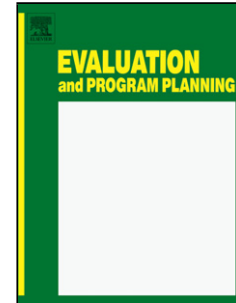


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Mixed method evaluation of the Virtual Traveller physically active lesson intervention: An analysis using the RE-AIM framework

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Highlights

- Explored teacher and pupil perceptions of a physically active lesson intervention
- Mixed methods were used to provide a more rigorous evaluation of the intervention
- Virtual Traveller had high participation, high implementation and low attrition rates
- This study is a thorough process evaluation of a physically active lesson intervention

Abstract

Background: Physically active lessons integrating movement into academic content are a way to increase children's physical activity levels. Virtual Traveller was a physically active lesson

intervention set in Year 4 (aged 8-9) primary school classes in Greater London, UK. Implemented by classroom teachers, it was a six-week intervention providing 10-minute physically active Virtual Field Trips three times a week. The aim of this paper is to report the process evaluation of the Virtual Traveller randomized controlled trial according to RE-AIM framework criteria (Reach, Effectiveness, Adoption, Implementation and Maintenance).

Methods: A mixed methods approach to evaluation was conducted with five intervention group classes. Six sources of data were collected via informed consent logs, teacher session logs, teacher and pupil questionnaires, teacher interviews and pupil focus groups.

Results: High participation and low attrition rates were identified (Reach) alongside positive evaluations of Virtual Traveller sessions from pupil and teachers (Effectiveness). Participants were from more deprived and ethnic backgrounds than local and national averages, with Virtual Traveller having the potential to be a free intervention (Adoption). 70% of sessions were delivered overall (Implementation) but no maintenance of the programme was evident at three month follow-up (Maintenance).

Conclusions: Mixed method evaluation of Virtual Traveller showed potential for it to be implemented as a low-cost physically active lesson intervention in UK primary schools.

Keywords: Physically active lessons, physical activity, intervention, process evaluation, RE-AIM, children, interviews, focus groups

Background

Current World Health Organisation (World Health Organisation, 2010) and UK physical activity guidelines (Department of Health 2011) recommend that school-aged children should spend at least 60 minutes per day in moderate-to-vigorous physical activity. However, only 18.5% of UK children met these guidelines (Scholes & Mindell, 2013). A range of school-based interventions have been developed to improve children's low activity levels (Dobbins et al, 2013), as schools allow frequent access to diverse children over regular, extended periods of time (Fox et al, 2004).

Physically active lessons which integrate movement into academic teaching have recently been tested in schools (Author et al, 2015a). A developing evidence base has shown physically active lessons to increase physical activity (Donnelly et al, 2009; Goh et al, 2014), academic achievement (Mullender-Wijnsma et al, 2016) and time on-task (Mahar et al, 2006; Mullender-Wijnsma et al, 2015), with research typically run in primary schools with pupil aged under 12 (Author et al, 2015a). For example, Donnelly and colleagues found their 3-year 'Physical Activity Across the Curriculum' (PAAC) randomized controlled trial to be associated with 27% greater overall moderate-to-vigorous physical activity compared to control group (Donnelly et al, 2009). However, short follow-up periods, poor activity measurement (Author et al, 2015a) and non-diverse pupil samples (Neelon et al, 2016) are limitations evident in physically active lesson research to date.

The current evidence base for physically active lessons is often drawn from relatively small-scale or pilot studies, which focus on assessing outcome effectiveness rather than also assessing the processes underlying these effects (Author et al, 2015a; Webster et al, 2017). Process evaluations include assessment of the context in which an intervention was delivered and the extent it was delivered as intended (McGoey et al, 2016). Medical Research Council guidelines for complex interventions recommend that these processes are assessed to allow better interpretation of findings and help identify required adjustments for future iterations (Medical Research Council, 2013; Oakley et al, 2006). Other school-based physical activity interventions have previously reported full process evaluations to allow assessment of implementation, context and costing (Jago

et al, 2015; McGoey et al, 2016; Sebire et al, 2016). As physically active lessons are still relatively novel (Author et al, 2015a), it is important that authors report full process evaluations to allow more effective future iterations to be developed. For example, the EASY Minds physically active lesson intervention performed a process evaluation featuring teacher sessions logs and pupil and teacher questionnaires (Riley et al, 2015; Riley et al, 2016). However, this process evaluation was only briefly reported and was not performed or described according to any evaluation framework.

The use of robust evaluation tools such as the widely used RE-AIM framework (Reach, Effectiveness, Adoption, Implementation, Maintenance) (Glasgow et al, 1999) helps to ensure that all aspects of process evaluation are assessed. In brief, Reach assesses the rate of participation and the sample's representativeness, Effectiveness assess the intervention's effects on outcomes, Adoption measures the potential influence of setting characteristics and real-world costs, Implementation assesses the extent the intervention was delivered as intended and Maintenance explores the level of sustained individual- and organizational-level behaviour change following the intervention (Gaglio et al, 2013; Glasgow et al, 1999). RE-AIM has been used to evaluate physical activity interventions across community (Koorts & Gillison, 2015), school (Dunton et al, 2009) and workplace environments (Dubuy et al, 2013). However, a review of child physical activity interventions using RE-AIM found that 80.8% of 78 interventions included less than 50% of framework dimensions (McGoey et al, 2016). External validity indicators such as start-up costs, protocol fidelity and participant representativeness were typically not assessed (McGoey et al, 2016), making it difficult to infer transferability of the intervention to wider school settings. Hence for the RE—AIM framework to be maximally useful, it is important for all aspects to be incorporated into the planning and analysis of process evaluations (Kessler et al, 2012).

Virtual Traveller was a cluster-randomised controlled trial run between March 2015 and May 2016 in year 4 (8-9 years) classes within ten primary schools in Greater London (UK). The intervention provided pre-prepared physically active lessons, integrating activity into primary school maths and

English teaching (Author et al, 2016). Virtual Traveller consisted of Powerpoint sessions known as Virtual Field Trips (VFTs), designed to be delivered using existing classroom interactive whiteboards. These sessions included embedded Google Earth videos showing transitions between different global locations, with on-screen prompts providing activity prompts to facilitate movement as children 'travelled' between and interact with virtual locations. A package of eighteen, 10-minute sessions were provided to teachers, to be delivered by them over a 6-week intervention period (Author et al, 2016). All Virtual Traveller sessions were developed around National Curriculum learning objectives for the age-group (Department for Education, 2013).

Intervention outcomes were physical activity assessed via accelerometers and observations, on-task behaviour assessed via observations and student engagement assessed via pupil questionnaires. These outcomes were assessed at baseline (T0), two- (T1) and four weeks (T2) during the Virtual Traveller intervention and one week (T3) and three months (T4) post-intervention (Author et al, 2016). Virtual Traveller was developed following piloting (Author et al, 2015b) and qualitative feasibility work (Author et al, 2015c). A protocol detailing all aspects of the intervention and outcome measurement was also published (Author et al, 2016).

We recently reported the results of the Virtual Traveller intervention, conducted in ten Year 4 classes (5 intervention and 5 control classes) (Author et al, Under Review). It was found to significantly improve lesson-time physical activity and on-task behaviour but have no effect on school-day, weekend-day physical activity or student engagement (Author et al, Under Review). The aim of this paper was to evaluate the processes underlying the Virtual Traveller intervention according to RE-AIM framework criteria.

Methods

The process evaluation included quantitative and qualitative aspects, with six data sources in total. All dimensions of process evaluation were aligned with aspects of the RE-AIM framework (Table 1). The study was approved by the University College London ethics committee (Ref: 3500-004), with written informed consent required from pupils, their parents and teachers (Author et al, 2016).

Quantitative data

Various elements of quantitative data were collected for process evaluation. Firstly, each teacher (n=10) recorded which pupils completed informed consent documents on a returned consent sheet document and provided proxy recordings of sex and English language status of the overall class. Secondly, a pen-and-paper teacher session log was completed by all intervention teachers (n=5) throughout the 6-week intervention period. This log was placed on the wall by the teacher's computer, with teachers prompted in initial training to complete the log immediately after each session to minimise forgetting (Author et al, 2016). Teachers logged which Virtual Traveller sessions were delivered (Author et al, 2016) and when, as well as rating the session out of 5. Finally, evaluation questionnaires were distributed to intervention participants at weeks 2 (T1) and 4 (T2) of the 6-week intervention period. The pupil evaluation questionnaire featured six items, including three 5-point Likert scale items assessing pupils' ratings of sessions, one 11-point item assessing pupil physical exertion with the well-validated Children's OMNI scale of perceived exertion (Robertson et al, 2000) from 0: 'not tired at all' to 10: 'very, very tired' and two free-text items assessing general strengths and weaknesses of Virtual Traveller. The teacher evaluation questionnaire featured eight items, six were 5-point Likert scale items assessing satisfaction with Virtual Traveller and two were free-text items assessing general strengths and weaknesses of the programme.

Qualitative data

All qualitative data was collected at the end of the 6-week intervention period. As done in a previous physically active lesson process evaluation (Riley et al, 2015), pupils were purposively invited to

ensure two children of lower, middle and higher overall academic ability were included in each focus group. Pupil focus groups were held in vacant classrooms during school time. They were facilitated by the lead researcher (EN) in a 'moderator' role to ensure focused discussion (Gibson, 2012) and run according to a semi-structured interview schedule. The schedule explored pupils' experiences of the Virtual Traveller intervention and ideas for future improvements. Teacher interviews were organized in-school at a time convenient to each teacher's schedule. The semi-structured interview schedule consisted of nine open-ended items exploring teachers' experiences of Virtual Traveller, including perceptions of session length and effectiveness, pupil enjoyment and behaviour, challenges experienced and ideas for improvement.

Data analysis

Questionnaire data was analysed using SPSS version 19, with descriptive statistics reported due to the small samples of quantitative data available from the intervention group. Pupil focus groups and teacher interviews were recorded using an Olympus DM-450 Dictaphone and transcribed verbatim. Thematic analysis was used to analyse transcripts, with data read and re-read, themes sought from raw quotes and themes reviewed against other themes and the entire data set (Braun & Clarke, 2006).

Results

Pupil evaluation questionnaires were completed by 90% of participating intervention group pupils at T1 (week 2 of intervention; $n=103/115$) and 85% at T2 (week 4 of intervention; $n=98/115$). All intervention teachers completed their evaluation questionnaires at both T1 and T2 ($n=5/5$). One intervention group class (Class 2) chose not to participate in qualitative evaluation. One pupil focus group was carried out in each of the remaining intervention classes ($k=4$, $n=6$ in each focus group, $n=24/115$; 21% of intervention group pupils), with 54% of pupils being boys ($n=13/24$). Four semi-

structured teacher interviews were performed (80% of intervention teachers), with three interviewed teachers being female. Findings are reported according to RE-AIM framework as outlined in Table 1 (e.g R1= Reach: Participation rates among eligible classes).

Reach

Ten out of twelve (83.3%) contacted schools agreed to participate in the study. The two declining schools reported time pressures as their reason for non-participation (R1). Of those pupils eligible in the ten participating classes (n=303), n=264 (87%) consented to participate. Reasons for non-consent reported by class teachers included pupils or parents forgetting to return forms (n=36/39; 92%) and apprehension of accelerometers and their use (n=3/39; 8%) (R2) (Author et al, Under Review). There was no significant difference in sex or English language status between consenting (n=264: from pupil demographic questionnaire (Author et al, Under Review) and non-consenting pupils (n=39: from teacher proxy reports of whole class demographics) (R3). However, recruitment was restricted to the Greater London area and West Berkshire (west of London) schools (Author et al, 2016), preventing generalisability to other more rural contexts. Additionally school contacts were made via School Sports and Public Health partnerships in boroughs (Author et al, 2016), meaning contacted schools may likely have already engaged in greater healthy lifestyle promotion. 4 out of 10 recruited classes (2 intervention and 2 control classes) were in schools with 'Healthy Schools' accreditation: a national scheme reflecting target setting and implementation of their own healthy lifestyle initiatives (R3) (Department for Education, 2011).

Effectiveness

As previously published (Author et al, Under Review), Virtual Traveller was found to have no effect on primary outcomes of school- and weekend-day physical activity (E1) nor on secondary outcomes related to student engagement (E2). Positive effects were found for secondary outcomes of lesson time physical activity and on-task behaviour during the intervention (E2) (Author et al, Under

Review). Pupils positively rated Virtual Traveller sessions in their evaluation questionnaires, scoring the sessions as 'liked' (Question 2: T1: 3.6/5, T2: 3.8/5; Table 2) and 'fun' (Question 3: T1 & T2: 3.8/5; Table 2). Focus groups revealed that some students found the movements in Virtual Traveller repetitive: *"you end up jumping a lot sometimes.. it would be good if we could run around more instead"* (Class 7) and *"it's ok to move inside sometimes but it would be good if we could have more classes outside as well"* (Class 10) (E3).

Teacher session logs revealed generally high ratings across all sessions, with overall mean scores for Maths sessions (3.9/5, SD=0.42) higher than for English sessions (3.7/5; SD=0.11; Table 3). Sessions rated particularly highly included M4 (London 2012 Olympics and beyond) with 4.8/5 (SD=0.45) and E4 (Explanation Texts) with 4.3/5 (SD=0.50). Lower rated sessions included M6 (Sports Galore) with 2.7/5 (SD=0.58) and E6 (Noun Reversal Charades) with 2.7/5 (SD=0.58; Table 3). Teacher evaluation questionnaire ratings of the Virtual Traveller intervention were relatively high, with sessions rated as moderately enjoyable (T1: 20/25, T2: 18/25) and easy-to-use (T1: 17/25, T2: 19/25; Table 4).

Teachers also rated children's enjoyment of Virtual Traveller sessions to be very high across time-points (T1: 21/25, T2: 22/25). Teacher interviews generally identified children to be more active during Maths Virtual Traveller sessions than English ones: *"actions in the Maths ones (sessions) were more obvious and the kids got it more, like jumping a number of moves to an answer.. it just makes sense for them"* (Class 10) (E3).

Pupils perceived Virtual Traveller sessions as having low physical exertion in the pupil evaluation questionnaire (Question 4: T1: 3.7/5, T2: 3.7/5; Table 2). There were no significant differences in perceived physical exertion ratings between intervention classes or demographics, suggesting ratings were relatively low and consistent across the sample. Such low perceived exertion was also mirrored in pupil focus groups, such as *"you sometimes get really out of breath but it's ok because it's fun and we're moving around"* (Class 2). However, teacher interviews identified alternative

perceptions: *“some of them are quite unfit generally and find it difficult to stay active even for one of these short sessions... it’s quite worrying”* (Class 5) (E4).

Adoption

The Virtual Traveller sample had much greater levels of poverty and slightly greater levels of overweight and obesity than local (greater London and Berkshire) and national averages (National Child and Maternal Health Intelligence Network, 2016) (Table 5). Levels of ethnic minority participants also greatly varied from local and national averages. This suggests that participants in the sample may not be indicative of others in their local areas, nor in wider UK areas (A1).

Recruitment, teacher training and intervention materials were provided free of charge by the researcher in this study. Estimated costs of real-world replication of Virtual Traveller are presented in Table 6. Teacher training could be implemented via face-to-face instruction as per the published study (Author et al, 2016) or via provision on free educational resource websites such as TES Resources (TES Resources, 2016). As Virtual Traveller fundamentally requires interactive whiteboards and projection equipment, the predominant costs for schools are based around whether they already have access to this equipment or not. Projected costs in purchasing and maintaining this equipment total £3890 (School Business Services, 2016). However as over 70% of UK classes already have access to interactive whiteboard technology (Futuresource Consulting, 2010), these purchases are irrelevant for the majority of potential users (A2).

Implementation

Teacher logs showed that the number of unique sessions completed ranged from 38.9% (Class 7) to 100% (Class 6), with 70% of sessions delivered overall across all intervention classes (Table 7).

Teachers delivered between 44.4% (Class 7) to 100% (Class 6) of Maths sessions and 33.3% (Class 7)

to 100% (Class 6) of English sessions at least once during the intervention. A comparison of teacher logs (Table 7) with teacher evaluation questionnaires (Table 4) shows positive teacher evaluations seem associated with greater implementation in this small teacher sample. For example, the teacher of Class 6 implemented the most sessions whilst also giving maximal scores for ease-of-use of the sessions and for interest in continuing to use the programme.

Importantly, pupil focus groups identified that teacher logs may not truly reflect full session implementation: *"I think our teacher stopped halfway once"* (Class 10). This highlights that although sessions may have been reported as delivered (Table 4), teachers may not have actually delivered all activities (I1). Some Maths sessions were reported as repeated in teacher logs (Table 7) and pupil focus groups: *"We did the Queen Marching one (M2: 'Maths Marching) two times but Miss changed the times tables that we marched to"* (Class 7) (I1).

Teacher interviews identified various facilitators and barriers to Virtual Traveller implementation. All teachers described the PowerPoint sessions as easy-to-use: *"You just click and go which saves a lot of time.. no fiddling with the internet or anything"* (Class 5). Some teachers described how they repeated sessions to recap content: *"We did the metric unit one (M5: Metric Movements) before and after we covered that content.. the questions were the same but the gap was long enough for them to have forgotten the answers!"* (Class 7). However, some teachers described not running specific sessions as they did not match with currently taught curriculum content: *"There was one on persuasive writing (E7: Persuasive Writing) but we did that last term so I didn't want to backtrack and cover it again"* (Class 5). Some teachers described the Maths sessions to enable physical activity in a more intuitive way than English sessions *"I felt like the activity links in the English ones were more tenuous... the Maths ones with counting and numbers seemed to make a lot more sense"* (Class 5). Also, some teachers commented that the PowerPoint sessions were somewhat inconvenient for practical reasons: *"You (the teacher) have to stay quite close to the computer to move the presentation along if you don't have a clicker.. it kind of limits you to how active you can be"* (Class

7). Finally, some teachers commented that the success of the intervention would depend on the teachers' technological confidence: *"It was fine for me but I can think of colleagues who wouldn't want to use their whiteboard even for these easy sessions"* (Class 10) (I1).

Virtual Traveller sessions were designed to be 10 minutes in length (Author et al, 2016), although actual provision was found to differ somewhat. Some pupils described how their overt reactions to a session altered the teacher's choice of session length: *"Some days we were tired and didn't want to stand up and so our teacher stopped it early"* (Class 7). This ad hoc adjustment to session delivery was also reported by some teachers: *"You can tell some days that they're just not ready for it, so I'd either move it to another day or just run a shorter version and cut bits out"* (Class 10). No teachers asked for longer or shorter sessions (I2).

Maintenance

No schools were lost to follow-up during the study. Of participants in the analytic sample, 72% (n=157/219) were 'remainers': providing study data all time-points, 11% (n=23/219) were lost to attrition and 18% (n=39/219) were 'returners': providing data intermittently during the study. At T0 (baseline), 'remainers' demonstrated significantly higher average school day accelerometer-assessed sedentary behaviour than those later lost to follow-up (655.55 minutes (SD=38.22) vs 634.55 minutes (SD=35.72); $F(202)=3.60, p<0.05$). There were no significant differences between participant attrition groups for any other outcomes at any other time-point. This suggests that there was unlikely to be any effect of attrition on outcomes during the Virtual Traveller study (M1).

No intervention group effects on any outcomes were seen at three month follow-up (T4) (Author et al, Under Review). Teacher interviews identified that no teachers had continued to use Virtual Traveller sessions beyond the intervention period. However, all teachers commented that the intervention had made them consider integrating physical activity into their teaching more in the future: *"I definitely noticed an improvement in their behaviour and happiness in class.. I wouldn't*

necessarily use this programme again because of the whiteboard-use, but I will definitely plan more activity into my planning for next year” (Class 7) (M2).

Discussion

This paper presents findings from a RE-AIM evaluation of a physically active lesson intervention designed to be integrated into primary school teaching. High participation and low attrition rates were observed. 83.3% of contacted schools agreed to participate in the study (Reach): much higher than the median rate of 44.5% (range 12%-100%) seen in a recent review of children’s physical activity interventions (McGoey et al, 2016). This was also complimented by low attrition rates with 87% of invited pupils giving consent (Reach): higher than the median pupil participation rate of 76.7% (range 4.3%-100%) in the aforementioned review (McGoey et al, 2016). Pupil attrition during the intervention was also low (Maintenance), with 11% of participants being lost to follow-up: lower than the median rate of 14% participant attrition observed in the same review (McGoey et al, 2016).

This low attrition may be the result of the ongoing pupil competition for accelerometer wear time during the study (Author et al, 2016) or indeed the positive perceptions of the intervention in teachers and pupils (Effectiveness). Positive questionnaire ratings were reported by both pupils and teachers during the intervention and were shown to remain largely stable within classes over time. These findings suggest that repeated exposure to sessions with relatively similar physical appearance remains appealing over the course of a 6-week intervention. This seems to contradict qualitative pilot work (Author et al, 2015c), where teachers warned of a potential limited novelty factor for the intervention. However it must be noted that pupil focus groups revealed less favourable evaluations of sessions, with activities within sessions judged to be somewhat repetitive.

Assessment of the intervention's Adoption showed the sample to be more ethnically diverse and disadvantaged relative to local and national averages, whereas most other physically active lesson interventions have predominantly featured white, middle-class participants (Neelon et al, 2016). Also, the high availability of required technology and potential for online resources was shown to give Virtual Traveller potential as a free-to-access intervention available to all teachers and schools.

Issues identified from process evaluation

Various concerns and required revisions to the Virtual Traveller intervention were identified in this process evaluation. Firstly, two schools (16.7% of those contacted) declined to participate in the study due to time pressures (Reach). This concurs with previous research showing a lack of time to be the primary barrier of physical activity provision in schools (Naylor et al., 2015). To better combat this, future iterations of Virtual Traveller should sell the short length of sessions (10 minutes) and minimal set-up time as positives of the programme. Secondly, participation in Virtual Traveller was restricted to the Greater London area (Reach) for practical reasons, which means outcome and process evaluation findings are unlikely relatable to other contexts. Also, 40% of included schools had 'Healthy Schools' accreditation: reflecting existing healthy practices within schools (Reach). This may have biased the sample as schools already had existing health-related practice and engagement.

Additionally, the suitability of English Virtual Traveller sessions was queried in both quantitative and qualitative evaluation findings (Effectiveness). Pupils and teachers queried the limited range of on-the-spot movements prompted by the sessions. Teacher log ratings showed less positive perceptions and lower implementation of English compared to Maths sessions, with teacher interviews describing physical activity prompts in English sessions as more tenuous. Physically active lessons to date have most commonly been implemented in Maths (Author et al, 2015a; Riley et al, 2015); although reasons for this subject choice have not been explicitly reported. Pilot teacher interviews reported great potential for VFT use across curriculum subjects (Author et al, 2015c), however it is

apparent here that English may not be as immediately suitable to VFT use. Before Virtual Traveller is more widely distributed, adaptations are needed to better integrate activity into English sessions.

Although teacher evaluations were largely positive, analysis of interviews revealed that the enforced technological provision of Virtual Traveller sessions could be problematic (Implementation). Firstly, as noted in qualitative pilot work (Author et al, 2015c), some teachers thought that their peers who were less confident in technology may not choose to implement these sessions or may require additional training. As seen in the Technology Acceptance Model (Venkatesh & Bala, 2008; Venkatesh & Davis, 2000), perceptions of ease-of-use and usefulness are key in predicting prolonged use of technologies, such as classroom technologies here. Unfortunately the existing use of classroom technologies by study teachers was not assessed in this study, which prevents suggestions of technology use and implementation relationships. Secondly, some pupils and teachers felt the technological basis of the intervention had a limited scope, describing a desire to combine Virtual Traveller sessions with non-technological or outdoor-based activities (Effectiveness). A greater variety of sessions beyond PowerPoint alone could help to maintain user interest and extend outcome effects of Virtual Traveller. Finally, although Virtual Traveller was demonstrated to be a low-cost intervention with a low time burden; real-world implementation will also require principal and teacher support, maintained high-quality training and alignment according to individual school goals (Forman et al, 2009; Naylor et al, 2015).

Strengths and limitations

A strength of this process evaluation is its inclusion of mixed method data sources: helping to give a more rigorous assessment of Virtual Traveller (Cresswell, 2014). The use of both quantitative and qualitative data helped to increase the validity and reliability of results and strengthen resulting conclusions. However, a potential researcher-participant relationship effect may have existed in interview and focus group data collection, as they were facilitated by the lead researcher who had also led outcome assessment of the Virtual Traveller intervention (Gibson, 2012). This may have led

pupil and teacher responses to have been overly positive, in aiming to please the familiar researcher. Another weakness is the reliance on teacher self-report via pen-and-paper session logs for important assessment of Implementation. For example, the teacher may have marked the session as completed, although all content may not have been actually delivered. An alternative for future research could be an online log with time-stamped entries to assess when teachers record sessions as delivered. Additionally, although the majority of study participants provided evaluation data, sample sizes were still small. This study provides the first example of a detailed process evaluation for a physically active lesson intervention, developed and structured according to the RE-AIM framework.

Conclusion

Reach of the Virtual Traveller intervention was good, with high participation and low attrition rates. Effectiveness was shown in the positive evaluations of the intervention by pupils and teachers. Mixed results were found for Adoption; although participants were not from representative backgrounds, Virtual Traveller was found to be very affordable for schools. Moderate Implementation rates were found, although this assessment largely relied on teacher self-report. Maintenance of Virtual Traveller was not observed at three month follow-up: suggesting that sustained provision of varied sessions may be required for sustained outcome effects.

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ACCEPTED MANUSCRIPT

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Author Biographies

Dr Emma Norris: Emma is a Research Associate on the Human Behaviour Change Project in the Centre for Behaviour Change. Her PhD, completed at UCL, involved the development and testing of behaviour change interventions to integrate physical activity into primary school teaching. She has research experience in systematic reviews and mixed-methods intervention evaluation. She is interested in using health psychology theory and principles to improve a broad range of public health issues, with specific interests in physical activity and technological interventions.

Prof Sandra Dunsmuir: Sandra is Director of the Educational Psychology Group at UCL where she leads professional doctorate training in educational psychology. She is also programme Co-Director of the UCL postgraduate courses in Cognitive Behaviour Therapy (CBT) for Children and Young People, based at the Anna Freud Centre. As well as being a qualified teacher who has worked in primary and special education, Sandra has extensive experience working as an educational psychologist in four different local authorities in the south-east of England. She continues to practice on a regular basis with children, their families and teachers in delivering CBT interventions in school and community settings.

Dr Oliver Duke-Williams: Oliver is a Senior Lecturer in Digital Information Studies in the Department of Information Studies at UCL, and was previously a Senior Research Fellow at the School of Geography, University of Leeds. His research interests include web-based access to geographic data (including presentation of spatial data, and dissemination of demographic data); disclosure control issues, especially those associated with migration and commuting data, and the past, present and future of census taking and other demographic information capture in the UK. He is interested in spatial visualisation of various kinds of data, and how we can use maps and other visualisation tools to make patterns in data easier to see and understand.

Dr Emmanuel Stamatakis: Emmanuel completed a PhD on physical activity and childhood obesity at the University of Bristol (UK). Between 2003 and 2014 he was based at University College London where he initially led the development and implementation of physical activity measures in large-scale nationwide epidemiological surveillance studies. He was subsequently awarded a Postgraduate Fellowship Award (2007) and a Career Development Fellowship (2011) by the National Institute for Health Research to studying the influence of physical activity, sedentary behaviour, and cardiorespiratory fitness on cardiometabolic and mortality. He joined the University of Sydney as an Associate Professor of Exercise, Health, and Physical Activity in early 2014, currently he is a National Health and Medical Research Council Senior Research Fellow at Charles Perkins Centre and the School of Public Health.

Dr Nicola Shelton: Nicola is the Head of the Health and Social Surveys Research Group. Her research is on health geography, health surveillance and the outcomes that can be measured through large and complex health data sets. She has particular interests in alcohol consumption and physical activity and older people's health and wellbeing. She is the director of CeLSIUS, the Centre for Longitudinal Study Information and User Support of the ONS Longitudinal Study. www.ucl.ac.uk/celsius She is the Director of the new BSc in Population Health <http://www.ucl.ac.uk/bsc-population-health> which started in 2015.

ACCEPTED MANUSCRIPT

Table 1. Process evaluation measures and their fit within the RE-AIM framework

Level	Dimension	Definition	Data collection timeframe	Data collected
Individual	<u>Reach</u>	1. Participation rates among eligible classes 2. Participation rates among eligible pupils 3. Representativeness of participants compared to non-participants	T0 T0 T0	1. Researcher logged 2. Returned consent sheet 3. Returned consent sheet, pupil demographic questionnaires
Individual	<u>Effectiveness</u>	1. Effects on primary physical activity outcome measures 2. Effects on secondary outcome measures of physical activity, on-task behaviour and student engagement outcome measures 3. Perceptions of intervention sessions 4. Perceived physical exertion in intervention sessions	T1-T4 T1-T4 T1-T2 T1-T2	1. Assessed in Author et al, Under Review 2. Assessed in Author et al, Under Review 3. Teacher intervention log, teacher and pupil evaluation questionnaires, teacher interviews and pupil focus groups 4. Pupil evaluation questionnaire (OMNI scale; Robertson et al., 2000), teacher interviews and pupil focus groups
Setting	<u>Adoption</u>	1. Representativeness of participating classes 2. Costs of intervention	T0 T1-T2	1. Pupil demographic questionnaires, teacher demographic questionnaires 2. Researcher reported
Setting	<u>Implementation</u>	1. Extent the intervention is delivered as intended 2. Time required to deliver intervention	T1-T2 T1-T2	1. Teacher intervention log, teacher interviews and pupil focus groups 2. Teacher interviews and pupil focus groups
Both	<u>Maintenance</u>	1. (Individual) Impact of attrition on outcomes 2. (Organisational) Continuation or modification of intervention beyond intervention period	T1-T4 T3-T4	1. Researcher logged 2. Teacher interviews

Table 2. Average ratings from Virtual Traveller pupil evaluation questionnaire

Questionnaire item	Class	T1 (n=103)	T2 (n=98)
Q1. How tired did Virtual Traveller sessions make you? (OMNI scale; Robertson et al., 2000)	Class 2	2.9/11 (1.82)	3.0/11 (2.66)
	Class 5	2.3/11 (1.75)	3.0/11 (2.09)
	Class 6	2.2/11 (1.77)	2.3/11 (2.08)
	Class 7	2.0/11 (2.17)	1.9/11 (1.99)
	Class 10	2.9/11 (1.70)	3.0/11 (2.42)
	Overall	2.4/11 (1.80)	2.7/11 (2.27)
Q2. How much do you like Virtual Traveller sessions?	Class 2	3.5/5 (1.29)	3.9/5 (1.20)
	Class 5	3.9/5 (1.36)	3.6/5 (1.38)
	Class 6	3.7/5 (1.28)	3.4/5 (1.50)
	Class 7	3.9/5 (0.80)	4.8/5 (0.43)
	Class 10	3.4/5 (1.27)	3.8/5 (1.28)
	Overall	3.6/5 (1.23)	3.8/5 (1.31)
Q3. I think Virtual Traveller sessions are fun	Class 2	3.5/5 (1.25)	3.9/5 (1.15)
	Class 5	3.7/5 (1.43)	3.6/5 (1.42)
	Class 6	3.8/5 (1.30)	3.6/5 (1.37)
	Class 7	4.1/5 (0.96)	4.6/5 (0.51)
	Class 10	3.8/5 (1.23)	3.7/5 (1.23)
	Overall	3.8/5 (1.25)	3.8/5 (1.24)
Q4. Virtual Traveller sessions help me learn	Class 2	3.8/5 (1.12)	4.1/5 (1.13)
	Class 5	3.7/5 (1.04)	3.4/5 (1.17)
	Class 6	3.7/5 (1.20)	3.6/5 (1.08)
	Class 7	3.9/5 (0.80)	4.1/5 (1.00)
	Class 10	3.6/5 (1.20)	3.5/5 (1.28)
	Overall	3.7/5 (1.08)	3.7/5 (1.16)

Note: The OMNI scale is an eleven-point scale, ranging from 0 (not tired at all) to 10 (very, very tired); Q's 2-4 are rated on a 5-point Likert scale where 0 = not very much and 5= very much.

Table 3. Virtual Traveller session ratings from intervention group class teachers

Class	M1	M2	M3	M4	M5	M6	M7	M8	M9	Teacher Maths overall rating
2	3	5	4	4	3	2	3	3		3.4/5 (0.92)
5		4	4	5		3			4	4.0/5 (0.71)
6	4	4	4	5	3	3	4	3	5	3.9/5 (0.78)
7		5		5	4				4	4.5/5 (0.58)
10	4	4	3	5	3		3	3	4	3.6/5 (0.74)
Average	3.7/5	4.4/5	3.8/5	4.8/5	3.3/5	2.7/5	3.3/5	3.0/5	4.3/5	3.9/5 (0.42)
Session Rating	(0.58)	(0.55)	(0.50)	(0.45)	(0.50)	(0.58)	(0.58)	(0)	(0.50)	
Class	E1	E2	E3	E4	E5	E6	E7	E8	E9	Teacher English overall rating
2	3	3	5	4	4	3				3.7/5 (0.82)
5	4		3	4					4	3.8/5 (0.50)
6	4	3	3	4	4	2	4	4	4	3.6/5 (0.73)
7	4	3					4			3.7/5 (0.58)
10	4	4		5	4	3		4	3	3.9/5 (0.69)
Average	3.8/5	3.3/5	3.7/5	4.3/5	4.0/5	2.7/5	4.0/5	4.0/5	3.7/5	3.7/5 (0.11)
Session Rating	(0.45)	(0.50)	(1.15)	(0.5)	(0)	(0.58)	(0)	(0)	(0.58)	

Table 4. Average ratings from Virtual Traveller teacher evaluation questionnaire

Questionnaire item	Class	T1 (n=5)	T2 (n=5)
Q1. Virtual Traveller sessions were easy to use	2	3/5	3/5
	5	2/5	3/5
	6	5/5	5/5
	7	4/5	4/5
	10	3/5	4/5
	Overall		17/25
Q2. Virtual Traveller sessions were enjoyable to use	2	4/5	3/5
	5	3/5	3/5
	6	4/5	4/5
	7	4/5	4/5
	10	5/5	4/5
	Overall		20/25
Q3. Since teaching Virtual Traveller, I feel more confident in incorporating physical activity into lessons	2	4/5	5/5
	5	5/5	5/5
	6	4/5	4/5
	7	4/5	4/5
	10	4/5	4/5
	Overall		21/25
Q4. I will continue to add physical activity into my teaching	2	5/5	5/5
	5	4/5	4/5
	6	5/5	5/5
	7	3/5	3/5
	10	4/5	5/5
	Overall		21/25
Q5. I will recommend the Virtual Traveller programme to other teachers	2	2/5	3/5
	5	2/5	3/5
	6	5/5	4/5
	7	3/5	3/5
	10	4/5	4/5
	Overall		16/25
Q6. My pupils have enjoyed Virtual Traveller	2	4/5	4/5
	5	4/5	4/5
	6	5/5	5/5
	7	4/5	5/5
	10	4/5	4/5
	Overall		21/25
Overall		116/150	120/150

Table 5. Comparison of Virtual Traveller demographics with local and national averages (n=219; National Child and Maternal Health Intelligence Network, 2016)

Demographic	Area	Virtual Traveller study	Local average	National average
Ethnic minority	Greater London	47.8% (n=64/134)	71.3%	28.9%
	Berkshire	58.8% (n=50/85)	21.3%	28.9%
Poverty	Greater London	30.6% (n=41/134)	21.8%	18.6%
	Berkshire	30.6% (n=26/85)	13.7%	18.6%
Overweight or obese	Greater London	39.6% (n=53/134)	37.2%	33.2%
	Berkshire	34.1% (n=29/85)	30.1%	33.2%

Notes. Table presents pupils in the analytic sample of outcome data of Author et al, Under Review ; * indicates local area comparison figures are from London; + indicates local area comparison figures are from South East England, ^o indicates poverty identified in the study sample as participants with a net family income <£15,000.

Table 6. Estimated Virtual Traveller costs in real-world implementation for one class

Resources	Unit cost £	Units required	Total cost £
Teacher training			
Researcher-delivered teacher training	£30/hour	1	£30
Printing – teacher guide	£1/guide	1	£1
<i>Teacher training total</i>			<i>£1 - £31</i>
Technology			
Interactive whiteboard ^a	£1,600	1	£1,600
Warranty ^a	£200	1	£200
Projector ^a	£1,500	1	£1,500
Installation and cabling ^a	£340	1	£340
Audio system ^a	£250	1	£250
<i>Technology total</i>			<i>£3890</i>
<i>Teacher training + technology total</i>			<i>£3891-£3921</i>

Notes. ^a represents costings of interactive whiteboard purchases reported by School Business Services (2016)

Table 7. Virtual Traveller sessions delivered in intervention classes

Class	No. of sessions completed	Maths sessions completed	English sessions completed	Sessions repeated
2	n=14 / 18 (77.8%)	n=8 / 9 (88.9%)	n=6 / 9 (66.7%)	n=0 / 18 (0%)
5	n=9 / 18 (50%)	n=5 / 9 (55.6%)	n=4 / 9 (44.4%)	n=3 / 18 (16.7%)
6	n=18 / 18 (100%)	n=9 / 9 (100%)	n=9 / 9 (100%)	n=0 / 18 (0%)
7	n=7 / 18 (38.9%)	n=4 / 9 (44.4%)	n=3 / 9 (33.3%)	n=4 / 18 (25%)
10	n=15 / 18 (83.3%)	n=8 / 9 (88.9%)	n=7 / 9 (77.8%)	n=1 / 18 (5.6%)
Overall	63/90 (70%)	34/45 (75.6%)	29/45 (64.4%)	8/90 (9%)