OPEN ACCESS
EURASIA Journal of Mathematics Science and Technology Education
ISSN: 1305-8223 (online) 1305-8215 (print)
2017 13(6):1653-1673
DOI 10.12973/eurasia.2017.00690a

Movement-based Mathematics: Enjoyment and Engagement without Compromising Learning through the EASY Minds Program

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Received 3 November 2015 ▪ Revised 3 June 2016 ▪ Accepted 7 June 2016

ABSTRACT
There has been a worldwide decline in interest and achievement in mathematics in young people. Despite the extensive benefits of physical activity, the majority of children are not sufficiently active. Schools have the potential to arrest both concerns through innovative teaching that challenges and complements traditional approaches. The aim of this paper is to report student and teacher perceptions of the Encouraging Activity to Stimulate Young Minds program, a school-based physical activity integration intervention designed to enhance learning and engagement in mathematics and increase physical activity levels in children using movement-based learning experiences. Four classroom teachers were interviewed and 66 students participated in focus groups following the 6-week intervention. The program provided positive experiences for teachers and students, both in terms of enjoyment and engagement, while ensuring high quality learning experiences. Embedding movement-based learning across mathematics, had a significant positive effect on children's enjoyment and engagement without compromising the quality of learning.
Keywords: engagement, mathematics, primary school, physical activity, quality teaching

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State of the literature

- Low level of student engagement in mathematics is an area of concern globally.
- Innovative interventions have the potential to positively affect student's attitudes and engagement.
- Embedding movement in mathematics may promote aspects of quality teaching and enhance learning experiences.

Contribution of this paper to the literature

- Embedding movement-based learning throughout the school day, across mathematics, had a significant positive effect on children's enjoyment and engagement in mathematics and physical activity levels.
- Embedding physical activity in mathematics does not appear to compromise the quality of learning.
- This is the first paper to focus on students' and teachers' perceptions of physical activity integration strategies and report on or investigated the quality of the pedagogy employed.

INTRODUCTION

Low levels of student engagement in mathematics has been an area of great concern to mathematics educators and researchers in recent years (Attard, 2013). In Australia and internationally, there has been a steady decline in the mathematical achievement of students in the middle school years (Thomson, De Bortolii, Nicholas, Hilman, & Buckley, 2010). Whilst the causes of this decline may be varied, disengagement with the subject has long been considered a factor (A.J. Martin, Anderson, Bobis, & Way, 2012). The most widely established factors that have been found to be associated with student engagement in mathematics include the influence of teachers (Anthony & Walshaw, 2009) and the pedagogies employed in mathematics (McKinney, Cappell, Berry, & Hickman, 2003). It is also recognised that these middle school years are the time period where students' behaviours, emotions and attitudes towards mathematics are formed with important implications for future study and academic performance (Bishop & Kalogeropopoulos, 2015; A.J Martin, Bobis, & Anderson, 2014). For many students, the use of traditional teacher-centred approaches in mathematics has been recognised as disengaging (Attard, 2013). A longitudinal study has reported that students often view mathematics as a set of isolated procedures, failing to see real-life applications of their learning outside of the classroom (Attard, 2013). Mathematical enjoyment is considered particularly significant for addressing student disengagement (A.J. Martin et al., 2012). However, researchers have found that mathematics classrooms and the individualistic nature of mathematics, whereby students work independently, actually discourages both social interaction and learning, which could reduce engagement and understanding (Attard, 2013). Improving student enjoyment of mathematics is therefore, a key strategy to address subject disengagement (Brown, Brown, & Bibby, 2007). Innovative teaching methods that provide positive mathematical learning experiences could help to enhance students' experiences and outcomes in mathematics.

In this paper we focus on the outcomes of a program that integrated physical activity into mathematics lessons as a novel pedagogical strategy for teachers to improve the engagement levels of students in mathematics. In addition to being a potentially innovative and appealing pedagogical approach to improve engagement in mathematics, increasing physical activity was also a program aim, given the multiple benefits for a child's physical, mental and cognitive health (Institute of Medicine of the National Academies, 2013). Traditionally, schools have used physical education (PE) as the primary vehicle for promoting physical activity within the school day (Lonsdale et al., 2013). However, the crowded school curriculum and school policy pressures have contributed to a decline in the quality and quantity of PE delivered in primary schools (Hills, Dengel, & Lubans, 2014; Morgan & Hansen, 2008). In this context, schools need to explore novel strategies to promote PA throughout the school day. The integration of PA across the school curriculum is one recommended strategy (Centers for Disease Control and Prevention, 2013; Erwin, Abel, Beighle, & Beets, 2009; Institute of Medicine of the National Academies, 2013).

Previous studies have demonstrated that embedding physical activity across the school day not only increases children's physical activity levels (Bartholomew & Jowers, 2011; Mahar et al., 2006; Riley, Lubans, Morgan, & Young, 2015), but also improves children's learning outcomes (Donnelly & Lambourne, 2011). School-based curriculum interventions have highlighted the important role teachers play in their delivery (Donnelly, Greene, & Gibson, 2009) however, they have also found that teachers, whilst willing to integrate physical activity into other subjects, often lack the necessary skills and knowledge to do so. It is therefore paramount that comprehensive professional development be provided to assist in the delivery of school-based physical activity curriculum interventions (Avalos, 2011; Centers for Disease Control and Prevention, 2013). Whilst previous studies have embedded physical activity across the curriculum and have reported on physical activity levels and various academic measures, none, to the authors' knowledge, has focussed on students' and teachers' perceptions of physical activity integration strategies or reported on or investigated the quality of the pedagogy employed which is the focus of this paper.

METHODS

The EASY Minds program

The Encouraging Activity to Stimulate Young Minds (EASY Minds) program, is designed to increase physical activity levels in children through movement-based mathematics learning experiences in primary schools. The EASY Minds cluster randomised controlled trial (RCT) was preceded by a successful efficacy trial (Riley et al., 2015). In the efficacy trial a member of the research team delivered the intervention. In the cluster RCT, classroom teachers were trained during one day of professional learning to deliver the 6-week intervention in order to build capacity among teachers and enhance the likelihood of the sustainability of the program. The professional learning day promoted two types of mathematical lessons developed using the NSW Quality Teaching model as the theoretical

basis: i) activities that used physical activity as a platform for the development of procedural fluency of fundamental number operations (Board of Studies, 2012);for example, students recall multiplication tables whilst skipping, throwing and catching a ball or running through drill ladders , and ii) activities focused on looking at mathematics in the world around the school; for example, estimating and measuring distance, finding shapes and identifying their properties in the natural environment, data collection and representation involving the fundamental movement skills of kicking, throwing and striking. The results for the primary and secondary outcomes have been reported elsewhere (Riley, Lubans, Holmes, & Morgan, 2016). In the cluster RCT, there were significant intervention effects found for the primary outcome of mean activity counts per minute (CPM) across the whole school week. Intervention effects were also found for CPM across mathematics lessons and reduced sedentary time across the school week and during mathematics. In addition, there was an increase in moderate-to-vigorous physical activity across the designated mathematics lessons. A significant intervention effect was also found for students' on task behaviour (Riley et al., 2016). The EASY Minds program demonstrated that integrating movement across the primary mathematics syllabus was a feasible and efficacious for enhancing school-based PA and improving on-task behaviour in mathematics lessons when delivered by classroom teachers. What is likely to persuade teachers to implement a curriculum whereby physical activity is used in the learning process is if we can demonstrate the potential of such an approach, to not only impact positively on children's health but also enhance student engagement and/ or performance in key learning areas such as mathematics while ensuring high quality teaching and learning experiences. Previous research has demonstrated teachers' willingness to participate in reform is enhanced if they can see benefits for their students: (Datnow & Castelllano, 2000; Meiers & Ingvarson, 2005; Timperley, Annan, & Robinson, 2009). Hence, the aim of this paper is to explore both students' and teachers' perceptions of a physically active program of mathematics lessons in the primary school and take a closer look at the pedagogy employed.

Pedagogical Model

Pedagogical models provide a framework through which educationalists can describe effective teaching (Ladwig & Gore, 2005). In Australia, as in many other Western nations there has been a series of initiatives to raise teaching quality and enhance professional standards (Australian Council for Educational Research, 2012; Australian Institute of Teaching and School Leadership, 2011, 2012). One such example of a pedagogical framework is the NSW Quality Teaching model. The NSW Quality Teaching model was designed to improve pedagogy and hence student learning (NSW DET, 2003b). The model supports teachers to develop their capacity to deliver lessons that promote high levels of intellectual quality (IQ), establish a quality learning environment (QLE) and generate significance (SIG) by making learning meaningful for students (NSW DET, 2003a). Like many other teaching models, this particular model is based on research showing that of all the things that schools can control, it is the teacher and quality of the pedagogy employed that most directly and

Table 1. The dimensions and elements of the NSW model of pedagogy

	Intellectual Quality	Quality Learning Environment	Significance
Elements	Deep knowledge	Explicitly quality criteria	Background knowledge
	Deep understanding	Engagement	Cultural knowledge
	Problematic knowledge	High Expectations	Knowledge integration
	Higher-order thinking	Social support	Inclusivity
	Metalanguage	Students' self-regulation	Connectedness
	Substantive communication	Student direction	Narrative

most powerfully affects the quality of learning outcomes that students demonstrate (Darling-Hammond, Wise, & Klein, 1999; Hattie, 2009; Hightower et al., 2011; NSW DET, 2003b). Each of the three dimensions (IQ, QLE, and SIG) of the Quality Teaching model is comprised of six elements that that have been linked to improved student outcomes (Ladwig & King, 2003) (**Table 1**). This model was chosen to both guide the professional learning day, to frame the feedback for observations, guide the development of teaching resources and provide a framework for the interviews and focus groups. All of the study schools are NSW public schools and the model was originally developed in conjunction with the NSW public school system. As such the teachers in the study cohorts were familiar with the model from either or both their pre-service training and additional in-service professional learning, given the model has been in use since 2003.

Subjects and Recruitment

Ethics approval was sought and obtained from the University of Newcastle, NSW, Australia and the New South Wales Department for Education and Communities (SERAP: 2013011). The methodology and outcomes of the EASY Minds cluster RCT have been reported elsewhere (Riley, Lubans, Holmes, & Morgan, 2014; Riley et al., 2016). In summary, grade 5/6 classes from eight public schools in New South Wales, Australia, were randomly allocated to intervention (n=6) or control (n= 4) groups. Teachers from the intervention group received one day of professional learning, a resource pack (physical activity promoting equipment) and a small example of lesson ideas from each strand (number and algebra, measurement and geometry and statistics and probability) of the NSW mathematics syllabus and were asked to adapt their lessons to embed movement-based learning in their daily mathematics program in at least three lessons per week over a six week period. Teachers were only given a small sample of lesson ideas to encourage creativity, autonomy and ownership of lesson content. Intervention support was provided via a weekly email offering ideas and strategies and three lesson observations were made by members of the research team following which an informal discussion took place where teacher and researcher discussed a 3 scale self-evaluation/ activity log. These were 1) mathematical concepts (n=3), e.g.; the key mathematical concepts reinforced throughout the movement based activity, 2) activity levels (n =3) e.g. transitions were managed smoothly and 3) engagement (n=3) e.g. students were engaged by the activities taught. Classes in the control group continued with their regular mathematics program. The primary outcome was

Table 2. Student Focus Group questions

1.	Can you tell me what the E.A.S.Y. Minds program is all about?
2.	How would you describe your math's classes before the EASY Minds program? Did you enjoy this?
3.	Did you enjoy the outdoor EASY Minds math's lessons? Why? Can you give me an example?
4.	Did you enjoy moving in the classroom? Did this make the math's activities more interesting?
5.	What kinds of activities did you enjoy doing in the E.A.S.Y. Minds program?
6.	What kinds of activities didn't you enjoy doing in the E.A.S.Y. Minds program?
7.	Can you tell me if being active in math class helped you learn? Why/why not? If so can you give me an example? Was it fun and enjoyable?
Suggestions for Improvement	
8.	What was the best thing about being involved in E.A.S.Y Minds?
9.	Is there anything that could be changed to make E.A.S.Y. Minds better?
10.	Do you have anything else to say about E.A.S.Y. Minds?

children's physical activity levels across both the school day and during mathematics lessons while moderate-to-vigorous physical activity and sedentary time, children's 'on-task' behaviour, enjoyment of mathematics and mathematics attainment were also assessed as secondary outcomes the completion of the intervention, class teachers were asked to nominate six children, two each of higher, middle and lower mathematical attainment (as determined by the class teacher based on students' previous attainment) to take part in the focus groups. Only students who had parental consent took part in the focus groups, each of which consisted of six students (3 girls, 3 boys) from the same class. Both interviews with teachers and student focus groups were conducted approximately two weeks after completion of the program.

Data collection

A focus group methodology was utilised for the student sample, partly due to time constraints, but also due to group interaction being capable of eliciting information and insights that are less accessible during individual interviews. This is particularly beneficial in groups in which members possess a high level of group affinity and connection (Rice & Ezzy, 1999), as was the case in this study.

The semi-structured discussion frameworks were designed and developed by the research team for the student focus groups and teacher interviews. They were developed to elicit responses and to facilitate discussion around each participant's perception of the program. Specifically, the questions asked in the student focus groups were designed to explore their perceptions of the EASY Minds mathematics lessons, and the nature and quality of their mathematics lessons prior to and subsequent to their involvement in the program (**Table 2**). Additionally, views were sought relating to the students' appraisal of how the EASY Minds lessons had influenced their perceptions of mathematics and learning related to mathematical concepts.

Table 3. Teacher Interview questions

1.	Can you tell me about your experiences with the E.A.S.Y. Minds program?
2.	Did you enjoy teaching an active Math's session as opposed to a classroom based lesson?
3.	What were the major challenges to you as a teacher of active math sessions?
4.	Do you think your students enjoyed the lessons/why/ why not? Have you noticed any changes with your students?
5.	What do you think were the benefits of an active math class for you and your students?
6.	How well do you they think the students understood the math content in the physically active lessons? Can you give me a specific example?
7.	Do you think the PA aspect of the lesson contributed to greater engagement in the lesson compared to how that same math content would usually be taught
Suggestions for Improvement	
8.	Is there anything that could be changed to improve E.A.S.Y. Minds?
9.	What was the best thing about being involved in E.A.S.Y Minds?
10.	Do you have anything else to say about E.A.S.Y. Minds?
11.	Are you likely to continue with this approach after the study?
12.	Have you disseminated this information to other staff members?
13.	How did students contribute to the lesson activities? Was this successful?

The interviews with teachers were designed to elicit their perceptions of EASY Minds lessons compared to regular mathematics lessons. Teachers were also asked to identify any challenges to the implementation of EASY Minds lessons, as well as their appraisal of learning outcomes and students' enjoyment of the lessons, with particular emphasis on the role of physical activity in student engagement (**Table 3**). In both interviews and focus groups, views were sought from participants as to the potential strengths of the program, as well as areas for improvement. Prompts were used as needed to explore topics in depth.

A total of 66 Grade 5/6 students participated in 11 focus groups. The students ranged in age from 10 to 13 years (mean= 11.2 years ± SD), with half (50%) being male. The focus groups were conducted in a separate classroom during school hours, while the telephone interviews were conducted with four teachers from two of the four schools involved in the EASY Minds program (due to teacher unavailability in two schools). Interviews were conducted with two consenting teachers from the same school in attendance at the same time (n=4). All focus groups and interviews were conducted by a research team member not directly involved in the delivery of the EASY Minds program, with interviews lasting between 15 and 17 minutes and the students' focus groups being of somewhat shorter duration ranging from between eight to 14 minutes.

Analysis

The focus groups and interviews were digitally recorded with the participants' consent and transcribed verbatim. A computer program (NVIVO 10) was used to assist with the organisational aspects of data analysis. Analysis was conducted by an independent researcher not previously involved in the program or data collection. Analysis was performed using a standard general inductive approach to qualitative analysis (Thomas,

2006). Initially, inductively derived codes or labels were formulated from the data. The developing coding scheme was continually revised and further expanded after coding of additional transcripts. Following coding of all the transcripts, emerging themes were identified and defined.

RESULTS

The thematic analysis of the student data revealed a number of themes representing their perceptions of the program and its impact and changes to their perceptions and experience of mathematics. The themes arising from the teacher data related to perceptions of the program, reflections on their own teaching, as well as their views on the benefits for students of the EASY Minds program. The findings have been grouped into i) enjoyment and engagement of mathematics lessons and ii) the quality of the learning experiences.

Student and teacher perceptions of the program

Students and teachers had positive perceptions of the program. A key theme that emerged from both groups was that of increased enjoyment and engagement in mathematics lessons.

Enjoyment and engagement of movement-based learning

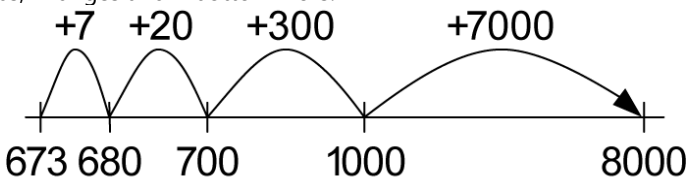
The majority of students found the EASY Minds program was enjoyable and engaging. While students had enjoyed a wide range of different activities, the following were some of the more commonly preferred; rotating activities - hop, skip and jump - recording and calculating averages; 'times tables' while jumping though ladders or bouncing/throwing ball; measuring the playground; throwing beanbags onto a target (**Table 4**). Most reported having enjoyed learning mathematics in a different way.

> *I liked pretty much everything. It was all entertaining. You could find out something that you didn't know before…then you could do maths with that and figure out your average and just manipulate simple things and just help you learn in a different way.*

Being outside and away from the confines of the classroom was in itself considered to be conducive to learning, and mentioned by most students as being the main attraction of the program – "being free", "having fun", and given "freedom to learn" were ideas commonly raised. "I like doing sport and being active and when you combine that with maths it makes it much more enjoyable."

Expending energy was a common theme among the students when talking about the benefits to learning. Students not only reported being able to concentrate and focus better, but also commented that it had acted to reduce talking, off-task time and other distractions. Many students could not specifically identify what aspect of the program had helped them learn mathematics better, but simply felt that it was being outside in the fresh air and having more fun.

Table 4. Example activities

Mathematics content	Using an empty number line
Number and algebra	• Students are encouraged to use a number line drawn in chalk outside and utilise the jump strategy. • Present the students with a number problem. E.g. 8000-673. • Students should try to complete the number line in the most efficient way. • Students assign each "jump" a physical activity. Students can create their own movements • For example; 1000=Squat, 100=jump, 10's =lunge, 1's = bottom kicks. • In this case the answer would be 7327. Students would perform 7 squats, 3 jumps, 2 lunges and 7 bottom kicks.  • Students can be presented with a series of operations and be encouraged to use an empty number line.
Measurement and geometry	**Netball court Maths** • Working in small groups students are to classify all shapes they can identify on a netball court. • Students are to then draw and measure all key parts. Students can choose formal or informal measurements to measure area and perimeter. • Students may decide to include length, width, radius, diameter, circumference, semi-circle and diagonals. • Using appropriate scale students are to draw an accurate scaled diagram **Estimating and measuring 2 D shapes** Students challenge each other to make 2 D shapes using marker cones. Students then have to place the markers in the correct shape and then measure. For example: An irregular pentagon with a perimeter of 22.5m
Statistics and probability	**Target maths** • Students are to take turns to throw 3 koosh balls on to the target. Students can draw their own target in chalk and write in their own numbers. • Students can choose to throw underarm, overarm or use a shot putt technique. • Total up your score and multiply your score by the number you roll on the dice. (Provide a variety of dice for students 1-6, 1-12, 1-20) • Have 3 attempts. • Work out your total and your mean score, median and mode. • Students could then create their own tables and analyse and interpret

Those with more advanced maths attainment, reported that the benefit of EASY Minds was "taking maths to a new level" - making it more exciting. Not surprisingly, it was equally or perhaps even more beneficial to those who were struggling with mathematical concepts. The more exciting hands-on instructional format provided all students with opportunities to grasp such concepts. Many students reported with some level of surprise, that mathematics now was a subject they were looking forward to.

> *EASY Minds stands for its name. It lets your mind relax and go through things, as you're doing fitness, or you're doing something else, that you actually like and you're mixing it with mathematics. That just makes it a whole lot different to what we normally do.*

Before EASY minds, many students reported that their mathematics lessons predominantly involved paper and worksheet-based activities. Not being able to move around, being inside, and simply being exposed to didactic teaching methods (copying work off the board, writing answers to questions in their books, completing worksheets were perceived as dull, boring, repetitive, and uninteresting. Students reported not learning well because they would get distracted, and 'drift off'. Many students reported more hands-on activities since involvement in the program, and many reported that their teacher was now more innovative using varied and interesting activities to improve their learning.

One child described his usual mathematics lessons as "rinse and repeat". He went on to say,

> *Before we had the EASY Minds program it was boring. One group goes on the computer and another group does a worksheet that we don't all understand. It's very boring and one group goes with Mr X which is even more boring.*

Most students perceived their teacher as having enjoyed the program either due to having liked to "try something a bit different", teaching in new ways, or (more commonly mentioned) not having had to attend to so many discipline problems (e.g., students talking and being off-task, general behaviour problems) both during outside and classroom time.

> *I think Mrs G has enjoyed it too because … she's not so stressed because we're doing something we enjoy, not something that we're going to run off and talk if she's not looking at us. So, I reckon she's pretty happy with that. We're not making so much noise and stuff inside the classroom.*

Indeed, many students commented that their teacher appeared to enjoy teaching the EASY Minds program. Reasons given focussed on students' obvious enjoyment of the program, and that students were now actually looking forward to their mathematics lessons, making it more enjoyable for the teacher.

All four teachers interviewed had perceived the program as highly enjoyable and engaging, with particularly positive views of the initial training day. The aims of the program were clear, intuitive and easy to carry out in practice.

> *I found the program to be highly engaging; we just thoroughly enjoyed the whole process. From the start the training day, the initial training orientation day with you guys at the University was probably the best day we've had as far as professional development.*

All four teachers felt their students had gained immense enjoyment from the EASY Minds lessons, with this also being true of students who previously had not enjoyed mathematics. It was perceived as making difficult concepts more "accessible", allowing normally disengaged students to "have a go", and also students were found to be more focussed during and after EASY Minds lessons. “I think that the kids definitely were able to understand and maybe a few of those kids that were disengaged, having a go, whereas they normally wouldn't attempt anything that's written or explicit in the classroom.”.

The quality of the learning experience

In this section, key elements from the dimensions of the NSW Quality Teaching model have been identified (**Table 1**). In this section, Quality Teaching dimensions are provided in italics and brackets.

These statements begin to address the impact of the EASY Minds program as a learning experience for students.

Promoting Intellectual Quality

‘Intellectual quality’ recognises that high quality student outcomes result from “pedagogy that is focussed on producing deep understanding of important concepts, skills and ideas. Pedagogy that treats knowledge as something that requires active construction and requires students to engage in higher order thinking” (NSW DET, 2003a). Example elements include activities that promote a deep understanding, and tasks that promote higher order thinking where students are engaged in activities that are multifaceted.

The EASY Minds lessons were reported by students to have "helped learning in a different way". Many students commented that they had found the mathematics easier once they returned to the classroom, as they had "done the maths with [their] bodies”. Students felt that their improved learning was due to having had the material presented in a different way often gathering their own data, which the students would then analyse and interpret (Higher order thinking) with the activities also having aided verbal explanations, which sometimes were not easily understood. These characteristics of EASY Minds lessons were felt to have prevented the students from ‘drifting off’’ which, teachers reported was often the case with a more didactic and traditional teaching style. One example of learning benefits frequently mentioned was a better handle on concepts such as averages with which they had previously struggled (Deep understanding), using data they had generated themselves. Quite a few students appeared to take a great deal of pride in their newfound skills and the processes through which they had acquired them.

> *Well, with me especially, sometimes in maths, I tend to drift off into my own little world because I don't always understand it when it's just on a sheet. But after doing the stuff in person, and her explaining to us what it is, I've learnt about averages and all that.*

Additionally, procedural fluency type learning (e.g., times tables) had particularly, been found to be subject to improvement.

> *When I first started, I wasn't very good at my timetables but with the timetable game that we played, you had to concentrate on two things. You had to concentrate on the numbers and moving your feet so it helped a lot.*

For those with more advanced maths attainment, the benefit of EASY Minds was that it was "taking maths to a new level"- making it more exciting (Deep understanding/Higher order thinking). Students in one particular group emphasised enjoyment creating their own mathematics problems for each other. For example, one group of students had to challenge each other to estimate and measure the perimeter of irregular shapes using cones (**Table 4**). "When I first started, I wasn't very good at estimating distance but with the measuring game that we played, you had to concentrate on two things. "You had to concentrate, on the shape and the distance"

Only a few students (n=5) had critical comments about the EASY Minds program. Criticisms were mainly about the amount of time provided to work out the mathematics problems. For example, one student felt that one of the activities had been particularly frustrating, a place value activity (where students had to throw numbered bean bags into hoops marked with hundreds, tens and units) "the one with the different colours") and felt that the frustration of not being able to "get it" (throw the bean bag accurately into the hoop) distracted from learning the mathematical concept.

Providing a quality learning environment

Quality learning environments provide high levels of support for students in their learning. A quality learning environment refers to a pedagogy that creates an environment that is clearly focussed on learning and develops positive relationships between teachers and students and among students (NSW DET, 2003a). Elements include social support where peers are encouraged to support each other, student direction whereby students exercise some degree of influence over what they will do and engagement demonstrated by students displaying sustained interest and attention.

The program was seen as alleviating the boredom associated with indoor, worksheet-type activities. As one student said: "[it's about] using maths in a fun way". For some it was the perceived freedom to choose how to learn which made EASY Minds an enjoyable program. (Self-direction). Students were encouraged to investigate their own mathematics problems. For example, groups could decide to work out the area or perimeter covered by certain positions in a netball game. Students in this activity were able to choose to use either formal measurements (metres and centimetres) or in-formal (for example: two footed jumps).

A few students mentioned that the social aspect of EASY Minds was particularly positive. For example, students liked talking to their peers about their work and working

together on group-based activities (Social support). More generally, students liked that the program combined two subjects in one - "getting fit and active while learning" was considered by the students as a double benefit.

One of the main comments which teachers volunteered during the interview related to how it had prompted renewed reflection on their own teaching style. Questions such as "am I being as creative as possible with my mathematics lessons?" and "are the kids really engaged?" were being asked.

> *It just gave me a fresh approach. You get a little bit stuck in your ways I think sometimes with the longer you teach. And if something works to you, you probably just keep repeating it.*

EASY Minds had prompted a desire to be more innovative in terms of incorporating physical activity and outdoor activities into their lessons and made the teachers re-evaluate how they taught all the core subjects not just mathematics as well as prompting ideas of alternative ways to teach concepts.

> *The benefit I think as a teacher is it makes you re-evaluate what you're doing. So, it makes you stop and think about how you're teaching and whether there's a different way that you can do it.*

Teachers volunteered examples of how their EASY Minds lessons had worked and reported, with some pride, positive results such as instances of enhanced student learning (AHA! moments) and peer learning.

We're also surprised by the level of support the other kids actually gave each other, whereas maybe sitting down in the class they wouldn't really help each other too much. But when they were actually out there in their groups, doing a physical activity, working through the mathematics, they actually supported each other a lot. And obviously, any kid that can help another kid, they're self-empowered… (Social support)

The group-based activities of the EASY Minds program were found to facilitate more peer learning, support and engagement, providing scope to incorporate students' different interests and abilities, in ways that benefitted all students. Indeed, one teacher commented that he had been surprised to see his students "taking ownership" of the program and excited to help set it up, design the activities and so on.

> *It just evolved that the kids were literally asking us, requesting to do things, wanting to be a part of it, wanting to organise it, wanting to set it up (Engagement), wanting to actually take control of what sort of lessons they wanted to do and how they wanted to do it. So for me personally I thought it was a great program. (Self-direction).*

Enhancing opportunities for significance

To achieve high quality learning outcomes, students need to understand why their learning matters. Teachers need to ensure that lessons have links to contexts outside of the classroom (NSW DET, 2003b). Elements of significance include knowledge integration where lessons demonstrate links with other key learning areas, and Connectedness whereby lesson activities promote real-life experiences.

Quite a few students commented on "multi-tasking" (doing mathematical and physical activities), noting that being presented with an additional challenge aided in their learning. Students used different ways to explain these benefits; "the exercise makes the brain work clearer"; "because your mind has been doing exercise, it kind of gets it ready for mathematics". One important concept, which quite a few students alluded to however, was that it was the physical activity 'before' doing mathematics which was felt to have aided their learning. Many students reported 'getting fit' as a second but equally important outcome of the program, and this appeared to be an important motivator for some, as it was acknowledged as an important goal (Knowledge integration). Learning the more practical aspects of mathematics and its real life applications (Connectedness) were considered an attractive feature of EASY Minds by many. Teachers commented that students would make connections with real jobs that would need a grasp of concepts. One teacher commented on student's amazement that Olympic athletes could jump so far when estimating their distance travelled in a hop, step jump activity.

Movement-based lessons

While all the teachers reported having enjoyed teaching the EASY Minds lessons more than regular classroom based lessons, they all acknowledged that the preparation took more time and effort because it involved teaching concepts in a new and practical way, away from the "safe" confines of the classroom, "requiring [one] to be more organised". This appeared mainly to be due to EASY Minds lessons requiring something other than simply pulling together familiar material from stable concepts such as fractions, area etc. and presenting it in the usual and traditional way. However, the teachers perceived that this extra effort would only be required until they "got the hang of it".

The teachers also talked of EASY Minds having forced them to be more creative and forward thinking as well as having to structure their planning to get EASY Minds aligned with the scope and sequence of the existing curriculum. However, this was discussed as a positive with much potential gain at the end.

> *I think it really forced us to actually being a little bit more creative and forward thinking about, 'okay this is actually the scope and the sequence of the school. How can we incorporate some physicality into that, make it engaging?*

All teachers interviewed were confident that they would continue with the EASY Minds approach after completion of the study, and the two schools represented in the interviews were, to varying degrees, in the process of adopting the initiatives on the level of whole school programming, allowing teachers to implement it in their own way. One teacher in particular commented on the financial and logistic benefits of having been provided with an EASY Minds "tool kit". "But I think the thing that really probably benefited us was having those exceptionally large bags full of [gear] and you didn't have to run around half the day trying to organise equipment for an activity."

Teachers commented that they would have liked to see the program extended to other subjects as well (i.e., English), while others thought it should be made available at a whole-school level. Other suggestions, which were testament to its popularity, were requests to extend the program duration and make EASY Minds lessons longer. One teacher suggested that a potential avenue for disseminating the program further would be for ideas from all involved teachers to be pulled together and made accessible to everyone, allowing sharing of lesson plan ideas.

DISCUSSION

The aim of this paper was to examine students' and teachers' perceptions of the EASY Minds program to gain insights into the potential, the challenges and impact of integrating physical activity in primary school mathematics lessons. Key benefits perceived by both students and teachers were increased enjoyment and enthusiasm for mathematics and enhanced opportunities for students' social, emotional, physical, and cognitive development.

These positive perceptions of the EASY Minds program demonstrate the potential of using a movement-based approach to teach mathematical concepts. Quality learning experiences have the potential to develop learners not only cognitively but also socially, emotionally and physically. The quality of the pedagogy employed is fundamental in the provision of quality learning experiences.

Mathematics in the middle school years is characterised by low levels of engagement (Attard, 2012; Bishop & Kalogeropopoulos, 2015). Before EASY minds, most students reported mainly doing paper- and worksheet-based activities as part of their maths lessons. Not being able to move around, being inside and simply being exposed to didactic teaching methods were perceived as dull, boring, repetitive, and uninteresting. Many students reported not learning well because they would get distracted, and not be able to concentrate This not only confirms the findings from our RCT that demonstrated a 14% increase in on-task behaviour during active mathematics lessons (Riley et al., 2016) but helps to explain why. Many students reported more hands-on activities since involvement in the program, and many reported their teacher now being more innovative with more varied and interesting activities to enrich their learning. Without exception, all teachers felt their

students had gained immense enjoyment from the EASY minds lessons, with this also being true of students who previously had not enjoyed maths.

Educators have long been concerned with a steady decline in students attitude towards mathematics (Larkin & Jorgenson, 2016). Research has previously found that towards the end of primary school, expressions of boredom from children in mathematics are indicative of lack of stimulation, lack of challenge and a lack of direction over learning (Bibby, 2008). It is clear from the students' perspective that the EASY Minds lessons were more engaging and enjoyable than typical mathematics lessons. Moreover, it is clear from both the student and teacher comments that the quality of mathematical learning was not compromised by this movement-based approach but rather learning was actually enhanced.

Teacher attitude towards mathematics is a key predictor of student attitudes towards mathematics (Lazarides & Watt, 2015).It has been suggested that the most powerful influence on a student's attitude towards mathematics is the pedagogical repertoire of their teacher (Anthony & Walshaw, 2009). A study investigating students' perceptions of mathematics teaching and learning in the upper primary school classroom found that the notion of "fun" was a dominant feature and engagement was therefore deemed likely to be more associated with fun activities (Attard, 2013). Similarly, teachers' own enthusiasm fosters a positive attitude towards mathematics among students. In our analysis students believed that their teachers actually enjoyed the lessons, because there were fewer discipline issues and students were more on task (Riley et al., 2016). Additionally, the pedagogies that are most likely to engage students are those that promote active participation, social interaction and highlight the relevance of mathematics (Attard, 2013).

The engaging pedagogies that the EASY Minds study appear to promote closely align with the NSW Quality Teaching model (NSW DET, 2003b).This was an expected and positive outcome as the model was integrated in to both the professional learning and observation sessions and may explain the positive student and teacher outcomes. Intellectual Quality, for example, was evident as mathematical concepts and ideas were central to all of the activities and the resources provided were carefully chosen to promote mathematical understanding and physical activity. Also, all activities were carefully aligned with the NSW Mathematics curriculum (Board of Studies, 2012). Social support is one of the key elements in establishing a quality learning environment. Teacher responses highlighted the importance of peer-support in the program. Previous studies have highlighted the role of peer-assisted and peer-supported learning as being key to both engagement and motivation in the primary classroom (Patrick, Ryan, & Kaplan, 2007). Movement-based mathematics lessons offer great potential to promote peer-assisted learning. Indeed a key component of the program was student autonomy. Students were encouraged to have control over their physical activity, by choosing both the nature of the actual physical activity and often the intensity and subsequent level of exertion as well as their learning (Self direction). Research has highlighted that students highly value this approach (Mouratidis, Vansteenkiste, Lens, & Sideridis, 2008). A key concept of the program was also ensuring the significance of the

activities. Students clearly enjoyed working outside the confines of the classroom and being exposed to real life implications of mathematics such as estimating and measuring areas within the school grounds and drawing scale diagrams.

Process evaluation of the EASY Minds study revealed that the professional learning component of the study had advanced teachers knowledge and skills in integrating movement in mathematics (Riley et al., 2016). Teachers in the study had attended a professional development day prior to the intervention. The one day workshop included a rationale for PA integration, presentation of results from a feasibility trial, practical examples of PA integration and a peer supported planning session. Teachers were encouraged to be creative and to develop their own lessons, thereby developing ownership of the program and increasing the likelihood of sustaining the program beyond the intervention period (C. Webster, 2011). The teachers interviewed in this study indicated that they were keen to continue with the program and assist in implementing whole school training. This level of commitment to the program may contribute to sustainable changes whereby integrating PA in mathematics becomes part of a whole school policy.

LIMITATIONS

Despite the positive findings of this intervention it is not without its limitations. Teachers highlighted the professional learning as a catalyst for their commitment to the study and the provision of the resource bag containing key mathematical physical activity promoting equipment such as stopwatches, tape measures, target mats, numbered bean bags etc. being fundamental to the program. The success of the intervention was also associated with the recruitment of teachers who were prepared to embrace the concept of movement-based learning. Previous studies have highlighted the importance of teacher behaviour on intervention outcomes (Donnelly & Lambourne, 2011). Previous curriculum-based PA intervention studies have provided actual materials for teachers to deliver (Gibson, Smith, & DuBose, 2008). A unique aspect of this study is that it allowed scope for teachers to plan and deliver their own lessons, thus making the possibility of future sustainability more likely. Previous research has highlighted that teachers own interest in physical activity may affect their competence in delivering movement-based lessons (C. A. Webster et al., 2013). The professional learning day in this study was delivered by researchers specialising in physical activity or mathematics. Therefore, future replication, translation and sustainability of the program may have financial constraints that will need to be addressed at a school policy level.

CONCLUSION

The impact of the EASY Minds program has demonstrated the potential of movement-based lessons and has encouraged the schools involved to change school policy and practice regarding the integration of physical activity across the school mathematics curriculum. Student enjoyment of mathematics is also recognised as a key ingredient for addressing

student disengagement (A.J. Martin et al., 2012) and, given that attitudes towards mathematics are not stable and fixed (Pierce, Stacey, & Barkatas, 2007), innovative interventions, such as PA integration, have the potential to positively affect attitudes and engagement (Pierce et al., 2007). The NSW Auditor General's report (2012) (Department for Education and communities, 2012) highlighted, as one of its recommendations, the need to improve children's physical activity levels through the integration of physical activity within the existing curriculum. Whilst this recommendation was in response to many children in NSW not meeting the recommended guidelines of 60 minutes of moderate to vigorous physical activity per day (Hardy, King, Espinel, Cosgrove, & Bauman, 2010), embedding movement-based learning across the school day, as demonstrated here in the EASY Minds program may have a significant positive effect on children's attitude and engagement in mathematics as well as promoting quality teaching and enhancing the overall learning experience.

ACKNOWLEDGEMENTS

This program is supported by the Department for Education and Communities, (New South Wales, Australia) Premier's Sporting Challenge, as part of the School Sport Unit's program to support teacher professional development. DRL is supported by an Australian Research Council Future Fellowship.

REFERENCES

Anthony, G., & Walshaw, M. (2009). *Effective pedagogy in mathematics* (Vol. 19). Belley, France: International Academy of Education.

Attard, C. (2012). Engagement with mathematics: what does it mean and what does it look like? *Australian primary Mathematics Classroom, 17*(1), 9-13.

Attard, C. (2013). "if i had to pick ant subject, it wouldn't be maths": foundations for engagement with mathematics in the middle years. *Mathematics Education Research Group, 25*, 569-587.

Australian Council for Educational Research. (2012). National School Improvement Tool. Australia.

Australian Institute of Teaching and School Leadership. (2011). Australian Professional Standards for Teachers. Australia: Australian Government.

Australian Institute of Teaching and School Leadership. (2012). Australian Teacher Performance and Development Framework. Australia: Australian Government.

Avalos, B. (2011). Teacher professional development in Teaching and teacher Education over ten years. *Teaching and Teacher Education, 27*, 10-20.

Bartholomew, J., B., & Jowers, E. M. (2011). Physically active academic lessons in elementary children. *Preventive Medicine, 52*, S51-S54.

Bibby, T. (2008). The experiene of learning in classrooms: Moving beyong Vygotsky. In B. T (Ed.), *The pschology of mathematicseducation: A psychoanalytic displacement*. Rotterdam: Sense.

Bishop, A. J., & Kalogeropopoulos, P. (2015). (Dis) engagement and exclusion in Mathematics classsrooms-Values, labelling and stereotyping. *Diversity in mathematics education*, 193-217.

Board of Studies, N. S. W. (2012). *Mathematics K-10 Syllabus* (Vol. 1). Sydney: Board of Studies NSW.

Brown, M., Brown, P., & Bibby, T. (2007). "I would rather die": reasons given by 16 year olds for not continuing their study of mathematics. *Research in Mathematics Education, 10*(1).

Centers for Disease Control and Prevention. (2013). Comprehensive School Physical Activity Programs: A Guide for Schools. Atlanta, GA: Department of Health and Human Services.

Darling-Hammond, L., Wise, A. E., & Klein, S. P. (1999). *A license to teach: raising standards for teaching*. San Francisco: Jossey-Bass Publishers.

Datnow, A., & Castelllano, M. (2000). Teachers' responses to success for all: How beliefs, experiences, and adaptation shape implementation. *American Educational Research Journal, 37*(3), 775-799.

Department for Education and communities. (2012). Physical activity in government primary schools. Sydney.

Donnelly, J. E., Greene, J. L., & Gibson, C. A. (2009). Physical Activity Across the Curriculum (PAAC) a randomised controlled trial to promote physical activity and diminish overweight and obesity in elementary school children. *Preventive Medicine, 49*, 336-441.

Donnelly, J. E., & Lambourne, K. (2011). Classroom-based physical activity, cognition and academic achievement. *Preventive Medicine, 52*, S36-S42.

Erwin, H., Abel, M. G., Beighle, A., & Beets, M. W. (2009). Promoting children's health through physically active math classes: A pilot study. *Health Promot Prac, 12*(2), 244-251.

Gibson, C. A., Smith, B. K., & DuBose, K. D. (2008). Physical activity Across the Curriculum (PAAC) year one processs evaluation results. *Int J Behav Nutr Phy, 5*(36), 1-11.

Hardy, L. L., King, L., Espinel, P., Cosgrove, P., & Bauman, C. (2010). NSW Schools Physical Activity and Nutrition Survey SPANS) *Full Report*. Sydney: NSW Ministry of Health.

Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analysis relating to achievement* London and New York: Routledge.

Hightower, A. M., Delgado, R. C., LLoyd, S., Wittenstein, R., Sellers, K., & Swanson, C. B. (2011). Improving student Learning by supporting quality teaching: Editorial Projects in Education Research center.

Hills, A. P., Dengel, D. R., & Lubans, D. R. (2014). Supporting Public Health Priorities: Recommendations for Physical Education and Physical Activity Promotion in Schools. *Progress in Cardiovascular Diseases*. doi:10.1016/j.pcad.2014.09.010

Institute of Medicine of the National Academies. (2013). *Educating the Student Body: Taking Physical Activity and Physical Education to School*. Washington D C: National Academy Press.

Ladwig, J. G., & Gore, J. M. (2005). Measuring teacher quality and student achievement. *Professional Educator, 42*(2), 26-29.

Ladwig, J. G., & King, B. (2003). *Quality teaching in NSW public schools: An annotated bibliography*. Ryde: NSW Department of Education and Training Professional Support and Curriculum Directorate.

Larkin, K., & Jorgenson, R. (2016). "I hate Maths: Why do we need to do Maths?" Using i pad video diaries to investigate attitudes and emotions towards mathematics in Year 3 and Year 6 Students. *International Journal of Science and Mathematical Education, 14*, 925-944.

Lazarides, R., & Watt, H. G. (2015). Girls and Boys perceived mathematics teacher beliefs, classroom learning environments and mathematical career intentions. *Contemporary Educational Psychology, 41*, 51-61.

Lonsdale, C., Rosenkranz, R. R., Peralta, L. R., Bennie, A., Fahey, P., & Lubans, D. R. (2013). A systematic review and meta-analysis of interventions designed to increase moderate-to-

vigorous physical activity in school physical education lessons. *Preventive Medicine, 56*(2), 152-161.

Mahar, M. T., Murphy, S. K., Rowe, D. A., Golden, D. A., Shields, A. T., & Raedeke T. D. (2006). Effects of a classroom-based program on physical activity and on-task behaviour. *Medicine & Science in Sports & Exercise, 38*, 2086-2094.

Martin, A. J., Anderson, J., Bobis, J., & Way, J. (2012). Switching on and switching offin mathematics: An ecological study of future intent and disengagement among middle school students. *Journal of Educational Psychology, 104*(1), 1-18.

Martin, A. J., Bobis, J., & Anderson, J. (2014). Exploring the ups and downs of mathematical engagement in the middle years of school. *The Journal of Early Adolescence*.

McKinney, S., Cappell, S., Berry, R. Q., & Hickman, B. T. (2003). An examination of the instructional practices of mathematics teachers in urban schools. *Preventing school failure, 53*(4), 278-284.

Meiers, M., & Ingvarson, L. (2005). *Investigating the links between teacher professional development and student learning outcomes* Barton, ACT.

Morgan, P. J., & Hansen, V. (2008). Classroom teachers' perceptions of the impact of barriers to teaching physical education on the quality of physical education programs. *Research Quarterly for Exercise and Sport, 79*(4), 506-516.

Mouratidis, A. M., Vansteenkiste, W., Lens, W., & Sideridis, G. (2008). The motivating role of positive feedback in sport and physical education. *Journal of Sport & Exercise Psychology, 30*(2), 240-268.

NSW DET. (2003a). *Quality teaching in NSW public schools: A classroom practice guide.* Ryde: NSW Department of Education and Training Professional Support and Curriculum Directorate.

NSW DET. (2003b). *Quality teaching in NSW public schools: Discussion Paper.* Ryde: Department of Education and Training Professional Support and Curriculum Directorate.

Patrick, H., Ryan, A. M., & Kaplan, A. (2007). Early adolescents' perceptions of the classroom social environment, motivational beliefs, and engagement. *Journal of Educational Psychology, 99*(1), 83-98.

Pierce, R., Stacey, K., & Barkatas, A. (2007). A scale for monitoring students' attitudes to learning mathematics with technology. *Computers and education, 48*, 285-300.

Rice, P. L., & Ezzy, D. (1999). *Qualitative research methods: a health focus*. Melbourne: Oxford University Press.

Riley, N., Lubans, D. R., Holmes, K., & Morgan, P. J. (2014). Rationale and study protocol of the EASY Minds (Encouraging Activity to Stimulate Young Minds) program: cluster randomized controlled trial of a primary school-based physical activity integration program for mathematics. *BMC Public Health, 14*, 816.

Riley, N., Lubans, D. R., Holmes, K., & Morgan, P. J. (2016). Findings from the EASY Minds Cluster Randomized Controlled Trial: Evaluation of a Physical Activity Integration Program for Mathematics in Primary Schools. *Journal of Physical Activity & Health, 13*, 198-206.

Riley, N., Lubans, D. R., Morgan, P. J., & Young, M. (2015). Outcomes and process evaluation of a programme integrating physical activity into the primary school mathematics curriculum:The EASY Minds pilot randomised controlled trial. *Journal of Science and Medicine in Sport, 18*, 656-661. doi:10.1016/j.jsams.2014.09.005

Thomas, D. (2006). A General Inductive Approach for Analyzing Qualitative Evaluation Data. *American Journal of Evaluation, 27*(2), 237-246

Thomson, S., De Bortolii, L., Nicholas, M., Hilman, K., & Buckley, S. (2010). Pisa in brief: Highlights from the full Australian Report. Challenges for australian Education: Results from PISA 2009. Melbourne, Australia: Australian Council for Educational Research.

Timperley, H., Annan, B., & Robinson, V. M. J. (2009). Successful approaches to innovation that have impacted on student learning in New Zealand. In C. Ng & P. D. Renshaw (Eds.), *Reforming learning: Concepts, issues and practice in the Aisa-Pacific region* (pp. 354-364). London: Springer.

Webster, C. (2011). Relationships between personal biography and changes in preservice classroom teachers' physical activity promotion, competence and attitude. *Journal of Teaching in Physical Education, 30*(4), 320-339.

Webster, C. A., Caputi, P., Perreault, M., Doan, R., Doutis, P., & Weaver, G. W. (2013). Elementary classroom teachers adoption of physical activity promotion in the context of statewide policy: An innovation diffusion and socio-ecologic perspective. *Journal of Teaching in Physical Education, 32*, 419-440.