Preliminary findings of Active Classrooms: An intervention to increase physical activity levels of primary school children during class time

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Abstract

This study evaluates the effects of a behaviour change intervention, which encourages the integration of PA into the teaching of academic lessons, on PA levels of students. The main outcome is mean minutes of moderate-to-vigorous physical activity (MVPA) daily generated during the intervention lessons. Teacher's perceptions and students' enjoyment of the programme were also evaluated. Students accumulated a mean of 8 minutes MVPA during the intervention lessons daily. The teacher and students were very satisfied with the programme. Therefore, changing teacher behaviour towards using physically active teaching methods is a promising way of increasing children's PA levels.

Keywords: Physical activity; Classroom; Academic Content; Primary School; Accelerometer

Introduction

Less than 20% of children globally are achieving the recommended 60 minutes of moderate to vigorous PA per day for health benefits (McCoy *et al.* 2012, World Health Organization 2010). Increasing their physical activity levels has been identified as particularly important to the long- term impact on public health (Waring *et al.* 2007). Schools have been targeted as the best environments to implement PA interventions as they are a primary location to reach the majority of children (Martin and Murtagh 2015). However, ironically, schools internationally are reported to be one of the dominating locations of sedentary behaviour in children with class time representing a significant sedentary period of the day (Holt *et al.* 2013). Children are required to sit quietly to receive instruction (Gibson *et al.* 2008). Globally it is recommended that all schools develop policies to address PA as part of the school day and not just in PE or active travel (World Health Organization 2010).

School-based interventions, such as Get Moving! (Spruijt-Metz *et al.* 2008), Bizzy Breaks (Murtagh *et al.* 2013), Active and Healthy Schools (Ball *et al.* 2015) and Take 10! (Stewart *et al.* 2004) that integrate PA throughout the day have been identified as effective tools for increasing PA levels (Spruijt-Metz *et al.* 2008). They are also more sustainable and show longer term outcomes than individual level interventions since they target large populations (Barr-Anderson *et al.* 2011). The Center for Disease Control and Prevention (CDC) Comprehensive School Physical Activity Program (CSPAP) recommends the inclusion of school-based PA opportunities to increase PA levels of young people. Specifically it has been recommended that PA should be integrated into classroom learning since movement has been found to enhance learning (Centers for Disease Control and Prevention 2010). However, emphasis on Literacy and Numeracy in primary school classrooms has resulted in a lack of time for PA and a lack of emphasis on PE (Bartholomew and Jowers 2011). In order to address this problem which places emphasis on academic content to the detriment of PA, methods of integrating PA into academic lessons in the classroom are warranted. Here we distinguish between activity breaks, which involve the promotion of PA in the classroom without curriculum learning outcomes, and methods of promoting PA that allow academic content to still be taught. School-based interventions to promote PA in this manner include active lessons (Erwin *et al.* 2011a, Gibson *et al.* 2008), active homework (Lubans and Morgan 2008) and changes to the classroom environment (Cardon *et al.* 2004). The school curriculum is an ideal avenue for accessing all children

and encouraging them to be physically active throughout the day. However, through a review of the literature it is evident that very few studies focus on classroom-based interventions and of those which have only four studies have integrated PA into the academic content of the primary school curriculum with PA outcomes (Bartholomew and Jowers 2011, Donnelly *et al.* 2009, Erwin *et al.* 2011a, Oliver *et al.* 2006, Riley *et al.* 2012). Results of these studies demonstrate that encouraging classroom teachers to integrate PA into the classroom can significantly improve student's PA levels during class time and over the entire school day, moving them towards achieving the recommended PA guidelines for health benefits. The researchers also found that incorporating movement in lessons can simultaneously contribute to children's academic performance (Erwin *et al.* 2011a). In these previous studies the implementation of physically active academic lessons contributed to significant improvements in time students spent engaged in academic learning and in 'on-task' behaviours (Grieco *et al.* 2009, Mahar *et al.* 2006, Riley *et al.* 2014).

Despite this evidence, few teachers use physically active teaching methods (Morgan and Hansen 2008a). Since what children do in the classroom is largely influenced by the teacher, teachers and their attitudes play a central role in determining the success or failure (Fullan 2007) of classroom based interventions therefore, it is essential that teachers are satisfied with the programme. Cothran *et al.* (2010) evaluated teachers' perceptions to PA interventions and they found that teachers' willingness to engage in PA interventions is influenced by their care for students' wellbeing and interest in their own wellbeing. Teachers' beliefs, perceptions and attitudes towards PA have been identified as the greatest barriers to PA promotion in the classroom (Morgan and Hansen 2008a) with time and assessment pressures also being identified (Cothran *et al.* 2010). More specifically, classroom management issues, maintaining teacher control, connection to the academic curriculum as well as student enjoyment of the lessons are among the factors which influence teacher decisions of including activity breaks in the classroom (McMullen *et al.* 2014). In a recent systematic review, 'lack of time' emerged as the most consistently identified barrier to implementation in school-based PA interventions (Naylor *et al.* 2015). Considering the increasing demands placed on teachers, PA integration across the curriculum is emerging as an important opportunity for PA promotion. Implementing change in the classroom is ultimately a personal, individual decision by teachers, therefore encouraging classroom teachers to assume responsibility for integrating PA into academic lessons requires behavioural change on

the part of the teacher, as well as presenting them with interventions that fit with their schedules, curriculum and their beliefs and values about teaching.

Of the existing classroom based PA interventions, only Texas I-CAN! (Bartholomew and Jowers 2011) and the Physical Activity Across the Curriculum (PAAC) study (Donnelly *et al.* 2009) focus on the behaviour of the teacher. For example Texas I-CAN! (Bartholomew and Jowers 2011) emphasises the importance of teacher attitudes and perceived behaviour control for successful interventions. The authors proposed that teacher training programs might be best centred on the Theory of Planned Behaviour (Ajzen 1985) which emphasises these factors. They reported that teacher implementation was enhanced by providing the teachers with training, equipment and lesson ideas to integrate PA into academic lessons. In the PAAC intervention Gibson *et al.* (2008) emphasise that behavioural changes are mediated by self-efficacy of the teacher to perform the behaviour. Teachers' level of confidence in their ability to incorporate PA into lesson plans is achieved through teacher training sessions and goal setting in the PAAC study and these features are consistent with social cognitive theories. However, it has been argued that the Theory of Planned Behaviour does not address impulsivity, habit, self-control, associative learning and emotional processing which all have important roles in behavioural outcomes (Michie *et al.* 2011), and other behavioural change interventions including social cognition models do not analyse the target behaviour in context to develop an effective intervention. Therefore, this paper proposes an alternative to these behaviour change models by characterising the intervention and linking it to an analysis of the targeted behaviour through the use of the Behaviour Change Wheel (BCW) framework (Michie *et al.* 2011). This framework not only allows the intervention to fit with the teachers' belief systems, which is essential to encourage compliance (Cothran *et al.* 2010) but, also analyses the nature of the outcome behaviour as a starting point for identifying the type of interventions that are likely to be effective in encouraging teachers to assume responsibility for integrating PA into academic lessons. This focus on teacher behaviour and designing the intervention with the outcome behaviour as a starting point contributes to the uniqueness of the study.

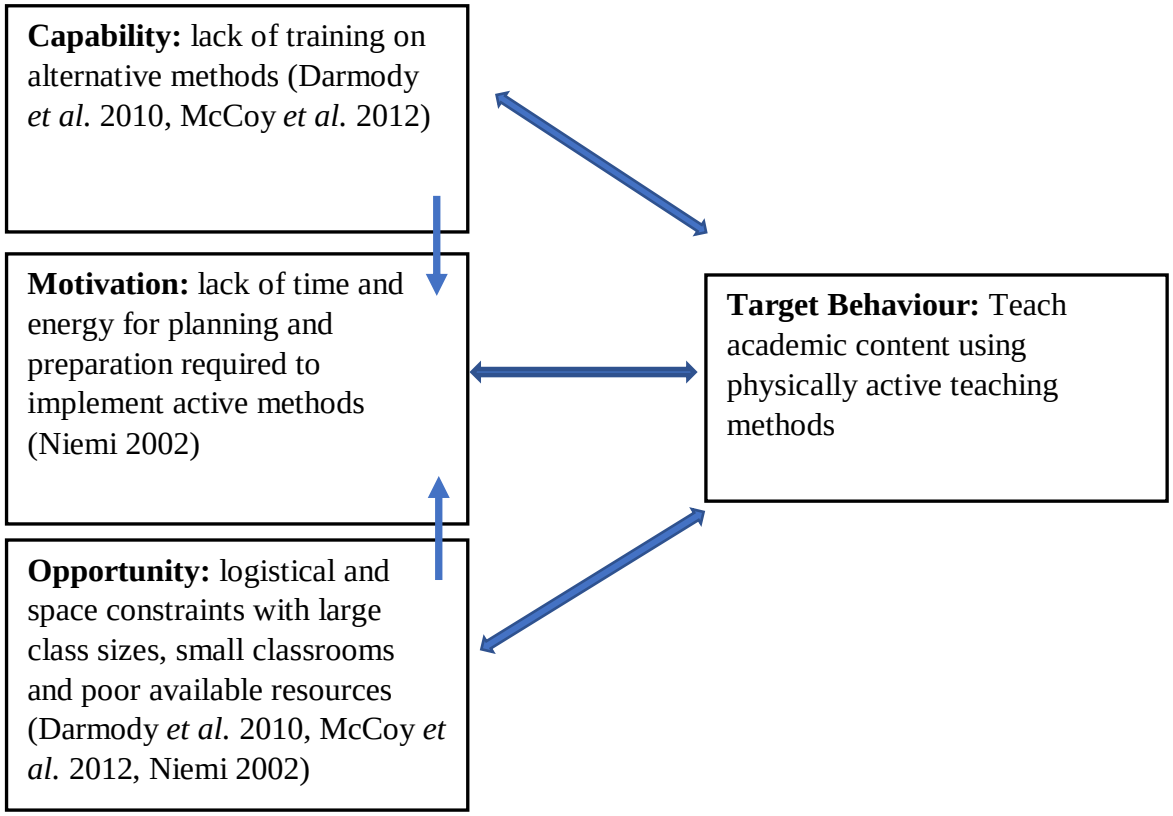
Use of Behaviour Change Theory

There is evidence that PA interventions informed by theoretically driven behaviour change models are more successful and lead to stronger more lasting changes (Michie and Abraham 2004) than those that are not. The Active Classrooms intervention design is guided by the Behaviour Change Wheel framework (Michie *et al.* 2011). This works on the principle that the target behaviour must be analysed to identify the type of interventions that are likely to be effective in bringing about the behaviour, with a target population, in a specific context. The capabilities, opportunities and motivations of the individual to perform the target behaviour are analysed and mapped onto intervention functions (COM-B). Figure 3.1 outlines the results of an analysis of the target behaviour with respect to teachers' capability, opportunity and motivation to implement physically active teaching methods. The figure design is based on a similar framework outlined in the original research (Michie *et al.* 2011) but each of the fields has been populated with barriers relevant to the target behaviour under analysis in the current study. The double headed arrows represent potential influences between components in the system and as such indicate that enacting a behavior can alter capability, opportunity and motivation.

Suggested solutions to these barriers to performing the target behaviour were then identified and linked to specific intervention functions. It emerged that teachers require further professional development to enhance their skills, education on the benefits of PA for their students, action planning, lesson plans and resources to enable them to teach using physically active teaching methods. Thus, to achieve the target behaviour Education, Training, Environmental Restructuring, and Enablement intervention functions were identified. Behaviour Change Techniques (BCTs), which are the 'active ingredients' (Michie *et al.* 2013) designed to change the behaviour were then selected from the 93 hierarchically- clustered techniques (Michie *et al.* 2013) and mapped to specific techniques to be applied in the 'Active Classrooms' intervention. These behaviour change techniques are the 'observable, replicable and irreducible components' of the intervention which specify its content and allow the intervention to be accurately replicated (Michie *et al.* 2013). The specific techniques incorporated in this pilot intervention include professional development, reorganising the classroom environment, goal setting, planning, and replacing previous teaching habits with active methods.

The incorporation of the COM-B analysis of teacher behaviour and behaviour change techniques (BCT) in the design of the 'Active Classrooms' intervention, endeavour to change teacher behaviour towards using physically active teaching methods therefore, enabling students to be more physically active during classroom instruction. The aim of this pilot study is to examine the effect of the 'Active Classrooms' intervention lessons on the MVPA levels of the children during the lessons.

Figure 3.1 Analysis of the target behaviour with respect to teachers' capability, opportunity and motivation (COM-B) (Michie et al. 2011)



Methods

Study Design

This paper outlines the 'Active Classrooms' pilot study which was conducted during school hours, over 5 consecutive school days, in the first week of October 2014. The purpose of the study is to evaluate the MVPA levels of the participants during the intervention lessons. Moderate-intensity PA requires a reasonable amount of effort and noticeably increases the heart rate (e.g. brisk walking, dancing, cycling) and vigorous-intensity PA requires a large amount of effort and causes rapid breathing and a substantial increase in heart rate (e.g. running and chasing games, jumping rope, playing basketball/football etc.) (WHO 2010). The primary outcome is minutes and percentage

time in MVPA during the intervention lessons. Comparisons will be made between the MVPA levels generated during intervention lessons and regular classroom instruction.

Design conduct and reporting of the Active Classrooms pilot intervention study adheres to the Consolidation Standards of Reporting Trials (CONSORT) (Moher *et al.* 2010, Schulz *et al.* 2010) guidelines and to the Consolidated Criteria for Reporting Qualitative Research (COREQ) (Tong *et al.* 2007).

All participating students (n=28) took part in one intervention English lesson and one intervention Mathematics lesson each day. Comparative data was gathered from approximately the same duration of comparison lessons taught each day to the same students by the same teacher. Twenty participating students in the class were randomly selected to wear accelerometers. An accelerometer is a lightweight, unobtrusive device worn on an elastic belt around the participants' waist. They have been regarded as appropriate for use with primary school children because they can measure PA levels in daily life and can be used by the participant with ease (Trost 2007). They measure PA patterns and intensities in counts per minute. Student enjoyment of the programme was evaluated using a write and draw technique pre- and post-intervention. A random sample of 4 participants also engaged in a focus group discussion with the researcher, in a vacant classroom, in the school the week following the intervention. The teacher's satisfaction of the programme was evaluated through a questionnaire completed immediately post-intervention.

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Table 3.1 Links between the components of the 'COM-B' model of behaviour and the intervention functions (Michie *et al.* 2008)

Model of Behaviour: Sources	Why are teachers not using physically active teaching methods?	What needs to change?	Education	Training	Environmental Restructuring	Enablement
Capability-Psychological	Teachers lacking skills to implement physically active methods (Darmody *et al.* 2010, McCoy *et al.* 2012)	Professional development/ training needs to be provided to teachers Development of action plans/goal setting	✓	✓		✓
Motivation-Reflective and Automatic	Teachers preference for direct instruction (McCoy *et al.* 2012) as active methods require much more preparatory work (Niemi 2002) Overloaded curriculum and a lack of time (Niemi 2002) Teachers' negative beliefs, perceptions and attitudes towards PA in the classroom (Morgan and Hansen 2008a)	Teachers must plan to use physically active methods and develop a habit of using them. Believe in the benefits of physically active methods by teachers (information sessions) Teachers must want to increase PA levels. Provision of integrated lesson plans and resources	✓		✓	✓
Opportunity-Physical	Space constraints within the classroom and large class sizes pose logistical constraints (McCoy *et al.* 2012) Poor teaching and learning resources (Niemi 2002)	Use of physically active methods with large groups of children even in classrooms with space constraints Provision of resources			✓	✓

Table 3.2 Examples of trial intervention features mapped onto behaviour change taxonomy and techniques (BCT)

Taxonomy	Intervention Function	BCT	Definition	Example in Active Classrooms Pilot Intervention
Shaping Knowledge	Educate Training	Instruction on how to perform a behaviour	Advise or agree on how to perform the behaviour (includes skills training)	Provide an individual information session and a sample of lesson plans to each participating teacher illustrating how to integrate physically active methods into English and Mathematics lessons
Feedback and Monitoring	Enablement	Self-monitoring of behaviour	Establish a method for the person to monitor and record their behaviour as part of a behaviour change strategy	Teachers keep a log of lessons taught using PA methods to include date, time, lesson, and duration of PA
Repetition and Substitution	Training	Behaviour Substitution	Prompt substitution of the unwanted behaviour with the wanted behaviour	Replace inactive teaching methods with physical activities in teaching English and Mathematics
Antecedents	Environment Restructuring	Restructuring the physical environment	Advise to change the physical environment in order to facilitate the performance of the wanted behaviour	Advise to arrange desks in the classroom to allow space for movement
Goals and Planning	Enablement	Goal setting (behaviour)	Set or agree a goal defined in terms of the behaviour to be achieved	Eg. Plan to teach using PA methods in at least two lessons each day (one English and one Mathematics)
	Enablement	Action planning	Prompt detailed planning of performance of the behaviour (must include at least one of context, frequency, duration and intensity)	Prompt to plan to teach a lesson using PA methods for at least 10 minutes twice a day during English and Mathematics lessons.

Recruitment and Study Participants

Prior to recruitment of the participants ethical approval for the study was granted by Mary Immaculate College Research Ethics Committee (MIREC), Limerick, Ireland (See Appendix I). One convenient primary school in Limerick, Ireland was invited to participate in the Active Classrooms pilot study. Consent was initially received from the principal allowing the school to take part. Children aged 8 - 9 years are the focus of this study therefore, the third-class teacher was invited to participate. Consent was received from the class teacher and student participants were sought from third class (students aged 8-9). All students were eligible to participate if they returned an informed consent form signed by their parents with child assent, and did not have any current injury or medical condition preventing them from participating. Twenty-eight children (100% of those invited) returned consent forms to participate (14 girls and 14 boys). Due to limited availability of devices PA measures were obtained from a random sample of 20 children (13 girls and 7 boys, aged 8-9 years) who wore accelerometers throughout the study. The teacher in this study is female aged 33 with 8 years teaching experience. The teacher indicated that she does not participate in any sports or exercises. No compensation was provided to participants in the study.

Treatments

Physical Activity Intervention

Active Classrooms programme

The functions of this intervention are to educate, train, and enable teachers to change their behaviour towards using physically active teaching methods in English and Mathematics lessons as indicated in Table 3.1. The details of specifically how this could be done are outlined in Table 3.2 and particulars of its implementation are outlined here. After recruitment the classroom teacher was given a one-to-one 30 minute training session which provided ideas on how to integrate PA into the academic content of English and Mathematics lessons. The teacher was educated on the use of accelerometers as well as the correct procedure for student wear. Demonstrations on how to log lessons taught and accelerometer non-wear time were also provided. Training included a description of the inactivity problem in primary school children; an explanation of the role classroom teachers can play to improve the problem, and action planning to teach using PA methods in at least two 10 minute lessons each day (one English and one Mathematics). The researcher was also available to support

the teacher on a regular basis to answer any queries as they arose or offer advice and suggestions during the intervention period.

Twenty English and 20 Mathematics lesson plans which integrate PA into the curriculum content, as well as, the resources to teach them were supplied to the classroom teacher. The lesson plans were created by the research team. One member of the research team is a primary school teacher trained to teach all primary school subjects with an in-depth knowledge of the Irish Primary School Curriculum. Another member of the research team is a teacher educator with expertise in teacher education, PA and PE. Lesson plans were linked to the strands and strand units of the English and Mathematics curricula (NCCA 1999) and cover a range of topics in both subjects. English lessons outline physically active methods, such as active relays, actions corresponding to letters, exercises to illustrate answers, exercises between activity stations and running to gather scrabble letters, for the teaching of spelling, vocabulary, grammar and creative writing. English lessons are also designed to enable the children to respond to stories and oral language using PA. Mathematics lessons include ideas for teaching number, operations, spatial awareness, patterns, sequences, fractions, time, data, and problem solving using physically active methods such as hopping figures, taking pulse after rest and after exercise for 1 minute and using exercises to work out answers, illustrate or communicate answers. The lessons intend to enhance the teaching and learning of specific content areas while also increasing the MVPA levels of the students during class time. The activities were designed to last a minimum of 10 minutes but could be extended by teachers if desired, this allowed the lessons to fit within the teachers' schedules and maximise compliance. The teacher was allowed to deviate from the lesson plans supplied. The plans outlined ideas which the teacher could adapt to fit with her schedule, student needs and learning objectives being taught in the classroom at the time. The teacher was asked to indicate the code of lessons taught and the duration of each lesson taught each day on the Teacher Log provided. It was intended that these adaptable lessons provide the teacher with ways of making topics she was scheduled to teach more physically active rather than being extra lessons to be implemented in the classroom. See Appendix E and Appendix F for sample English and Mathematics lesson respectively and see Appendix G for an over view of the range of lessons provided to the teacher.

Data Collection Procedures and Measures

Physical Activity

PA was monitored during school hours over 5 consecutive school days using ActiGraph accelerometers (models GT3X and GT3X+, ActiGraph LLC, Pensacola, Florida) to collect the data. Accelerometers are considered to be valid and reliable objective tools for measuring children's PA levels (Dollman *et al.* 2009, McClain and Tudor-Locke 2009, Trost 2007) and the Actigraph model has good psychometric properties against other accelerometer types among children (de Vries *et al.* 2006). This study considers best practice recommendations (Ward *et al.* 2005) for accelerometer use with children such as the body location the unit is worn, epoch length, measurement period and wear time calculation. These are described in more detail below.

Accelerometers were mounted on elastic belts and worn around the waist with the accelerometer unit placed over the right hip. Each accelerometer was marked with a unique code and the teacher was provided with a list assigning each student to a particular accelerometer to ensure that each child wore the same device each day. The teacher was asked to distribute the accelerometers each morning and collect them before the children left school in the afternoon. She was also asked to record when and why any student was not wearing the device during school time (eg. absent/ swimming/ home early etc.). The teacher was asked to teach one physically active Mathematics lesson and one physically active English lesson each day and she recorded the times and duration of each active lesson taught. This allowed time filters to be applied in Actilife (ActiGraph, Pensacola, Florida) so that data could be examined for each individual physically active lesson taught. All remaining class time was considered regular teaching time. Accelerometer data was collected in 15 second epochs (time intervals). Evenson cut points were used to categorise the four intensity levels (Sedentary 0-100 counts per minute (CPM), Light 101- 2295 CPM, Moderate 2296 – 4011 CPM, Vigorous > 4012 CPM) as these provide the most acceptable classification accuracy for use with children (Trost *et al.* 2011).

Teacher's Perceptions

The teacher's perceptions on the effectiveness and sustainability of the intervention programme were evaluated through a survey which consisted of a series of open and closed ended questions. This teacher questionnaire was adapted from that used and validated in the process evaluation of the 'Toy Box' intervention (Androutsos *et al.* 2014). The teacher was

asked to indicate on a Likert-type scale the ease of implementing the programme and likelihood of continuing to use it in the future. The Likert-type scale required the teacher to specify her level of agreement or disagreement for a series of statements on symmetric agree-disagree scales. She was also requested to indicate on similar scales the effect the lessons had on the students' PA levels, and on teaching and learning in the classroom. Finally, open ended questions allowed the teacher to record any difficulties or challenges with implementing the programme and also to suggest any improvements. Table 3.3 outlines sample questions included in the teacher questionnaire which is available on request from the researchers.

Table 3.3 Sample questions from the teacher questionnaire adapted from the 'Toy Box' intervention (Androutsos *et al.* 2014)

1) Please rate the ease of implementing the active Maths/English lessons on the following scale: 1= very difficult, 2= difficult, 3= neither difficult nor easy, 4= easy, 5= very easy
2) To what extent did you enjoy teaching the active lessons?
3) To what extent do you think your students enjoyed participating in the active lessons?
4) To what extent do you feel the active Maths/ English lessons enhanced your teaching:
5) To what extent do you feel the active Maths/ English lessons enhanced your students' learning:
6) Please outline any difficulties/ challenges you found while implementing the intervention programme:
7) Please outline any strengths/weaknesses of the intervention programme:

8) Please state any changes you would make to improve the intervention to enhance teaching or learning while also encouraging physical activity in the classroom:

Student Enjoyment

Student enjoyment has been found to control and influence the effect of PA interventions (Howie *et al.* 2014) and teacher approval also relies on this enjoyment. Therefore, it is essential to evaluate the students' enjoyment of the programme to develop an effective intervention. The use of visual approaches such as photographs, paintings and drawings have been recommended to extend our understanding of children's perspectives (Clark and Moss 2011, Crivello *et al.* 2012, Knowles *et al.* 2013, Loveridge 2010). However, it has been acknowledged that drawings may not be useful as stand-alone images in themselves (Veale 2005) since without children's explanations they cannot be interpreted adequately. Children's comments contextualise the data for the researcher (Christensen and James 2008), their drawings provide visual data but it is the verbal material recorded as the participants give their explanations that provide the data for interpretation- words about pictures (Veale 2005). Therefore, this research has employed a write and draw technique combined with focus group discussions since this has been considered a developmentally appropriate approach to use with primary school children (Knowles *et al.* 2013, Te One 2007).

Table 3.4 Focus group discussion questions adapted from the EASY Minds study (Riley *et al.* 2014)

1	How would you describe your Mathematics classes before the Active Classrooms programme?
	Did you enjoy this?
2	How would you describe your English classes before the Active Classrooms programme?
	Did you enjoy this?
3	How would you describe the active Mathematics lessons? Did you enjoy this? Why?
	Can you give me an example?
	Did this make the Mathematics lessons more exciting/ interesting?
4	How would you describe the active English lessons? Did you enjoy this? Why?

	Can you give me an example?
	Did this make the English lessons more exciting/ interesting?
5	What kind of activities did you enjoy doing in the Active Classrooms programme?
6	Can you tell me if being active in Mathematics and English lessons helped you learn?
	Why/why not? Can you give me an example?
7	Is there anything else you would like to share about the Active Classrooms programme experience?

Prior to the intervention, baseline data regarding the children's experiences of English and Mathematics lessons were collected. The classroom teacher was provided with worksheets for the children and asked them to 'Draw what you think of when you think of a Mathematics lesson and what you think of when you think of an English lesson. Write a few sentences describing each picture'. These instructions were also written on the worksheet. On the final day of the intervention the teacher was asked to repeat the activity with the children using the same instructions as before. The week following the intervention a randomly selected sub-sample of 4 students (female = 3, male = 1) were invited to participate in a focus group discussion with the researcher. All students selected took part. The female researcher was known to the children as she teaches in their school. However, the researcher had never taught the participants involved in the study. The discussion took place in a classroom which was vacant at the time with only the researcher and participants present. The conversation lasted 12 minutes. The children's drawings provided a basis for the conversation. The focal questions are outlined in Table 3.4 above. These are adapted from the EASY Minds study (Riley *et al.* 2014). Additional questions specific to the children's drawings were also asked (E.g. Can you tell me what's happening in this picture?).

Data Reduction & Analysis

Physical Activity

For the purpose of this pilot study, the MVPA levels of the students in a random sample of 5 regular classroom lessons (mean 33 min per day) were compared to their MVPA levels during the intervention lessons (both intervention lessons per day combined = mean 36 min per day). Therefore, comparison lessons involved the same students taught by the same classroom teacher throughout the learning day at school so all children participating in the intervention also participated in the comparative lessons.

Accelerometer data was used to determine the number of minutes and percentage time in each intervention lesson the students spent in each of the PA intensity categories. The results were compared to the number of minutes and percentage time the students spent in each of the categories during regular classroom instruction. The minutes and percentage time each participant spent in each of the PA categories (sedentary, light, moderate, vigorous and in MVPA) were averaged over the entire school week, in intervention lessons, break and lunch time, during a sample of comparison lessons and during total regular instructional time (total classroom teaching time minus intervention lesson time). These averages were used in subsequent analysis. A paired samples t-test was used to compare mean minutes in MVPA between usual practice and intervention lessons. The level of significance was set at 0.05.

Wear-Time

This study examines the PA levels of the students during the school day therefore minimum wear time was set at 272 minutes (80% of the school day, 340 minutes) which follows the 70/80% rule outlined in best practice recommendations for accelerometer use (Ward *et al.* 2005). At least 70% of the children wore accelerometers on all five days of the study so all 5 days were included in the analysis. Due to the nature of this study which includes sedentary data, 10 minutes of consecutive zeros could not be classified as 'non-wear time' (Yildirim *et al.* 2011). It is possible that children may remain in sedentary behaviour for extended periods of time in the classroom. Hence, the minimum activity threshold required to start a non-wear period was set at 60 minutes. Accelerometer data from 20 randomly selected children (n=13 girls, n=7 boys) was collected in this study; data from one child was excluded from analysis on the second day as she went home early and did not meet the minimum wear time requirements. Nineteen children met the wear time requirements on the last day since one child was absent and therefore her data was excluded. All 20 children were included in the analysis on the remaining 3 days. Following recommendations for accelerometer use, 15 000 counts was set as the cut point for the upper limit count values to avoid spurious data (Esliger *et al.* 2005) and spike tolerance was set at 2 minutes.

Teacher Perceptions

Results of the teacher survey were coded and input into Microsoft Excel 2010 where means were calculated for analysis. The results were used to evaluate the teacher's satisfaction with the programme. Direct quotations are used to highlight themes emerging from the open ended questions.

Student Enjoyment: Write and Draw & Focus Groups

The focus group discussion which was audio recorded and transcribed to accurately reflect the participants' views, was framed around the children's drawings and written texts. The use of these multiple data collection sources enabled triangulation and has been recommended to strengthen the quality of the data (Crivello *et al.* 2009). The following quality measures (Knowles *et al.* 2013) were used in the analysis of the write and draw activity. The writing must be legible and the drawings must be clear representations of people, events, or places (n=27 included). The researcher analysed the data in the following phases (Ritchie and Lewis 2003): (1) familiarisation with the raw data was established through immersion in the data by listening to the recordings, writing up and reading transcripts, reading students written texts and studying notes, (2) a thematic framework was established by the researcher who identified all key issues, concepts and themes from the participants' oral and written statements. Sub themes within each theme were also identified, (3) themes and sub-themes were assigned a code and these codes were applied to the data to assist with analysis and for subsequent retrieval and exploration, (4) the data was rearranged in the form of a chart, (5) the chart was used to find associations between the themes. Quotations and pictures were subsequently used to expand and highlight emerging themes (Knowles *et al.* 2013). Feedback was obtained from the research participants by checking back (Greene and Hogan 2005) with them during the discussion to ensure that their meanings and perspectives are accurately represented. Microsoft Excel 2010 was used to assist in managing the data.

Results

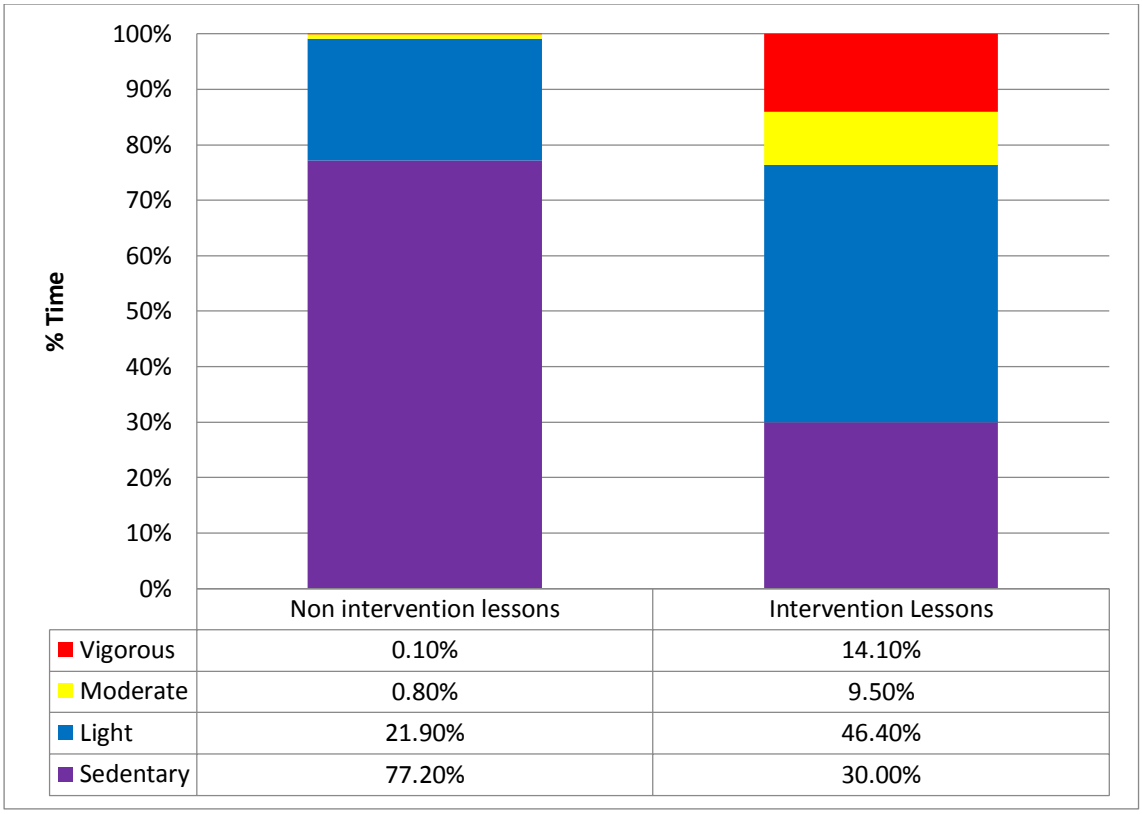
Data was gathered from predominantly Irish Caucasian students in a non-socio economically disadvantaged school on the suburbs of Limerick City, Ireland. Of the 28 students invited to participate in the study all 28 returned signed informed consent and assent forms. The mean age of the 20 children randomly selected to wear accelerometers was 8.1 years.

Physical Activity

Two active intervention lessons (one English and one Mathematics) lasting an average of 18 minutes (5.5% of the school day) each were taught by the classroom teacher during class time each day. Students accumulated 18 minutes of light and 8 minutes of MVPA overall during the two active lessons each day. Girls (8.3 minutes) accumulated slightly more MVPA per day during the lessons than boys (7.5 minutes) however, with a p-value of 0.16 there is no significant difference between the groups. The children spent a mean of 23.6% of time in

MVPA during the active lessons. The mean time (minutes) students spent in each PA category during intervention English and Mathematics lessons is outlined in Table 3.5.

A mean of 0.3 minutes was spent in MVPA during regular classroom instruction as outlined in Table 3.5. Figure 3.2 illustrates the mean percentage time spent in each PA category during comparison and intervention lessons. This figure also illustrates that the children spent over three quarters of regular classroom instruction in sedentary behaviour. This was reduced to 30% during the intervention lessons.



	Non intervention lessons	Intervention Lessons
Vigorous	0.10%	14.10%
Moderate	0.80%	9.50%
Light	21.90%	46.40%
Sedentary	77.20%	30.00%

Figure 3.2 Mean % time in each PA category during comparison and intervention lessons

Table 3.5 Mean minutes in each intensity category by comparison and intervention lessons

n = 20	Comparison lessons mins per day (SD)	Intervention lessons mins per day (SD)	P Value
Sedentary	25.8 (2.7)	11.4 (2.2)	<.001
LPA	7.1 (2.1)	17.6 (1.9)	<.001
MPA	0.3 (0.2)	3.4 (0.8)	<.001

VPA	0.0 (0.1)	4.6 (1.2)	<.001
MVPA	0.3 (0.2)	8.0 (1.6)	<.001
MVPA boys (*n* = 7)	0.4 (0.3)	7.5 (1.7)	<.001
MVPA girls (*n* = 13)	0.2 (0.2)	8.3 (1.6)	<.001
Lesson duration (mins)	33.3	36.8	

Note: P values refer to differences between intervention lessons and comparison lessons

An average of 11.7% of school time during the week was spent teaching the active lessons (two lessons, five days a week). Each intervention lesson contributed 2.7% to the overall school time spent in sedentary each day. However, each lesson contributed towards 16.1% of the overall MVPA accumulated daily therefore, 33% of the students' school day MVPA throughout the week was accumulated during the intervention lessons (2 per day). This almost matches the time spent in MVPA during break and lunch times (37.8%). Regular classroom instruction contributed to 89% of the time the students spent in sedentary behaviour during the school day.

Teacher Satisfaction

The intervention English and Mathematics lessons were highly regarded by the teacher, receiving an average rating of 5 on a 5-point Likert-type scale. She found the lessons very easy to implement and sustainable in a classroom context. The teacher taught the English and Mathematics lessons 5 days in the week. She perceived that the children were much more active in the intervention lessons compared to previous English and Mathematics lessons and she indicated that the Active Classrooms programme greatly enhanced the teaching and learning in the classroom rating both a 5 on a 5 point Likert- type scale. She also stated that *'the children were learning without even realising it and I could see a big improvement in their work'*. The teacher identified a lack of available space for some of the activities as a limitation of the programme. She stated that '*the biggest difficulty I had was space in my classroom. I couldn't do any of the floor exercises (i.e burpees, crunches). I went to the hall on 2 occasions but the hall isn't always available'*. The teacher indicated that she is definitely likely to continue using the lessons after the study, stating that '*I will most definitely be continuing the activities and only wish I had more time to try out all the lessons'*. When asked to suggest any changes to improve the intervention to enhance teaching or learning while also encouraging PA in the classroom the teacher said '*I can't think of any changes I would make*' she added that '*the children loved it and I found that they were focused more on the rest of the days' events/ lessons'*.

Student Enjoyment

Twenty-seven children completed the write and draw activity and four children also participated in the focus group discussion. One blank write and draw sheet was returned because one child was absent on the day. The data collected revealed common themes relating to students' attitudes about the programme. Many students' responses identified more than one theme and so were categorised in each theme identified. The majority of responses referred to the high level of enjoyment experienced through participating in the active lessons. Most children mentioned that the lessons were 'fun' (n=26) or 'enjoyable' (n=4). Others mentioned that the lessons were great (n=3) or that they 'liked' (n=21) or 'loved' (n=21) them. Participant 10 wrote '*It is really fun. I like to do different activities and the exercises are fun too. It makes an English lesson fun'*. Participant 11 wrote '*I loved those exercises. They were really fun! Learning Mathematics and English especially Mathematics through those exercises was really, really, really, very fun!*' Health and PA (n= 26) was identified as the second theme with *participant 3* and *20* respectively stating, '*I loved the English lessons because it's ...really good exercise'* and '*I am more healthy because of the lessons*'. Enhanced learning (n= 4) was another theme recognised (*participant 9*:'*being active in the lessons helps you (learn) a little bit more' and '...we were learning in a fun way'*), (participant 15: *'I like English more now with all the exercises we do. We did this thing called verb and adverb, and I am really able to understand what they are now because we had to act them out')*. This theme emerged in the teacher's questionnaire also. In response to an open ended question she stated '*I loved the fun activities for Mathematics. Children were learning without even knowing. Tables can be boring for them but they loved the games so were able to learn them much better*'. Only one student expressed a negative attitude towards the lessons stating '*I don't want a Mathematics lesson, it's too hard'* (*participant 28*). It's unclear if this refers to the Mathematics content in general or the active lessons. The themes identified in the focus group discussion were consistent with those identified through the write and draw activity '*we learned sums that we didn't really do before… like multiplies. We learned a bit more, it was good fun' (student 1)*. When asked if they would like to do the programme again, the children reported they '*would love it*'. The children's expressions, tone of voice and non-verbal behaviour also reinforced the enjoyment and excitement experienced through the programme. Samples of the participant's responses are displayed in Figure 3.3 and Figure 3.4 below.

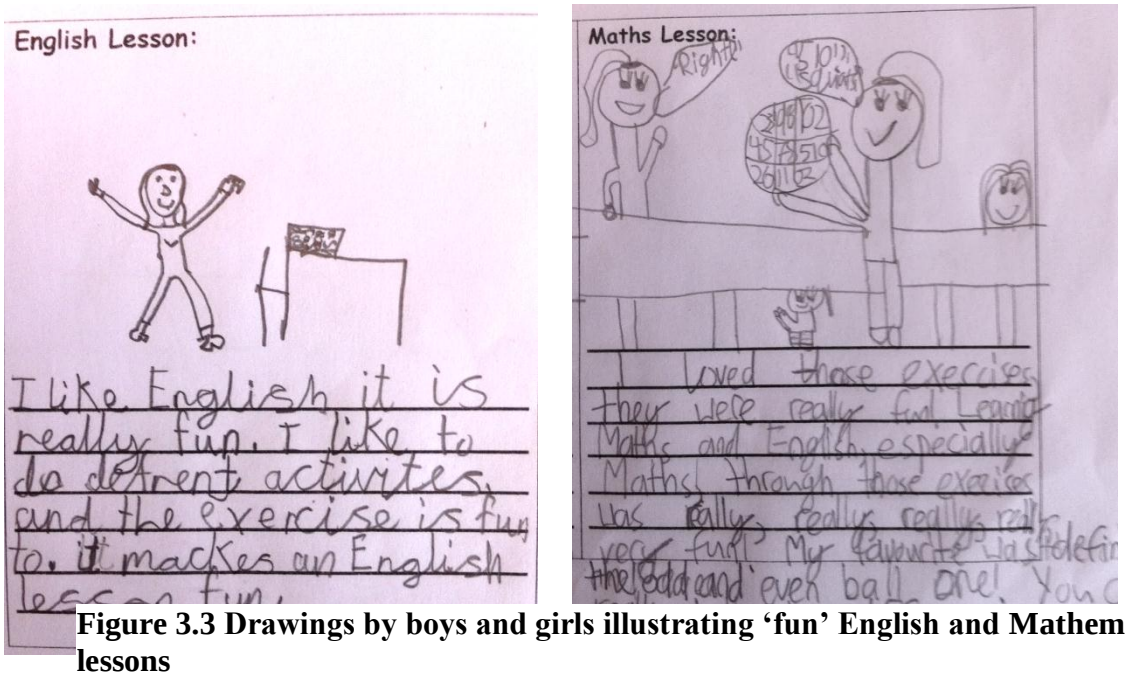
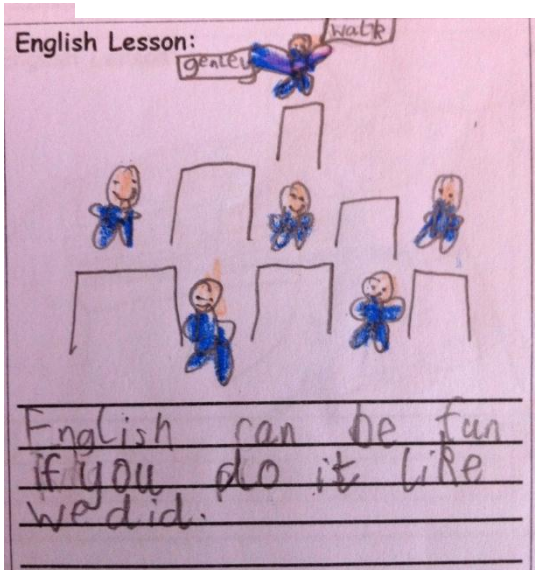


Figure 3.3 Drawings by boys and girls illustrating 'fun' English and Mathematics lessons



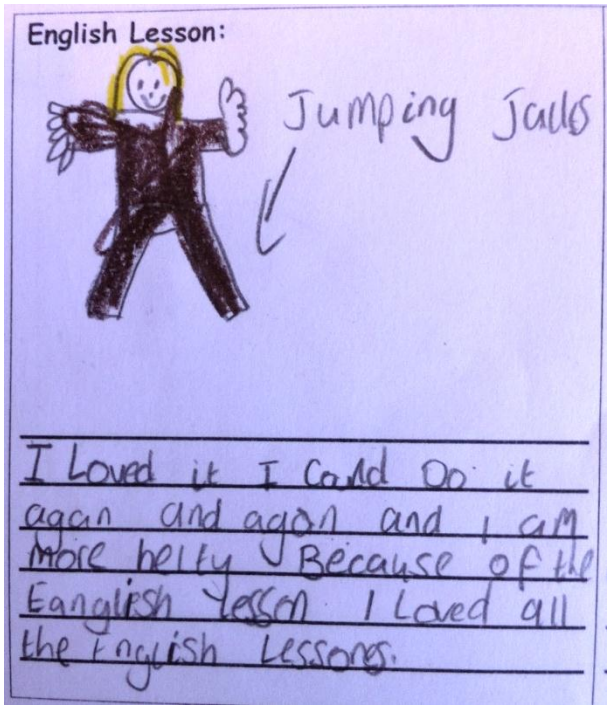


Figure 3.4 Drawing by a girl illustrating that the exercises helped her become 'more healthy'

Discussion

The purpose of this study was to evaluate the effectiveness of a curriculum integrated PA intervention on the MVPA levels of the children during the active lessons. The results of this pilot study are promising as they demonstrate that a classroom based intervention which integrates PA into the curriculum content of English and Mathematics lessons, taught by the classroom teacher, can improve the PA levels of primary school children during the intervention lessons and throughout the entire school day. These findings augment the growing body of evidence on the efficacy of teaching academic content using physically active methods (Norris *et al.* 2015). Specifically this study illustrates that changing the behaviour of the teacher enabled the students to accumulate more PA during the English and Mathematics intervention lessons than during regular lessons while also enhancing their learning and providing enjoyable experiences for them.

Children's physical activity levels

The World Health Organisation recommends that children participate in at least 60 minutes of MVPA most if not every day of the week (WHO 2010) and also highly recommend that schools take an active role in implementing policies to improve PA. Conversely, out of reach targets can undermine PA participation and with time, curriculum and space limitations there are many barriers preventing schools from implementing an hour of PA each day. Therefore,

accumulating at least moderate PA in short bouts throughout the day is a goal deemed easier to achieve and has many beneficial health effects, especially for those most at risk (Barr-Anderson *et al.* 2011, Janssen and LeBlanc 2010). This outlook was employed in the development of this project and proved successful in assisting the children accumulate PA in school.

In this study a mean of 23.6% of each intervention lesson was spent in MVPA. Other studies which have integrated PA and academic content have reported that children spent between ~20 and 100% of the lesson time in MVPA (Bartholomew and Jowers 2011, Donnelly *et al.* 2009, Stewart *et al.* 2004). While the duration for which children can sustain MVPA may be influenced by the length of each active lesson, for example the shortest lesson of 10 minutes enabled the children achieve moderate to vigorous intensity physical exercise and maintain these levels for 100% of the lesson (Stewart *et al.* 2004), these studies demonstrate that there may be scope to improve the proportion of time spent in MVPA during the Active Classrooms' intervention lessons. The students spent 50% (9 minutes) of each active lesson in light activity, this may suggest that the duration of the Active Classrooms' lessons implemented by the teacher (~18 minutes) was perhaps too long for the students to maintain sustained periods of moderate-to-vigorous intensity PA. Nonetheless, the intervention lessons contributed 13% of the children's recommended daily PA and any increase in children's PA levels can have significant health benefits (Janssen and LeBlanc 2010).

PA accumulated across the school day has been shown to increase whole-day PA to a degree greater than expected from the school day PA sessions alone (Groffik *et al.* 2012). However, no consensus has been drawn on discrete guidelines for school day PA accumulation. The New Zealand-based Energize Project suggests that 20 minutes of the recommended 60 minute MVPA goal should be accumulated during the school day (Rush *et al.* 2012). In contrast Nettlefold *et al.* (2011) suggest that 30 minutes (50%) of the 60 minute recommendation should be achieved during the school day. During the current study the mean MVPA accumulated across the whole school day was 24.8 minutes. This is greater than other studies which examined MVPA during school time in primary schools in Ireland. A study which evaluated Irish primary school children's PA levels during the segmented school-day found that the children accumulated a mean of 18.6 minutes of MVPA (Hegarty *et al.* 2013) during the whole school day. Hegarty *et al.* (2013) reported that children achieved the least amount of PA during class time with the accumulation of only 8 minutes of

MVPA. This is much lower than the present study which accrued a mean of 15 minutes of MVPA during the same period of the day. Implementing the active lessons is largely responsible for this significant difference.

The Active Classrooms study did not find a significant difference between PA levels accumulated by males and females during the intervention lessons. This is an interesting finding since females are often shown to be less active than males, especially during school (Hegarty *et al.* 2013). It can be suggested that the PA accumulated by both males and females during the lessons are similar because all children present in the classroom were presented with the same opportunities to participate and engage in the same activities during the lessons and were requested to do so as part of their teacher's instruction of the English and Mathematics lessons. This supports assertions by Belton *et al.* (2010) who report that interventions targeted towards increasing PA during class time have a significant effect on increasing children's PA levels, particularly lesser active children and girls.

Emerging evidence demonstrates that independent of PA levels, prolonged periods of sedentary behaviours of greater than 2 hours per day are associated with an increased risk of coronary heart disease, cardiovascular disease, type II diabetes, all- cause mortality, a multitude of psychological and physiological problems as well as decreased fitness, lower self-esteem and decreased academic achievement in children and youth aged 5-17 (Katzmarzyk 2010, Owen *et al.* 2010, Tremblay *et al.* 2010, Tremblay *et al.* 2011, Treuth *et al.* 2007). Results of the Active Classrooms study illustrate that the intervention lessons not only improve the students' PA levels but also reduce time spent in sedentary behaviour when compared with regular classroom instruction. Therefore, by enabling teachers to teach traditionally sedentary academic lessons using physically active methods, this programme has the potential to break prolonged sedentary periods consequently reducing the ill effects of this behaviour.

Teacher Satisfaction

The high levels of teacher satisfaction with the Active Classrooms programme is encouraging for its ongoing implementation. Teacher satisfaction is essential as teachers play a central role in determining the success or failure of a change intervention (Fullan 2007) by their willingness to engage in it. Changing their methods of teaching is ultimately a personal, individual decision by the teacher and their inclination to engage is influenced by their

perceptions of the programme (Cothran *et al.* 2010). Teacher satisfaction is especially imperative for the implementation of classroom-based PA interventions since what children do in the classroom is largely controlled by the teacher (Fullan 2007) and students cannot be physically active in a classroom setting without the support and guidance of the teacher. Additionally, it has been found that teacher implementation rates largely affect the benefits students receive from the intervention (Donnelly *et al.* 2009). Therefore, it is important to consider factors associated with teacher satisfaction and implementation of these lessons.

In their examination of classroom teachers' perceptions of using PA breaks in the classroom Mc Mullen *et al.* (2014) identified three main factors which contribute to teachers adopting the practice: 1) the need for classroom control, 2) a preference for breaks with connections to academic content, and 3) the importance of implementation ease and student enjoyment. These determinants of how, when and if classroom teachers will use a PA intervention in their classrooms were considered in the design of the Active Classrooms programme. In the application of the Behaviour Change Wheel Framework (Michie *et al.* 2008) the target behaviour was analysed and features included in the intervention as a result of this analysis contributed towards teacher satisfaction and compliance with the programme. Lesson plans linked to the academic content of the Irish Primary School Curriculum (NCCA 1999) with the identification of specific strands and strand units and resources required to teach them such as flashcards, a beach ball, playing cards, a PowerPoint presentation, maps etc. were provided for the teacher as well as training on how to implement the active lessons. Images on how to perform the exercises were also provided (See Appendix H). The teacher indicated that the lessons were extremely easy to implement and the provision of training and resources allowed the teacher to manage the lessons easily and maintain classroom control. This supports the recommendations for professional development and teacher preparation in relation to PA inclusion in the classroom as outlined by McMullen *et al.* (2014). Results of the Texas I-CAN study by Bartholomew *et al.* (2011) also indicate that teacher implementation rates were enhanced following training based around a theory and the provision of active lessons and equipment needed for the classroom.

Aligning with the work by McMullen *et al.* (2014) the teacher identified a lack of classroom space as an issue with implementing the lessons. She found that due to a lack of available space in the classroom the children were not able to perform some of the floor exercises however, the design of the lessons allowed the teacher to substitute these with other activities

included in the programme such as jumping jacks and squat jumps which enabled her to continue with the lesson. The lesson plans were designed to last a minimum of 10 minutes each but could be extended as desired to fit into the teacher's schedule. Variations of each lesson were also included in the plans which allowed the teacher to adjust the content to suit the topics she was teaching. This finding builds on previous work by Morgan and Hansen (2008b) who found that adaptability of the programme contributes to teacher compliance and the development of positive attitudes towards PA promotion in the classroom. Adaptability gives teachers ownership allowing them to adjust the intervention to fit with their beliefs and values about teaching as well as, with their curriculum and schedule.

Student Enjoyment

Enjoyment is the primary element of acceptability and the dominant motivational factor for children to participate in PA (Allender *et al.* 2006). The children in this study expressed an extremely positive attitude towards the lessons claiming that they were '*fun*', '*exciting*' and '*enjoyable*'. They expressed their hope of learning actively '*doing all the exercises again'*. This finding is crucial to the potential sustainability of the 'Active Classrooms' programme as PA interventions are unlikely to be implemented widely, no matter how potentially effective and efficient they might be, if they are not shown to be acceptable to both students and teachers (Howie *et al.* 2014, McMullen *et al.* 2014, Woods *et al.* 2012). As such results of the current study build on previous studies which indicate that levels of student enjoyment have been shown to determine the beneficial effects of PA interventions with increased enjoyment resulting in increased PA (Dishman *et al.* 2005, Schneider and Cooper 2011) and where children do not experience enjoyment this may have negative effects on their future participation in PA. Physically engaging the children in lessons in ways they have not experienced before is responsible for their enjoyment of the 'Active Classrooms' lessons. Students commented on how '*you could really tell the difference*' between the active lessons and regular lessons and on how much they enjoyed throwing a ball to one another around the classroom to learn about odd and even numbers, and '*doing P.E.'* in their English and Mathematics lessons. They expressed their enjoyment of running to collect letters for a team game of scrabble and exercising while moving from station to station to write collaborative stories. This enjoyment may be attributed to their engagement in pair and small group activities which supports previous findings that children experience enjoyment during positive social interactions with their peers (Knowles *et al.* 2013).

Enhanced Learning

While not a planned outcome of this study, a recurrent theme identified by both students and the teacher was enhanced student learning and student focus. This finding adds to the results of previous studies which examined student time on task and academic achievement outcomes of classroom based PA interventions. Mahar *et al.* (2006) found that participation in these types of lessons resulted in a significant increase in time on task for subsequent traditional style, sedentary lessons. Bartholomew *et al.* (2011) also found that the students maintained a greater focus on academic material after a physically active lesson. Donnelly *et al.* (2009) and Erwin *et al.* (2011a) found significantly higher results in students' achievement in Mathematics and Literacy assessments. Our findings therefore lend support to the contention that, contrary to some teachers' beliefs (Morgan and Hansen 2008a), integrating PA into academic content does not detract from students' performance outcomes or behaviour. These lessons not only teach and review academic material, but they also enhance learning and student behaviour in lessons that follow. This provides strong potential to enhance teacher motivation to implement physically active academic lessons.

Limitations

Although this pilot study demonstrates the potential for encouraging classroom teachers to integrate PA into the classroom to increase children's PA levels without interrupting academic teaching time, the use of a convenience sample of only one classroom and one classroom teacher is a limitation. The inclusion of randomisation to select schools, and increasing the number of classrooms and teachers in future studies would allow generalisability of the findings while also providing a better understanding of teacher perceptions and compliance. The short time frame of this study should also be noted. While the study was not conducted using a control group, requesting the teacher to record the times and duration of the active lessons taught, allowed the researcher to filter the intervention lessons and a sample of regular lessons from the accelerometer data. Therefore, comparisons could easily be made between regular and intervention lessons to evaluate the success of the intervention on the MVPA levels of the participants. A future study is warranted using control and intervention schools to assess the effectiveness of the programme on a larger scale and over a longer time period.

Conclusion and Future Research

Our findings demonstrate that the Active Classrooms programme can improve children's PA levels when implemented each day. This initiative complements policy at a national (Department of Health 2013) and global level (WHO 2008) by promoting PA in the school setting through changes in behaviour and education. The positive attitudes expressed towards teaching and learning using physically active methods by both the students and the teacher supports the notion that pedagogies should be adapted by teachers and teacher educators to include PA as a means to improve children's overall health. These positive attitudes were also prominent in the Wellness Weeks approach which advocated PA implemented by classroom teachers throughout the school day (Corbin *et al.* 2013). Similarly, this approach allows each teacher flexibility in implementing a programme which provides support and sound educational and PA resources.

Future recommendations include the evaluation of individual lessons to identify those which contribute most to the children's MVPA levels. Further lessons could then be designed to incorporate the most active pedagogies. Research should also be conducted to objectively assess student learning through participation in the Active Classrooms lessons. It is also acknowledged that students in this study may compensate throughout the whole day for PA accumulated during the active lessons (Metcalf *et al.* 2012). Therefore, a future larger scale controlled study should be conducted to evaluate if children are more active throughout the whole school day when intervention lessons are implemented in comparison to traditional lessons. Finally, long term follow-up to measure sustainability of the programme is warranted.

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