et al. (2005) defined them as those who are performing well below the average score. Dowker (2005, p.10) defined them as "children who struggle or fail to cope with some of the aspects of arithmetic that are necessary or desirable for educational purposes".

There are many reasons for mathematics difficulties and low attainment. Numerous researchers have written about deficits in cognitive abilities that cause low achievement in mathematics, such as working memory and executive function. Jordan (2010) stated that mathematics difficulties are widespread, and up to 10% of students will be diagnosed with a learning difficulty in mathematics at some point in their school career. It is imperative that teachers are aware of early signs of mathematical difficulties. Research shows that early indicators include deficits in calculation fluency (Chan, 2009, Bryant & Pedrotty Bryant, 2008, Gersten et al., 2005; Geary, 2004), deficits in number fact retrieval (Chan) and the sophistication of the child's counting strategies (Gersten et al.).

It was noted by Wright (1991, 1994) that there can be up to a three-year difference in the range of number knowledge of children in their first year of school. Children who begin school with less mathematical knowledge, and who do not receive intervention, are likely to continue to be low achievers in mathematics throughout their school career (Aubrey, Godfrey & Dahl, 2006; Aunola et al., 2004,). The Learning Support Guidelines (DES, 2000) state that early intervention begins in Senior Infants but Dooley et al. (2014, p.93) believe that this should be re-examined in light of the fact that there is now greater knowledge and understanding of young children's early mathematical development. The recent circular from the DES (13/2017) on the new Special Education teacher allocation model and the accompanying Guidelines for Primary Schools (DES, 2017) describe the process in identifying pupils' needs in the early years of primary school and putting interventions into place to address their needs, through in-class support or withdrawal from the classroom, either in groups or individually as part of the Continuum of Support (NEPS, 2007).

CONTEXT

Continuum of Support

In the Irish education system, NEPS published the Continuum of Support Guidelines in 2007. This recognises that the educational needs of children can occur on a continuum. The Continuum of Support encompasses a graduated framework of responding to the needs of all pupils through a three-stage approach (Whole-School & Classroom Support, School Support, School Support Plus). There is a considerable emphasis placed on this approach in the Special Education Teacher Allocation Model where schools use the Continuum of Support Framework to identify the educational needs of students, provide them with the appropriate level of support to meet their needs, plan teaching and learning, and monitor their progress.

Mata sa Rang/Maths Recovery

Mata sa Rang is based on the Maths Recovery programme and has been designed by Maths Recovery Ireland. Maths Recovery has been used in DEIS (Delivering Equality of Opportunity in Schools) schools since 2007 where it has enjoyed significant success in improving pupil attainment and encouraging teacher professional development. It is suitable for all pupils. *Mata sa Rang* was piloted in non-DEIS schools in 2011 and at the time of writing training continues to be available through the Education Centre network nationwide. The delivery of the training, the design of the programme and support for implementation is being led by Maths Recovery Ireland. The training is aimed at teachers who wish to implement approaches from Maths Recovery in-class. There are currently two programme modules available. Individual schools are at liberty to decide how to implement the content based on the profile and needs of their school.

METHODOLOGY

This small scale research study aimed to establish if co-teaching, using *Mata sa Rang* approaches, would improve the performance of students in numeracy as measured by the *Mata sa Rang* assessment tasks while addressing their varying needs through in-class support. Quantitative data analysis was used to address the research question.

PARTICIPANTS

Twenty two students in a multi-grade First and Second class in a rural mainstream primary school took part in the study. Students ranged from 6 to 8 years old and

included children with diagnosed SEN and students with low achievement in mathematics. Three adults were involved in the study, all female, with classroom teaching and Special Education teaching experience ranging from 8 to 15 years.

PROFESSIONAL DEVELOPMENT

The teachers involved in *Mata sa Rang* co-teaching had attended the *Mata sa Rang* training modules in the local education centre for fifteen hours with tutors from Maths Recovery Ireland prior to beginning this intervention. The extensive professional development and support delivered by Maths Recovery Ireland is considered to be an integral element of *Mata sa Rang* as it helps the teacher to develop awareness of students' arithmetic knowledge and thinking but it also helps develop awareness of the teacher's own teaching (Wright et al., 2012). It emphasises assessment observation, gaining knowledge of a child's strategies and current mathematical knowledge and learning how to build on that. During the period of the intervention, the Special Education Teachers (SET) and the class teacher met on a weekly basis to discuss and plan the work collaboratively for the following week.

CO-TEACHING

Station Teaching is a form of co-teaching in which the children benefit from working and being instructed in small groups. Friend et al. (2010, p. 11) stated that "the intent of co-teaching is to make it possible for students with disabilities to access the general curriculum while at the same time benefiting from specialised instructional strategies necessary to nurture their learning." This project aimed to be inclusive as it was supporting all learners in their classroom through collaborative practices. A number of factors contributed to the choice of Station Teaching by the teachers involved, such as instructional objectives, the characteristics of the students in the class, the expertise of the teachers and available resources.

ANALYSIS

The first step was for the teachers to identify the numeracy needs of each individual child in the class. They gathered this information through the administration of the *Mata sa Rang* assessment tasks. These can be administered in a one-to-one interview with each child and their explicit purpose is to inform the teaching which takes place subsequently. They assess the mathematical knowledge, skills

and strategies of the children, and help to identify their strengths and needs. There are four sets of tasks, corresponding to four areas of numeracy: Number Words & Numerals, Structuring Number, Early Addition, and Advanced Addition & Subtraction.

Having identified the needs of the students, the second step was to meet and discuss how the needs of the students could be met. Each child was assigned to one of three groups, corresponding to three stations, based on the picture gathered of their mathematical strengths and needs. The stations were: Number Words & Numerals, Structuring Number, and Addition and Subtraction (Early or Advanced). One adult took responsibility for each station, with each station's activity lasting for a timed ten minutes. Approximately one minute was allowed for adults to move to the next station. The sessions emphasised mathematical communication, active engagement and reasoning, including specific development of number sense, where the children interacted flexibly with numbers.

The intervention took place three times per week between October 2013 and March 2014. Activities for each group were selected from the book "Teaching Number in the Classroom with 4 – 8 year olds" (Wright et al, 2006). The instructional activities were carefully planned and specifically targeted towards addressing the diverse needs of the children in the class.

Travers (2011) asks if interventions such as Maths Recovery can inform class teaching. On the other two days of the week the class teacher taught the class programme to the whole class, integrating Maths Recovery approaches which the pupils were experiencing during station teaching, using them to inform her class teaching and encouraging the pupils to apply and generalise their knowledge and skills.

The class teacher and special education teachers were conscious of the need to monitor and review the progress of the children; the third step was that each child completed the *Mata sa Rang* assessment tasks again in March. This data was gathered in order to review and monitor the progress of each individual child and ascertain whether or not they needed to move to the next stage of the Continuum of Support. The data also enabled the teachers to determine if the intervention had a positive effect on the numeracy skills of the children as measured by the outcomes of the assessment tasks.

FINDINGS AND DISCUSSION

This study aimed to establish if co-teaching using *Mata sa Rang* approaches, improved the performance of students in numeracy as measured by the *Mata sa Rang* assessment tasks while addressing their varying needs through in-class support. It should be noted that the assessment tasks do not give "scores"; they are used to inform planning and teaching. For the purposes of this study the number and type of questions answered correctly on the tasks pre- and post- intervention by each individual child was reviewed. The teachers wished to determine if there was a significant change in the students' achievements in the *Mata sa Rang* assessment tasks following participation in the intervention and to ascertain if any students required further support in numeracy. The findings are presented and discussed in terms of the four assessment domains.

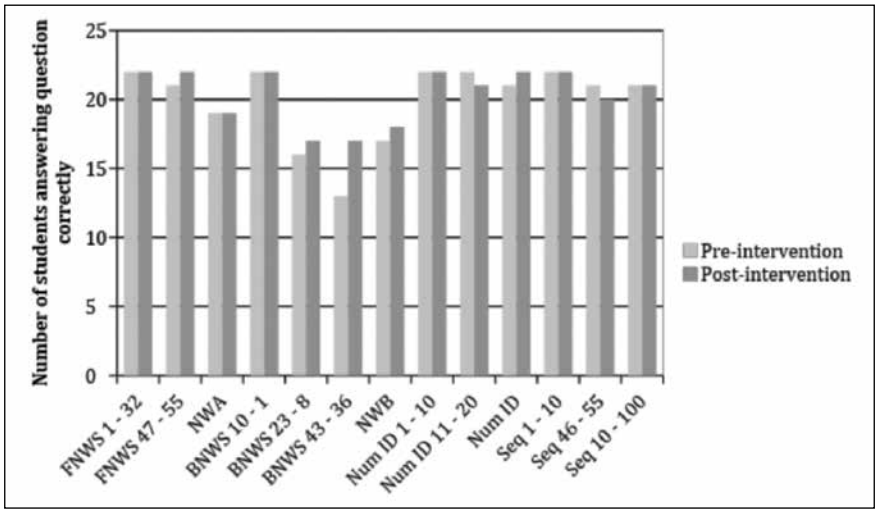
1. Number Words and Numerals Assessment Tasks

Initially a paired samples t-test using the SPSS software programme was completed on the total number of questions that each child in First and Second Class completed correctly on the Number Words and Numerals assessment tasks, pre- and post-intervention to determine if there was a statistically significant difference.

The overall difference between the mean number of questions answered correctly by the children in the class in the Number Words and Numerals tasks pre- and post-intervention was not statistically significant, but as the teachers were monitoring the progress of their students, each child's tasks were examined individually. It was noted that a small number of children did not increase or maintain their scores. Figure One illustrates a further breakdown of the questions answered correctly by the children.

The abbreviations used can be read as follows:
FNWS: Forward Number Word Sequence
NWA: Number Word After
BNWS: Backwards Number Word Sequence
NWB: Number Word Before
NUM ID: Numeral Identification
Seq: Sequence

Figure One: First and Second Class - Number Words and Numerals Assessment Tasks



Going forward, the teachers used this information to carefully plan the next step of the Continuum of Support. They decided that the children who did not increase or maintain their achievements on the assessment tasks would be withdrawn from the classroom in a group to receive further targeted support in selected areas of Number Words and Numerals from the special education teachers.

2. Structuring Number Assessment Tasks

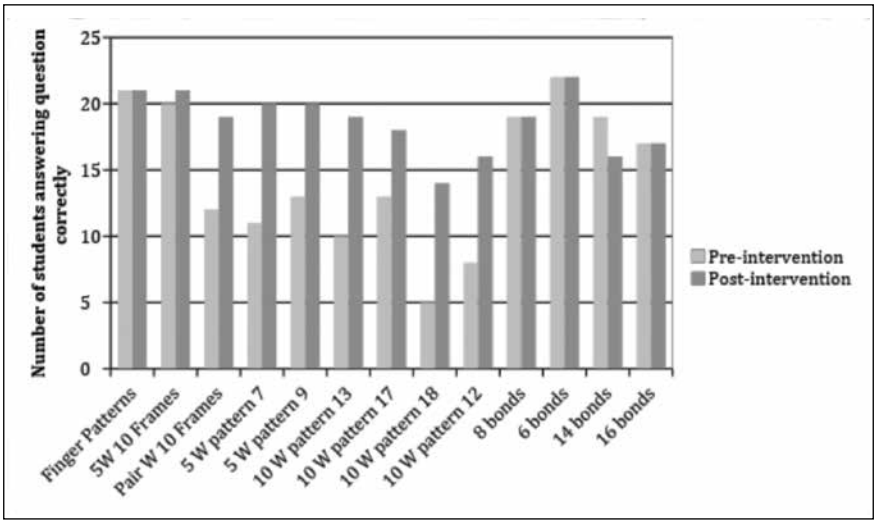
A paired samples t-test using SPSS was conducted to compare the mean number of questions in the Structuring Number Assessment Tasks that the children answered correctly pre- (M = 48.32, SD = 6.01) and post-intervention (M = 52.53, SD = 3.53); t (22) = 3.868, p = .001. This suggests that *Mata sa Rang* approaches had an effect on the numeracy achievements of the children in the class in the Structuring Number Assessment Tasks. In Figure 2, it can be clearly seen that the questions on Spatial Patterns (Five-wise and Pair-wise ten frames) showed an increase in the number of children who answered the questions correctly post-intervention.

The abbreviations used can be read as follows:

5W 10 frames: 5 Wise 10 frames

Pair W 10 frames: Pair Wise 10 frames

Figure Two: First and Second Class - Structuring Number Assessment Tasks



Information from the post-intervention assessment tasks was used to select a small number of children to form a group that were withdrawn from the classroom to receive further targeted support from the special education teachers in the area of Structuring Number.

3. Early Addition Tasks

In the pre-intervention tasks, eight of the twenty two children were assessed as being figurative counters (collections not visible, counting from one), three children were perceptual counters (counting items that they can perceive) and eleven were at the stage of counting on. After the intervention the students who were figurative counters had all moved to counting on; one of the students who was a perceptual counter was now counting on and the other two perceptual counters were now figurative counters.

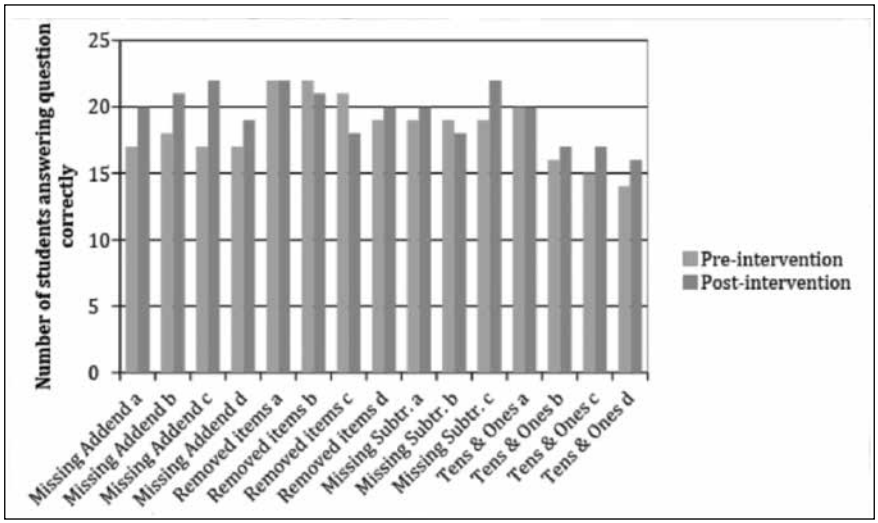
4. Advanced Addition and Subtraction

A paired samples t-test using SPSS was conducted to compare the mean number of questions in the Advanced Addition and Subtraction that the children answered correctly pre- and post-intervention. There was not a statistically significant difference overall but again when each student's assessment tasks were examined individually, further information was gleaned to monitor the progress of each

pupil and inform teaching and learning. Figure Three shows a further breakdown of the number of children answering each question correctly.

The abbreviations can be read as follows:
Missing Subtr: Missing Subtrahend

Figure Three: First and Second Class: Advanced Addition and Subtraction Assessment Tasks



Similar to the other assessment tasks, the teachers used the information gleaned from the post-intervention assessment tasks to select children for further support in a small group and to inform the focus of that support.

SUMMARY

The majority of the children in First and Second Class continued to maintain and improve their knowledge of number based on the *Mata sa Rang* assessment tasks. Although it is not possible to state conclusively that any gains in achievement were completely attributable to the intervention, as they may be due to maturational

reasons or teaching received in class, it is notable that many of the pupils increased and maintained their achievements on the assessment tasks. There is a measure of standard error in quantitative data, the size of the sample of children is small and findings may not necessarily apply to other settings.

The *Mata sa Rang* assessment tasks helped the class teacher and special education teachers to carefully identify the strengths and needs of the pupils in the class in the area of numeracy. They could collaboratively plan further interventions along the Continuum of Support, targeted specifically at areas of need in numeracy.

CONCLUSIONS

This small scale research study sought to ascertain if the use of *Mata sa Rang* approaches during co-teaching improved the performance of students in numeracy as measured by the *Mata sa Rang* assessment tasks. Their varying needs were addressed through in-class support. The school identified the improvement of teaching and learning in numeracy as a starting point. Teachers completed the comprehensive *Mata sa Rang* professional development; they gathered evidence through the *Mata sa Rang* assessment tasks. They planned the implementation of *Mata sa Rang* in First and Second Class, and implemented it three times per week for six months in the form of Station Teaching. On completion of the intervention, the *Mata sa Rang* assessment tasks were repeated with each child. They served as a comprehensive review of the pupils' achievements in numeracy, and aided the school to plan the next steps in their learning and ascertain their responses to interventions through data gathering, monitoring and recording of their progress. Some children required further intensive instruction and *Mata sa Rang* helped to inform the next step in the Continuum of Support and plan targeted support for them.

Programmes such as *Mata sa Rang/*Maths Recovery could be of benefit in all school contexts as the use of Maths Recovery approaches has the potential to develop number sense, which is the foundation for successful acquisition of numerical concepts. Early intervention is needed to put in place interventions for children who begin school with less mathematical knowledge (Aunola *et al,* 2004; Aubrey, Godfrey & Dahl, 2006). *Mata sa Rang* can be implemented by teachers from Junior Infants onwards in both mainstream and special education settings. Class teachers can use Maths Recovery approaches to inform their daily teaching and learning; in-class support could be used in a "purposeful fashion" (Mullan & Travers, 2010, p.102). Each school can decide the format of this based on their individual context and circumstances.

Assessment, differentiation and personalised teaching and learning were key factors in the success of this inclusive intervention through the effective use of the Station Teaching model of co-teaching. It is hoped that the study has helped to set the children involved on the road towards mastering numeracy to the best of their abilities.

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