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More active lessons: teachers' perceptions of student engagement during physically active maths lessons in Finland

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ABSTRACT

The Moving Maths study was conducted to increase third grade pupils' physical activity and support their learning in Finland. Altogether 397 children (mean age 9.3 years) and 22 teachers took part in an intervention with two types of physically active maths lessons for five months. One group carried out lessons in which PA was integrated into maths learning goals, while another group implemented PA as short breaks. A control group was also allocated. The aim of the current study was to qualitatively examine classroom teachers' (n = 12) experiences and perceptions of student engagement during the intervention. The results indicated that pupils showed positive emotional and social engagement in both intervention groups. Positive cognitive engagement was indicated by concentration on seated work after the activities, but some teachers reported uncertainty about the learning results. It is concluded that in addition to reducing children's harmful sedentary behaviour, physically active lessons can positively affect student engagement and may thus enhance learning.

KEYWORDS

Engagement; physically active learning; mathematics; intervention; teacher interview

Introduction

Children's low levels of physical activity (PA) have been increasingly discussed. The World Health Organization recommends that children and adolescents should do at least sixty minutes of moderate-to-vigorous physical activity per day. In addition to that, vigorous-intensity activities and those that strengthen muscle and bone should be incorporated at least three days a week, and excessive sedentary time should be limited (*WHO Guidelines on Physical Activity and Sedentary Behaviour*, 2020). However, international comparisons show persistent trends of low PA and high sedentary behaviour among children and youth worldwide (Aubert et al., 2018). Consequently, many interventions increasing PA during the school day have been conducted to solve children's low levels of PA. One of the alternatives to increasing the amount of PA in schools is physically active learning (PAL), in which PA is combined with academic content (Daly-Smith et al., 2020). To bring further perspectives to the implementation

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of PAL, especially from pedagogical and psychological points of view, student engagement was chosen as the framework for the current study. The framework characterises how students act, feel, and think (Fredricks, Blumenfeld, & Paris, 2004). Engagement can be considered a pivotal contributor to learning and academic success, and a growing body of research has linked student engagement to higher achievement, grades, and school completion rate (Fredricks, Filsecker, & Lawson, 2016).

Student engagement is believed to be amenable to improvement via pedagogical choices (Lawson & Lawson, 2013). First, in an Australian study, Riley and colleagues (Riley et al., 2017) demonstrated that PA embedded into mathematics lessons had a significant positive effect on children's enjoyment and engagement. Similar results were found in their later Thinking while Moving in Maths -programme (Riley, Mavilidi, Kennedy, Morgan, & Lubans, 2021) and by Howie and colleagues in the US (Howie, Newman-Norlund, & Pate, 2014). Secondly, school-based interventions have been shown to increase students' levels of time-on-task (Goh, Hannon, Webster, Podlog, & Newton, 2016; Mullender-Wijnsma et al., 2015) which can be seen as positive behavioural engagement. Thirdly, in Norwegian (Lerum et al., 2019) and British (Marchant et al., 2019) studies, teachers reported benefits of PAL on students' social engagement. Lastly, PA's effects on cognitive engagement have been studied mainly through measuring changes in children's cognitive functions (Donnelly et al., 2016; Hillman et al., 2014). However, to our knowledge, the theoretical framework of student engagement has been systematically employed earlier only in a study investigating pupils' PAL experiences (Sneck, Järvelä, Syväoja, & Tammelin, 2020).

Other effects of PAL interventions have been more widely investigated, and the results of review studies have demonstrated improvements in children's lesson time and overall educational outcomes (Norris, van Steen, Direito, & Stamatakis, 2019; Watson, Timperio, Brown, & Hesketh, 2019). Based on a review of 29 intervention studies (Sneck et al., 2019), there is evidence indicating that increased PA during the school day in various ways may have positive effects on children's maths performance in particular. Singh and colleagues (Singh et al., 2019) also found strong evidence for the beneficial effects of PA on maths outcomes based on high-quality intervention studies. However, as Vetter, Orr, O'Dwyer, and O'Connor (2020) conclude in their synthesis of systematic reviews and meta-analyses, there is still high heterogeneity between primary intervention studies, and more evidence is needed.

There is a need for learning experiences that simultaneously improve health, well-being, and school engagement while addressing curriculum needs (Marchant et al., 2019). Primary schools are ideal places for promoting increased PA, as they reach children regardless of their socio-demographic background. To meet this need, we carried out a five-month Moving Maths intervention in 13 Finnish primary schools from 2019 to 2020 to investigate the effects of physically active maths lessons on children's engagement and maths performance. Nine-year-old pupils were taught maths either by integrating PA into their maths lessons or carrying out PA breaks during maths lessons. The design was based on the research findings mentioned above and on evidence indicating that cognitive and motor development are linked from an early age (Davis, Pitchford, & Limback, 2011).

Engagement as a framework for understanding teacher perceptions of PAL interventions

The concept of engagement is central to the major theories of motivated behaviour in academic settings, including self-determination theory and self-regulated learning theory (Eccles, 2016). The components of student engagement are dynamically embedded within individuals (Fredricks et al., 2004).

In this study, the components of engagement are further defined as follows. First, emotional student engagement refers to pupils' positive and negative reactions to teachers, classmates, and academics (Fredricks et al., 2016). It encompasses affective responses to school, such as enjoyment or boredom (Owen et al., 2016). Motivational constructs, such as perceptions of value related to school, are also connected to emotional engagement (Sinatra, Heddy, & Lombardi, 2015). Secondly, behavioural student engagement refers to participation and attention. It involves positive conduct and the absence of disruptive behaviour (Fredricks et al., 2016). Behavioural engagement is also connected to motivational constructs, such as persistence and effort (Sinatra et al., 2015). Thirdly, one of the simple definitions of cognitive engagement is investment in learning (Owen et al., 2016). More precisely, cognitive engagement is defined in terms of self-regulated learning and the use of deep learning strategies (Fredricks et al., 2016). Concentration is sometimes considered to be an aspect of cognitive engagement; however, defined as the action of focusing attention, it is more commonly connected to behavioural engagement (Fredricks et al., 2004).

Without a doubt, peer relations play an essential part in engaging students in learning tasks (Pietarinen, Soini, & Pyhältö, 2014) and collaborative learning has become increasingly important in educational contexts (Järvelä, Järvenoja, Malmberg, Isohäätä, & Sobocinski, 2016). Recently, the social engagement component has been suggested to be added to the engagement framework (Xerri, Radford, & Shacklock, 2018). While teamwork played an essential role in the Moving Maths intervention, the dimension of social engagement was included in this study.

Primary schools in most countries cater to pupils with a wide range of ability levels and other characteristics. A further consideration in analysing school-based PA interventions entails the abilities and characteristics of the students. According to the synthesis by Vetter and colleagues (Vetter et al., 2020), it is currently unclear whether PAL is differentially beneficial for high, mainstream, or poor maths performers. The simple term "pupils needing support" was chosen for the current study to describe children needing learning support due to cognitive, emotional, behavioural, or social challenges at school.

Facilitators and barriers of physically active learning

In addition to measures of pupils' educational outcomes, several studies have approached school-based PA interventions by investigating teachers' and other stakeholders' perceptions of barriers and facilitators concerning PAL. British teachers' confidence and competence, concerns over classroom space, preparation time, and overall school culture were barriers to implementing PAL (Quarmby, Daly-Smith, & Kime, 2019). Similarly, US teachers (Benes, Finn, Sullivan, & Yan, 2016) considered lack of

knowledge, planning time, pressures related to curriculum, and an environment not favourable for PA as the main barriers to PAL.

While teachers in the UK identified positive outcomes of PAL: enjoyment of learning, engagement in classroom activities and enhanced learning through improved retention (Benes et al., 2016), in the US, the themes identified as facilitators of PAL were teacher training, amount of work experience, value of role modelling, availability of lesson plan materials and teacher adaptability. Among Norwegian teachers, the main facilitators for implementation of PAL were ease of organising, inclusion of PAL into the curriculum and active leadership and teacher support (Dyrstad, Kvalø, Alstveit, & Skage, 2018). Lerum and colleagues (Lerum et al., 2019) highlighted the finding that teacher agency is present if there are options for action, and creativity is allowed in applying PAL. Furthermore, Daly-Smith et al. (2020) proposed that investment in PAL within initial teacher training could impact PAL implementation positively. In Australia, investments in evidence-based professional learning were seen as a solution to increase the amount of PA in schools (Riley et al., 2021).

Aims of the study

This study examined Finnish primary school teachers' perceptions and experiences of student engagement during the Moving Maths intervention lessons. The research questions were as follows:

I) What are teachers' experiences and perceptions of pupils' emotional, behavioural, social and cognitive engagement during the Moving Maths intervention, and how do pupil characteristics affect engagement during PAL? II) How do teachers' experiences and perceptions of engagement differ in the group where PA was integrated into maths learning goals versus the group with PA breaks? III) What do teachers consider the main facilitators and barriers to the implementation of PAL?

Materials and methods

Intervention

The Moving Maths intervention was a five-month cluster randomised controlled trial (RCT) to investigate the effects of physically active maths lessons on children's maths performance and student engagement. Twenty-two third grade classes were randomly assigned at school level to follow three different teaching methods: Group 1, the Integrated PA group, physically active maths lessons in which 20 minutes of PA was integrated into maths curriculum goals; Group 2, the PA break group, maths lessons with two five-minute PA breaks with no maths content; and Group 3, control group with traditional teaching. Groups 1 and 2 implemented intervention activities in all four weekly 45-minute mathematics lessons. Activities for the Integrated PA and the PA break group were designed in cooperation with specialists in physical education, physical activity researchers, class teachers, and a special education teacher (<https://www.likes.fi/wp-content/uploads/2021/08/Liikkuen-matikkaa-2021.pdf>, <https://www.likes.fi/wp-content/uploads/2021/05/Liikuntabreikit-2021.pdf>). PA in these learning tasks was planned to be versatile and enhance motor skills, especially balance,

Table 1. Teacher participant profiles.

Characteristics	No. of participants
Gender	
female	9
male	3
Years of teaching experience	
< 5	3
5 to 15	3
> 15	6
Age, years	
< 30	2
30 to 50	6
> 50	4
Class size, number of pupils	
< 20	3
20 to 25	9

locomotor skills, manipulative skills or strength. Maths syllabus for grade three pupils comprised, for example, multiplication, division, geometry, and addition and subtraction of numbers 0 to 10,000. About one third of the programme activities were piloted in 2018, followed by some adjustments. Teachers in the Integrated PA group and the PA break group received a three-hour training for implementation of the intervention. They were provided with links to video material and web pages, which helped teach the PA skills included in the interventions. Teachers were contacted and supported over the phone or by email every two weeks to enhance programme fidelity during the intervention. According to the teacher diaries, the Integrated PA group teachers had delivered on average 68% (range 40–91%) and the PA break group 73% (49–88%) of the planned lessons.

Altogether 13 schools and 24 third grade teachers were invited to participate in the study between September 2019 and April 2020 in Central Finland. Two teachers declined to participate. All the participating teachers were trained class teachers, out of which one (teacher 6) had in addition PE teacher qualifications. Furthermore, teachers' previous experience using physically active methods during maths lessons was inquired at baseline. Before the intervention, 59% of teachers had integrated PA into maths tasks, and 77% had used PA breaks once a week or more. Only one teacher had not integrated PA into maths tasks before the intervention. More demographics are presented in [Table 1](#).

The pupil population consisted of 397 participants (mean age 9.3 y., 49% boys). Ethics approval was obtained from the Ethics Committee of the University of Jyväskylä (28 September 2018), and both children and their guardians signed informed consent. Due to Covid-19, the original intervention length of 22 weeks was cut short: the intervention in the Integrated PA group lasted for 20 weeks and the PA break group for 19 weeks.

Data collection

Data for the current study was collected by teacher interviews. Twelve out of 15 teachers from the Integrated group and the PA break group volunteered to be

interviewed over the phone in April-May 2020. Control group teachers were not interviewed as they did not deliver any intervention activities. Each interview lasted for 40–50 minutes. Seven teachers had carried out maths lessons with integrated PA, and five had carried out PA breaks.

A qualitative approach was chosen for both data collection and content analysis. Semi-structured interview questions were designed by the author team and followed the four dimensions of the student engagement framework. Questions concerning teachers' perceptions of the barriers and facilitators of PAL, in general, were included. Due to the unique nature of the intervention, the only option was to use the first interview as a pre-test of the instrument. Minor modifications were made to the interview schedule and wording of the questions after that.

Semi-structured interviews as a method allowed to consider subjects' perspectives openly and gave room for spontaneous responses. Clarifications and add-and-delete probes during the interview further enabled deepening of the data (Lune, 2013). Some flexibility during the interview, for example, change of question order, was allowed to avoid rigid predetermined structures (Tuckman & Harper, 2012).

Data analysis

First, all 12 interviews were digitally recorded and transcribed verbatim. In the second step, transcriptions were transferred to a datasheet, which helped reduce and reorganise the data and enabled searches for similarities and differences. The data were analysed through an iterative process to identify meaningful responses. Where necessary, the responses were reorganised to match the pre-designed dimensions of the framework. To a great extent, the categories were predetermined, thus giving the analysis a confirmatory approach, as described by Guest, Macqueen, and Namey (2014). Some quantification, that is, counting the number of similar responses, was utilised to achieve more precise results. Some of the responses were reduced to either affirmative (yes), negative (no), no clear answer (unclear), or a very brief excerpt (Lune, 2013). In the interpretation phase, context sensitivity was acknowledged; that is, the data were constructed and discussed in the existing cultural and temporal context (Denzin, 2002; Tuckman & Harper, 2012).

Results

The results of teacher experiences and perceptions of student engagement for each intervention group are presented separately. They are structured following the four dimensions of the student engagement framework. Direct interview quotes are also presented, marked, for example, as T6 (teacher 6). The main results are summarised in [Figures 1 and 2](#). Lastly, the barriers and facilitators to implementing PAL are introduced, as described by teachers.

Teachers' experiences and perceptions of student engagement in the Integrated group

A summary of the main results in the Integrated PA group is displayed in [Figure 1](#). Expressions in green present positive engagement, and expressions in red present negative engagement.

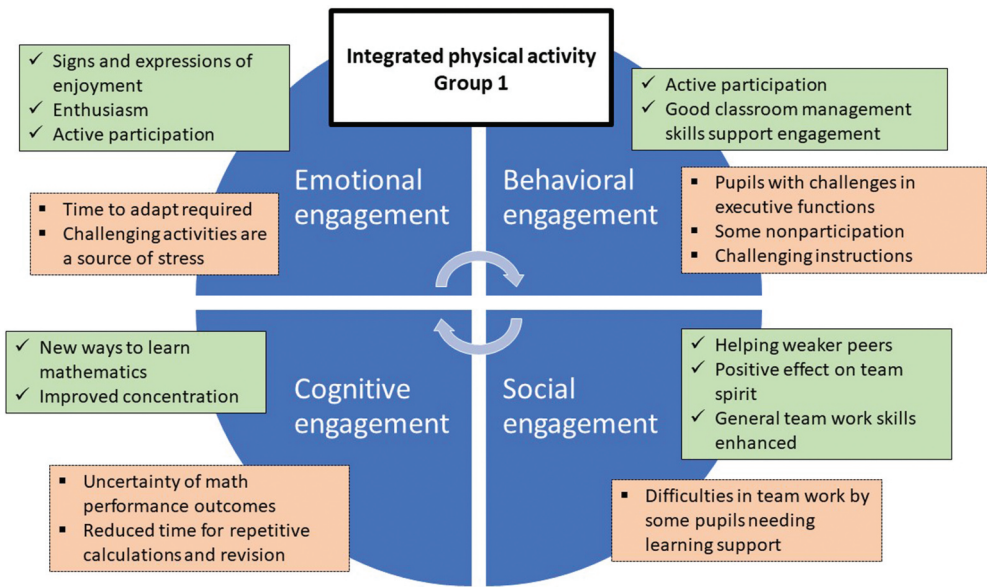


Figure 1. Summary of main results in the Integrated physical activity group, where physical activity was integrated into maths learning goals

Emotional student engagement

Most teachers reported positive emotional student engagement in the Integrated PA group, particularly after the pupils had adapted to the new maths lessons. Three out of seven teachers saw that pupils' enthusiasm varied depending on the time of the day or the kind of activity. Some pupils needing learning support had found it harder to adapt to the programme, as they would have required a more structured learning environment.

T7: In the beginning, they were perhaps baffled. This was a different method: doing physically active tasks for 20 minutes. But when time went on, they started looking forward to the lessons, and some kind of enthusiasm awoke.

Teachers discussed the following activities as emotionally engaging for pupils: activities outside the classroom, activities with speed or competition, relays with maths content and activities with equipment, for example, throwing balls or bean bags. In turn, some activities seemed to cause emotional disengagement: PA performed next to one's desk, activities where moving style was strictly instructed, and muscle strength exercises.

Challenging instructions were also mentioned as a cause for emotional (and behavioural) disengagement. The two less-experienced teachers saw this as a challenge to pupil engagement. These teachers would have preferred to carry out similar activities in subsequent lessons since it might make classroom management easier, particularly concerning pupils needing learning support.

Next, we enquired whether specific pupil characteristics indicated lower emotional engagement. Two teachers saw that some pupils with problems in executive function skills were often unable to keep up with the activities and expressed negative feelings.

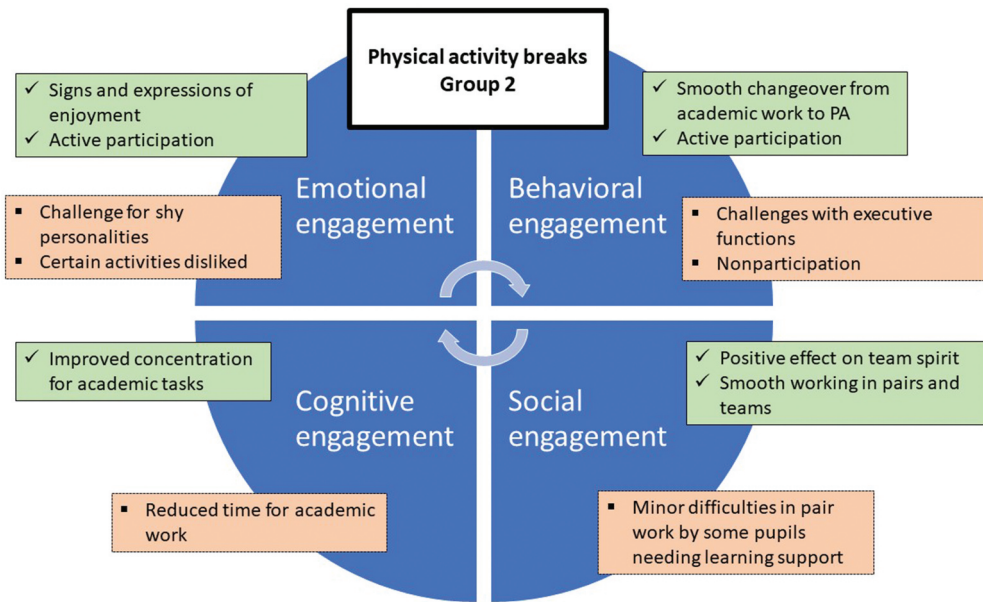


Figure 2. Summary of main results of teacher experiences and perceptions of student engagement in the physical activity break group

One teacher noticed a pupil needing learning support feeling apprehensive about the PA activities. Four teachers could not name any specific pupil characteristics.

T10: In the beginning, it was emotionally disengaging for some. For example, for a pupil needing learning support, it was so challenging that he was a lot more restless than earlier, but it faded out gradually.

Two teachers thought that the most emotionally engaged pupils were the ones who enjoyed PA otherwise, too. Other characteristics supporting emotional engagement were: “The ones that found it hard to concentrate”, “extroverts” and “pupils who got the math idea easily”.

When asked if pupils’ emotional engagement changed during the intervention, two teachers replied that engagement had increased. Other replies were: “Not so enthusiastic in the end – it became a norm”, “They always enjoyed it” and “It changed from day to day”.

Teacher 9: The boy [needing learning support, not coping in the beginning], I believe, got happy experiences in the end and even enjoyed these activities.

Behavioural engagement

Three out of seven teachers saw that the behavioural engagement of the whole group had been very good.

T9: Most of them did [the activities] enthusiastically and diligently and followed instructions, and there were no deliberate disturbances. If someone did not understand the activity or had something else bothering their mind, some problems occurred.

T12: In general, very good. I had doubts, being this kind of old teacher, I thought how on earth, what is this going to be ... So I was very pleased and gave many times feedback to the pupils on how well they did.

Two teachers discussed considerable challenges with behavioural engagement during the programme. One of them was a newly qualified teacher, describing her class as a generally restless and challenging group. Sometimes, she was forced to stop her PA activities and return to independent, sedentary activities to calm down the group. The remaining two teachers expressed mixed experiences of pupil behaviour.

Teacher 8: Behaviour was also dependent on the activity. In ball activities, I did not need to push the pupils so much ... and if there was a competition or such then I did not need to encourage them that much, but they voluntarily and gladly participated.

Five out of seven teachers responded that it was not any particular type of activity causing behavioural disengagement, but rather some pupils' problems with executive function skills or interaction with team members. The challenges were solved by either clarifying or simplifying instructions, dividing the class into two groups or carrying out the activity when it was possible to have two adults supervising the class.

T7: There were distractions away from the activities at the end [of the intervention], too, but less than in the beginning. Perhaps my own way of giving instructions became more established, and it had become a routine to all. They knew what to expect.

Social engagement

Four out of seven teachers replied that social engagement in their class had been really good, good or fairly good. The lesson plans mainly included activities carried out in pairs or 4–5 pupils teams. Teachers were advised to choose permanent pairs and teams, at least for a certain period, to strengthen the pupils' teamwork skills and save organising time.

T6: Really well and supporting each other. They helped their classmates. Within the teams, they discussed the instructions and made decisions if there were any options in the activities. I could see team leadership, creativity, and organisational skills. They were enthusiastic.

Two of these teachers explained some problems:

T6: We had some challenges in pair work ... but then as a whole, there was some kind of development in teamwork; their skills developed. ... I also saw them encourage each other and thrive to achieve better [than other teams].

One teacher expressed her worries over the more capable pupils during team activities: 'Perhaps it was a bit demanding for some of them, as some pupils were still relatively weak in their multiplication tables ... so working as an "assistant teacher" from one lesson to another must have been hard.'

One teacher replied shortly that "social engagement varied", while the last two teachers expressed clear challenges:

T12: In this class, I think pair activities worked best. This class has a lot of concentration troubles, or a big part of the class has. For example, the multiplication activities done in a circle, in that [activity] it was impossible for some to participate.

Second, it was asked if the teachers saw any changes in the pupils' sense of team spirit. Three teachers replied clearly positively, two answered "I don't know", and two thought that the development of team spirit of the class had been positive during the five months. Still, it was impossible to distinguish whether the intervention was the cause.

Cognitive engagement

Perceptions of cognitive engagement were assessed by asking how well the teachers thought their pupils had met their maths learning goals. All teachers had tested their pupils' progress in maths by using curriculum-based, non-standardised end-of-unit tests designed by the study book publisher. This is a common practice in Finnish primary schools.

Four out of seven teachers expressed unsure or slightly critical experiences of cognitive engagement. Two teachers felt that the activities took too much time from repetitive mechanic calculations and revising more complex topics. Three teachers mentioned that occasionally they omitted the intervention lesson plans and held regular lessons instead.

T12: In the multiplication unit, there were a couple of pupils who still had not learned them; it was really difficult. But I somehow think that it surely helped them, too, that we skipped and practised them differently, using many ways.

T11: Well, that is hard to answer. I did have the tests, and I noticed that the weak ones haven't perhaps learned any more [than usual], the results have not been better ... maybe the smarter ones [have improved] ... I can't generalise this at all.

By contrast, three teachers were of the opinion that their pupils' learning of maths was "good".

T10: Well, when I looked at the [unit] tests, they were at a good level. Not in any case worse [than earlier]. In the beginning, the child needing learning support, I could see clearly that he was somehow lost, but gradually it evened out. In the end, the tests went well.

Four teachers were of the opinion that after the PA activities, the pupils concentrated very well on maths book exercises and seemed motivated to complete them.

T6: Absolutely easier to concentrate after the PA. I always had the activity at the beginning of the lesson and then the teaching [session], and in the end, we always calculated for 10 minutes. Everyone was quiet and sat on their seats. It worked well.

The teachers who expressed critical opinions about the impact of PA on concentration were the ones who had experienced challenges with their pupils' behavioural engagement and/or felt that there was too little time for repetition and revision.

Next, we asked, "Who were the pupils that benefited from integrated PA from the point of view of math learning?" Four teachers expressed that the PA had improved the cognitive engagement of the pupils' who found it hard to concentrate and sit for 45 minutes. One teacher was of the opinion that all pupils had benefited, and one teacher saw that the activities had improved some pupils' prior negative attitude towards maths lessons.

On the other hand, three teachers discussed how pupils with lower cognitive ability might not have been as engaged as the others since they had occasionally found it

challenging to grasp the PA instructions first and then the maths topic. Thus, PA might have hindered their learning.

Lastly, teachers discussed activities that, in their opinion, supported cognitive engagement and maths learning. Activities strengthening number line skills, for example, skipping or throwing balls and simultaneously reciting multiplication facts, were mentioned by three teachers. Moreover, activities such as relays, moving from one learning station to another, and shopping were mentioned.

Teachers' experiences and perceptions of student engagement in the PA break group

A summary of the main results in the PA break group is displayed in [Figure 2](#). Expressions in green present positive engagement, and expressions in red present negative engagement.

Emotional engagement

All five teachers in the PA break group thought that their pupils mainly had expressed positive emotional engagement during the intervention. This was demonstrated by taking eagerly part in the activities or reminding their teacher about breaks during lessons. Two teachers explained that even though most of the pupils showed engagement by being active, some commented: “No, I can't be bothered” or “Can I leave out the break today?”. In one of the classes, the weaker pupils were eager all the time and showed it with words and by being active.

T2: Of course, whenever we have physical activities, some pupils are weak or their skills are poor, they don't dare, they are afraid of somebody watching how I do these, and the others do much better.

The teachers discussed the PA breaks that they perceived to be emotionally engaging for pupils: breaks performed outside the classroom, breaks with equipment (e.g. balls) and breaks with humour or a storyline. On the other hand, physically more demanding activities were considered less engaging. Despite the less positive reactions by pupils, the teachers regarded these breaks equally important.

The teachers were also asked to discuss whether there were any shared characteristics within the emotionally most engaged pupils. In two classes, normally physically active pupils seemed to enjoy the breaks most. Then again, one teacher was somewhat surprised that the usually very calm pupils showed emotional engagement.

T2: Perhaps it is the kind of pupils who have concentration problems. They seemed to clearly enjoy that they could be 'let loose' for a while. But also good pupils [academically] enjoyed the breaks.

On the other hand, some pupils did not seem to enjoy the PA breaks. Some of them had felt too shy in front of others and might have retreated from some breaks. Some pupils needing learning support, for example, having challenges with perception, found it difficult to comprehend the instructions, and for that reason felt stressed. Teacher 4 discussed how pupils with less PA in their free time seemed to struggle more with technique and strength than others and might not have enjoyed the breaks so much.

Two teachers had seen a mild decline in enthusiasm in the course of the intervention, and some pupils had expressed boredom, but in all, there was not much change in the pupils' emotional engagement.

Behavioural engagement

Four out of five teachers in the PA break group thought that behavioural engagement had been generally good or fairly good during the breaks. In contrast, one teacher saw that behavioural engagement varied, especially if an adult was not supervising all the time. It was mentioned that some pupils who had either challenges in PA or social situations had occasional difficulties participating.

T3: Somehow, it worked well, even when I left them in the corridor ... Often they independently read the instructions.

We asked whether some specific activities in the intervention had been a source of lower behavioural engagement. Three teachers mentioned that activities with balls had caused some troubles, but at the same time, balls were considered to motivate pupils to participate. Two teachers had experienced that a crowded classroom had sometimes challenged behavioural engagement.

T4: Well, of course, some pupils might have felt that it disturbed their work if the break activity 'stayed on'. Quite quickly, they calmed down again to do calculations and independent work.

Social engagement

All five PA break group teachers were of the opinion that social engagement had been good in their classes. Most PA breaks were carried out individually or in pairs, while only some activities were performed in teams. According to the teachers, preassigned pairs and teams helped the social engagement of the pupils described as shy, the pupils with poor language skills and the less able pupils (in maths).

Three teachers acknowledged that the programme positively affected their class's team spirit. In comparison, two teachers found it hard to tell whether the programme itself had played any part since pair and group work was part of their pedagogy anyway.

T3: They had to regularly work with pupils they did not know so well, so somehow you had to get to know the other one better ... so it indeed had a positive effect.

Cognitive engagement

Perceptions of cognitive engagement were assessed by asking how well the teachers thought their pupils had met their maths learning goals. Four teachers were of the opinion that their pupils' learning of maths during the intervention was "good", whereas one teacher was uncertain.

Three teachers saw that the breaks positively affected the rest of the lesson (normally maths study book work) by improving concentration. However, two teachers thought that the breaks had taken quite a lot of time from academic tasks and were uncertain whether the pupils had enough time for maths exercises.

T5: Maybe sometimes I felt that 45 minutes is too little for two PA breaks and checking homework, and there should be time for calculating ... A 60-minute lesson, in this case, would have worked better.

We also asked, “Who were the pupils that benefited from PA breaks from the point of view of math learning?” One of the teachers briefly replied: “All nine-year-olds”, while the others discussed various viewpoints. They mentioned physically active boys who are good at maths, kinaesthetic learners, pupils with concentration problems, the ones with hyperactivity, and mid-level ordinary pupils.

T4: Perhaps such pupils to whom math might be too easy; this is an extra challenge to them. Then, on the other hand, the ones who need movement.

Three teachers replied that the breaks had not hindered any pupils’ learning. The others did not see considerable difficulties for anyone but discussed some characteristics of pupils to whom the breaks could cause difficulties: “the ones who like to immerse themselves in book exercises”, “the ones who get overexcited about PA activities” and “some pupils with concentrating problems who focus on irrelevant things and there is no energy left for learning math”.

Facilitators and Barriers to the Implementation of PAL

Teachers discussed their perceptions of facilitators and barriers to the implementation of PAL. The Integrated PA group teachers were satisfied with the instruction materials provided for the intervention: guidebook, equipment and videos. They considered that good quality age- and theme-specific teaching materials would promote the implementation of PAL. In the future, in-service training would provide both practical pedagogical tools for PAL and enhance the school atmosphere towards physical activity in general. Reinforcement of PA in national and local curricula could strengthen the role of PA during school days.

The Integrated PA group teachers perceived that classroom management challenges might hinder teachers’ implementation of PAL. Lack of space to carry out PA activities was also mentioned, especially in ordinary classrooms. Further, teachers can feel pressured to emphasise academic learning content, often dictated by extensive national and/or local curricula, and are thus reluctant to introduce new pedagogical methods, fearing that pupils’ academic achievement will suffer. Increased time for pedagogic planning was also seen as a barrier to implementing PAL.

In the PA break group, teachers perceived that increased pupil enthusiasm and engagement, proven by the current intervention, act as factors facilitating the future implementation of PAL. Similar to the Integrated PA group, the availability of PA equipment needed for PA in the classroom to reduce lesson preparation time was considered significant.

Even though the PA break group teachers were of the opinion that it was possible to run the programme mainly in ordinary classrooms, a lack of suitable space for PA was discussed as a barrier to PAL. Contrary to the Integrated PA group, these teachers expressed that preparing and planning the breaks had taken very little extra time and thus did not see pedagogic planning time as a barrier to implementing PA breaks. Then again, two teachers expressed that it would be more practical to organise PA breaks if

they could be integrated into learning maths simultaneously. They expressed that giving a stronger significance to PAL in the curricula would result in an increased amount of PAL. The role of positive support from pupils' homes and society towards PA was also seen as a crucial factor.

Discussion

To summarise the participating teachers' experiences and perceptions, it is concluded that most pupils in the Integrated PA and PA break groups showed positive emotional engagement throughout the intervention. There was generally more variation in behavioural engagement in the Integrated PA group than in the PA break group. In particular, some pupils with challenges in executive functions found it difficult to actively and appropriately join the activities. However, the challenges diminished towards the end of the intervention. Pupils' social engagement was generally positively experienced by teachers in both groups. However, some individual pupils, usually those needing learning support, found it hard to engage actively in group activities. Teachers in the Integrated PA group expressed more uncertainty regarding cognitive engagement and meeting maths learning goals than teachers in the PA break group. However, teachers in the Integrated PA group appreciated the new pedagogical method for maths lessons and highlighted their pupils' increased emotional engagement and enthusiasm.

The finding of positive emotional engagement is in line with earlier studies on PAL interventions, which reported increased enjoyment and engagement by pupils themselves (Riley et al., 2017) and as teacher-identified outcomes (Benes et al., 2016; Riley et al., 2021). In an earlier study, pupils also reported increased emotional engagement, especially in the Integrated PA group (Sneck et al., 2020). In all, the teachers did not seem to have a shared understanding of the specific characteristics of the pupils most emotionally engaged; both low and high achievers and physically less and more active pupils seemed to enjoy the activities and the change of routine. Unsurprisingly, the change of routines caused stress, confusion, or behavioural disengagement in some pupils needing learning support, especially at the beginning of the intervention.

The challenge with behavioural engagement, especially in the Integrated PA group, needs to be acknowledged. However, it should be noted that the two teachers who reported behavioural disengagement also discussed how the class was restless on other lessons. Notably, one of the teachers was a young substitute teacher. If a class has several individuals with conduct problems, or challenges with concentration or executive function skills, more time might be needed when introducing new methods. Similar findings were reported in the US (Goh, Hannon, Webster, & Podlog, 2017), where students' resistance towards movement integration was seen as a hindrance to increasing PAL. Dyrstad et al. (2018) also found teacher classroom management skills as a possible barrier to implementing PAL. In the current study, the teachers suggested assigning permanent teams of 4–5 pupils or permanent pairs as one solution to resolving this challenge. A reward system or differentiation of activities based on pupils' ability levels might be a pedagogical method for addressing the issue. On a larger scale, to ease the challenges of behavioural engagement, PAL activities need to be introduced

from the onset of school so that pupils see integrating PA into academic lessons as a common learning method.

The findings concerning teachers' experiences of pupils' high levels of social engagement are in line with earlier studies. Dyrstad et al. (2018) reported positive experiences of PAL carried out in groups rather than individually. The findings of a large-scale Norwegian intervention indicated that PA interventions could be beneficial for the social climate in class (Lerum et al., 2019). Moreover, about half of the teachers in the current study observed that the intervention had improved their pupils' sense of team spirit.

However, the teachers found it hard to draw conclusions about pupils' cognitive engagement. Even though all teachers were undoubtful that adding PA into lessons was beneficial to nine-year-olds, many felt uncertain about whether their pupils had learned maths sufficiently. A similar concern was expressed in a study with US teachers (Benes et al., 2016). However, the fact that in the Integrated PA group, most pupils had actively participated in the learning tasks and concentrated well on individual study book work could be interpreted as increased cognitive engagement, that is, investment in learning (Owen et al., 2016). In the PA break group, the pupils had mostly settled down smoothly and concentrated on sedentary activities after the breaks, indicating that they were cognitively engaged. In the framework of student engagement, concentration is perceived as a concept encompassing both cognitive and behavioural engagement. As mentioned earlier, challenges with cognitive engagement might also be overcome by the pedagogical differentiation of both PA and maths tasks. What seemed to be the source of concern for the teachers was the reduced amount of time left for teacher-led instruction and individual study book work. Naturally, the crucial question of how much traditional learning time during lessons can be transformed to PAL or PA breaks remains.

Pedagogical autonomy is a widely accepted principle among teachers in Finland (Ministry of Education and Culture, 2017). This is reflected in the solution that the teachers in this study offered to the challenge of reduced time for traditional teaching. As Lerum and colleagues (Lerum et al., 2019) suggested, during typical school days, it is not realistic to have physically active lessons on every maths lesson of the week but rather place them where they best suit the themes to be learned and at times of the day or week when the pupils benefit from PA the most.

Contrary to earlier studies (Benes et al., 2016; Dyrstad et al., 2018; Quarmby et al., 2019), the teachers in the current study did not see planning time as a barrier to implementing physically active lessons. This was most likely due to easy-to-use intervention materials and the fact that in the Integrated PA group, the activities were planned explicitly for the age group and followed the maths syllabus. In the future, successful integration of PA into academic lessons, in ways that enhance cognitive engagement and, thus, result in planned learning outcomes, needs to be designed in collaboration between specialists in education, specific subjects, and professionals in PA/PE. When age- and subject-specific pedagogical solutions are readily available, it will save teachers' limited planning time (Quarmby et al., 2019) and make it possible to integrate PAL into busy and unstable school days. As suggested by Daly-Smith et al. (2020), initial teacher training needs to be involved in the process. "Teacher education surely also has a role in what kind of pedagogical choices teachers make" was a very

valid comment made by a newly qualified teacher in this study. In turn, Riley et al. (2021) reported successful teacher experiences of large-scale professional workshops on PAL, stressed the importance of high quality, evidence-based training and concluded that sustainable pedagogic changes require collaboration with education authorities who are in charge of the dissemination of new methods in teaching. Moreover, companies producing teaching materials need to be engaged in developing more active lessons, for example, by integrating PA activities with teacher guides and online materials.

As in earlier studies (Benes et al., 2016; Quarmby et al., 2019), the question of sufficient and suitable space for performing PAL was seen as one of the challenges in this study. As suggested by some of the teachers, it is possible to overcome this barrier through the co-operation of teachers and other staff in each school. However, a change in traditional classroom-based routines is needed. A similar discussion was reported by US teachers (Goh et al., 2017). Lastly, the availability of PA equipment in the classroom made it not only easy to organise PA activities, but the “Moving Maths package” also increased pupils’ emotional engagement towards PAL.

There are strengths in this study. The intervention content was carefully planned, a pilot study was conducted, and improvements were made before the actual intervention. The participating pupils represented a variety of socioeconomic backgrounds, ability levels, physical activity levels, and school sizes. There were both rural and urban schools in the study. Eighty per cent of the participating teachers consented to the interview, and both intervention groups were sufficiently represented. Both newly qualified and experienced teachers, younger and older, reported their experiences in the semi-structured interviews. The student engagement framework embraces how pupils feel, act, and think during the activities, thus giving a broad perspective to the data. Having one researcher conduct all the interviews allowed for consistency in the data collection process. In all, there were aspects of both internal and external generalisability in this study (Maxwell, 2002). However, this study also has some weaknesses. Since the intervention was the first of its kind in Finland and unique in its design, it was impossible to follow any pre-tested interview questions for data collection. Particularly, investigation of cognitive pupil engagement could benefit from additional in-depth questions in the future. The control group teachers were not interviewed, and it is acknowledged that their interviews would have provided valuable information for study question III; facilitators and barriers of PAL. Moreover, a short observation study could give more information on student engagement during a similar intervention. Lastly, since school culture and practices are tightly connected to national cultures and policies, the results of this study might not be generalisable to all school environments.

Conclusions

The results of this study demonstrated positive emotional and social engagement in pupils during physically active maths lessons as promising outcomes of the Moving Maths intervention. In addition to reducing children’s harmful sedentary behaviour, physically active lessons can positively affect student engagement and may thus enhance learning. Possible challenges with behavioural engagement in the classroom during PA activities may be mitigated by increasing collaboration with experts in physical activity

and education sciences. Thus, designing more physically active lessons requires interdisciplinary approaches as it is vital to consider the wide range of pupil characteristics and needs in learning situations. To accomplish more active school days for all children in a sustainable way, it is essential that physically active learning plays a more significant role in national policies or curricula. According to the results, we strongly recommend pre-and in-service teacher training to strengthen teachers' competence and confidence in implementing more PA during school days.

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Appendix 1

Moving Maths Study Teacher Interview Questions

Emotional Engagement

- How do you think pupils felt about the Moving Maths lessons? How did pupils express their feelings about the activities?
- What kind of activities did the pupils especially like? Can you give examples?
- What activities didn't many pupils like? Can you give examples? How would you change these types of activities?
- Do you think any children in the group of pupils felt that this way of teaching was more challenging on an emotional level? (prompts if needed: pupils in need of learning support, performance pressures, weak in PA)
- Do you think any children in the student group found this teaching method easier than usual on an emotional level? (prompts if needed: pupils in need of learning support in maths? Pupils who enjoy PA?)
- Did you think the pupils' feelings changed during the intervention? (Prompt: specific pupil characteristics?)
- How do you think the activities affected children's attitudes towards maths in general? (Prompt: specific pupil characteristics?)

Behavioural Engagement

- How did the pupils participate? Did they carry out the activities according to the instructions? (if needed: how did you try to encourage/motivate them?) How did pupils needing learning support participate?
- Was pupils' behaviour different than during traditional maths lessons? Did you see differences in the various parts of the lessons (e.g. sedentary work at the end of the lesson?)
- Did certain types of activities cause challenges with behaviour? How did you solve/try to solve these challenges?
- How did the change from one activity type to another go (from PA activity to sedentary work)? What supported the transition?
- Did anything change in pupils' behavioural engagement during the six months? (e.g. pupils needing learning support?)

Social Engagement

- How did pupils cooperate in pair and group activities?
- especially the Integrated group: Did you carry out activities in permanent teams of pupils? What is your experience here? (Prompt if needed: understanding of instructions, effects on teacher workload, collaboration skills) How were pupils needing learning support integrated into the teams, how did you form the teams?
- Do you feel that the lessons affected the social interaction between pupils?

Cognitive engagement

- How do you think pupils learned the maths topics during the programme (multiplication tables, division, geometry, adding and subtraction in columns, numbers 100–10,000)? How well do you think they memorised the learned topics?
- If any, who benefited from the PAL lessons? (Prompt: what about pupils needing learning support? Other characteristics?)
- If some, to whose learning was PAL a barrier? (Prompt: what about pupils needing learning support? Other characteristics?)
- What activities/breaks did you think best supported maths learning?
- How do you think PA affected studying during the rest of the lesson? (e.g. individual study book work)
- How does this way of teaching affect the assessment of children's learning?
- What do you think about the connection between children's learning and physical activity in general? (Background information given if needed: International studies have investigated, for example, the effects of PA on these issues: attention, inhibition, flexible thinking, working memory, long-term memory, neurobiological mechanisms, stage of concrete learning of operations in development 7–11 years, changes in mathematical anxiety)
- Have your perceptions of the connection between children's learning and physical activity changed during the programme?
- Did anything change in your own actions or thoughts about teaching maths during the intervention?

Facilitators and Barriers of PAL

- How much time did you spend preparing for the lessons?
- How did you manage to stay on schedule? (Group 1: 20 min, Group 2: 2 × 5 min)?

(Continued)

(Continued).

- What is your experience with the equipment and materials used in the activities? (Should there be more or less of them, what kind?)
 - What do you think of the instructions? What would you change in the instructions? Online vs paper guide, what is your opinion on these? What about the online videos?
 - What do you think about the space required for PAL? (minimum requirements, optimal facilities)
 - What do you think about your knowledge and experience to carry out PAL now, after the program?
 - How and when do you think PAL should be implemented/ integrated into lessons?
 - How should schools/authorities support the integration of PA into lessons?
 - What do you think are the most important facilitators to implementing PAL?
 - What do you think are the most critical barriers to implementing PAL?
-