Learning Environments Research (2021) 24:137–151
https://doi.org/10.1007/s10984-020-09321-2

ORIGINAL PAPER

Effects of using a variety of kinesthetic classroom equipment on elementary students' on-task behaviour: a pilot study

Michelle Flippin[1] · **Emily D. Clapham**[1] · **M. Shane Tutwiler**[1]

Received: 11 March 2019 / Accepted: 16 June 2020 / Published online: 23 June 2020

Abstract
The ability for students to maintain attention to classroom instruction is a critical factor for learning because loss of instructional time due to off-task behaviour has negative impacts on academic achievement. Early studies suggest that use of kinesthetic equipment in place of traditional seating in classrooms can improve student on-task behaviour. To date, however, limitations of the kinesthetic classroom research literature include small sample sizes, often without controls, use of a single equipment type (e.g. standing desks or exercise balls) and lack of objective measures of student on-task behaviour. We report a pilot study of the impact of using a variety of kinesthetic equipment in elementary classrooms on objectively-measured student on-task behaviour.

Keywords Attention · Elementary classrooms · Kinesthetic classroom · Off-task behaviour

Introduction

An integral component of learning is the ability for students to maintain focused attention on instruction. However, it is estimated that children in elementary-education classrooms spend between 10 and 50% of their time off-task (Baker 2007; Lee et al. 1999). Sustaining attention to instruction requires that students successfully process and filter meaningful signals from distractions (Posner and DiGirolamo 1998). Students' ability to regulate behaviour, persist on difficult tasks, ignore distractions, follow classroom rules, inhibit inappropriate behaviour and attend to classroom activities reflect their executive functioning (Blair and Diamond 2008). Executive function skills include attention shifting, working memory and inhibitory control, or the ability to ignore certain stimuli while attending to others, which is a particularly important prerequisite for young children's learning as on-task behaviour is strong predictor of academic outcomes (Berlin and Bohlin 2002). In contrast, engagement in off-task behaviours is an indicator that a student's attention is not focused on instructional activity and is negatively associated with academic achievement (Posner and DiGirolamo 1998).

✉ Michelle Flippin
mflippin@uri.edu

[1] Department of Communicative Disorders, University of Rhode Island, 25 West Independence Way, Kingston, RI 02881, USA

For school children, one factor that can influence on-task behaviour in classrooms is extended periods of sitting. Currently, it is estimated that U.S. children spend 4.5 h of the school day sitting (Rideout et al. 2010). High levels of sedentary time are linked not only to poorer health outcomes, but also to poorer academic performance (Mitchell et al. 2012; Tremblay et al. 2011). In contrast, positive associations between physical activity and executive function skills and academic performance are well documented in the literature (Alvarez-Bueno et al. 2017; U.S. Department of Health and Human Services 2010; Van der Niet et al. 2015). Given these associations, physical activity interventions have been utilised to increase students' on-task behaviour. In examining effects of physical activity interventions on student on-task behaviours, researchers have demonstrated that increased on-task behaviour is associated with: physical activity programs implemented before and after school (Davis et al. 2011; Mulrine et al. 2008); physical activity breaks during school (Reilly et al. 2012; Schmidt et al. 2016); and physically active lessons (Bartholomew and Jowers 2011; Erwin et al. 2009; Kibbe et al. 2011; Mullender-Wijnsma et al. 2016). Despite positive outcomes of various physical activity interventions on student attention, behaviour and academic performance, there are several barriers to effectively and widely implementing these programs. For example, programs that take place before and after school require resources and staffing. In addition, teachers have reported drawbacks to using physical activity breaks within the classroom and physically-adapted lessons, including limitations in time to target academic goals, support from schools, resources and teacher training (Benes et al. 2016).

In comparison to these approaches, fitting classrooms with kinesthetic equipment can offer several practical advantages for teachers and administrators aiming to increase student on-task behaviour. Use of kinesthetic equipment can incorporate and increase movement in the classroom by replacing traditional desks and chairs with seating options (e.g. stools, balls, standing desks, pedals) that allow students to students engage in various motion activities during class. After initial set up, use of kinesthetic equipment in classrooms is relatively easy to implement because it requires minimal training, modification of instruction or reduction of instructional time (Dornhecker et al. 2015; Koepp et al. 2012). Thus, ease of use can make kinesthetic classrooms feasible for many schools.

Kinesthetic equipment interventions and on-task behaviour

A growing body of evidence suggests that use of kinesthetic equipment in classrooms can reduce sedentary time and have beneficial effects on both student health and learning outcomes (Tremblay et al. 2011). For example, stand-biased desks can have positive effects on learning outcomes for middle- and high-school students (Minges et al. 2016). In a randomised controlled trial, when Mehta et al. (2015) used imaging measures to examine the neurocognitive benefits of using stand-biased desks with a sample of high school students, left frontal lobe activation and improved working memory capabilities executive function skills were found. Benefits of using standing desks in classrooms have also been documented for elementary students. In a large study of students in grades 2–4, 158 students in classrooms fitted with standing desks had higher levels of academic engagement during observations at two time points (fall and spring semesters) compared with 124 students in control classrooms fitted with traditional desks (Dornhecker et al. 2015). Taken together, emerging evidence suggests that use of standing desks in classrooms is a promising intervention for potentially increasing student on-task behaviour and learning outcomes. Compared with results of studies with standing desks, results for the impact of using exercise balls on student academic outcomes have been mixed.

In examining student on-task behaviour in classrooms, three single-subject studies have shown that use of exercise balls improved the in-seat behaviour of children with ADHD and preschool students with autism spectrum disorders (Fedewa and Erwin 2011; Schilling et al. 2003; Schilling and Schwartz 2004). Similarly, in a nine-month randomised control trial, Fedewa et al. (2015) noted a downward trend in disruptive behaviours among students in two treatment classrooms fitted with stability balls when compared with students in control-group classrooms fitted with traditional chairs. However, levels of student on-task behaviour and achievement were similar across both treatment and control groups. The researchers suggested that students who began the intervention with few learning or behavioural impairments might not benefit from stability ball use to the same degree as students with academic or behavioural challenges. In a study of the behaviours of subsample of 8 children (out of 43) who used stability balls in 4th grade classrooms, Erwin et al. (2016) also found no effect of stability ball use for students' on-task behaviour in general education classrooms. In contrast, other studies of the impact of dynamic seating on student attention have largely suggested that use of stability balls in classrooms can improve attention among elementary-school students, both with and without attention and hyperactivity concerns (Eggen and Kauchak 2004; Fedewa and Erwin 2011; Gaston et al. 2016). Collectively, these findings highlight the need for continued research into the impact of kinesthetic equipment use on students' learning outcomes, and highlight several important gaps in our understanding of the potential benefits of kinesthetic classrooms on students' on-task behaviour.

One limitation is that, with few exceptions, studies of kinesthetic equipment use with elementary-school children have involved single-case designs or studies with small sample sizes (less than 10) and without control groups. In a recent review, Rollo et al. (2018) highlighted the need for larger studies, randomised control trials, alternating treatment, or multiple baselines to improve the rigour of kinesthetic classroom experimental designs (Rollo et al. 2018). In addition, studies have primarily examined outcomes associated with use of a single type of equipment (e.g. stand-biased desks or exercise balls). However, in elementary-school learning environments, students often transition from sitting on a rug to working at desks and stations, both individually and in groups, and thus require a variety of seating options throughout the day. Identifying the effects of utilising a variety of equipment options on student on-task behaviour could be beneficial for understanding the feasibility and validity of more widely implementing kinesthetic classrooms in elementary schools. Finally, in the kinesthetic classroom literature to date, measurement of student off-task behaviours has primarily been conducted via teacher ratings. However, direct observations of classrooms can provide more reliable and valid measures of student on-task behaviour (Rollo et al. 2017). Overall, despite limitations of the current literature, an emerging body of evidence suggests the benefit of using kinesthetic equipment in elementary classrooms for improving student behaviour and attention (Rollo et al. 2018). Modifying student behaviour through changes to classroom design has the potential to greatly enhance learning by increasing student on-task behaviour during academic instruction. Understanding the rates and types of off-task behaviour associated with using a variety of equipment with elementary students is an important next step in examining student outcomes associated with kinesthetic classrooms.

Study purpose

This pilot study aimed to add to the limited research into the potential impact of a kinesthetic equipment intervention on short-term learning outcomes for elementary students. Specifically, this study aimed to answer the following questions. First, does student on-task behaviour increase during kinesthetic equipment phases compared with baseline and withdrawal phases? Second, does student on-task behaviour change across use of various kinesthetic equipment types? Third, are there changes in types of student distractions during kinesthetic equipment phases compared with baseline and withdrawal phases?

Methods

Participants and setting

In this pilot study, a kinesthetic classroom intervention was implemented with a convenience sample of three grade 2 classrooms in an elementary school in a New England suburb. After securing IRB approval, parent permission, child assent and teacher consent, we recruited a total of 47 students (24 females, 23 males) in three classrooms and their three teachers in a single elementary school in a northeastern suburb. Of these, 87% were White, 7% African American, 2% Hispanic, 2% Asian and 2% Native American. Twelve students (26%) received subsidised lunch, one student was an English Language Learner and seven students (15%) had an Individualised Education Plan (IEP). Demographic data for student participants is are provided in Table 1.

Procedures

The effects of utilising a kinesthetic classroom on student time on-task were examined during a five-week intervention using an ABAB withdrawal design. During baseline and

Table 1 Demographic information for participating students

Demographic variable	*N*	%
Gender		
Male	23	49
Female	24	51
Race/ethnicity		
African-American	3	7
Asian	1	2
Caucasian	41	87
Hispanic	1	2
Native American	1	2
FRPL	12	26
ELL	1	2
IEP	7	15

FRPL Free/Reduced-Price Lunch, *ELL* English Language Learner, *IEP* Individualised Education Plan withdrawal weeks (i.e. weeks 1, 3) students used standard classroom desks, tables and chairs in the existing classroom design. During intervention and generalisation weeks (i.e. weeks 2, 4, 5), classrooms were fitted with kinesthetic equipment. The three grade 2 teachers in this school utilised a team approach for instruction, with one teacher teaching Science, one teacher teaching Mathematics, and another teacher teaching English and Social Studies. The existing team-teaching schedule required students to switch classrooms to receive their lessons from the appropriate teacher. To address this potential confounder, data were collected and analysed at the level of individual students rather than by teacher or classrooms, and all three grade 2 classrooms were fitted with identical kinesthetic equipment.

Kinesthetic classroom equipment

During intervention weeks, each classroom was fitted with five types of kinesthetic equipment (i.e. exercise balls, standing desks, kneel-and-spin desks, under desk pedals, and bouncy bands). Descriptions of the types and number of kinesthetic equipment pieces used in each of the three sampled classrooms are provided in Table 2. Equipment was chosen based on the following criteria: cost, ease of application, ease of assembly. In addition, researchers attempted to offer options to vary physical movements (e.g. standing, balancing, kneeling, kneeling and spinning, sitting and cycling), as these movements are common for children throughout the day (Reilly et al. 2012). Finally, the variety of equipment was selected in order to allow give teachers and students flexibility to use equipment in multiple classroom spaces throughout the day (e.g. classroom rug, desks, individual desks, tables/workstations).

Behavioural coding and reliability

Student engagement in on-task and off-task behaviours was coded during systematic classroom observations. Interval sampling was chosen to allow us to collect data on multiple behaviours (e.g. on/off-task behaviours, equipment type) that might not have a clear beginning or ending (Barlow et al. 2009). Students were observed using a round-robin strategy in which children wore assigned numbers on front and back of their shirts to allow easy identification by observers. Children were observed in order of ascending shirt numbers. Coders conduced in vivo observations of classroom behaviours using Noldus Pocket Observer software loaded onto a Samsung tablet platform. At the start of each coding interval, Pocket Observer generated an audio signal to begin the observation. After hearing the audio prompt, coders observed the target student, coded behaviours and then waited for the audio signal to code the next student in the established order. The first unambiguous

Table 2 Kinesthetic equipment used in each classroom

Kinesthetic equipment	Pieces per classroom
Exercise balls	5
Stand-biased desks	3
Kneel and spin desk	1
Standard desk and chair fitted with under desk pedals	5
Standard desk and chair fitted with bouncy bands	5

behaviour observed during the 20-second period was recorded. Coders then cycled through the class in established order until the end of the observation was reached.

For each observed interval, coders first classified children's behaviour as on-task or off-task. Children were coded as on-task if they were either looking at the teacher or following instructions (e.g. writing, reading, completing worksheets). If children were neither looking at the teacher nor otherwise engaged with the expected instructional task, the child's behaviour was coded as off-task and the type of distraction was entered (i.e. self-distraction, peer distraction, environmental distraction, supplies, walking, other). Finally, coders selected either the type of kinesthetic equipment used by the student (i.e. exercise ball, standing desk, kneel-and-spin desk, pedals, bouncy bands) or recorded 'no equipment' for intervals in which students were not actively using equipment (e.g. seated on rug).

Off-task behaviour distraction types

The distraction types that were coded in the current study were adapted from classroom off-task observation methods outlined by Ocumpaugh et al. (2012). Six mutually-exclusive categories of off-task behaviour were coded: Self-distraction, Peer distraction, Environmental distraction, Supplies, Walking and Other. Distraction types are described in Table 3.

Reliability

The primary coder, an undergraduate student in communicative disorders, was blind to the research questions and hypotheses. The secondary coder was the first author. Coders trained to 80% reliability on each behavioural code on practice observations. Thirty observations were completed (two observations per week for each of the three classroom) over 5 weeks of the study. For nine observations (30% of sessions), student behaviours were independently coded by both coders and results were compared. Intraclass correlations (ICCs) for coded variables were as follows: on task behaviour (ICC = 0.95; 95% CI [0.91, 0.96]); distraction type (ICC = 0.94; 95% CI [0.87, 0.98]); and kinesthetic equipment type (ICC = 0.91; 95% CI [0.86, 0.93]). The lower bounds of the confidence intervals for the ICC values were uniformly above 0.80 for each coded variable, which exceeds the ICC value of 0.70 suggested for acceptable reliability (Mitchell 1979).

Table 3 Off-task distraction types

Off-task distraction type	Definition
Self distraction	Student engages with something on own body or clothing (e.g. shoe laces, tugging on shirt, picking at fingers)
Peer distraction	Student looks at, talks with or touches another student when not directed to do so
Environmental distraction	Student looks at something in classroom other than teacher or focus of instruction (e.g. looks across room or out window)
Supplies distraction	Student inappropriately uses any object part of the assigned task (e.g. playing with a pen or pencil)
Walking distraction	Student walks around classroom when not considered appropriate for the task
Other	Student behaviour that is not on-task but does not clearly align with other categories

Plan for data analyses

To answer our research questions, we first estimated the proportion of student time on-task by dividing the number of on-task observations by the total number of observations during a given week:

$$P_{timeontask} = \frac{n_{ontask}}{\left(n_{ontask} + n_{offtask}\right)}$$

We then examined the average proportion of time on task across the baseline and withdrawal weeks (1 and 3), as well as the intervention and generalisation weeks (2, 4 and 5). Due to the non-random nature of our sample and non-normality of observed patterns of on-task behaviour across weeks, we tested for differences in mean proportions of time on-task using a permutation-based non-parametric Wilcoxon-Pratt sign-ranked test (Ernst 2004). Statistically significant ($p<0.05$) results from these analyses can be interpreted as a low probability that the observed differences were attributable to chance observations between the two weeks being compared. For the existing school schedules, grade 2 students rotated between classrooms and teachers, so that data were not nested in classrooms but analysed at the level of individual students. All analyses were conducted in the R statistical programming language (R Core Team 2018), with permutation-based tests specifically conducted in the *coin* package (Torsten-Hothorn et al. 2008). Results of data analysis procedures are described relative to each of the research questions below.

Results

Results of the descriptive analysis showed that, during the baseline week, students were on-task for 60% of the time. In week two (intervention phase), students were on-task for 75% of the time (89% of the time when only looking at instances of equipment use). In week three (withdrawal phase), students were on-task for 65% of the time. In week four (intervention phase), students were on-task for 82% of the time (95% when only looking at instances of equipment use). In week five (maintenance phase), students were on-task for 87% of the time (92% when only looking at instances of equipment use). Table 4 presents the proportion of on-task time across study weeks/phases.

Student on-task time for baseline versus intervention phases

Differences in the proportion of student on-task behaviour between baseline (week 1) and the first intervention (week 2, $z=-2.81$, $p=0.00$), second intervention (week 4, $z=-4.16$,

Table 4 Percentage of student on-task time by study week and phase

On-task time	% on-task time				
	Week 1	Week 2	Week 3	Week 4	Week 5
	Baseline	Intervention	Withdrawal	Intervention	Maintenance
All intervals	60	75	65	82	87
Equipment only intervals	–	89	–	95	92

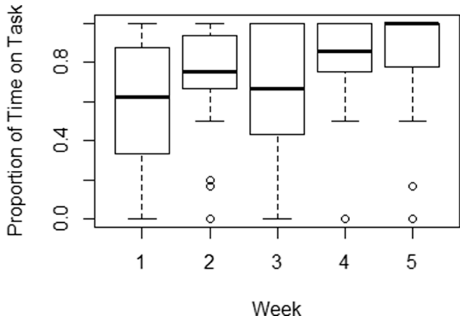

Fig. 1 Proportion of student on-task time (equipment and no equipment) in intervention and maintence phases (weeks 2, 4, 5)

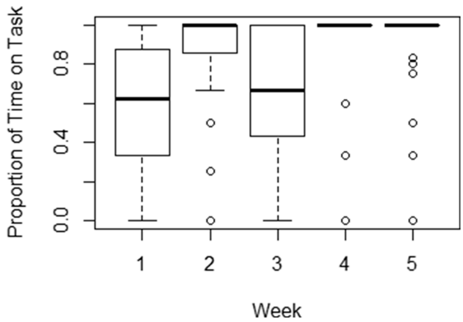

Fig. 2 Proportion of student on-task time with active equipment use during intervention and maintenance phases (weeks 2, 4, 5)

$p = 0.00$) and the generalisation week (week 5, $z = -3.84$, $p = 0.00$) were all statistically significantly different in the observed sample, with students demonstrating a lower proportion of on-task behaviours in the baseline week. Differences between week 1 and 3 (i.e. baseline and withdrawal phases) were not statistically significantly different for this sample ($z = -1.08$, $p = 0.28$). Figure 1 depicts proportion of student time on-task across all study phases.

Student on-task time during active equipment use

Permutation-based Wilcoxon-Pratt signed-rank tests were used to examine differences in students' proportion of on-task time, limited only to intervals in which students were coded as actively using kinesthetic equipment in the classrooms (e.g. sitting on ball). Intervals in which students were not actively using kinesthetic equipment (e.g. sitting on classroom rug) were not included in the analysis. Differences in the proportion of time when students were on-task during active equipment use, compared with baseline, was also statistically significant. Moreover, the proportion of time on-task during active equipment use was larger than time on-task during intervals when children both did and did not actively use kinesthetic equipment ($z_{1-2} = -4.19$, $p = 0.00$; $z_{1-4} = -4.73$, $p = 0.00$; $z_{1-5} = -4.43$, $p = 0.00$). Figure 2 presents the proportion of student time on-task for intervals when students were actively using equipment.

Table 5 Percentage of student on-task time for different kinesthetic equipment types during different intervention phases

Equipment	Week 2		Week 4		Week 5	
	%	*n*	%	*n*	%	*n*
Bouncy bands	58.9	92	71.8	110	78.7	85
Exercise balls	88.7	55	92.5	37	93.9	77
Kneel/spin desks	100	8	100	9	100	7
Pedals	91.8	67	100	30	95.8	46
Stand-biased desks	86.7	39	96.2	25	94.3	33

Cells are %, (N)

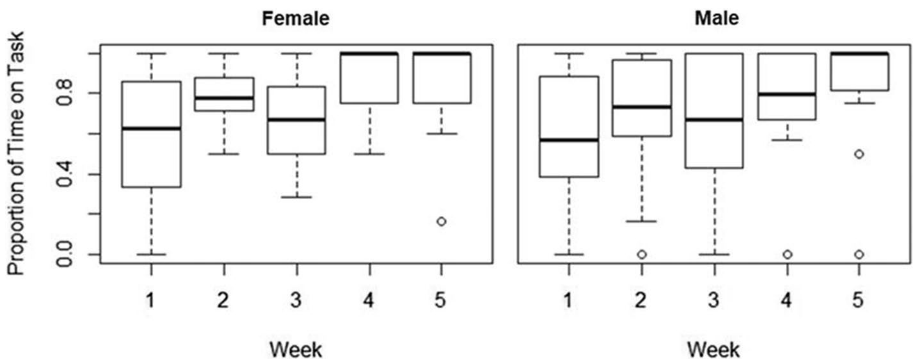

Fig. 3 Proportion of student on-task time (equipment and no equipment) in intervention and maintenance phases (weeks 2, 4, 5) for girls (left) and boys (right)

Student on-task time by kinesthetic equipment type

Descriptive summaries were used to examine proportion of student on-task time according to equipment type (i.e. stand-biased desk, exercise ball, bouncy bands, pedals, kneel-and-spin desk). Table 5 describes the proportion of student on-task time by equipment type. With four kinesthetic equipment types used in the study (i.e. balls, pedals, stand-biased desks, kneel-and-spin desk), the average proportion of student on-task time was over 90%. In contrast, with use of bouncy bands, the average proportion of student on-task time was 69.8% across equipment weeks.

Post-hoc analysis of results by gender and free/reduced-price lunch

In a series of post hoc analyses, we graphically explored the stability of these trends across gender and free/reduced-price lunch (FRPL) status. Null hypothesis significance testing was not appropriate given the reduced sizes of these subsamples. In Fig. 3, the proportion of time on task was higher, in general, during implementation (weeks 2 and 4) and generalisation (week 5) periods for both girls (left plot) and boys (right plot) in the sample. On-task trends for students actively engaged in equipment use were also robust across gender (Fig. 4).

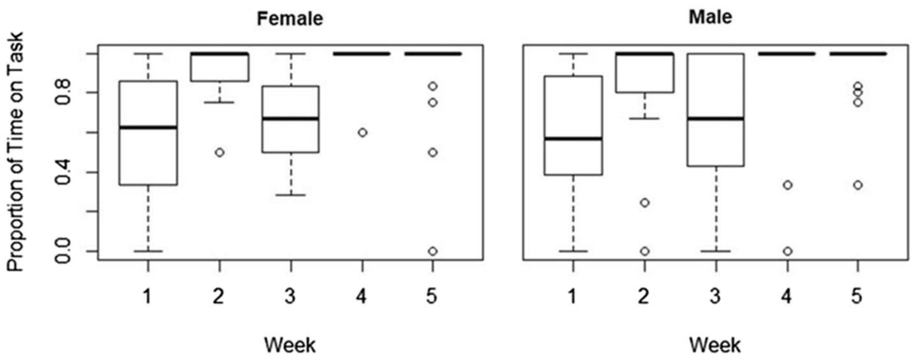

Fig. 4 Proportion of student on-task time with active equipment use in intervention and maintenance phases (weeks 2, 4, 5) for girls (left) and boys (right)

General trends in increased proportions of on-task times during implementation (weeks 2 and 4) and generalisation (week 5) phases also held for students who both are (Fig. 5, left plot) and are-not (Fig. 5 right plot) eligible for free/reduced public lunch (FRPL) eligible. This is true even when we examine active student use of equipment during implementation and generalisation weeks (Fig. 6).

Student distraction types by intervention phases

Overall, large reductions in the frequency of total distractions were seen from baseline ($n=132$) and withdrawal weeks ($n=91$) weeks compared to intervention (weeks 2, $n=83$; week 4, $n=47$) and maintenance ($n=36$) weeks. Comparing maintenance to baseline levels, the largest reductions in distraction by type were found for peer distraction, supplies distraction, walking, environmental distraction and other distraction, respectively. In contrast to reductions in these five types of distractions, small increases were found in the frequency and proportion of self-distractions from baseline levels ($n=6$, 5%) across intervention week 2 ($n=28$, 34%), intervention week 4 ($n=11$, 23%) and maintenance ($n=17$, 47%). The frequency and proportion of distractions by type and intervention phase are described in Table 6.

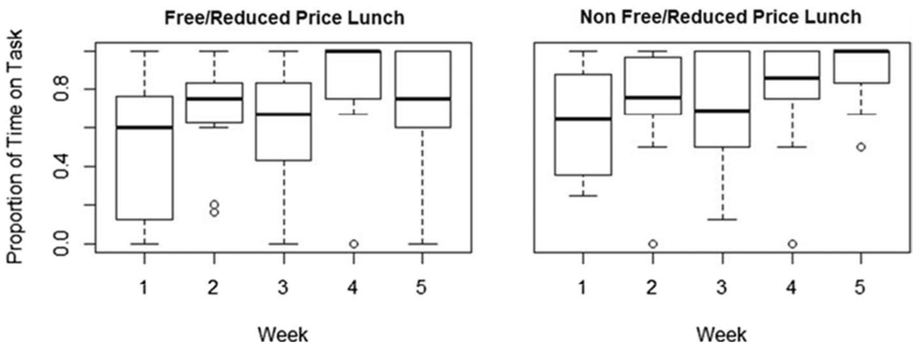

Fig. 5 Proportion of student on-task time (equipment and no equipment) in intervention and maintenance phases (weeks 2, 4, 5) for FRPL (left) and non-FRPL (right) students

Fig. 6 Proportion of student on-task time with active equipment use in intervention and maintenance phases (weeks 2, 4, 5) for FRPL (left) and non-FRPL (right) students

Table 6 Frequency and percentage of student distraction types by study weeks and phases

Distraction type	Week 1		Week 2		Week 3		Week 4		Week 5	
	Baseline		Intervention		Withdrawal		Intervention		Maintenance	
	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*
Self distraction	5	6	34	28	16	15	23	11	47	17
Peer distraction	41	54	18	15	30	27	17	8	31	11
Environmental distraction	16	21	20	17	26	24	38	18	14	5
Supplies distraction	22	29	17	14	13	12	6	3	0	
Walking	15	20	8	7	12	11	15	7	8	3
Other	2	2	2	2	2	2	0	0	0	
Total	100	132	100	83	100	91	100	47	100	36

Discussion

Positive associations between physical activity and student on-task behaviour have been well documented in the literature and emerging evidence suggests that use of kinesthetic equipment also could be associated with increased on-task student behaviour. To date, however, studies of effects of kinesthetic equipment use with elementary students often have been small and without experimental controls. Moreover, studies have tended to focus on one or two types of kinesthetic equipment (e.g. stand-biased desks or exercise balls) and outcome measures have been teacher ratings rather than direct observations of student on-task behaviour (Rollo et al. 2018). To begin to address these limitations in the kinesthetic classroom literature, the current pilot study used direct observations of student behaviour to examine the extent to which elementary students' ($n = 47$) on-task behaviours are related to use of a variety of kinesthetic equipment in three grade 2 classrooms.

Use of kinesthetic equipment was associated with significant increases in the proportion of students' time on-task during equipment weeks compared with baseline and withdrawal weeks, a finding which held across both student gender and FRPL status. In baseline and withdrawal weeks (i.e. without kinesthetic equipment) students were on-task 65% and 60% of the time, respectively. The proportion of off-task behaviour found in this study is consistent with other studies of off-task behaviour among elementary students (Baker 2007). During intervention phases, students in the sample spent significantly more time on-task and less time distracted. Moreover, after limiting analysis to intervals when students actively used kinesthetic equipment, differences between proportion of student on-task time between baseline and intervention weeks were even larger. Overall, results demonstrated a positive relationship between students' use of kinesthetic equipment and on-task behaviour, with a stronger relationship during active equipment use. These findings extend the results of impact for kinesthetic equipment in elementary classrooms.

Interestingly, effects of increased student on-task time were found for intervention weeks during intervals when students were actively using equipment (e.g. sitting on ball) and also when students were not actively using kinesthetic equipment (e.g. sitting on classroom rug). This suggests that having opportunities to use kinesthetic equipment throughout the day could improve students' on-task behaviour even if equipment is not continuously used throughout the day. Although future research is needed to confirm this hypothesis, this finding is potentially important for determining the feasibility of kinesthetic classroom interventions. For example, teachers interested in implementing kinesthetic equipment in classrooms might be concerned that, to be effective, students need to use the equipment continuously throughout the school day. Future research is needed to identify optimal dosage and timing for kinesthetic equipment use for elementary students.

In addition to overall effects of kinesthetic equipment, we also investigated differences in student on-task behaviour according to equipment type. To date, studies of kinesthetic equipment in classrooms have focused primarily on the use of stand-biased desks or stability balls. However, elementary students might need more flexibility for various pedagogical activities and various student groupings. With four out of the five kinesthetic equipment types used in the study (i.e. balls, pedals, standing desks, kneel-and-spin desk), the proportion of student on-task time during active equipment use was over 90%. The finding suggests that use of several types of kinesthetic equipment could have similar effects on student on-task behaviour. In contrast to student on-task time during use of other kinesthetic equipment (i.e. standing desks, kneel-and-spin desks, exercise balls, pedals), students' proportion of time on-task while using standard classroom chairs fitted with bouncy bands was similar to proportion of on-task time during baseline and withdrawal phases. One explanation for the relatively smaller effects with this equipment type might be that the addition of bouncy bands to standard classroom chairs did not provide students with greater opportunity for movement or sensory input over and above using standard classroom chairs alone.

Finally, when investigating the effects of kinesthetic equipment use on student distractions, and consistent with increases in student time on-task, decreases were found in total frequency of distractions for intervention and maintenance weeks compared with baseline and withdrawal weeks. In examining student distractions by type, the largest reductions in frequency and proportion of distractions were found for peer distractions (i.e. student looks at, talks with or touches another student when not directed to do so) and supplies distractions (i.e. student inappropriately uses any object part of the assigned task (e.g. playing with a pen or pencil). In contrast to reductions across all other distraction types, small increases were noted in the frequency and proportion of student self-distractions (i.e. student engages with something on own body or clothing such as shoe laces, tugging on shirt, picking at fingers) for intervention weeks compared with baseline and withdrawal weeks. One possible explanation for findings of small increases in self-distractions associated with equipment use might be that, compared with traditional desks and chairs, use of kinesthetic equipment led to greater awareness of and/or need to adjust clothing, shoes, hand placement, etc. Findings of reductions across most coded distraction types (i.e. peer, supplies, walking, environment, other) and increases in one type of distraction (i.e. self-distractions) are interesting and warrant future research into potential differential effects of kinesthetic equipment use in classrooms on types of student distractions. Taken together, findings from this pilot study support the need for more-refined studies to identify the relative effectiveness of various equipment types for elementary student on-task behaviour.

Limitations and future directions

Results from this study provide preliminary evidence of significant increases in elementary students' on-task behaviours with use of kinesthetic equipment in classrooms. Several limitations of the present study must be highlighted. The first limitation was the small sample size ($n=47$) of grade 2 students drawn from a single elementary school. Students who participated in this study could differ in important ways from students in other schools who do not participate in research. Studies with larger samples of students across multiple grade levels and schools are warranted. Second, although use of variety of equipment with elementary students supported the ecological validity of this study, more-refined studies are now needed to identify optimal equipment and dose for elementary students. Additional research also is needed into whether physical education classes might have an impact on the effectiveness of kinesthetic equipment in terms of student behaviour in elementary classrooms. Finally, in this pilot study, we measured student on-task and off-task behaviours over a short time period (i.e. five weeks), but the impact of kinesthetic equipment use on academic performance across the school year was not assessed. Future research with larger samples is needed to determine the effects of using kinesthetic equipment on long-term academic performance for elementary students. Despite these limitations, results provide important early empirical support for continued investigations into associations between the use of kinesthetic equipment and the on-task behaviours of elementary school students. Continued investigation of this research might have strong implications for policy makers, public health professionals and school administrators when considering simple and sustainable interventions to increase student on-task behaviour and academic performance.

Conclusion

Results of this pilot study suggest that use of a variety of kinesthetic equipment in classrooms can be effective for increasing on-task attention for elementary-school students. The proportion of student time on-task significantly increased with use of kinesthetic equipment, and effects were larger for intervals when students were actively using equipment. Reductions in frequency of student off-task behaviours were found for five of the six coded distraction types (i.e. peer distraction, supplies distraction, walking, environmental distraction, other distraction). However, small increases were noted in student self-distractions during phases with kinesthetic equipment use. Findings are potentially important for teachers and schools considering the use kinesthetic equipment in elementary classrooms. Although research is needed with larger populations over longer time periods, these early findings suggest modifications to the classroom seating environment, that allow students more opportunities for movement within the classroom, can be a worthwhile addition to other interventions that improve on-task behaviours for elementary students.

Acknowledgements We thank Cassidy Cabral, Kara Penney and the participating teachers, students and administrators for their support of this project.

Compliance with ethical standards

Conflicts of interest The authors declare no conflicts of interest.

Ethical standard All procedures involving human participants were completed in accordance with the ethical standards of the URI Institutional Review Board.

Informed consent Informed consent was obtained from all individual participants included in the study.

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