MATHS ON THE MOVE

Exploring the Effects of a 6-week *Maths on the Move* intervention on Primary School Children's Physical Activity Levels and Maths Performance.

Prepared by Jade L Morris,

Suzanne Bond and Dr Andy Daly Smith

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Point of first contact:
Jade L Morris
107 Churchwood, Leeds Beckett University
Headingley Campus, Leeds, LS6 3QJ
Phone: 0113 812 1916
Email: jade.morris@leedsbeckett.ac.uk

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Executive Summary

Purpose: To assess the impact of a six-week 'Maths on the Move' (MOTM) physically active learning programme on children's physical activity levels and maths performance.

Method: Physical activity was assessed using accelerometry for five consecutive school days at baseline and during the final week of the intervention (final sample: *n*=92). Maths performance was assessed with two tests: (i) a maths attainment test developed by Aspire, assessing numeracy - mathematical content taught during the programme and (ii) the Maths Addition and Subtraction, Speed and Accuracy Test (MASSAT). The maths tests were conducted at baseline and following the intervention (week 7). A write and draw activity took place with intervention classes (*n*=76). Focus groups interviews were conducted with a selection of pupils (*n*=12) across the intervention classes. Three teachers were interviewed, one from each school.

Results: On average, During the MOTM lesson, on average children secured an additional 5 minutes of moderate-to-vigorous physical activity (MVPA) and 5.7 minutes of light physical activity (LPA) with a reduction of 9.5 minutes of time spent sedentary compared to children that remained in the classroom, as the control condition. During the MOTM lesson, there was a variable response to physical engagement; the most active child spent 13 minutes in MVPA, 19 minutes in LPA and 13 minutes sedentary. The least active child spent 2 minutes in MVPA, 40 minutes in LPA and 7 minutes sedentary. On days MOTM was completed, there was an additional 28% of children achieving the school-based MVPA guidelines of 30-minutes. Maths attainment test performance significantly improved over time for children in the MOTM (Baseline *M*=11.3±5.5, Post *M*=18.1±5.4) compared to controls (Baseline *M*=10.1±6.1, Post *M*=11.0±1.0). No improvement was found in the MASSAT.

Nine emerging themes were derived from the pupil focus groups and four themes from the interviews with teachers. Children felt the MOTM sessions resulted in social and environmental improvements, which improved learning during the sessions. Children in the focus groups described the MOTM sessions as enjoyable, fun, engaging and invigorating – resulting in positive associations to learning and activity. Similar themes were revealed in the write and draw activity. Teachers praised the MOTM lessons as an excellent way for fostering engagement and managing children's behaviour for subsequent lessons.

Recommendations: The following recommendations have been made to aid the future implementation of the intervention.

- The MOTM intervention, in its current form, may be used to improve physical activity levels during the school day, accumulating on average 5 minutes of MVPA and 5.7 minutes of LPA during the MOTM lesson.
- Children in the MOTM conditions showed increases in MVPA levels on days then MOTM was conducted. As a result, 28% more children achieved the daily school-based guidelines of 30-minutes of MVPA.
- The MOTM intervention, in its current form, allows the more active child to achieve 13 minutes more MVPA compared to very sedentary lessons. The least active child achieved one additional minute of MVPA and 29 minutes of LPA during MOTM compared to lesson time.
- The MOTM intervention, in its current form, may be used to improve physical activity and reduce time spent sedentary of children in academic lesson time.
- For the MOTM programme to have optimal benefits on children's enjoyment and engagement it is essential the lessons continue to split the class up, working with 50% of the pupils at a given time.
- The MOTM programme should continue to be aware of pupils mixed abilities during the sessions.
- The MOTM programme in its current forms supports confidence and resilience in pupils which transfers back into the classroom.
- To boost pupil's maths performance, schools may benefit from implementing a programme such as MOTM.

Introduction

Global and UK based reports suggest physical activity levels in children are at an all-time low (Tremblay et al., 2016, NHS Digital, 2019). In response, the UK government have released the Primary P.E. and Sport Premium fund to support primary schools with £320 billion every year (Department for Digital Culture Media and Sport & Department for Education, 2015, Department for Education & Department for Digital Culture Media and Sport & Department of Health and Social Care, 2019). The funding is aimed at helping schools achieve the required 30 minutes of in-school physical activity each day for children (Department of Health and Social Care, 2018). Yet, challenges persist with schools receiving little guidance on how best to spend the money.

In response, a growing body of research and practice has focussed on integrating movement within lessons (Bartholomew and Jowers, 2011, Bartholomew et al., 2018, Daly-Smith et al., 2020). One form of intervention to increase physical activity in lesson times is physically active learning (PAL); the integration of movement within the learning experience (Bartholomew and Jowers, 2011, Bartholomew et al., 2018). A growing body of literature has begun to emerge on the benefits of introducing physical activity into the school day to enhance cognition and academic learning (Bartholomew and Jowers, 2011, Resaland et al., 2016, Bartholomew et al., 2018). In recent systematic reviews and meta-analyses, PAL has been shown to improve physical activity levels and pupils time-on-task (Watson et al., 2017, Daly-Smith, 2018, Daly-Smith et al., 2018, Norris et al., 2019). Yet, little is known on the direct benefits of PAL to academic performance; specifically, in relation to the learning of a discrete program of study (Daly-Smith et al., 2018). Previous physically active learning programs have focussed on activities that provide reinforcement of previously learnt concepts from across the subject curricular (Morris et al., 2019b). For example, reinforcing spelling through active spelling relays in the playground (Morris et al., 2019b).

More recently, a study in Australia has assessed a PAL lesson, also incorporating movement and mathematics learning, focusing on multiplication in Year 3 pupils (Vetter et al., 2020). Following a 6-week intervention, with three sessions a week, multiplication scores improved in the intervention group compared to the control group (ES=0.23, p=0.045). However, there was no significant difference in general numeracy (ES=0.05, p=0.66). The findings reinforce additional evidence to understand the potential benefits of PAL on maths performance, with a need to focus on specific academic outcomes (Vetter et al., 2020).

The unique focus on the current study is the use of a defined scheme of work focussed on a specific Numeracy topic. This provides a step-change in the focus of PAL, moving from understanding the impact on cognitive processes and overall academic performance to specific academic outcomes. Therefore, the current project will aim to evaluate the impact of a physically active learning product – Maths on the Move (MOTM). The MOTM product is widely used within the primary setting to engage pupils in active learning in mathematics. In 2018/19 academic year the MOTM programme has been delivered to 221 groups, working with over 3,000 pupils. The present study aims to assess the impact of a six-week physically active learning programme on children's physical activity levels and maths performance.

Method

The current study used a between-subject study design, using a randomised-control trial (see appendix A for a flow diagram of the study design and protocol). Randomisation took place within the schools at the class level; two classes per school were recruited. One class was randomly allocated to the MOTM six-week programme. The other class was allocated to the control, continuing with standard provision.

Recruitment

Aspire contacted schools to discuss the research project in addition to the MOTM programme. The programme was adapted to a six-week MOTM programme. Schools received the 6-week intervention free of charge for the project. Headteachers from schools read a gatekeeper letter and signed a consent form. Next consent and assent forms were signed by parents/guardians and children.

Participants

Four two-form entry schools in Birmingham signed up to take part in the project, with a total of 225 children in Year 5 invited to take part in the project. Consent was particularly challenging in one of the schools (2/56 children), and therefore before the project started, this school was dropped from the project. Of the remaining three schools a total of 140 children consented out of 169 children to take part in the project (MOTM n=76 ; Control n=64).

Protocol

Data collection took place between September and December 2019. Researchers visited the schools on four occasions. On day one (Monday), children completed a familiarisation of the Maths Addition and Subtractions, Speed and Accuracy Test (MASSAT). This was to remove any learning effect that may

occur from baseline to post-testing (Goldberg et al., 2015). Children were fitted with accelerometers to assess their physical activity levels. Children were instructed to wear these for five consecutive school days; putting them on upon arrival at school and taking them off just before leaving the school grounds. Children also had their height measured on this initial day (Monday).

Exactly one week later, children completed the baseline MASSAT (Morris et al., 2019a) and maths attainment test, created by Aspire. During week six - the final week of the MOTM intervention - children were fitted with accelerometers to wear for five consecutive school days. On the Monday following the end of the intervention, children completed post MASSAT and maths tests (seven weeks following baseline). Children were also asked to complete the Write and Draw activity during this morning. Later on, during the day, or the next day, a smaller group of children (*n*=4 per school, total *n*=12) were invited to take part in a focus group.

MOTM Intervention

Children in the MOTM classes engaged in one ~50-minute MOTM lesson each week. Lessons were delivered to half of the class at any one time (~15 pupils) with both groups completing the same lesson objectives. The remaining 15 pupils remained within the classroom with their usual teacher, swapping over after 30 minutes. Lessons followed the same structure and content across the three classes in different schools. The content of the lessons was agreed in advance of the intervention between Aspire and the schools. The MOTM lessons were delivered by an experienced member of Aspire staff with prior teaching experience who was external to the school.

Each lesson focused on a specific numeracy objective form the UK Year 5 National Curriculum. The final lesson recapped the objectives that were covered throughout the programme. The following objectives were covered: (i) solve problems involving number up to three decimal places, (ii) identify, name and write equivalent fractions of a given fraction, represented visually, including tenths and hundredths, (iii) read and write decimal numbers as fractions, (iv) multiply proper fractions and mixed numbers by whole numbers, supported by materials and diagrams, (v) recognise mixed numbers and improper fractions and convert from one form to the other. The curricular content was combined with a range of multi-skills physical activities and challenges were used to create the game-based lessons. Children had a workbook where they completed some of the tasks each week.

Children in the control condition did not deviate from typical academic lessons, continuing with their usual school routine for the duration of the project.

Measurement Tools

Accelerometers

Physical activity was assessed using a combination of GT1, GT3x, GT3x+, wGT3X+ and GT9 (ActiGraph, Pensacola, FL) accelerometers. Pupils received the same monitors pre-to-post. Accelerometers were the preferred measurement tool for PA: they are affordable, reliable and valid within field-based research (Fitzhugh, 2015) and widely used with children (Rowlands and Eston, 2007). All accelerometers collected data in uniaxial mode, worn on the right hip attached with a clip to their trousers/skirts. Accelerometers were fitted upon arrival on each school day and removed before leaving the school grounds. Previous research has revealed stronger validity scores for hip placements ($r=0.965$; $p<0.01$) compared to wrist-worn placement (Phillips et al., 2012).

Evenson et al. (2008) cut-points are were used: sedentary (0-25 counts per 15 seconds), light (26-573 counts per 15 seconds), moderate (574-1002 counts per 15 seconds) and vigorous (<1003 counts per 15seconds). Evenson et al. (2008) cut-points are a favoured choice, demonstrating a high degree of accuracy across different intensity levels (Trost et al., 2011). Assessing the validity of the Evenson et al. (2008) cut-points in combination with 15-second epoch length against indirect calorimetry, revealed a ROC-AUC of 0.93-0.99, which is strong. When analysing physical activity data with counts, Evenson et al. (2008) cut-points are the most appropriate when looking at children's activity levels. Activity thresholds would be produced for sedentary time, light physical activity (LPA) and moderate-to-vigorous physical activity (MVPA).

Measuring Maths Performance

Two tests were used to measure maths performance. The first test was the MASSAT (Morris et al., 2019a), a validated tool for assessing addition, subtraction, and inverse operations. The MASSAT takes five minutes to complete. The MASSAT has 100% construct validity and has a test-retest reliability of 0.85 (Daly-Smith, 2018).

The second test was a maths attainment test, designed by Aspire. The test took 30 minutes, with 25 marks. The maths attainment test was designed to assess aspects from the number – fractions (including decimals and percentages) content domain in the Year 5 National Curriculum Programme of Study. The questions were age-appropriate and in line with the statutory requirements for Year 5.

Both maths tests were counterbalanced, meaning the order the participants completed the different versions of the tests was randomised and equally split, eliminating any order effects.

Height and Biological Maturity

Children had their height measured using a Seca 217 Stadiometer (Seca, Germany). Biological maturity (maturity offset) was calculated using children's age from peak height velocity, a valid and reliable measure of maturity status (Moore et al., 2015). While less accurate than pubertal status or skeletal age, the simplicity and non-invasive nature of the method suited the study population and reduced the complexity of the ethical process (Mirwald et al., 2002, Beunen et al., 2006). Age from peak height velocity was established using the following equations for standing height (Moore et al., 2015).

Boys:

Maturity offset = -7.999994 + (0.0036124* (age * height))
R2 = 0.896; SEE = 0.542

Girls:

Maturity offset = -7.709133 + (0.0042232* (age * height))
R2 = 0.898; SEE = 0.528

Write and Draw Activity

Children in the MOTM classes were asked to complete a write and draw task to provide them with an opportunity to express their own thoughts and opinions on the intervention (*n*=76) (Noonan et al., 2016). The conflict that can often occur when trying to engage young children in research (i.e. due to delayed writing ability and cognition) at this age has been found to be alleviated through a draw and 'show' (explain) approach as it helps re-address the power balance and enable them to have a voice in their own right. Similar to Noonan et al. (2016), the lead researcher facilitated a class-based activity, handing out booklets which had spaces for children to fill out four questions. First, can you write or draw what you do in a typical maths lesson? Second, can you write or draw how you feel during a typical maths lesson? Third, can you write or draw what you did in a MOTM lesson? Finally, can you write or draw how you felt during a MOTM lesson? In alignment with previous research, children were given a range of pencils and colouring pens to promote creativity (Noonan et al., 2016)

Focus Groups

Following the write and draw task, four children per intervention class were invited to take part in a focus group to 'show' (explain) their writings and/or drawings (*n*=12*)*. Focus groups lasted between 22 to 32 minutes; taking place in quiet space such as a spare classroom or the school library. The four children in each class were chosen based on their MVPA levels during baseline data collection. Two children classified as low activity levels and two children having high activity levels. An attempt was made for an even gender split where possible.

The focus groups were designed to broadly explore the children's perceptions and experiences of both a typical maths lesson and MOTM lesson. Children used their 'write and draw' sheets to inform discussions between the facilitator and the other children. During the focus groups, the same four questions from the write and draw activity were posed to the children — the facilitator asking the children to explain their answers.

Teacher Interviews

One school staff member from each school was invited to take part in a semi-structured interview. Teachers were given time to consider the invitation, read the information letter and sign a consent form. Teachers were asked several questions regarding their perceptions around the MOTM project.

Data Analysis

Of the 140 children that consented to take part in the study, only 92 had a complete data profile include physical activity and maths performance data. Accelerometer data were downloaded using ActiLife 6 and analysed in KineSoft (v3.3.75, KineSoft, Loughborough, UK).The screening included assessing non-wear time and ensuring children met 300 minutes of wear time during the school day, with a minimum of three valid days. Segmented day analysis was conducted to look at the activity thresholds during different parts of the day (lesson time, break, lunch, P.E.). The physical activity data was then exported from KineSoft into an excel file and merged with all existing data collected. Once formatted, the data was pulled into R Statistics for analysis.

Independent t-tests were conducted to assess between group differences in between baseline measures (e.g., age). To estimate the effect of MOTM on maths performance over time (continuous variable: Maths test total score, MASSAT number of correct responses, MASSAT number of errors and MASSAT total score), a series of two-level regression models were conducted. Models allowed for the nesting of measurement occasions (level 1), within students (level 2) and random slopes for the time.

Qualitative data gathered from semi-structured interviews with school staff and unstructured focus groups with children were transcribed verbatim. The rich qualitative data provided was analysed using Braun and Clark's (2006) thematic analysis methodology. Overall perceptions of their experiences of the programme were ascertained, whilst also examining potential barriers and facilitators of engagement. Thematic analysis is a robust approach for identifying, analysing, and reporting patterns within a data set (Braun & Clark, 2006; Patton, 2002). Initially, codes and themes were processed inductively. Themes were agreed upon and relabelled with two researchers.

Results for Quantitative Findings

Participants Characteristics

Table 1 below reveals the baseline characteristics of the children in each condition (MOTM and Control). While there was no significant difference between the two conditions for pupils age or height, there was a significant difference between maturity offset.

Table 1: Children's baseline characteristics

	MOTM (*n*=49)	Control (*n*=43)	*p*
	M (SD)	*M (SD)*	
Age (year)	9.64 (0.29)	9.57 (0.28)	0.125
Gender	25 boys / 26 girls	21 boys / 25 girls	
Height (cm)	149.71 (86.19)	134.21 (6.80)	0.148
Offset Maturity (y)	-2.19 (3.04)	-2.89 (1.27)	0.0389

Note. MOTM: Maths on the Move ; M: Mean; *p*: significance; SD: Standard deviation.

Physical Activity Levels

School Time Physical Activity

Table 2: Minutes of time spent in each activity threshold at baseline and week six, stratified by the condition during the school day.

	Sedentary Mins (SD)		LPA Mins (SD)		MVPA Mins (SD)	
	Baseline	Week 6	Baseline	Week 6	Baseline	Week 6
MOTM	256.4 (27.9)	208.7 (53.9)	105.3 (20.5)	145.1 (57.3)	25.1 (10.4)	38.2 (19.3)
Control	249.3 (42.2)	189.1 (44.4)	103.4 (28.7)	111.8 (40.8)	24.8 (12.0)	27.3 (15.6)

Note. LPA: light physical activity; MVPA: moderate-to-vigorous physical activity

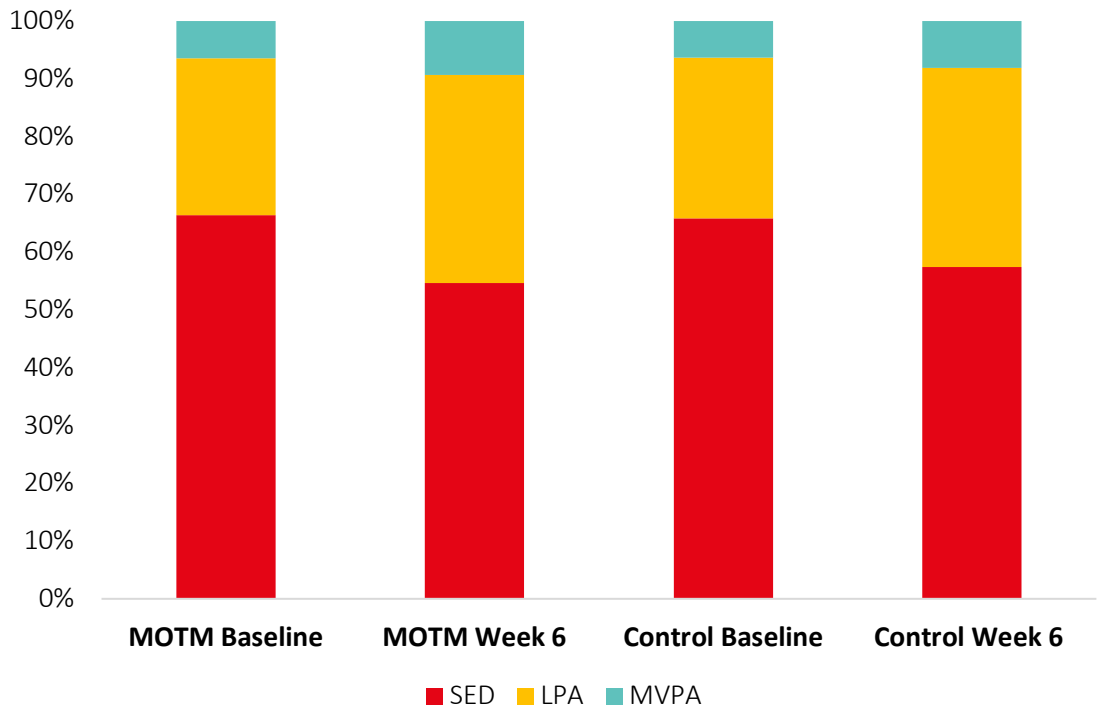


Figure 1: Percentage of time spent sedentary in LPA and MVPA stratified by condition (intervention or control) and timepoint (baseline or week 6 data). (n=58 MOTM, n=57 Control).
Note. LPA: light physical activity; MVPA: moderate-to-vigorous physical activity; SED: sedentary time.

Table 2 provides minutes of activity in each threshold (sedentary, LPA and MVPA) at baseline and in the final week of the intervention (week 6), stratified by the condition. It is important to note the number of daily minutes may vary depending on children's average wear time. Therefore, the percentage of time spent in activity threshold has been explored.

Figure 1 above provides aggregate scores for the percentage of time spent in each activity threshold (sedentary time, LPA and MVPA) during the school day. There was a significant interaction between time and condition for the percentage of time spent in school in MVPA (b=1.51, SE=0.70, 95% CI: 0.14, 2.88, p=0.0335, d=458). On closer inspection, this was due to significant differences between the two condition in the week 6 MVPA levels which favoured more MVPA in the children taking part in MOTM (b=1.87, SE=0.82, 95% CI: 0.26, 3.48, p=0.0253, d=212). There was no significant interaction in the time spent in LPA (p=0.173, d=0.289) or in sedentary time (p=0.102, d=0.348).

From post-to-pre (week 6 to baseline), in the MOTM condition, MVPA levels increased by 2.8%. LPA levels increased by 9% and sedentary time decreased by 11.7%. In the control condition, MVPA increased by 1.8%, LPA increased by 6.6% and sedentary time decreased by 8.4%. Comparing post scores in the MOTM condition over the control demonstrated an increase of 1.2% in MVPA, 1.7% in LPA and a decrease of 0.3% in time spent sedentary.

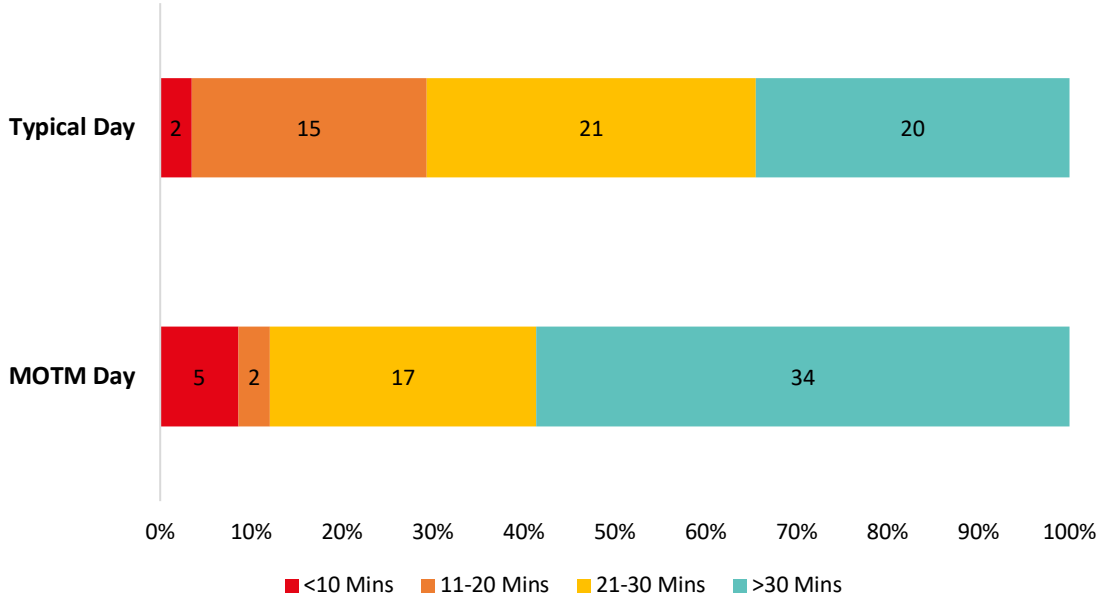


Figure 2: Physical activity thresholds of MVPA minutes, comparing MOTM day versus typical school day. All week 6 data (n=58)

Figure 2 compares the proportion of children who achieved the 30-minute in-school physical activity guidelines on a typical day compared to a MOTM day. On a MOTM day, 34 children (59%) achieved the 30- minute guideline, compared to 20 (34%) on a non-MOTM day. Therefore, MOTM enabled 14 more children (24%) to achieve the in-school 30 minutes of MVPA.

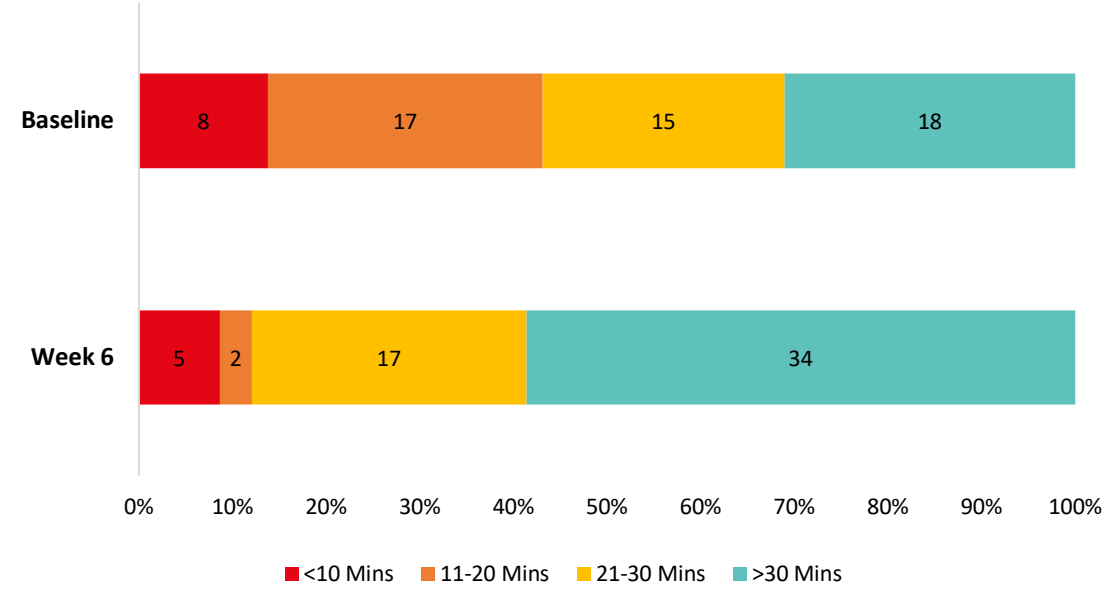


Figure 3: Physical activity thresholds of MVPA minutes, comparing week 6, MOTM day versus a baseline-replicated day with MOTM group only (n=58)

Figure 3 compares the proportion of children who achieved the 30-minute in-school physical activity guidelines on a typical day during baseline data collection compared to a MOTM day. On a MOTM day, 34 children (59%) achieved the 30-minute guideline, compared to 18 (31%) on a non-MOTM day. Therefore, MOTM enabled 16 more children (28%) to achieve the in-school 30 minutes of MVPA.

Physical Activity Levels during Maths on the Move

Children (*n*=58) who engaged in the MOTM lesson accumulated 6.4±3.6 minutes of MVPA, 19.8±5.2 minutes of LPA and 18.0±7.5 minutes of sedentary time. In comparison to the same period of lesson time, children in control during the same period of time accumulated 1.4±2.1 minutes of MVPA, 14.1±7.7 minutes of LPA and 27.5±9.9 minutes of sedentary time. As a result, children taking part in the MOTM lesson, on average, accumulated an additional 5-minutes of MVPA compared to remaining in the classroom. Children also achieved an additional 5.7 minutes of LPA with a reduction of 9.5 minutes spent sedentary.

Looking at the percentage of time in each activity threshold, children in the MOTM condition spent 13.8±8.3% of the time in MVPA, 46.9±11.0% in LPA and 39.3±15.3% of the time sedentary. In comparison, lesson time typically is much more sedentary. Children in control during the same period of time spent 3.1±4.3% of the time in MVPA, 32.3±13.0% of the time in LPA and 64.6±16.2% of time sedentary. Comparing the data to overall academic lesson time in the control (post data) children spent 3.0±1.4% of the time in MVPA, 26.0±6.3 of time in LPA, and 71±7.1% of time sedentary. Overall academic lesson time in the MOTM condition (post data) for children revealed 4.6±2.0% of the time was spent in MVPA, 27.3±8.1% of time spent in LPA and 68.1±9.1 of time spent sedentary.

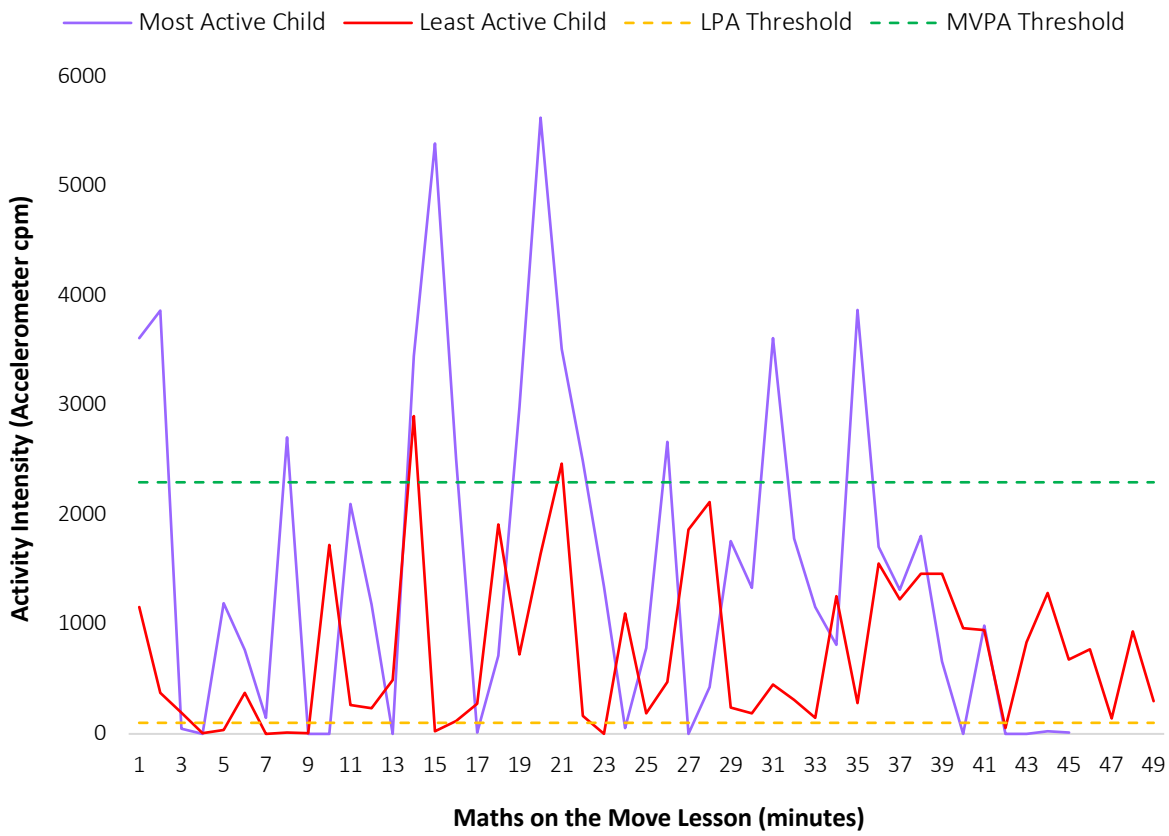


Figure 4: Activity intensity during the Maths on the Move Lesson for the most and least active children.
Note. cpm: counts per minutes; both children are from different schools and are male.

Figure 4 above overviews the range in children's physical activity engagement levels during MOTM. Both children demonstrated sporadic bursts of MVPA. During a 45-minute session, the most active child – based on the child who accumulated the most minutes of MVPA – spent 13 minutes in MVPA, 19 minutes in LPA and 13 minutes sedentary. During a 49-minute session, the least active child who spent the least amount of time in MVPA, spent 2 minutes in MVPA, 40 minutes in LPA and 7 minutes sedentary. The timings provided for lesson lengths were slightly different, which has resulted in the 4-minute variation.

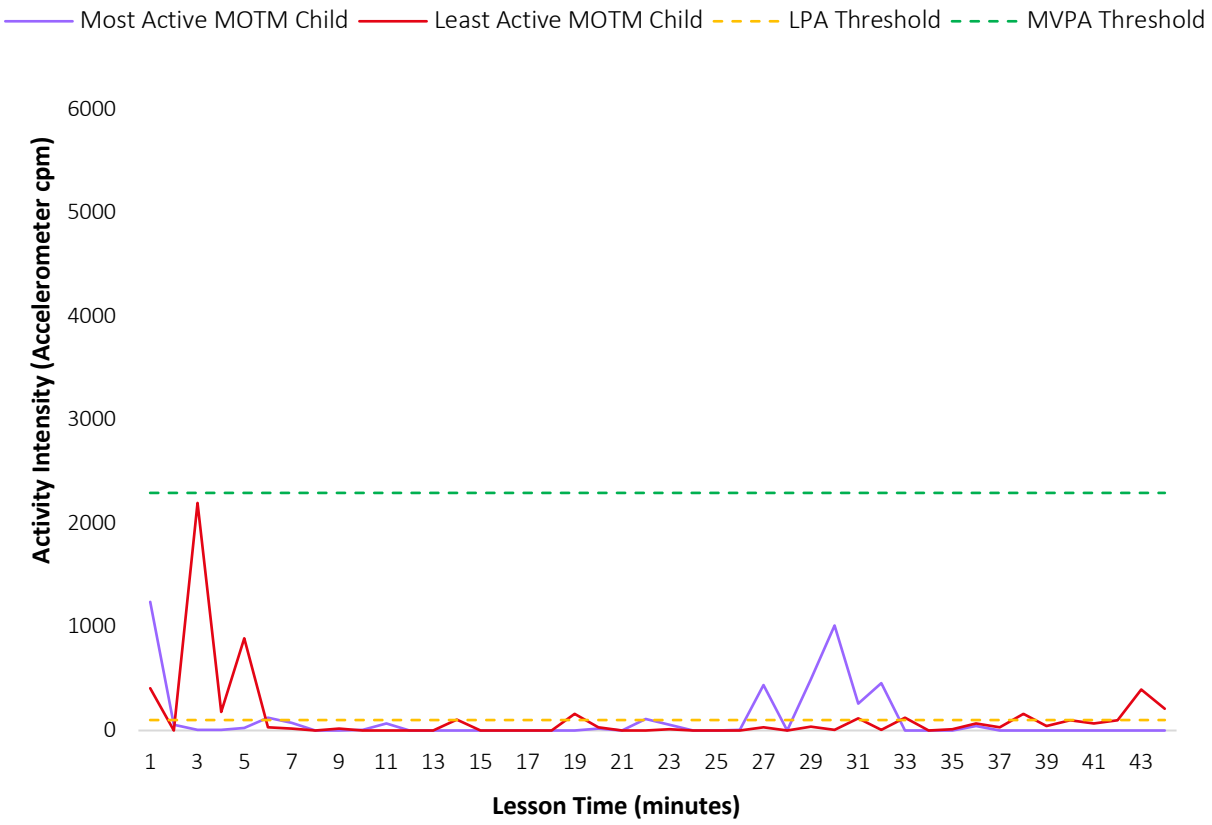


Figure 5: Activity intensity during a typical classroom lesson for the most and least active children from the MOTM condition. Lesson time is during the same time MOTM took place, on a different day of the week.

Note. cpm: counts per minutes; both children are from different schools and are male.

Figure 5 presents the same two children observed in Figure 4, looking at counts per minute in a typical classroom lesson. Within the classroom lesson, children's activity levels are consistently sedentary, with some sporadic movement at the beginning of the session for the least active child and some movement during the session for the other most active child. Both children demonstrate mostly sedentary movement with some sporadic light intensity movement. The most active child in the MOTM spent 9 minutes in LPA and 36 minutes sedentary during a 45-minute lesson. The least active child in the MOTM spent 2 minutes in MVPA, 11 minutes in LPA and 32 minutes sedentary during a 45-minute lesson.

Maths Performance

Maths Attainment Test

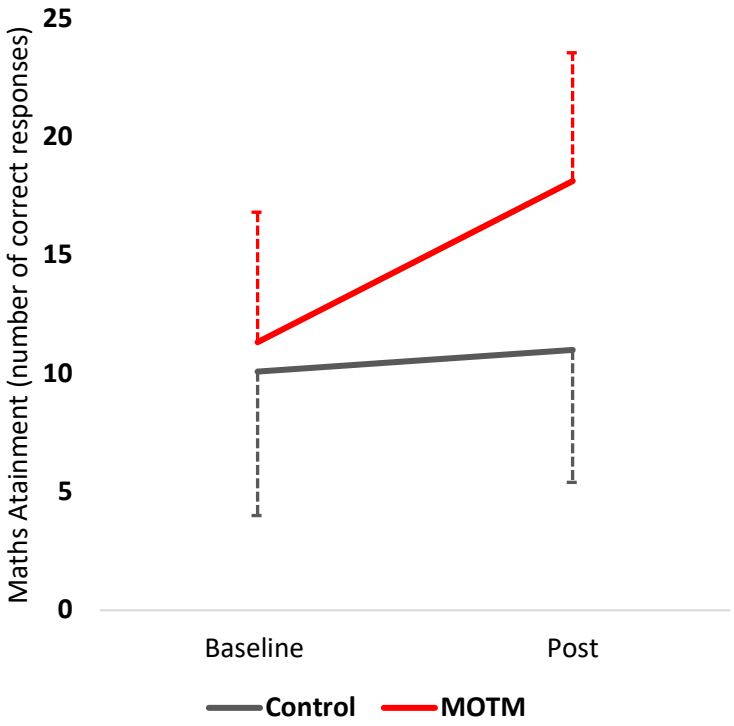


Figure 6: Baseline and post maths test total score, stratified by condition.
Note. MOTM: Maths on the Move.

Figure 6 above demonstrates the change over time in performance for the maths attainment test. Children in the MOTM condition improved performance over time, getting on average 7 more answers correct (Baseline *M*=11.3±5.5, Post *M*=18.1±5.4). Children in the control condition demonstrated an increase in 1 additional answer correct (Baseline *M*=10.1±6.1, Post *M*=11.0±1.0). Table 3 below reveals there was a significant interaction between time and condition for maths test scores ($p \leq 0.0001$, $d=1.507$). On closer inspection this was due to a significant increase over time in the MOTM condition ($b=5.58$, SE=0.71, 95% CI: 4.26, 7.43, $p \leq 0.0001$, $d=1.480$). There was also a significant difference between the post maths test scores between conditions ($b=7.12$, SE=1.11, 95% CI: 4.94, 9.30, $p \leq 0.0001$, $d=1.301$).

Table 3: Models for the maths attainment test

	b (SE)	95% CI	*p*	*d*
Maths Attainment Test, Time by Condition Model (*n*=92)				
Intercept	11.06 (1.09)	8.92, 13.20	≤0.0001	
Time (Post)	1.14 (0.59)	-0.01, 2.29	0.0558	
Condition (MOTM)	1.22 (1.21)	-1.16, 3.60	0.3169	
Offset Maturity	0.39 (0.22)	-0.05, 0.83	0.0855	
Time (Post) : Condition (MOTM)	5.85 (0.81)	4.26, 7.43	**≤0.0001**	**1.507**

Note. b: unstandardised beta coefficient; CI: confidence intervals; d: Cohen's d effect size; MOTM: Maths on the Move; SE: standard error.

Maths Additional and Subtraction, Speed and Accuracy Test (MASSAT)

Table 4 reveals the baseline and post scores for the MASSAT correct responses, total errors and total score. Both conditions increased correct scores and the total score from pre-to-post. For errors, the MOTM increased compared to a decrease in controls. Figure 7 provides a visual representation of the MASSAT scores at baseline and post timepoints.

Table 4: Baseline and post MASSAT scores stratified by condition

	MASSAT Correct		**MASSAT Errors**		**MASSAT Total Score**	
	Baseline *M* (SD)	Post *M* (SD)	Baseline *M* (SD)	Post *M* (SD)	Baseline *M* (SD)	Post *M* (SD)
MOTM	32.1 (10.7)	36.0 (11.5)	2.0 (1.9)	2.8 (3.0)	30.1 (11.1)	33.0 (12.7)
Control	29.3 (9.9)	31.3 (10.5)	4.3 (4.7)	2.3 (2.8)	24.6 (13.4)	29.0 (12.2)

Note. M: mean; MASSAT: Maths Additional and Subtraction, Speed and Accuracy Test; MOTM: Maths on the Move; SD: standard deviation.

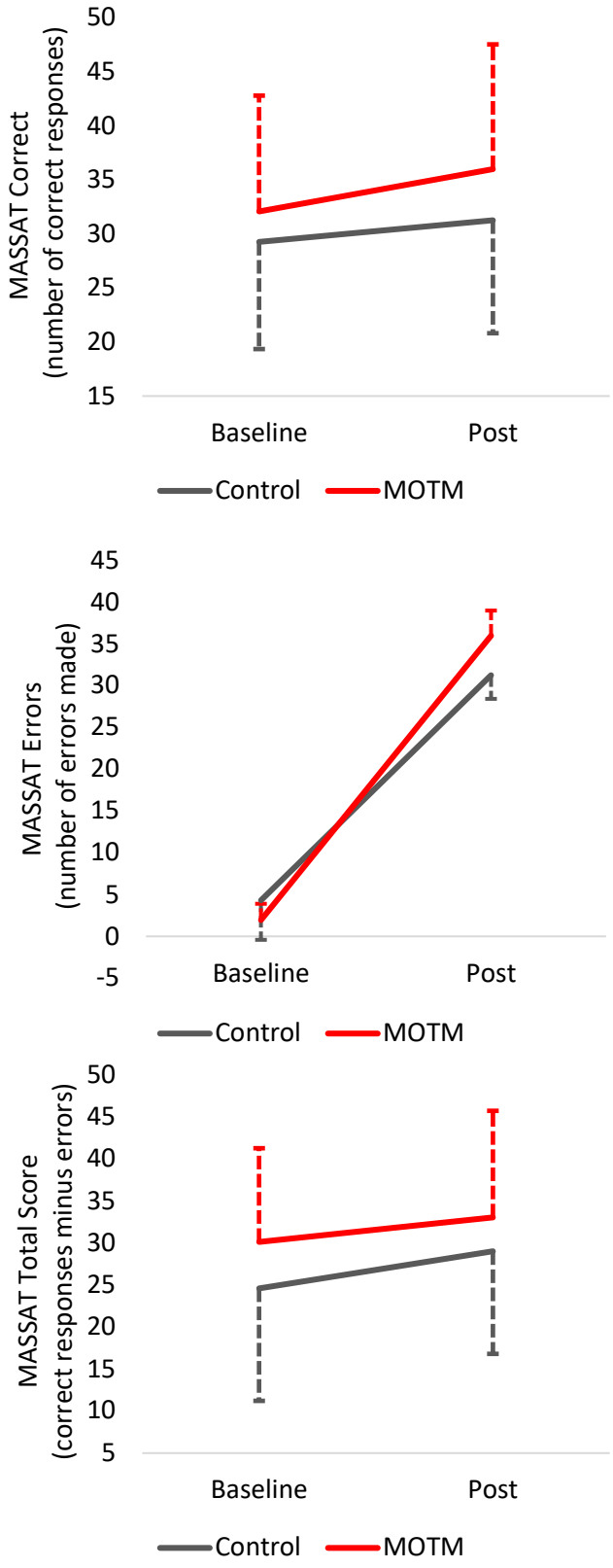


Figure 7: Baseline and post MASSAT test correct responses, errors and total score
Note. MASSAT: Maths Additional and Subtraction, Speed and Accuracy Test; MOTM: Maths on the Move;

Table 5 below shows the outputs from statistical analysis on all three MASSAT outcomes. There was no significant interaction between time and condition for MASSAT correct responses (p=0.2856, d=0.227) or for MASSAT total score (p=0.2607, d=0.237). For the total errors made, there was a significant interaction between time and condition. On closer inspection, this was due to a significant decrease in the number of errors made over time for the control condition (p=0.0035, d=0.081) and a significant difference between the condition in the baseline scores (p=0.0042, d=0.633).

Table 5: Multilevel modelling on MASSAT

	b (SE)	95% CI	*p*	*d*
MASSAT Total Score, Time by Condition Model (*n*=92)				
Intercept	27.87 (2.31)	23.34, 32.40	≤0.0001	
Time (Post)	5.11 (1.26)	2.65, 7.58	0.0001	
Condition (MOTM)	4.61 (2.53)	-0.34, 9.56	0.0714	
Offset Maturity	1.15 (0.50)	0.18, 2.12	0.0225	
Time (Post) : Condition (MOTM)	-1.97 (1.74)	-5.38, 1.44	0.2607	0.237
MASSAT Correct Responses, Time by Condition Model (*n*=92)				
Intercept	32.31 (2.00)	28.40, 36.22	≤0.0001	
Time (Post)	2.59 (0.97)	0.69, 4.50	0.0091	
Condition (MOTM)	20.9 (2.15)	-2.11, 6.30	0.3317	
Offset Maturity	1.10 (0.44)	0.24, 1.96	0.0140	
Time (Post) : Condition (MOTM)	1.45 (1.35)	-1.19, 4.08	0.2856	0.227
MASSAT Errors, Time by Condition Model (*n*=92)				
Intercept	4.25 (0.62)	3.03, 5.47	≤0.0001	
Time (Post)	-2.30 (0.60)	-3.47, -1.12	0.0002	
Condition (MOTM)	-2.30 (0.77)	-3.80, -0.79	0.0035	
Offset Maturity	-0.04 (0.10)	-0.23, 0.15	0.6845	
Time (Post) : Condition (MOTM)	3.02 (0.83)	1.40, 4.64	**0.0004**	0.801

Note. b: unstandardised beta coefficient; CI: confidence intervals; d: Cohen's d effect size; MASSAT: Maths Additional and Subtraction, Speed and Accuracy Test; MOTM: Maths on the Move; SE: standard error.

Results and Discussion for Qualitative Findings

Focus Groups and Write and Draw Activity with Children

Analysis of the focus groups transcripts revealed nine key themes; (i) facilitating learning, (ii) benefits from altering the environment, (iii) a more inclusive approach to increase engagement, (iv) cooperative learning between children, (v) galvanising resilience and confidence, (vi) depth of learning and understanding, (vii) MOTM left me feeling ecstatic, (viii) welcoming cognitive and physical challenges and (ix), can MOTM stay forever. Each theme will be explored in turn below.

Facilitating learning

The first emerging themes offered facilitated learning at two levels. First, from the instructor level, facilitating the sessions allowed children to learn more mathematical content. Second, from the pupil level; children felt a sense of accomplishment during the lessons.

Instructors facilitating learning

A common theme identified across all pupils in both the Write and Draw activity, as well as the focus groups, was the vital role the Aspire instructor was playing. Pupils described the instructor(s) leading MOTM gave them an opportunity to learn about maths in a fun and exciting way. Some pupils also felt the support given by the instructor was really helpful, especially when there were multiple instructors.

> *"…they helped you during the Maths lesson, and then there was more than one [Aspire instructor] to help you." – Sabir*

Pupils feeling a sense of accomplishment

Pupils also discussed a sense of accomplishment throughout the MOTM sessions. Children described overcoming the challenges of the activities, and they were feeling proud of their efficient work. Pupils observed this with confirmations from the instructors seeming pleased with the groups to progress during activities. Figure 8 provides an example of the write and draw activity, with a child saying they have fun during the activity and learn about maths.

> *"…when [the Aspire instructor] do it with us they always start smiling because it's really funny that we can finish it in such a short amount of time." – Sana*

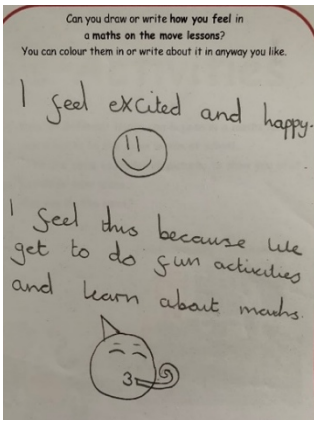


Figure 8: A child expressing, they feel excited and happy during MOTM with lots of learning taking place.

Benefits from altering the environment

Pupils discussed a more positive learning environment in the MOTM lessons. The modifications encompassed only half the class taking part in MOTM at a time and working in a spacious room adequate for physical activity games – usually the hall. As a result of these modifications, pupils felt having smaller numbers helped the session become more fun and engaging. One child felt being in the MOTM lessons, not necessarily with your friends was useful. This meant they weren't getting distracted playing with their friends and could engage in the lesson properly.

> *"...because everyone would start being silly and going to their friends and like having fun with them being silly, trying to cheat and stuff. But we had less people, and they split our friends up from… and it was actually a lot more fun because nobody was being silly and stuff." – Yasmin*

Additionally, pupils felt the sessions worked well because there were fewer interruptions from children often misbehaving in class. This improved pupil's engagement levels and the general structure of the session.

> *"I think I love it because I don't have any of the… I don't have any of the three R's [three boys whose names begin with R]. I'm not being mean, but I'm saying that we can actually get on with the lesson without any interruptions." – Yasmin*

Pupils felt if the whole class took part in MOTM at the same time, the environment would be too loud and chaotic. Therefore, it was essential to break the class into two groups to ensure everyone was enjoying the sessions.

> *"Because if it was all of the class in the same room doing the same thing, it gets so loud that people's ears would pop off because in Maths on the Move sometimes it gets really loud." – Yasmin*

A more inclusive approach to increase engagement

The MOTM sessions were often favoured as an alternative approach to getting children involved in the physical activity elements but also more involved in the maths elements, providing twofold benefits. In particular, the inclusivity of the MOTM sessions was discussed throughout the focus group and write and draw activities. Often the drawings encompassed children drawing the team activities they took part in during the sessions, as seen in Figure 9.

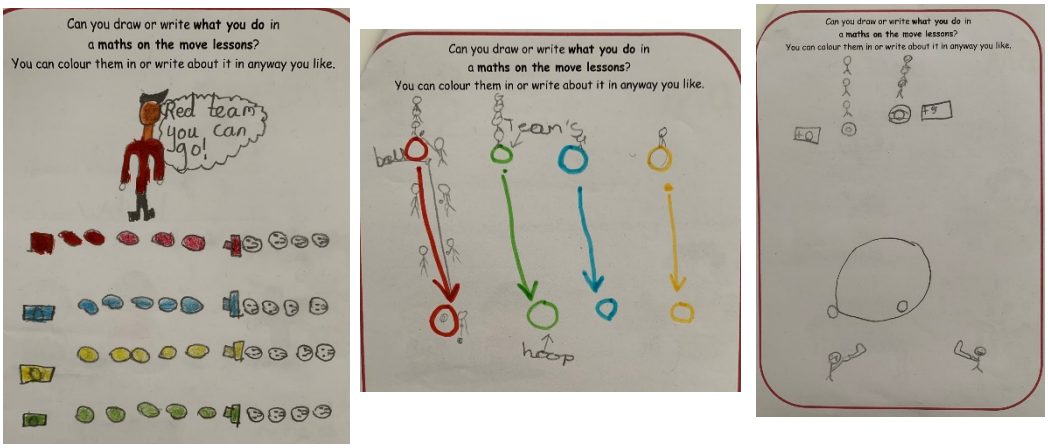


Figure 9: Some drawings from three different children, drawing some of the team activities they did during MOTM.

Getting children involved physically who don't usually engage

Additionally, some of the pupils opened up about not usually getting to take part in sport or P.E. lessons because their peers often leave children out – particularly those who are not classified as being that good. Contrastingly, the MOTM sessions prevented this isolation from occurring and allowed everyone to get involved and take part in the sessions.

> *"Sometimes I just don't like it [sport] because some people are… like, don't include other people who aren't that good in games." – Sabir*

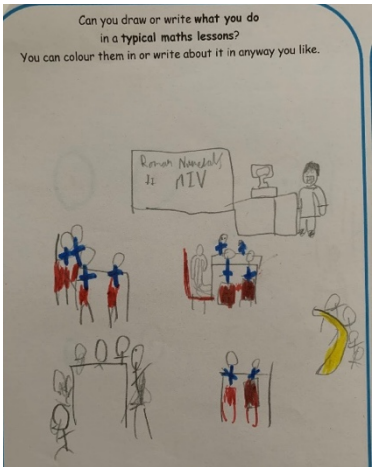
Getting children involved academically who usually find maths 'boring'

Additionally, the MOTM lessons provided an alternative approach to engaging children into the maths elements of the sessions. Pupils described the MOTM lessons as a much more engaging and fun way to learn maths. Typically, pupils felt traditional maths lessons were quite dull.

> *"I have one simple sentence – like watching paint dry." – Eva*

> *"And sometimes it's not much fun because it's basically just writing sums and things like that." – Sana*

Throughout the write and draw activity and highlighted in Figure 10, many pupils described a typical maths lesson as being boring, not having fun, or finding the session hard. Children also commonly drew all their peers sat down, being very sedentary during a typical lesson.



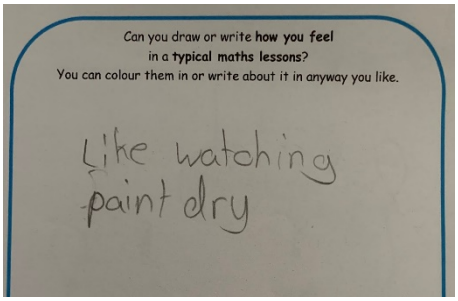


Figure 10: On the left a child drawing a typical maths lesson and, on the right, a different child describing how they feel during a typical maths lesson.

Cooperative learning between children

During the focus groups, pupils discussed the importance of working with their peers during the different maths activities taking place in a MOTM session. In particular, the MOTM sessions allowed pupils to collaborate. Pupils were able to explain how they worked together, and in some situations helped their peers learn something new because of their support.

> *Yes, me and [Zia] really enjoyed that, so we enjoyed doing it with [Eva] as well. [Eva] kind of helped [Zia] to learn a bit more and so did I." – Rafie*

Pupils also descried the MOTM sessions helping encourage healthy competition. In some of the activities, they were racing against each other.

> *"It makes me feel competitive because it… to me, it feels like we're racing, whoever can find all the emojis first." – Aisha*

On top of the competition, pupils during the focus groups discussed working in a team and the importance of interacting with their peers.

> *"We had to work as a team because you had to tell everybody like… you can write this, and then you had to… I mean you had to like interact with other people to know what they got." – Laila*

Not being with their friends during the MOTM sessions meant they had to interact with other peers. Pupils could interact with different children in their class; offering a new way of feeling included within the session. These discussions really alluded to the importance of changing the social environment to support new social interactions and collaborations.

> *"I like it because some people don't have any friends in their group, where its better just mixed because you get to interact with other people." – Sabir*

Galvanising resilience and confidence

In addition to the new social interactions taking place during the MOTM sessions, pupils expressed the newfound confidence being brought into the classroom. Suggesting the benefits occurring during the MOTM sessions were seeping back into the traditional classroom environment. Pupils said they felt more confident in putting their hands up, now knowing more of the answers. This may suggest the confidence stemmed from heightened learning during the MOTM sessions.

> *"I want to say like… kind of like boosts up my confidence because some of like questions I don't know, and I never used to put my hand up, but some things I know now, and I can put my hand up in class then." – Aisha*

Increases in confidence levels identified some changes in pupils feeling they can answer questions in class. As a result of answering more questions in class, this reinforced the improvements in confidence as pupils felt better when they answered the questions correctly.

> *"It [getting questions correct in class] made me feel like confident in what I'm doing." – Sana*

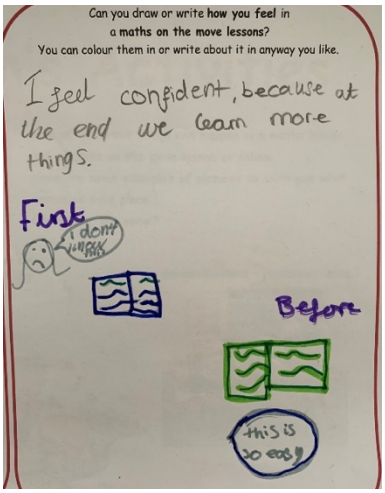


Figure 11: A child drawing how they feel in MOTM lessons, demonstrating improvements in their confidence levels because they feel they learn more.

Depth of learning and understanding

On top of the increases in pupils' confidence, children described learning more mathematical content which they felt they were not always getting in traditional maths lessons. Pupils described the MOTM lessons as beneficial in giving a more cerebral understanding of the topic at hand and helping them feel more confident in their abilities.

> *"..if I know how to do it but it gives me a deep understanding in what I'm doing because like, it was… nobody really teaches me things; I just do it like by myself, so then when they tell me like how we actually find out the answer, it gives me deeper understanding of what I'm doing." – Sana*

Similar themes of learning were captured throughout the write and draw activity, with pupils expressing how fun the sessions were and feeling happy to learn new things.

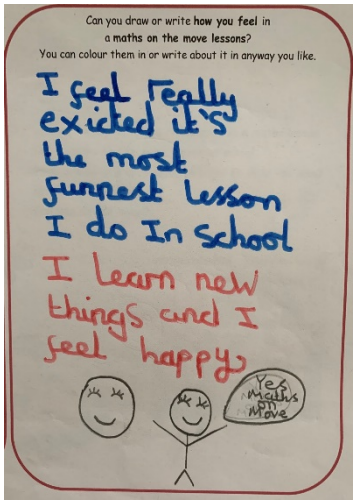


Figure 12: A child drawing how they feel in MOTM lessons, demonstrating improvements in learning and feeling excited and happy.

MOTM left me feeling ecstatic

A common theme revealed in both the focus groups and write and draw activity was the pupils' feelings and emotions. Pupils often described feeling really happy and excited and having a lot of fun. Some of the reasons that explained these emotions came from the games they played, the questions they had to answer through the games and the opportunity to learn new things.

> *"Maths on the Move it makes me really happy and stuff. Because when I'm not playing the games, we also have to do like questions." – Alek*

> *"I wrote here that I feel really excited. It's the most funnest lesson I do in school, and I learn new things, and I feel happy." – Laila*

"I drew a picture of me with a big grin on my face because I'm happy, I also drew me running, and I also drew just stick men dancing and having fun because that's what it was like, we had fun." – Zia

"I feel excited and happy; I feel this because we get to do fun activities and learn about Maths." – Aisha

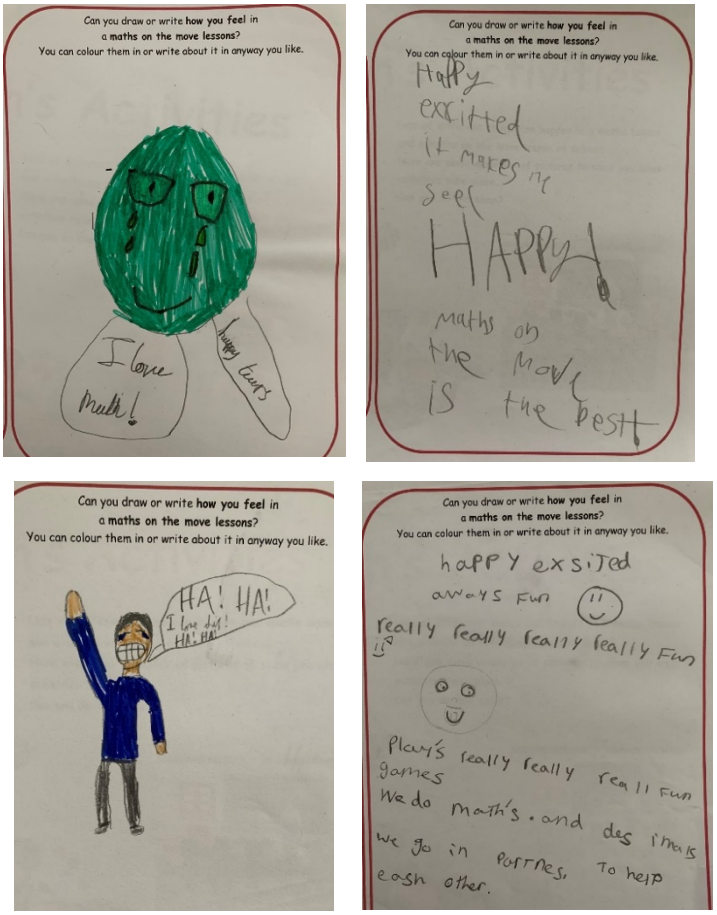


Figure 13: Drawings from four children writing how they feel during a MOTM lesson.

Welcoming the cognitive and physical challenge

Pupils said they felt MOTM is more challenging than traditional maths which was a good thing. They felt they wanted the additional challenge to help them learn more.

"When they challenge us, it's better though." – Aisha

Some of the pupils said they loved the combination of the physical activity with maths because together they created challenging games which added something different to traditional lessons.

"I like sports, but erm, I also like Maths a bit. So, its… I like them all together and its really fun because you err challenge each other because erm, they're like challenging games to do." – Sana

Can MOTM stay forever?

During the focus groups, pupils emphasised how much they enjoyed MOTM that they didn't want the sessions to end. Pupils felt really sad that they wouldn't be having any more sessions.

> *"It makes me slap myself in the face which I only do when I'm really happy [if Maths on the Move were to continue]." Aisha*

> *"The sad thing is that it is ending." – Rafie*

Pupils said they felt it would be really beneficial for the programme to continue because it not only is fun but also helps them feel energised for the rest of the day.

> *"I think it would be really good if it continues because it's really fun and always gets me awake for the day." - Zia*

Other pupils saw the benefits of MOTM not just in the short term, but long term in helping their grades, and even helping them towards a better future.

> *"If it continues [Maths on the Move] it will help us learn more Maths, it would help us generate even better grades, and soon we also get a better future as well." – Rafie*

See Figure 14 below for an overview of the themes discussed within this section, with supporting quotes.

Additional themes emerged from the drawings regarding typical maths lessons. A summary of the drawings can be seen in Figure 14 below. Drawings often included a teacher at the front of the room teaching, with a whiteboard while and pupils were seated at their desk learning. The drawings suggest maths lessons are typically very sedentary. For the drawings where pupils were asked to draw how they feel during maths lessons, common responses included feel bored, sad, upset as well as finding it hard and unenjoyable.

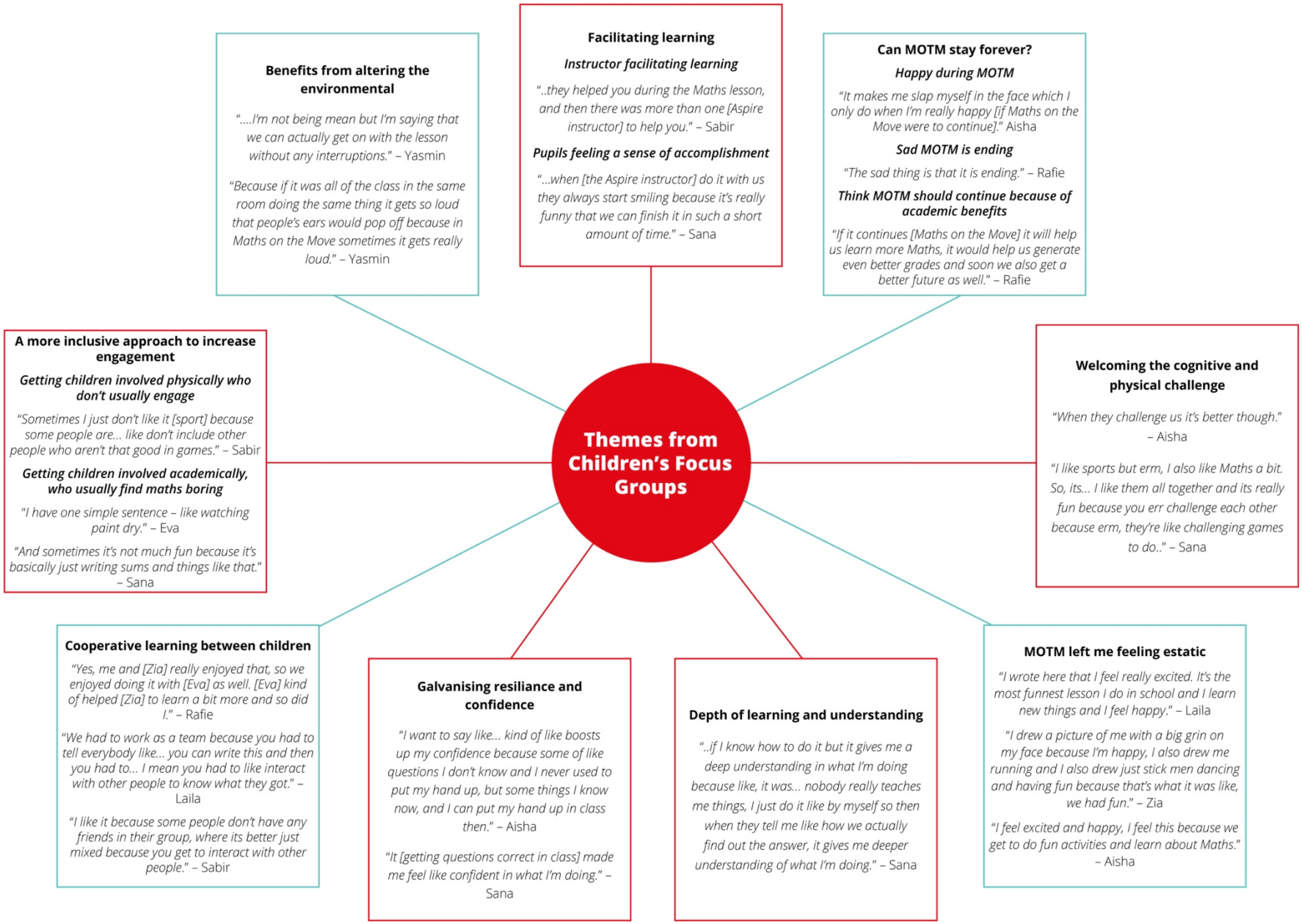


Figure 14: Pen profile overview of key themes emerged from the focus groups.

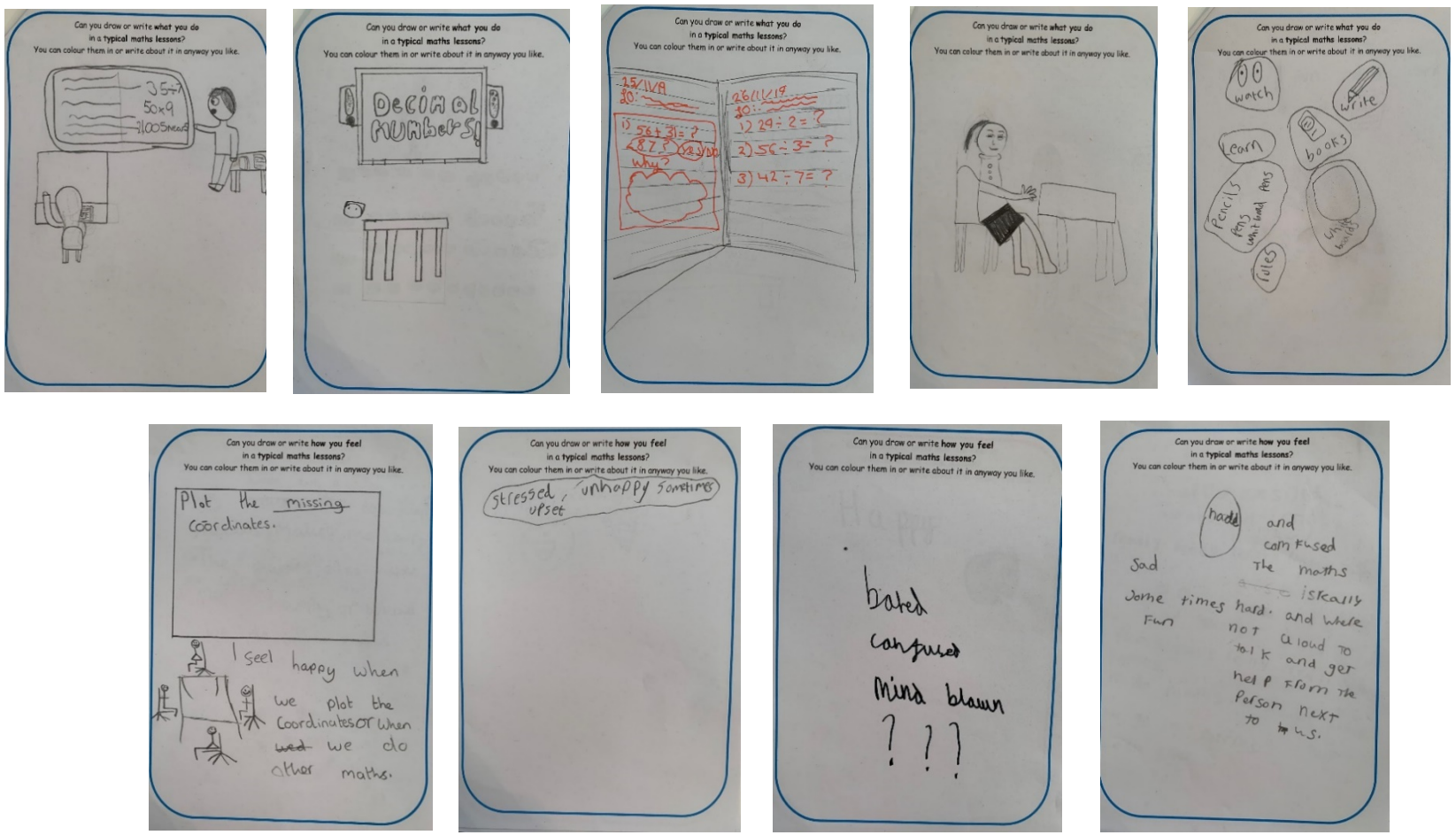


Figure 15: Additional drawings derived from a typical maths lesson.

Note. For what children usually do in a typical lesson (top row), drawings included sitting down, looking at the whiteboard with the teacher at the front, working on equations, and a range of stationery used during the lessons. For how children feel during typical maths lessons (bottom row), drawings included feeling confused, nervous, scared, upset, bored, unenjoyable and difficult.

Interviews with School Stakeholders

Analysis of the interview transcripts revealed four key themes; (i) fostering engagement, (ii) a way to improve behaviour and learning, (iii) sustainability, (iv) recognising the need to differentiate. Each theme will be explored in turn below.

Fostering engagement

Teachers expressed the importance of MOTM fostering engagement in the pupils. In particular, MOTM provided several novel ways of engaging the hard to engage children.

> *"I've been down and seen a few of those sessions and the children seem a lot more engaged with Maths. Those girls that weren't engaged were a lot more engaged in Maths." – Taylor*

In particular, the children that often don't like maths seem to be getting involved. One of the teachers felt the children who often don't engage almost forgot they were participating in maths because of the other ways they were engaged and getting active during the sessions.

> *"…you know it's a way of getting them engaged, getting them involved, making them forget sometimes it's Maths." – Taylor*

The physical activity element of the sessions seemed to be the critical element of the MOTM programme that really engaged the pupils.

> *"Those that don't like Maths, they're hooked by the moving, and those that like Maths anyway they're just happy to do Maths as well as something else." - Taylor*

From being more active, teachers observed some of the pupils looking happier during the sessions. Almost as if they are enjoying the maths side of things more than usual.

> *"And they tend to enjoy it more; you see the smiles on their faces as they're doing it." - Taylor*

> *"If Maths on the Move is part of your curriculum, it would have an impact on the general enjoyment of Maths." – Shannon*

A way to improve behaviour and learning

Teachers also mentioned they felt the MOTM sessions were instrumental in managing the pupil's behaviour in subsequent lessons.

> *"They're quite calm considering they've had such an active and quite loud session. They come back in really calm, and it's nice to see actually they've had that energy, but they've concentrated." – Taylor*

During the MOTM pupils were burning lots of energy during the sessions and then coming back to class calmer and relaxed.

> *"I would say the ones who maybe struggle behaviourally in Maths lessons, in general, haven't so much because they can move and it's fine." – Taylor*

Other comments were made regarding the pupil's attitude, suggesting some of them seemed to be more confident and resilient. Teachers felt this might have been contributed to the structure of the MOTM lessons, helping children feel less anxious.

> *"In terms of their attitudes towards learning, they seem more resilient and a lot more confident, and they don't have any tears if they can't answer any of the questions. They just persevere with it. I know some of the other classes, by comparison, didn't have [the Aspire Instructor] work, so they seem a lot more anxious when it comes to a challenge." – Zuri*

Some of the teachers suggested the MOTM was facilitating learning. Some pupils were improving their capabilities with elements of maths taught during MOTM.

> *"We did a little assessment, and I think a lot of them have got more fractions knowledge now than they would of done." – Taylor*

One teacher found the MOTM helpful in giving pupils an opportunity to learn the foundational knowledge of a mathematical topic, which could subsequently be developed on in class.

> *"They're learning Maths quicker, so they're approaching new subjects, so when it comes to teaching them in class, they have the basic foundation knowledge of it." – Taylor*

Finally, one of the teachers said while there are clearly observed benefits form the pupil's engagement with MOTM, they felt the project would need to be conducted for longer to see any impact on mathematical attainment.

"If you're looking at impact on Mathematical attainment, I think you need a longer spell [project length]." – Taylor

Teachers perceived competencies

Teachers praised the programme but mentioned accountability to be a big challenge when considering the sustainability of the programme, if they were going to use the Maths on the Move programme and try and implement it themselves.

"The challenge for schools is the accountability and how they're judged. I think that's where programmes like this sometimes do struggle in some schools for it." – Taylor

In particular, teachers felt it would be challenging to integrate the MOTM concept into traditional maths lessons on a more permanent basis.

"I think thinking creatively about how we can teach Maths is positive. I think there's more to be done on it and I think one of the challenges with it I feel that it's getting these types of lessons to be part of your traditional Maths lesson." – Shannon

A teacher suggested if they had to take ownership of the project, there would be additional barriers. In particular, managing the children's behaviour could be challenging, given how excited the children get.

"I think they [the teachers] might be a little worried. I suppose about managing behaviour as some of the children can get over-excited. Or they might be worried on how to pitch the questions." – Zuri

Another teacher said because of timetabling issues; the project has an impact on other subjects. If the project continued, this would need to be looked at more carefully to ensure MOTM did not cause disruptions for other lessons during that day.

"The only issue I've found really is how it impacts on other subjects [due to timetabling issues]." – Shannon

Continuing to recognise the need to differentiate

Some of the teachers suggested that there may be a varied response to the success of the MOTM project. In particular, the project should continue to recognise the mixed abilities of pupils. In some instances, pupils may struggle to combine movement and learning.

> *"I know the children are quite dependent on the adults, so they might struggle a little to be more confident with… you know, moving around and answering questions at the same time." – Zuri*

Some pupils may have better cognitive abilities to quickly apply the skills compared to other pupils that may require more formal teaching to understand the concepts.

> *"I can see that so children might more quickly have the cognitive ability to more quickly apply skills. I think it may be easier to do that um, and it may be more difficult when children take longer to understand the concepts and have to have more formal teaching." – Taylor*

As a result, teachers felt the project needed to recognise the mixed abilities during the sessions.

Summary

Physical Activity

The MOTM programme led to increased daily in-school LPA and MVPA. On closer inspection, there was a significantly greater amount of time spent in MVPA during week 6 for children in the MOTM condition compared to those in the control condition.

The MOTM programme supports the purpose of the Primary P.E. and Sport Premium fund. Children taking part in the MOTM lesson, on average, accumulated an additional 5-minutes of MVPA compared to remaining in the classroom. Children also achieved an additional 5.7 minutes of LPA with a reduction of 9.5 minutes spent sedentary. MVPA levels demonstrated a variable response during the MOTM session, ranging from 2 to 13-minutes. Moreover, physical activity levels were not impacted across the school day; children in the MOTM condition achieved an additional 1.2% of MVPA compared to the control. This was supported with an additional 28% of children achieving the daily school-based physical activity guidelines on a day the MOTM was completed compared to the baseline day when they did not take part in MOTM.

Maths Performance

Performance in the maths attainment test demonstrated positive findings that support key drivers for schools. There was an increase in the number of correct responses over time for the MOTM condition, suggesting an improvement in numeracy. This significant improvement was not found in children that were in the control condition. This improvement suggests the children that took part in the MOTM programme improved mathematical performance on the topics included during the course and the test.

Outcomes for the MASSAT demonstrated no changes for the correct number of responses or the total score. However, there was a significant decrease in the number of errors in the control condition. Additionally, the scores were significantly different across conditions at baseline. This may suggest the decrease in errors over time matched the post scores in the MOTM condition. These findings are not worrisome given the type of test the MASSAT is, focusing on speed and accuracy. Previous studies looking to improve such processes often focus on acute effects.

Focus Groups and Interviews

The perceived benefits of MOTM from pupils were multifaceted. Children identified the MOTM lessons offered an adapted space for learning which sparked inclusivity and cooperative learning. Pupils explained the MOTM felt supported by Aspire instructor, which facilitated their learning, as well as feeling a sense of accomplishment. Importantly, children described the MOTM sessions as enjoyable, fun, engaging and invigorating – resulting in positive associations to learning and activity. Teachers praised the MOTM lessons as an excellent way for fostering engagement. Teachers felt the sessions were useful in managing children's behaviour for subsequent lessons.

Recommendations

Based on the project evaluation, the following recommendations have been made to aid the future implementation of the intervention.

- The MOTM intervention, in its current form, may be used to improve physical activity levels during the school day, accumulating on average 5 minutes of MVPA and 5.7 minutes of LPA during the MOTM lesson.
- Children in the MOTM conditions showed increases in MVPA levels on days then MOTM was conducted. As a result, 28% more children achieved the daily school-based guidelines of 30-minutes of MVPA.
- The MOTM intervention, in its current form, allows the more active child to achieve 13 minutes more MVPA compared to very sedentary lessons. The least active child achieved one additional minute of MVPA and 29 minutes of LPA during MOTM compared to lesson time.
- The MOTM intervention, in its current form, may be used to improve physical activity and reduce time spent sedentary of children in academic lesson time.
- For the MOTM programme to have optimal benefits on children's enjoyment and engagement it is essential the lessons continue to split the class up, working with 50% of the pupils at a given time.
- The MOTM programme should continue to be aware of pupils mixed abilities during the sessions.
- The MOTM programme in its current forms supports confidence and resilience in pupils which transfers back into the classroom.
- To boost pupil's maths performance, schools may benefit from implementing a programme such as MOTM.

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Appendices

Appendix A – Additional Physical Activity Data

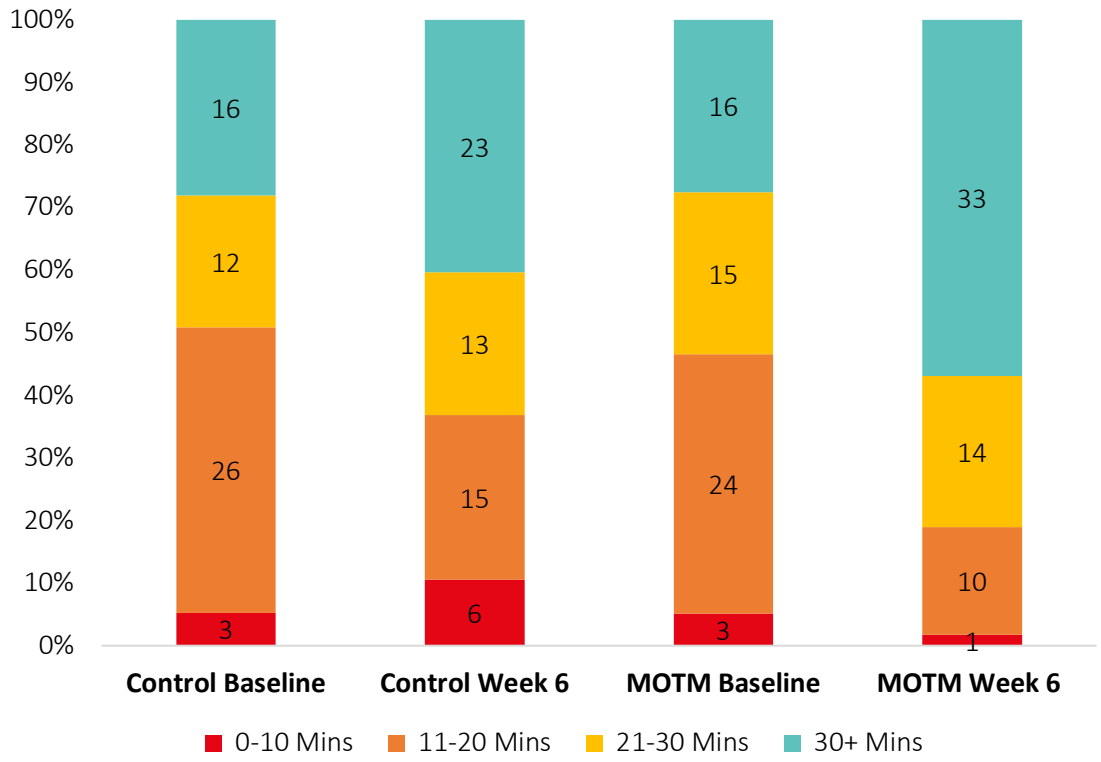

Figure 15: Physical activity data, baseline and week 6 stratified by condition and threshold of MVPA minutes (n=58 MOTM, n=57 Control)

Figure 15 above provides an overview of children in different activity thresholds depending on the amount of MVPA minutes they accumulate on average during the school day. The results revealed 17 more children met the daily in-school physical activity guidelines of 30-minutes MVPA. Seven more children met these guidelines in the control condition.

Figure 16 overleaf reveals no changes in baseline and week 6 physical activity data in lesson time. There are increases in LPA and MVPA and decreases in SED time for breaks, lunch and P.E. lessons. Figure 17 for the control children demonstrates a similar pattern across all segments, comparing pre and post physical activity scores. Some small increases LPA and MVPA and decreased SED in breaks, lunch and P.E. but not as high as the intervention group

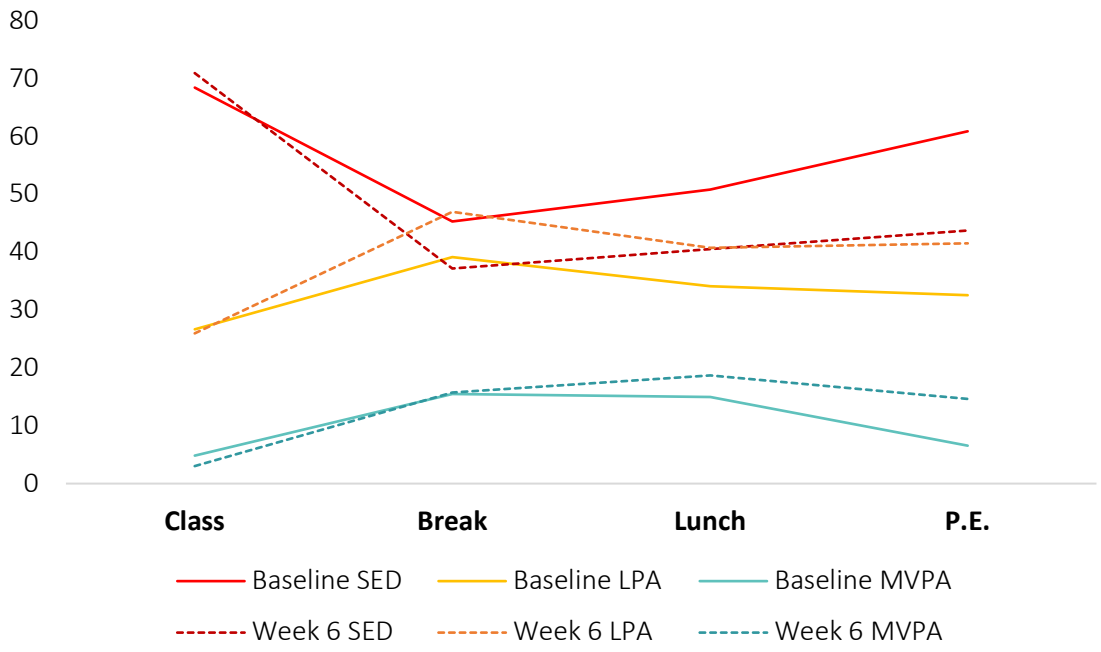

Figure 16: Percentage of time spent in each activity threshold on average for each segment of the school day for children in the Maths on the Move classrooms.
Note. LPA: light physical activity; MVPA: moderate-to-vigorous physical activity; P.E.: Physical Education; SED: sedentary time.

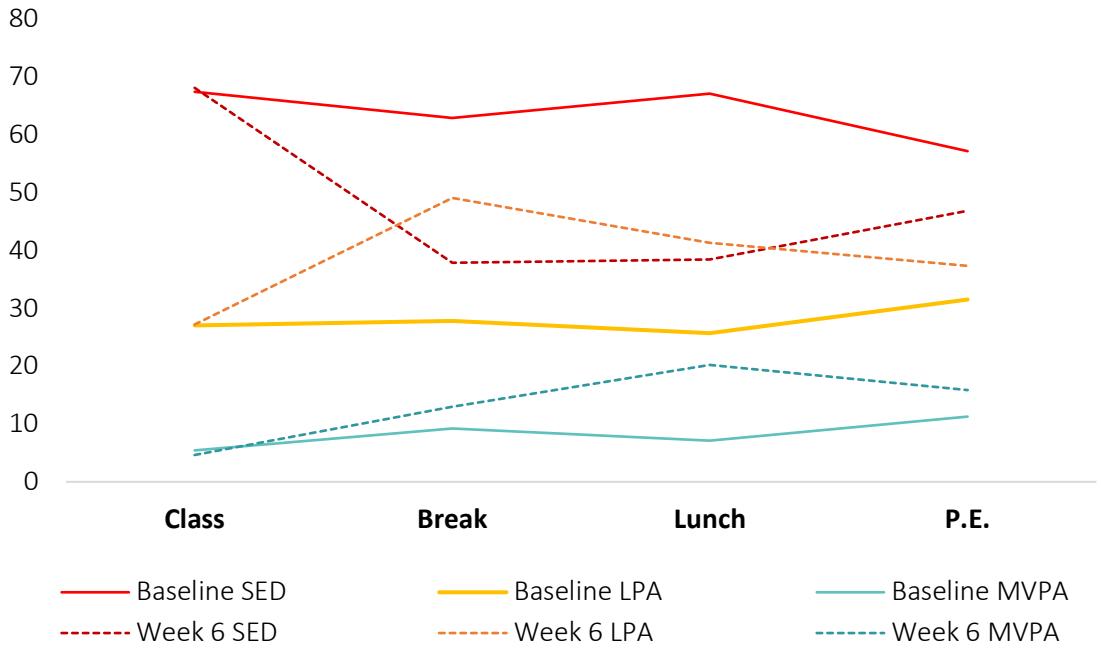

Figure 17: Percentage of time spent in each activity threshold on average for each segment of the school day for children in the control classrooms.
Note. LPA: light physical activity; MVPA: moderate-to-vigorous physical activity; P.E.: Physical Education; SED: sedentary time.