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ABSTRACT

Overweightness continues to increase at an exponential rate in children. This coupled with the demand to increase academic time in elementary schools has contributed to efforts to discover solutions that meet both challenges. Potential solutions are movement curricula and active seating options. However, little has been published relative to best practices of their implementation. Therefore, the purpose of this paper is to discuss the lessons learned while utilizing pedal desks in first and second grade classrooms as stations and whole class seating. Additionally, two different types of heart rate monitors (Polar Oh1 and IHT Spirit) were employed, in an attempt to increase pedaling consistency. It was discovered that elementary students can engage adequately in academic lessons while seated at pedal desks and that limitations do exist relative to the usefulness of the pedal desks. Teachers were also able to develop protocol that adequately maintained classroom management and student learning.

1. Introduction

Globesity is arguably the most significant public health issue facing our world (WHO, 2016) as 43 million preschool children are overweight or obese and 92 million more are at risk of becoming overweight (Onis et al., 2010). The rate of obesity prevalence in the US has more than tripled since 1980 for those, ages 2–19 (Ogden et al., 2010). The consequences of overweight and obesity increase individual health risks such as high blood pressure, type 2 diabetes, risk for cancer, stroke and arthritis (Singh et al., 2008) but also include decreased academic performance and increased depression (Castelli et al., 2007).

The purpose of this article is to highlight the need to incorporate activity into the general education classroom. The secondary purpose of this article is to share implementation strategies for active seating options in primary classrooms. The article will share cues and benefits and challenges to consider when choosing active seating stations.

Sedentary behavior is a major factor impacting childhood obesity (Benes et al., 2016). Children and adolescents are encouraged to participate in a minimum of 60 min of physical activity per day for optimal health, basic wellness practices, and weight management. However, adolescent sedentary time continues to rise throughout the US (CDC, 2012). The Youth Risk Behavior Survey (YRBS) conducted by the Centers for Disease Control, reports 13.8% of students in grades 9–12 did not participate in any activity within the seven days prior to the survey while a mere 49.5% reported they were physically active five or more days within the past week (2012).

Because children spend a majority of their time at school, the educational setting has been identified as a prime environment to promote healthy eating patterns as well as regular physical activity (IOM, 2013; Lagarde et al., 2008; Pate et al., 2006). Schools are second, only to family, relative to influence on children's social, emotional, physical and cognitive development (Benes et al., 2016). Unfortunately, the majority of the school day is inactive and sedentary in nature, despite the research encourages the infusion of movement for increased cognitive development (Benes et al., 2016; CDC, 2010; Mellecker et al., 2013; Robert Wood Johnson Foundation, 2009).

As Medina (2014) stated, movement could be considered “cognitive candy”. It has been found through research that physical activity can improve reading and math scores, overall academic success, on-task time, focus, positive learning experiences, and longer duration of concentration (CDC, 2010; Mellecker et al., 2013). In 2005, Hannaford discovered children's brains were most engaged when they were active and many other researchers support these findings by noting the part of the brain that processes movement is also the same that processes learning (Hannaford, 2005; Stevens-Smith, 2016). Researchers have argued that current education practices should be reformed to increase movement in the classroom thereby increasing cognitive gain, but also decreasing sedentary behavior and tipping the obesity “scale” back in the healthy direction (Medina, 2014; & Sattelmair and Ratey, 2009).

Movement in the classroom as well as the overall fitness levels of children does have an impact on academic achievement. Activity breaks have been found to improve cognitive performance (Bartholomew and

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Jowers, 2011; CDC, 2010; Hill et al., 2010). Donnely and Lambourne (2011) found physically active lessons (moderate intensity) improved performance on standardized tests by six percent compared to the sedentary controls. Researchers have found a significant positive correlation between standardized test scores and fitness levels in language arts and math (Blom et al., 2011) as well as significant improved test scores for grades 3–6 specific to reading and math (Wooten Green, 2016). Furthermore, sacrificing physical education (PE) or physically active time for students does not improve academic performance (Sattelmair and Ratey, 2009).

Three potential solutions to increase student movement in the classroom are kinesthetic seating options, active based learning (ABL) and activity breaks. The kinesthetic classroom is one where traditional seating options are limited or obsolete. Teachers swap traditional seating options for standing, have more core engaged seating options (physioballs or wobble chairs) instead of traditional chairs or desks, or use even more active learning stations (tread desks, pedal desks, strider desks) where students can channel their movement without distracting their peers or detracting from the learning process.

Active Based Learning techniques are intentionally designed teaching strategies implemented by the teacher to help students learn through movement. Classrooms may still include traditional seating options however, teachers create brain-body connections through regular and intentional movement opportunities. Examples may include task teaching with stations, hands on student activities where students are learning skills (CPR), role playing various scenarios, or having students create shapes or follow patterns physically (see Figures 1, 2, 3, 4, and 5).

Activity breaks can simply be a set time where students have the option to move. Students may have the option to exercise within their target heart rate zone but do not have to exert themselves for physical or mental benefit. Teachers may opt to take students outside or choose videos from Youtube or GoNoodle or can self-direct activity.

Benes et al. (2016) found that teachers are knowledgeable about the health and cognitive benefits of adding movement to the classroom, yet teachers are hesitant to do so. Some reasons listed include; lack of implementation knowledge, lack of support from within the school, lack of ability to explain the research supported neurological connections, and nervousness concerning student "buy-in". Many teachers also reported a

Figure 1. First grade classroom organization/set-up.

Figure 2. Second grade classroom organization/set-up.

negative past experience with physical education, which in turn, reduced their desire to incorporate physical activity into their content area (Clayton, 1999; Linker and Woods, 2018). Teachers with less teaching experience were more positive about shifting their teaching and planning styles compared to veteran teachers (Benes et al., 2016). Finally, teachers reported a lack of awareness and confidence in adding active learning strategies to their lessons and therefore simply continue their traditional teaching style (Benes et al., 2016; Linker and Woods, 2018).

There are many options to choose from which are referred to as "Active Seating" for elementary and secondary students. These products include but aren't limited to pedal desks, stepper desks, strider desks, stability balls, wobble chairs, tread desks, standing desks and balance boards. Despite the fact that students do not maintain an intensity level normally associated with exercise, active seating options require students to engage their core, trunk, legs, and brain in a conscious manner (Zipes, 2005). According to Medina (2014) movement, even in the classroom setting, connects neural pathways between the cerebellum and prefrontal cortex. This increase in synapse efficiency leads to improved reading and math, improved student attention and focus, and student enjoyment (Medina, 2014). Standing work stations for school-aged children have been found to reduce sitting time and also increase caloric expenditure (Benden et al., 2011; Blake et al., 2012). Blake et al. (2012) also reported that parents and teachers reported that kids were more attentive and focused even though students had the option to stand or sit at their traditional desk. Stability balls have been found to increase student alertness and arousal during academic instruction (Mead et al., 2016). Mead et al. (2016) also found math standardized assessment scores were significantly higher for students in sixth grade who used stability balls compared to those using traditional seating options. In fact, sixth grade students who used the stability balls showed even greater improvement than classroom students who experienced short duration, vigorous, physical activity breaks (Mead et al., 2016).

Pedal desk research is limited to adults and results are varied. Straker, Levine and Campbell (2009) found a decrease in computer task performance, specifically when using a mouse. However, Carr et al. (2014) noted a decrease in sedentary time and increased calories burned. These findings raise significant concerns about the implementation of specific types of workstations. One potential reason for the lack of knowledge concerning the use of pedal desks with children is likely related to what we know about children. Integrating these in the elementary classroom creates the potential for a significant distraction that could impact learning. As in all research, variables must be controlled if possible although in an applied setting this is typically quite challenging. While many instructors and districts are interested in active learning products, challenges for implementation and storage arise with the removal of traditional products. Given that active seating appears to be the next positive move toward decreasing sedentary behavior while increasing brain functionality, methods of implementation need to be studied. Furthermore, best practices for implementing each product needs to be outlined in order to reduce classroom management distractions for teachers. This may help reduce teacher apprehension to considering an alternative seating environment. Therefore, the purpose of this paper is to present lessons learned and suggested implementation methods discovered after one and a half years of experimentation which will hopefully assist researchers and practitioners to seamlessly implement pedal desks into their curriculum (See Table 1).

2. Methods

A rural northwest school in the United States was chosen due to proximity to the university, size of class, experience of the teacher,

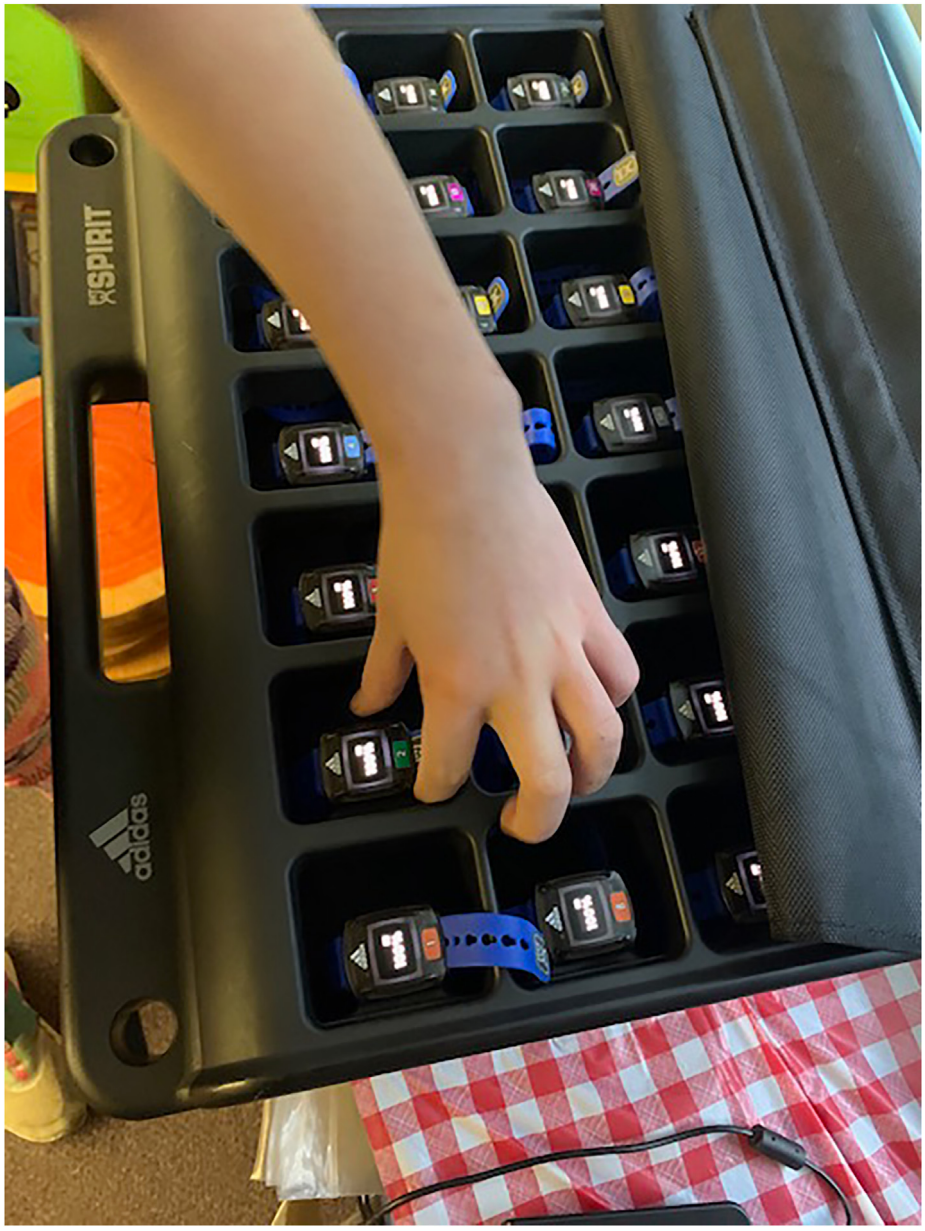

Figure 3. Watch storage.

expertise of the teacher and support of the administration. Pedal desks were placed in classrooms in two different applications across two grades. The initial implementation was as a learning station of six pedal desks grouped together in one specific classroom for math and reading. This class housed 21 students. This station was separate from the traditional seating which students were in the majority of the time. The second implementation was as a full classroom seating environment for a class of 23 students. The first picture shown demonstrates the setting in the first-grade classroom compared to the second-grade classroom set up. The second-grade classroom not only had individual pedal desks for each student, but also heart rate monitors (second picture).

Two different types of heart rate monitors were employed to encourage students to pedal. The first set of heart rate monitors were Polar's OH1. This heart rate monitor provides an optical reading of the heart and was placed near the brachial (inside of bicep) artery. A signal was transmitted to an i-pad which is projected on a wall, allowing students to see their heart rate. Students were able to monitor heart rates by looking at the projected display which associated HR (Heart Rate) color. The color indicated how fast their heart rate was beating. Students were encouraged to pedal at a low intensity steady state. The second heart rate monitor that was implemented as an IHT Zone Monitor. This heart rate monitor is designed to display a color that reflects the heart rate on the actual monitor. The pictures below show the IHT Zone monitor in storage, during the "check-out" process, and in use.

3. Results

3.1. Pedal desks as a station within a traditional classroom

The stations were utilized specifically for reading and mathematics lessons. After the students learned basic classroom management rules and procedures, the classroom teacher was able to position herself at the station during the reading with adult volunteers and paraprofessionals working with other students at additional stations. During the math lessons the teacher moved among the various stations including the pedaling desk station. In this environment the researchers noted

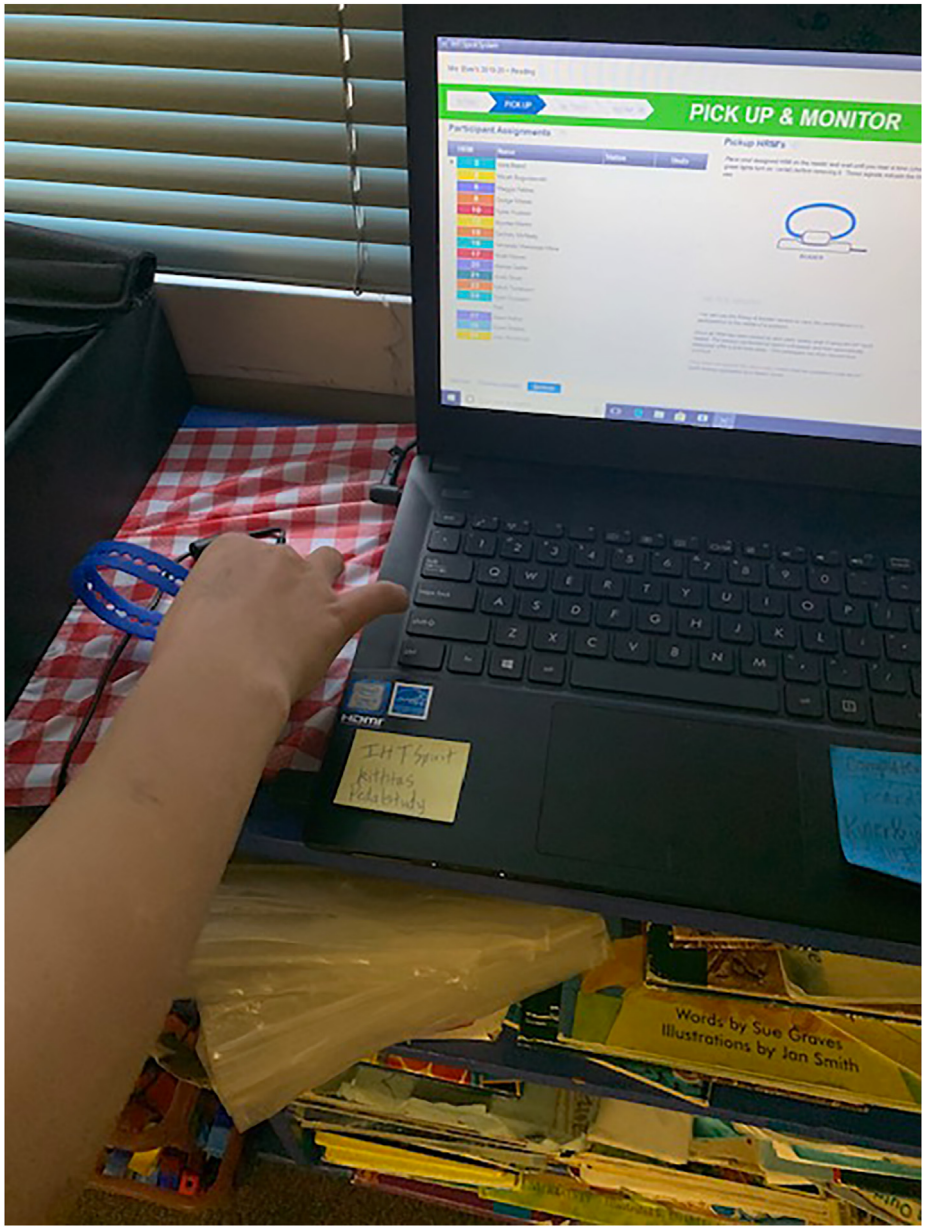

Figure 4. Watch check out.

anecdotally from observation as well as teacher interviews quickly determined the following:

- the novelty was quite exciting but quickly wore off
- children don't naturally pedal when given the opportunity to sit at a pedal desk
- children pedal intermittently if they pedal
- children pedal in half turns as a fidgeting technique
- children won't pedal the full rotation if the seat height is incorrect
- manipulative activities are very difficult while pedaling
- when doing partner work, they tended to stand next to the stations instead of sit
- children stand on the pedals while in the seat without pedaling
- they struggle with partner activities while pedaling
- they use these as standing desks much of the time
- kids were able to read out loud without difficulty when they were pedaling
- to minimize distraction, protocols must be well established
- it is difficult initially, for the teacher to monitor and motivate pedaling while teaching

As a part of our attempts to get children to think about pedaling consistently at an intensity that still allowed them to read, we incorporated Polar Oh1 heart rate monitors. The heart rate monitors were set up so that students would learn to pedal at a low intensity heart rate. However, since the children had to look at the wall where a color, representing their pedal intensity, was displayed, focusing on reading became a challenge. After an experimentation, the teacher was able to identify strategies that enabled the students to read and monitor their heart rate effectively (see Table 1). In fact, the teacher would have the students follow along as others read aloud and when the reader was switched, the teacher reminded them to check their heart rates.

In the two elementary classrooms where the pedal desks were put in as the only available seat for students, one teacher preferred them and the other teacher preferred the traditional seating arrangement. The teacher who chose not to continue after four months was new to the pedal desks

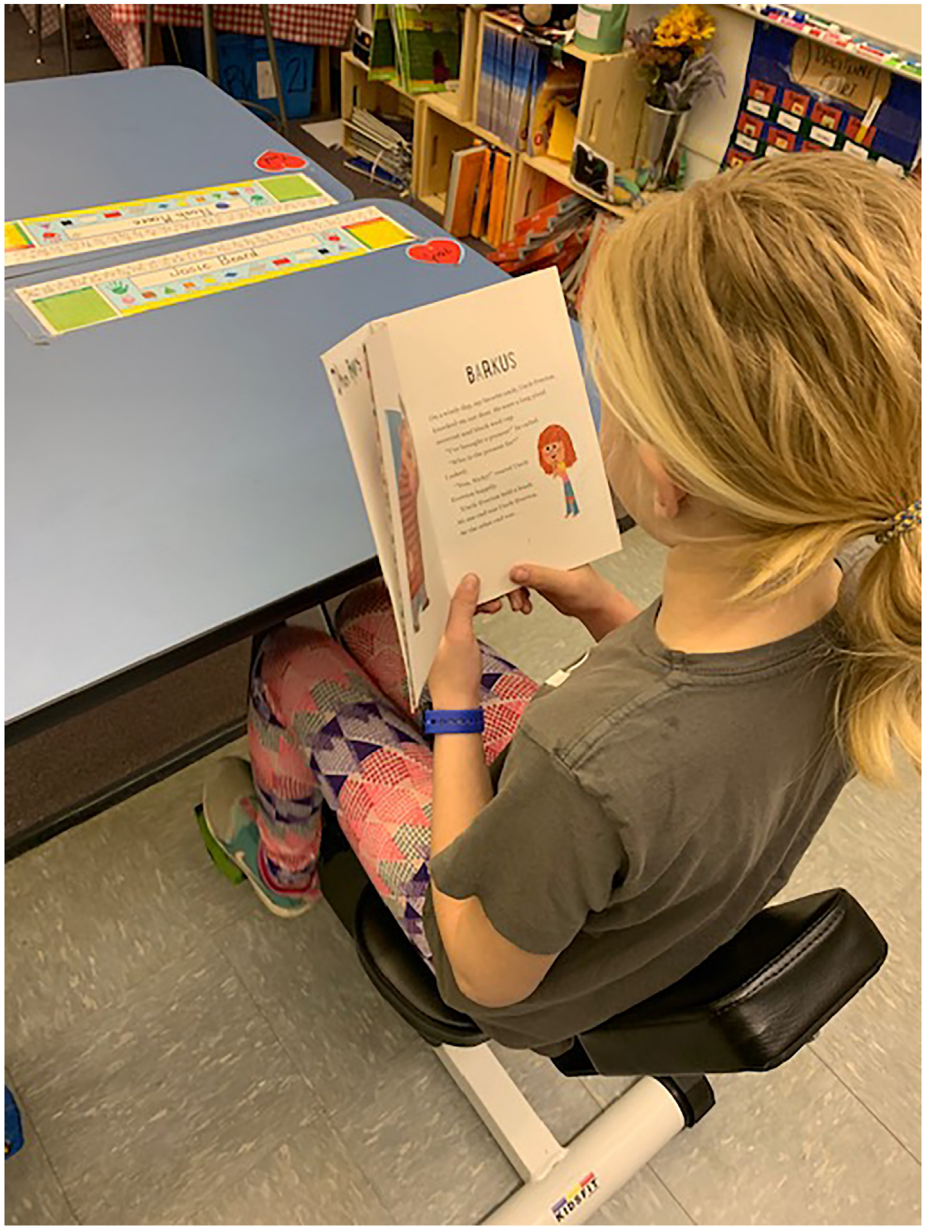

Figure 5. Student reading at pedal desk.

Table 1. Strategies for pedal desk implementation.

	Strategies	Challenges
Organization	* Individual or group settings. * If using computers for on-line curriculum, make sure desks are by plug ins or computers are charged.	* Many pedal desks do not have storage capacity like traditional seating.
Implementation	* Students will need time to practice reading and pedaling. * Students may need encouragement to pedal softly as they read. * Practitioners may notice a difference in fluency when reading out loud while pedaling. * If students are using keyboards or a mouse, allowing students to stand may improve their dexterity. * Students can stand or sit at the workstations.	* Each pedal desk needs to be measured to appropriately fit each student. * Keep this in mind if seating chart changes are made. *Students may pedal loudly. * Cues such as "pedal softly" are needed for reminders for some students.

and felt that the additional classroom management challenges associated with the nontraditional desks were not something that she wanted to manage. However, the second-grade classroom teacher that chose to continue to use the classroom set of pedal desks felt that they were well worth the challenge. She also developed protocol specific to them and

Table 2. Pedal desk implementation considerations identified by teachers.

Observation	Explanation
1. Students do not naturally pedal as they read or work.	Students would stand or pedal in 180-degree rotations front to back as a fidgeting technique
2. Partnering is difficult with the pedal desks if students are expected to maintain pedaling momentum.	There is too much distance between the seats for students to continue pedaling.
3. Heart rate monitors did encourage consistent pedaling.	Students did pedal more consistently when wearing their heart rate monitors. They were more motivated to stay in their "zone".

was able to quickly reorient the students as well as encourage them to pedal as the situation allowed (see Table 2).

While the Polar OH1 heart rate monitors provided a monitoring tool that led to pedaling success, the challenge of additional equipment and set up was overwhelming for the teacher. Given the need to help students monitor pedaling intensity, a less intrusive replacement heart rate monitor was sought. IHT Spirit heart rate monitors provide both a number and a color that is directly on the watch face. These were brought into the second-grade classroom from the start of the year so that students could easily monitor their own heart rate by looking at their wrist as opposed to having to look at a wall with the projection of their heart rate. This also kept students from comparing their heart rate with others. Students were taught the basic protocol for accessing, putting on and returning the heart rate monitors for nightly charging. With the IHT heart rate monitors, students were encouraged to maintain a heart rate in a specific zone which was identified by a color on their watch (a low intensity steady state) while reading.

Scaled scores were analyzed using SPSS software with the HOTELLING'S T2 statistical test. Preliminary assumption analysis indicated that data were normally distributed and there was one outlier as determined by a boxplot analysis. There was a homogeneity of covariance as assessed by Box's M test $p > .05$. It was found that there was no significant difference (scores included a pretest, midterm test, and end of the year compilation. The differences between the classes on the combined dependent variables was not statistically significant, $F(3, 43) = 2.610$, $p = .064$. However, it is interesting to note that from the first assessment to the last assessment, participants in the pedal desk classroom experienced a mean gain score of 135.96 while the students learning reading in the traditional classroom experienced a gain of 123.

3.2. Observations

Table 2 has a list of our initial observations for the classroom where the pedal desks were used with second grade students in a cluster setting. Where we initially thought students would be pedaling too much or above their recommended heart rate, the observations were on the contrary.

Adding the heart rate monitors motivated students to continue pedaling while reading. However, adding the watches was an additional challenge for the instructor. Table 3 is provided as a summary to minimize the learning for other teachers who choose to use pedal desks, both for instruction as well as strategies to encourage pedaling. Due to a lack of research and knowledge on how to introduce active seating options, researchers and teachers involved in the study really did not know what to expect as challenges or how to provide cues for success. Teaching students how to use each device appropriately and providing cues for desired use is essential for learning to occur with limited distractions. Table 2 below highlights suggestions for those interested in pedal desks as well as heart rate monitors.

Table 3 is a collection of qualitative reflections from the two teachers included in the study. Teachers were asked questions related to the implementation of not only the pedal desks but also the heart rate monitor watches in the classroom setting. Because there is very little data or suggestion related to how to implement activity via seating options, teachers provided cues, managerial strategies, and potential distractions as well as pros and cons they experienced throughout the study in order to make the transition from the traditional setting more fluid.

Table 3. Teacher reflections following implementation.

Topic	Pedal Desks	Watches
Benefits of Using Active Seating Options in the Elementary Classroom	* Janitors and teachers found pedal desks easy to clean around * Majority of students use the equipment appropriately * Pedal desks double as a standing workstation throughout the day * Movement is consistent even if it isn't the full circular pedaling motion * Distraction fades with practice * Organization has been an improvement even though originally it was an adjustment * Even when the novelty faded, students continued to pedal.	* Students pedal more with the watches * It is harder for certain students to focus when wearing them but others seem more focused, students want to wear them * The frequency of looking at the watches dramatically decreased after week 1 * Some students, especially those on medication will need the zones adjusted accordingly.
Challenges for Active Seating Options in the Elementary Classroom	* Hyperactive students still don't sit and pedal * A bigger seat or bench seat may be best for safety and comfort * The desk is a long way away from the seat, an arm rest may help students stay in the seat or seated correctly more * Direct instruction is a challenge * They are hard to manipulate and move, circular hole in the desk impacts handwriting	* Some students have ruined the stops on the watches * Boys react differently to the watches than girls in that boys are trying to see how high they can make their heart rate climb while girls are trying to maintain their heart rate zone * The charge doesn't last all day * Looking at the colors is distracting for some * The log in and log out process takes time * Students have a hard time putting them back on the charger correctly
Distractions	* Noisy pedals * Detracting behaviors for the seat size and movement on the seat * The type of shoes matter for pedaling	* Looking at colors * Battery life diminished with the duration of use and activity
Cues	* "Soft feet" * "Quiet feet" * "Clunky feet" * "Pedal softly" * "Pedal in a circle" * "Slow and steady"	* "Check your colors" * "Are you in your zone?" * "Green is go, red is whoa" * "Zone check!"
Final Reflection	Would still recommend pedal desks to others. The new organization system has worked well. Students of all classes love the pedal desks, students who struggle to self-regulate do not regulate better with the pedal desk, but the students do enjoy them	The lock screen on the computer does matter, easy to implement but now the battery life is almost too much of a distraction. Students who cannot typically self-regulate are extra destructive to the watches.

4. Conclusion

Movement is like "cognitive candy" (Medina, 2014) which may help motivate and energize students in the classroom setting. One way to incorporate activity into the classroom setting is via active seating options like pedal desks. The pedal desk study did increase student calorie expenditure—but expenditure did increase exponentially after the addition of the heart rate monitors. While research notes elementary teachers believing in the importance of physical activity in the classroom, many are hesitant to try active learning strategies due to the compromise of classroom management (Benes et al., 2016). Pedal desks and/or heart rate monitors may be the solution for elementary teachers to increase physical activity which will increase blood flow, focus and cognition without sacrificing classroom management and the suggestions for implementation can assist with the seamlessness of the seating change.

Declarations

Author contribution statement

Judy Beard, Kirk Mathias: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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