

FACILITATING SELF-REGULATION THROUGH PHYSICAL ACTIVITY

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## ABSTRACT

## Facilitating Self-Regulation through Physical Activity

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Self-regulation skills have been connected to positive school success and increased academic achievement (McClelland, Acock, & Morrison, 2006). One recently explored method to aid students in their ability to self-regulate is physical activity (Becker, et al., 2011). The purpose of this study was to explore the facilitation of self-regulation through physical activity via access to an exercise bicycle within an elementary and secondary school setting. Student bicycle usage was explored via student documentation to determine frequency and duration of use. Teacher observations were collected via email correspondence were analyzed via thematic content analysis and reflections made by the teachers at a follow-up debriefing session were summarized. Overall, a novelty effect was apparent with the bicycle, where it was used extensively in the first month of the study and then use sharply declined thereafter. Teachers felt that the bicycle appeared to provide some students with support, however there were challenges with integrating the exercise bicycle into the classroom. As well, teachers stated that factors such as bicycle placement and engagement levels must be explored further in order to understand the impact an exercise bicycle could possibly have on a student's ability to self-regulate.

Keywords: Self-regulation, physical activity, exercise bicycle

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## Facilitating Self-Regulation through Physical Activity

Self-regulation is a term that is often associated with concepts such as self-control, willpower, or emotion regulation (Burman, Green & Shanker, 2015). In a broad context, self-regulation can be defined as the ability to alter response or state (e.g., regulate feelings of emotion from negative to positive). Self-regulation is important across the lifespan but is especially key during childhood (Rosanbalm & Murray, 2017). Self-regulation skills allow children to regulate their emotions, manage stress, and control impulses, which can aid in improved attentional focus (McClelland & Cameron, 2011; Shanker, 2012) and have a positive impact on a child's ability to concentrate (Baumeister, 2014). The ability to self-regulate also allows a child to learn how to respond to emotions like frustration or anger using different strategies, in order to return to calm and alert emotional states (Shanker, 2012).

Many of the skills learned through the facilitation of self-regulation during childhood and adolescence are useful within the context of the educational setting. Positive school success and higher levels of academic achievement have been linked to self-regulation skills (Ladd, Birch, & Buhs, 1999; McClelland, Acock, & Morrison, 2006). School based programs, such as Zones of Regulation (based on a cognitive behavioural approach), help students learn to self-regulate through the use of a colour coded system that helps identify and categorize feelings (e.g., intense emotions = red; calm emotions = green; Kuypers, 2011). This program has shown some success (Hoffman, 2018), however implementation requires access to program materials and teacher compliance. Another recently explored method for increasing self-regulation is the use of physical activity via a stationary bicycle in the classroom. This allows students

the opportunity to either increase their energy when feeling depleted or decrease their energy when feeling fidgety at any point within the day. Past research has identified an association between physical activity and self-regulation (Audiffren & Andre, 2015; Becker, McClelland, Loprinzi, & Trost, 2011). Children who complete higher amounts of physical activity scored higher on self-regulation tasks and ultimately achieved higher math and reading test scores (Becker, et al., 2011). As well, past research shows links between physical activity levels and increases in self-regulatory skills such as attention, inhibitory control, and working memory (Mahar, 2011; Palmer, Miller & Robinson, 2013). There is limited research, however, regarding the efficacy of physical activity in facilitating self-regulation in a school environment via accessibility to a stationary bicycle in a classroom (Mueller, Wudarzewski & Avitzur, 2017). The purpose of the current study is to explore the facilitation of self-regulation through physical activity via access to a stationary bicycle placed within two school settings: a grade 3/4 classroom and a resource room in a secondary school.

### **Self-Regulation and the Strength Model**

Self-regulation can be defined as the ability an individual has to change or control responses, behaviours, or thoughts (Baumeister & Vohs, 2007) and is proposed to be composed of three domains: cognitive, emotional, and behavioural (Murray, Rosanbalm, Christopoulos & Hamoudi, 2015). Cognitive self-regulation refers to processes that are applied to cognitive tasks and includes focused attention, problem-solving, and the formation of goals. Emotional self-regulation is related to the process of managing emotions and learning to be aware of internal and external stressors that impact the feelings we have. Behavioural self-regulation refers to our ability to manage or control

our actions, often related to delayed gratification or the ability to comply with rules (Murray et al., 2015). One model of self-regulation that specifically incorporates components from these different domains is the strength model of self-regulation (Baumeister et al., 1994).

Baumeister et al. (1994) proposed a model of the self-regulatory process through a three-ingredient model (standards of behaviour, monitoring, and willpower), known as the strength model of self-regulation. This widely used model incorporates the term *ingredients* to represent the necessary components for self-regulation. This model is referred to as the strength model to conceptualize the idea that an individual's ability to achieve self-control is similar to using a muscle; the ability to control our actions or responses decreases the more we take part in this control process, similar to how a muscle becomes tired after repeated use (Baumeister, Heatherton, & Tice, 1994). More recently, Baumeister and Vohs (2007) revised this model to include another ingredient (motivation) to more accurately reflect the most current research in self-regulation. Baumeister and Vohs emphasized that all four ingredients were needed in order for the self-regulatory process to occur. However, if one ingredient is not present or is at a lower level (e.g., willpower), higher levels of the other three ingredients (i.e., standards of behaviour, monitoring, and motivation) may serve to compensate. If we consider this model in a developmental way, caregivers could provide the ingredients needed for self-regulation in children until the child learns standards of behaviour and develops monitoring, willpower, and motivation.

**Standards of behaviour.** In order for an individual to be able to execute the self-regulatory process, there must be a standard of behaviour that is to be achieved.

Standards of behaviour can be a desired state or a specific goal the individual is hoping to reach (Baumeister, Schmeichel & Vohs, 2007). Standards are important for self-regulation as they help the individual focus on altering either a behaviour or a response by providing an ideal behaviour or response to complete the change. (Baumeister, Schmeichel & Vohs, 2007). Standards of behaviour in the self-regulatory process were determined by Baumeister, Schmeichel and Vohs (2007) with the research of Higgins (1987) in mind. Higgins identified two different types of standards, ideal or ought. According to Higgins, ideal standards are developed in conjunction with positive (ideal) behaviours we want to achieve, such as attempting to exercise to become healthier. Ought standards are also linked to developing positive behaviours but focus on behaviours we should be moving away from rather, for example restricting specific foods or moving away from certain foods in order to lose weight and become healthier. Therefore, standards of behaviour provide achievable goals or expectations for a behaviour or response.

**Monitoring.** Monitoring refers to the process of monitoring our progress in accordance with the standard of behaviour that we have set. This ingredient is linked closely to the feedback-loop theory (Carver & Scheier, 1981), which states that we monitor our progress by comparing ourselves to the standard we set and make adjustments if we have not yet met that standard. In the feedback-loop theory, this process of monitoring our progress is known as *test*, *operate*, and *test and exit* (Carver & Scheier, 1981). First, the individual reviews their progress against the standard they set (test), if they do not meet the standard, they continue to try to meet the set standard of behaviour (operate), and keep reviewing their progress until they meet the standard they



set (test and exit). The strength model of self-regulation suggests that we monitor our progress of achieving self-regulation of behaviours or responses through a similar sequence as that suggested by the feedback-loop theory. If we are able to increase our ability to monitor our progress of meeting the standards of behaviour that we set, this can lead to an increased ability to self-regulate.

**Willpower.** Also referred to as self-regulatory strength, willpower is an ingredient that allows for the process of self-regulation to persist. In order to change or alter a behaviour or response, energy is required to do so (Baumeister, Schmeichel & Vohs, 2007). The concept of ego depletion, introduced by Baumeister, Bratslavsky, Muraven and Tice (1998), states that our will to complete tasks uses energy and therefore once we have executed the self-regulatory process, our energy is expended, resulting in the state of ego depletion. Willpower, or the persistence to complete self-regulation, is directly influenced by the amount of energy we have available during self-regulation. Research by Gailliot et al. (2007) supported a physiological basis for ego depletion in the self-regulatory process. They suggested that when ego depletion occurs, our glucose is expended and as we complete the self-regulatory process, our body utilizes glucose as a form of energy. This physiological link coincides with our ability to control our behaviours or responses; if we self-regulate for periods of time our glucose levels can decrease, which results in a decreased ability to self-regulate.

**Motivation.** The last, and fourth, ingredient of the strength model of self-regulation was added when Baumeister and Vohs (2007) noted that even though the other three ingredients may be present, someone might still fail at self-regulation. Adding motivation as an ingredient for self-regulation helped to explain why some individuals

experience self-regulatory failure even with the presence of standards of behaviour, monitoring, and willpower. Without sufficient motivation, an individual might not want to complete the self-regulatory process. It is important to note that motivation was proposed to act as a substitute when other ingredients are either decreased or not present. For example, if an individual is in a state of ego depletion, high motivation will allow effective self-regulation (Baumeister & Vohs, 2007).

The ability to self-regulate increases with development and has been connected to a number of positive outcomes (e.g., physical and mental health, social and academic functioning) across the lifespan (Moffitt et al., 2011). Of particular interest is the development of self-regulation in childhood and adolescence, which has been associated with positive academic outcomes and improved school success. Although the strength model of self-regulation has only been applied to adults, this model can be used to inform the conceptualization of self-regulation across the lifespan.

### **Self-Regulation in Childhood and Adolescence**

**Self-regulation in childhood.** One of the first scholars to provide a proposed progression of the development of self-regulation in children from infancy to age 6 was Kopp (1982). She believed that individuals developed antecedents to self-regulation (sensorimotor modulation, compliance, and control), which contributed to the development of self-regulation later on in childhood. According to Kopp, self-regulation begins around 3 months (sensorimotor modulation) when the infant displays reflex movements and initial self-regulation results from reactions to external stimuli via internal reflexes. For example, when an infant hears a loud noise, they look towards the sound and then to an attachment figure. During this time, caregivers are thought to aid the

child's self-regulation (Als, 1978) and the caregiver provides the child with an optimal environment for self-regulation (Fogel, 1993). At this stage, the caregiver provides the child with assistance and structure in order to aid and scaffold the child's ability to self-regulate. Therefore, at this stage in development, the caregiver acts as a critical support for the child's initial self-regulatory processes. According to Kopp (1982), self-regulation becomes more purposeful between 3 and 12 months of age (compliance) and the child begins to engage in voluntary motor actions (e.g., reach and grasp) in response to the environment. The third phase of the development of self-regulation (control) takes place from 9-12 months until 18 months of age and in this phase the child begins to utilize cognitive processes to aid in self-regulatory behaviours. However, Kopp noted that within this phase, children are in the initial stages of incorporating cognitive processes (intention, conscious awareness of actions, and forms of memory), therefore they start to control but not regulate their behaviours at this time. Therefore, at this point in development, the standards of the strength model of self-regulation cannot be utilized until further development occurs.

A child's ability to self-regulate becomes more refined from the age of 3 to 4 years as they transition from the use of antecedents of self-regulation (sensorimotor modulation, compliance, control) to an ability to integrate these skills to perform self-regulatory functions as a whole (Kopp, 1982). This is suggested to be related to the development of specific self-regulatory skills linked to executive function such as inhibition (Anderson, 2002). Inhibition, which allows effortful control of impulses, actions, or responses has been noted to be associated with positive control of emotions later on in life, specifically the intensity and frequency of suppressing anger (Kochanska,

Murray & Harlan, 2000). At the age of 3, children are often able to inhibit specific behaviours, but still have difficulty controlling all their impulses (Diamond & Taylor, 1996). Diamond and Taylor (1996) found that inhibition skills, measured using Luria's tapping test the child taps once if the experimenter taps twice and taps twice if the experimenter taps, increased from 3.5 to 7 years of age. Diamond and Taylor (1996) concluded that inhibition increases with age, coinciding with the development of the frontal lobe. With respect to the strength model of self-regulation, the development of inhibitory skills can be linked to the standard of willpower or the strength to complete self-regulatory tasks.

In addition to the development of inhibition between the age of 3 to 4 years, children become increasingly better at delaying gratification (Mischel, Ebbsen, & Zeiss, 1972). Specifically, children appear to be able to delay gratification by shifting their focus or responses away from a potential reward. The ability to delay gratification in early childhood (ages 4-5) has been related to positive academic and social competence in adolescence (Mischel, Shoda & Peake, 1988). Although many components of self-regulation develop during childhood, self-regulation is further refined and developed well into adolescence (Gestsdottir & Lerner, 2008). As adolescents are exposed to new challenges, and physical and social changes during this time; they are met with increasing demands on their self-regulatory abilities.

**Development of self-regulation in adolescence.** In comparison to the vast literature on the development of self-regulation in childhood, research focused on the developmental progression of self-regulation in adolescence is limited. However, self-regulation skills that are formulated in childhood, such as inhibitory control or delay of

gratification, are further refined as an individual develops from a child into an adolescent (Gestsdottir & Lerner, 2008). During this developmental period, the ability to establish a goal behaviour (or standards of behaviour) and the monitoring of these goals in order to self-regulate increases. Murray and Rosenbalm (2017) highlighted self-regulation skills that are under further development in adolescence, such as problem-solving, monitoring of goals, and the ability to delay gratification. We know that adolescents also continue to develop their executive function skills, which is reflected in the continued pruning and myelination of the prefrontal cortex in this period (Blakemore & Choudhury, 2006). In particular, the ability to delay gratification for longer periods of time increases in adolescence when compared to childhood (Lerner, 2001). This can assist an adolescent in their ability to comprehend the results of their actions and ultimately lead to improved decision-making or future goal setting (Lerner, 2001).

The development of self-regulation across childhood and into adolescence coincides with the different changes that can take place both physically (e.g., puberty) and socially (e.g., transition from elementary to secondary school, identity development; Gestsdottir & Lerner, 2008). In particular, self-regulatory skills has been noted to have a positive impact on school success.

### **Self-Regulation and School Success**

Self-regulation within the school environment has been associated with school success, both in terms of the transition to school from preschool (school readiness) and as the student progresses through their years in elementary and secondary schools with respect to positive classroom behaviours (e.g., attentive listening, proper social skills, engagement in class content), and enhanced academic achievement (Blair & Razza,

2007).

**School readiness.** School readiness is related to the level of readiness a child has when they are adjusting from preschool to kindergarten; it is often associated with level of academic achievement and how engaged the student is within their daily activities at school (Blair, 2002). Blair (2002) noted that enhanced school readiness and self-regulation are closely linked, as self-regulatory skills aid and prepare a student with their adjustment to school. Schmitt, McClelland, Tominey and Acock (2015) evaluated the impact of a self-regulation intervention program on students during their transition from preschool to kindergarten and found that students in the program displayed higher levels of self-regulation as they transitioned into kindergarten. As well, they noted that participants who were English language learners had significant increases in their math skills from preschool to kindergarten (Schmitt et al., 2015). Schmitt et al. (2015) concluded that self-regulation may be an important part of developing the needed skills for the transition from early childhood education to formal elementary school education.

**Classroom behaviours.** Self-regulation has also been linked to increases in positive classroom behaviours. Wyman, Cross, Hendricks Brown, Yu, Tu and Eberly (2010) explored the impact of a self-regulation intervention on the school behaviours of students in kindergarten to grade 3 who experienced problems in behavioural, emotional or on task behaviour. Wyman et al. (2010) evaluated the Rochester Resilience Project Intervention, which teaches specific self-regulatory skills that aid students in the ability to manage their emotions. The child's aggressive or disruptive classroom behaviours and social-emotional functioning, as well as number of disciplinary reports were collected during the intervention to examine whether intervention changed the students'

behaviours. Wyman et al. found that children who received the self-regulation intervention showed decreases in negative classroom behaviours (e.g., aggression, disruptiveness or moodiness), disciplinary incidents, and office visits. However, there was no change in peer social skills (i.e. positive social interactions with other classmates) for boys, whereas girls saw larger increases in their social skills with their peers. Therefore, an intervention targeting self-regulation skills for students experiencing social-emotional and behaviour problems may aid in the formation of skills needed to decrease negative school behaviours (Wyman et al., 2010).

**Academic achievement.** Self-regulation skills have also been linked to enhanced academic achievement across childhood (Blair & Razza, 2007; McClelland & Wanless, 2012; Ponitz, McClelland, Matthews & Morrison, 2009; von Suchodoletz et al., 2013) and adolescence (Gestsdottir & Lerner, 2008; Bakracevic Vukman, & Licardo, 2010). For example, Blair and Razza (2007) conducted a study to determine which components of self-regulation were related to improved early academic achievement for students in kindergarten and grade 1. They measured aspects of self-regulation (attention shifting, impulse control, and effortful control) while also testing math and reading skills. Blair and Razza found that all three aspects of self-regulation were positively related to math skills, as well as letter recognition. These results suggest that better self-regulation may be related to early academic achievement (Blair & Razza, 2007). These findings were replicated by McClelland and Wanless (2012) in a group of children with demographic risks (low-income or English as a second language learners) over the transition from pre-kindergarten to kindergarten. Higher self-regulation predicted both higher math and reading abilities, regardless of the demographic risks the child experienced. von

Suchodoletz et al. (2013) showed higher scores on the 'Head-Toes-Knees-Shoulders' measure (used to tap inhibitory skills, which are an aspect of self-regulation) were associated with better academic skills in pre-kindergarten and kindergarten students in Germany and Iceland. These results indicate that the finding that self-regulation skills are associated with better academic achievement regardless of cultural differences that may be present.

Self-regulation also has been associated with positive academic performance in adolescence. For example, Bakracevic et al. (2010) examined students aged 14-15, 17-18 and 22-23 years on different aspects of self-regulation (cognitive, metacognitive, motivational, and emotional) and overall grade performance average (GPA). They found that metacognitive self-regulation (proposed to provide control over our own cognition), predicted a higher GPA across all ages measured. The strength model of self-regulation can be used to help explain how ego depletion and willpower might affect academic achievement in adolescence. Englert and Bertrams (2017) manipulated ego depletion and willpower in secondary school students using two tasks. One task required self-control in the form of suppressing emotional reactions while watching a video clip. Due to the willpower required in this task (i.e., emotion suppression), ego depletion would occur. In the other task, students completed a similar task but were not asked to suppress their emotional reactions. As a result, little ego depletion would occur, and minimal willpower would be required. Englert and Bertrams found that the students who completed the task requiring emotion suppression performed worse on a knowledge retrieval task in comparison to students who did not have to suppress their emotions. Englert and Bertrams concluded that depleted strength to self-regulate may hinder students when they



perform cognitive learning tasks as they progress through secondary school education. The reviewed research suggests that some aspects of self-regulation may be associated with positive academic performance both in childhood and adolescence (Bakracevic et al., 2010).

### **Facilitation of Self-Regulation within the School Environment**

Due to the academic benefits that self-regulation can provide, school boards have looked to incorporate different programs that facilitate self-regulation in the classroom. One program that has been popular in recent years is the Zones of Regulation. The Zones of Regulation was developed to be a cognitive behavioural approach to self-regulation that aimed to increase understand of emotions by categorizing them into four distinct colour zones (Kuypers, 2011). The red, yellow, green colour zones were designed to mimic the colours of a traffic light with red representing anger or frustration, yellow representing nervousness or anxiety, and green representing calmness or alertness. The fourth colour, blue, represented sadness or low energy levels. According to this program, the child was helped to conceptualize the colour zone they were in so they could learn strategies that would aid them in returning from the undesirable colour zones of red, yellow, or blue to the optimal colour zone of green for learning (Kuypers, 2011). In relation to the strength model of self-regulation, this program focused on helping students identify a standard of behaviour (returning to optimal colour zones) while learning to change that behaviour to an ideal outcome (monitoring).

Empirical support for the Zones of Regulation is limited and the few studies examining the program highlight limitations. Hoffman (2018) noted that the amount of classroom conflict amongst students that had participated in learning and using the Zones

of Regulation did not increase or decrease. Hoffman (2018) highlighted that students could learn to identify the colour zone they were in; however, they were not able to find a strategy to return to the green zone effectively without the help of a teacher. Other criticisms of the Zones of Regulation program are centred on the accessibility to the resources and materials. The program and its associated resources must be purchased, extending costs for both schools and school boards looking to utilize the program. In addition, student compliance has been shown to be problematic. For example, Quale (2019) showed that the Zones of Regulation program was effective at reducing problematic classroom behaviours (e.g., non-compliance, talking out of turn) but only during the implementation of the program, not afterwards. Therefore, the Zones of Regulation program may only be effective when it is facilitated within a student's time in the specific classroom.

Another method recently utilized within the school setting to facilitate self-regulation is the use of physical activity. Research indicates that an increased ability to self-regulate has been related to the presence of physical activity for different age groups (McMorris, Sproule, Turner & Hale, 2011; Niederer et al, 2011; Davis et al., 2011). Physical activity has been noted to aid individuals with increased ability to focus, improve impulse control as well as positive impacts on overall mental health and well-being (Audiffren & Andre, 2015; Strong et al., 2005).

### **Self-Regulation and Physical Activity**

Physical activity has been linked to increased ability to perform self-regulatory skills in the classroom such as maintaining attention (e.g., listening to the teacher) or controlling inappropriate impulses (e.g., not speaking out of turn), specifically across

childhood development (Becker et al., 2011). For example, Palmer, Miller and Robinson (2013) examined the impact of exercise on preschool students' ability to sustain their attention. They determined that students who completed a 30-minute movement program had less errors on the cognitive function test utilized to measure sustained attention. Palmer et al. (2013) suggest that physical activity requires aspects of motor control, which could engage processes such as the ability to sustain attention. In addition, Becker et al. (2011) found that the amount of active play students participated in (measured with accelerometers worn by students) was associated with behavioural self-regulation (measured by the Head-Shoulders-Knees-Toes task). Becker et al. suggested that increased physical activity could increase self-regulatory skills, which in turn could increase academic achievement. The strength model of self-regulation suggests that self-regulation is a limited resource. However, it is possible that physical activity may assist in efficient use of an individual's self-regulation resources by providing a mechanism for students to increase depleted energy resources when feeling low in energy. This idea is supported by research conducted by Oaten and Cheng (2006) who found that college students showed a significant increase in self-regulatory behaviours after taking part in an exercise program. According to the strength model of self-regulation, individuals need to have an understanding of the behaviour or goal they want to achieve. Participants in Oaten and Cheng's study self-reported levels of consumption behaviour of different substances; including alcohol, cigarettes and junk food, which helped to make them cognizant of the behaviours of interest. After completing an exercise program, the students reported that they were able to regulate certain consumption behaviours presumably due to an understanding of the goals they wanted to achieve (Oaten & Cheng,

2006).

The benefits that physical activity can provide students with respect to self-regulation has increased interest in considering programs or initiatives that incorporate activity in classroom settings. Although the aforementioned studies indicate benefits from long periods of physical activity, there appears to be no research that examines short periods of physical activity within the classroom to facilitate self-regulation. Exercise or active play may provide benefits, but they cannot be practically integrated into the classroom environment without disrupting academic curriculum. Incorporating physical activity within the classroom could be achieved if the physical activity does not take away instructional time. One proposed way to facilitate self-regulation through access to physical activity in a classroom is the use of a modified exercise bicycle. These exercise bicycles are modified to include a sturdy base (to reduce tipping dangers), wheel coverings (to protect fingers and toes), and easy to manipulate handles (for quick and easy adjustments for riders of different sizes). They are also low noise to reduce classroom disruption. Therefore, modified exercise bicycles in the classroom could provide students with the ability to access brief periods of physical activity in order to potentially aid with their ability to self-regulate. The current study will explore modified exercise bicycles within the classroom through the following questions using quantitative and qualitative methods:

- 1) Who is using the bicycle during the school day?
- 2) Why is the student using the bicycle?
- 3) When is the bicycle being utilized during the day?

## **Method**

### **Recruitment**

The recruitment process began with a consultation meeting with the Mental Health Lead for the Peterborough Victoria Northumberland Clarington Catholic District School Board (PVNCCDSB) to discuss implementing a pilot study that would focus on the use of exercise bicycles in the classroom to aid student self-regulation. This pilot study would fit with their 2017-2020 Strategy for Mental Health & Well-Being (Mind Body Spirit: Be Well). Two modified exercise bicycles had been donated by Run for Life Canada, a not for profit organization that aims to incorporate exercise bicycles in the classroom for positive learning and social outcomes.

At this meeting, it was decided that two classrooms (one in an elementary school and one in a secondary school) would be selected by the mental health lead of the school board. This selection was based on teacher willingness and interest in having a modified exercise bicycle in their classroom, as well as no prior exposure to exercise bicycles within the selected school. The resource classroom was chosen for the secondary school after consulting with the administration because it provided a stable location where the bicycle could remain; rotating schedules in secondary schools mean different teachers in different classrooms, which would impact usage of the bicycle for students. Upon approval from the Trent University Research Ethics Board and the Ethics Review Board of the PVNCCDSB, two schools were contacted to partake in an information session regarding the study procedures.

A letter of information was provided to the elementary school teacher and two secondary school teachers who agreed to be part of the study by the mental health lead

once they indicated their interest in participating. The elementary school teacher taught a grade 3/4 split class and the two secondary school teachers worked in the resource classroom. The letter of information provided the teachers with the purpose and rationale of the research and outlined their role in the study. The teachers were then provided an informed consent to review and sign prior to taking part in the information session. The teachers of both classrooms distributed consent forms to all the students in each classroom. The consent forms for the elementary school class were directed to the parent/guardian whereas the consent form for secondary school student was directed to both the parent/guardian and the student themselves. In the latter case, informed consent from both the parent/guardian and the student was required in order for the student to participate in the study. Students who did not have consent to take part in the study were still able to utilize the modified exercise bicycle but no data was collected from them.

### **Participants**

A total of 24 students in the elementary school classroom and two students in the secondary school resource room consented to be participants in the study.

### **Procedure**

The three participating teachers attended a full day information session about the study at the PVNCCDSB head office main conference room prior to the start of the study. This information session took place within the second term for elementary schools and the second semester for secondary schools. The exercise bicycles were delivered to the schools following this information session and then monthly emails were sent (February to May 2017) to each participating teacher to check on what was working and not working in regards to having the bicycles in the classroom. The bicycles remained in the

chosen classrooms for the rest of the school year (until June 2017). Students were provided access to the exercise bicycle in their classroom to be utilized throughout the school week. Students were instructed on how to utilize the bicycle safely via teacher demonstrations in the initial week of having the bicycle placed within their classroom. Students were asked to complete an entry in an individualized logbook sheet that documented: date, time on the bicycle, time off the bicycle, subject they were in, and whether they were using the bicycle to get energy or get rid of energy. The students in the elementary classroom kept their logbook sheets in a binder with individualized dividers close to the bicycle and students who used the secondary school resource room kept their logbook sheets in individualized folders in the resource room near the bicycle. The logbook sheet for both the elementary and secondary school students can be found in Appendix A and B respectively.

At the end of the school year (June 2017), a debriefing session with the participating teachers was held at the school board head office conference room to discuss the study as a whole. In addition, teachers were asked about their views and ideas regarding utilization of an exercise bicycle in their classrooms. The exercise bicycles were donated to each participating school for their use.

## **Measures**

**Information session.** The full day information session briefed the teachers and principals on all methods and data analysis procedures. The morning portion was spent discussing the study purpose and rationale, self-regulation and access to physical activity in the classroom, and the board's Mental Health Strategy. After a provided lunch, the afternoon portion included tips on introducing the bicycles into the classroom and

reviewing in detail the study method and data collection procedures. In addition, a safety overview demonstration was conducted by the research team to ensure relevant personnel in the participating schools were versed on the safety parameters of the exercise bicycle they had received. Each school was provided with an information package of how to utilize the safety features of each bicycle, as well as an instruction/safety manual from the bicycle manufacturer. The informational session agenda can be seen in Appendix C.

**Student usage of the exercise bicycle.** Student usage of the exercise bicycle was documented using an individualized log sheet. Students were asked to document on the log sheet the following information: date, subject in which they were using the bicycle within, the time they got on the bicycle, the time they got off the bicycle, and to identify whether they were using the bicycle to “get energy” or “get rid of energy”. The terms “get energy” and “get rid of energy” were selected to serve as a simplified way of asking the student to select which state of arousal they identified with. The elementary school student’s log sheet included an additional question for students to identify how they felt before and after they used the bicycle, via the selection of either a smiling or frowning emoticon (see Appendix A).

**Teacher observations.** Teachers provided the research team with monthly observations about the exercise bicycle’s integration into the classroom environment via email correspondence with the research team. Each teacher was asked to provide information regarding the following: 1) what has been working, 2) what has not been working, and 3) general comments, questions, or concerns. These responses were collated and anonymized into a secure document for qualitative data analysis purposes. Teacher responses were also collected during the debriefing session, which was used to discuss



the implementation, concerns, and challenges associated with having an exercise bicycle placed within the classroom setting in an open-ended discussion format. The topics discussed at the debriefing session included: Implementation, placement considerations, engagement levels, benefits for certain populations, future research methods, avoidance of the bicycle, overall impact, and next steps. The topics discussed by the teachers in the debriefing session were scribed by a member of the research team into a secure anonymous document and divided by each school (see Appendix D and E).

**Debriefing session.** After a 3.5-month period of data collection, the participating schools were contacted to determine a date to schedule a debriefing session. A debriefing session was organized to have teachers and principals share their experiences about having the exercise bicycle within the classroom. The debriefing session was held at the school board's head office conference room.

The debriefing session was not audio-recorded; however, teachers and principals consented to have their responses scribed by two members of the research team. Responses including what the teachers felt they would start doing, stop doing, and continue doing in relation to the exercise bicycles within their classroom. Responses from the teachers and principals centered around topics that pertained to access to an exercise bicycle in the classroom such as methods of introducing the bicycle to their students and placement considerations of the bicycle. This latter topic was of particular interest as teachers noted that the exercise bicycle had to be accessible but also be a minimal distraction. The teachers' perceptions of the student engagement levels with the bicycle were also reviewed (e.g., differences between elementary and secondary school students, avoidance of the bicycle at the secondary school) and teachers also provided their

opinions of who they felt could benefit the most from access to an exercise bicycle. They also highlighted their ideas for future research to provide context for moving forward with research in this area.

### **Data Analysis Approach**

Two different approaches were used in order to explore the teacher and student observations: 1) quantitative statistics for student usage of the exercise bicycle and 2) thematic content analysis for the teacher observations.

### **Quantitative Analysis**

Prior to submitting the logbooks to the researchers, the teachers removed any identifiable information so that all student responses were anonymous. In addition, two student logbooks from the elementary school group were withheld because the two students did not consent to take part within the study. Frequency and duration of time spent utilizing the exercise bicycle were calculated. In addition, counts of the academic subject(s) students were engaged in when the bicycle was used were calculated to determine the class academic subject(s) in which the bicycle was most often utilized.

### **Qualitative Analysis**

**Thematic content analysis.** Thematic content analysis was applied to the teacher observations collected via email in order to explore themes regarding the integration of exercise bicycles in the classroom or school environment to facilitate self-regulation. Teacher responses scribed from the debriefing session were summarized and were not included in the thematic content analysis process.

**Process of Thematic Content Analysis.** Thematic content analysis, as outlined by Braun and Clarke (2006), was used to analyze all the data obtained from the teachers.

Thematic content analysis is a form of qualitative data analysis that allows researchers to examine responses from participants for common themes to further understand the experiences and perceptions of those participants. All teacher observations collected via email correspondence were anonymized and then reviewed for emerging themes. Descriptive codes were created by the principal investigator, which provided short descriptions of the teacher observations, for sentence or passage. For example, if a teacher noted that all students wanted to try the bicycle on the first day, a descriptive code for this sentence would be student excitement or implementation. These descriptive codes were compiled, and the principal investigator reviewed the list of descriptive codes to note any commonalities. Then, the principal investigator went back to the observations to review sections that contained similar descriptive codes in order to compare them for similar thematic content and identify the major themes that were present. Select passages from the teacher observations were included in the results section to highlight each theme.

**Reflexivity.** Multiple steps were completed to ensure reflexivity throughout the data collection and analysis procedures of the study. Reflexivity is important to safeguard against potential personal biases that could have an impact on the thematic content analysis procedure. After the principal investigator extracted emerging themes from the teacher observations, a member of the research team reviewed the descriptive code list alongside the data to check that the descriptive codes represented the data provided by the teachers. The descriptive codes and preliminary themes were confirmed by having both the principal investigator and a research team member agree on the descriptive codes and themes in the data provided.

To ensure validity of the extracted themes and that the process of theme development was completed without bias, cross-validation of themes was conducted. Once the descriptive codes were established through approval by a member of the research team, the principal investigator formulated the themes noted to be present within the data. Once these themes were determined, a member of the research team reviewed them and provided feedback regarding the theme descriptor. Based on the feedback provided, minor changes to the theme descriptor were suggested (e.g. changing the description of a select theme from *individual students* to *individual differences*). The updated theme descriptors were reviewed by another member of the research team in order to reach agreement that the descriptors for the themes were representative of the observations.

## **Results**

### **Student Usage of the Exercise Bicycle**

**Elementary school students.** Anonymized student log sheets were used to calculate frequency and duration of time spent utilizing the exercise bicycle, the different academic subjects students were being taught when they used the exercise bicycle, and whether the students identified the reason for use as either “get energy” or “get rid of energy”. Any incomplete entry was removed and not considered when descriptive statistics were calculated. The elementary school students ( $n = 12$ ) spent an average of 6.58 minutes on the exercise bicycle ( $SD = 2.99$ , range: 2-16 minutes). A count of the different academic subjects that participants were engaged in when the bicycle was used showed that students utilized the bicycle most frequently during French (12 recorded uses), followed by: Lunch/Snack breaks (6 recorded uses), Math (4 recorded uses),

Science (3 recorded uses), Religion (3 recorded uses), and Writing (2 recorded uses).

There was 1 recorded use for each of the following subjects: Gym, Bell Work, and Desk Clean. The majority of the sample indicated that they utilized the bicycle to get rid of energy (62% of log entries), with 39% of log entries indicating that they used the bicycle to get energy.

Elementary students were also asked to identify how they felt when getting on the bicycle and getting off the bicycle by selected either a smiling emoticon to represent positive emotions or a frowning emoticon to represent negative emotions. Out of the 24 completed log book entries, the majority of entries by the students indicated that they felt positive when they got on and off the bicycle (21 recorded entries). The remaining three entries included the selection of negative emotions: one student circled the negative emoticons both when they got on and off the bicycle and in two entries the students circled the positive emoticon getting on the bicycle and then circled the negative emoticon getting off the bicycle.

**Secondary school students.** Students in the secondary school sample ( $n = 2$ ) spent a longer period of time on the bicycle on average than the elementary school sample ( $M = 9.64$  minutes,  $SD = 4.01$ , range: 5-15 minutes). The two secondary students utilized the bicycle most frequently during Science (6 recorded uses), followed by: Math (4 recorded uses), Geography (3 recorded uses), Religion (3 recorded uses), English and Resource (both had 1 recorded use). As for the reason identified for utilizing the bicycle, one student indicated in their logbook that they used the bicycle to get energy, whereas the other student noted in their entries that they used the bicycle to get rid of energy.

### **Teacher Observations**

Observations from the teachers (i.e., what was working, what was not working, any other pertinent information) were collected via email correspondence throughout the duration of the study. The complete email correspondence for both schools can be found in Appendix F. A thematic content analysis was completed to understand the teacher's experiences navigating the integration of an exercise bicycle into their classroom. The collected teacher observations indicated three main themes: 1) usage of the bicycle, 2) individual differences in bicycle usage, and 3) challenges with the bicycle in the classroom.

**Usage of the bicycle.** The main theme of bicycle usage was subdivided into two subthemes: a) reason for usage and b) progression of bicycle usage. This division was used to allow for a greater understanding of the bicycle's usage within the classroom environment.

*Reason for usage.* The reason for using the bicycle was a consistent subtheme that was present in the teachers' observations. Teachers from both the elementary and secondary school noted that students appeared to utilize the bicycle for different reasons.

*Elementary school.* The elementary teacher mentioned that a student informed her that the bicycle was a "good workout not too hard or too easy." The teacher also mentioned that, "Often the bike is being used for getting rid of energy rather than getting energy." In addition, the same teacher noted that the students used the bicycle to promote positive feelings, she said "most students indicate that they are happy when they begin using it and happy after they use it."

*Secondary school.* The secondary school teacher also noted that she believed the students that utilized the bicycle within the resource classroom were appearing to use the

bicycle to change their state of regulation, stating “[the] students use the bike regularly to up-regulate/down-regulate.”

*Progression of bicycle usage.* In addition to the reason for using the bicycle, a subtheme of how bicycle usage changed over the course of the data collection was also noted.

*Elementary school.* At the beginning of the data collection period, the elementary teacher noted the bicycle was used “organically as the students feel the[y] need to use it.” In addition, the teacher also noted a time specific trend for bicycle usage, stating “[I’ve noticed] a trend of the bike being used in the afternoon mostly.” She stated that because they return from recess to attend class immediately after, she felt that it was heavily used after this transitional period from free time to instructional time. However, as the data collection period went into its second month the elementary teacher noticed a decline stating, “in the last month I have noticed the usage of the bike decline.” Ultimately, by the end of the data collection period, the same teacher noted zero changes in usage, “I haven’t noticed any change since the last time I wrote.” Therefore, the usage of the bicycle in the elementary classroom ultimately declined across the data collection period.

*Secondary school.* The teacher from the secondary school noted a different progression of usage as there were only two students who used the bicycle throughout the data collection period. In her first email correspondence the teacher noted, “I am having a little trouble getting permission forms back from students, but some are in and we have started filling out the tracking sheets.” In her second email correspondence, the teacher highlighted the positive changes in bicycle usage, stating that “the good news is that for the students who have returned the paperwork to participate in the study the Spark bike is

working out beautifully.”

**Individual differences in bicycle usage.** Another theme that was apparent after analyzing teacher observations was that the bicycle appeared useful for certain students who required support to maintain attention or focus within the classroom.

*Elementary school.* The elementary teacher explained her experience working to help students with attentional concerns to use the bicycle:

“What I am trying now is to assist students with times when they need the bike, e.g., students who have difficulty sitting for instructions, students [who] are not paying attention or [who are] fidgety or who are talking a lot[.] I am asking them to try the bike and explaining why to them. They are often indicating that they do feel better after using the bike and I would have to agree that it is leading to more focus.”

She also noted other observations like “my most active (hyper or fidgety) kids are using it,” and “I use it for kids that can't sit during instruction or are distracted. I find it helps them and me.” All of these observations collected from the elementary teacher suggest that she felt that the bicycle might be most beneficial for specific students, like those with attentional deficits.

*Secondary school.* The secondary school teacher did not note any individual differences between the two students who utilized the bicycle during the data collection period. The teacher’s comments regarding the students she felt benefited the most in the secondary school resource room were noted at the debriefing session and are included in the debriefing session results section.

**Challenges with the bicycle in the classroom.** The teachers noted different



challenges associated with having the bicycle in the classroom.

*Elementary school.* The elementary teacher noted one challenge that she faced was the sharp decline in usage of the bicycle (“in the last month I have noticed the usage of the bike decline”). She felt she needed to encourage certain students to use the bicycle (the ones she felt would benefit) rather than the students deciding to use the bicycle on their own volition.

*Secondary school.* The secondary school teacher noted that there were a very small number of students using the bicycle, stating “we don't have a large number of students accessing the bicycle.” In the secondary school the bicycle was placed in the resource room, where approximately 30 students had access to it during the semester the data was collected yet the teachers noted that they found that only two students were interested in using the bicycle. Comments regarding the challenges around getting students to use the bicycle were also made in the debriefing session and will be summarized below.

### **Debriefing Session**

As the debriefing session was not audio-recorded, the notes collected by the principal investigator will be summarized. The topic areas that were discussed at the debriefing session were: 1) implementation, 2) placement considerations for the bicycle, 3) perceptions of which students benefited, 4) avoidance of the bicycle, and 5) engagement levels, 6) research methods, and 7) perceived overall impact. In addition, personnel at both schools were asked to provide the research team with feedback regarding what they would stop doing, ideas to start doing, and what they would continue doing with the Spark Bike within their class and/or school.

**Implementation.** This topic area was selected by the research team to provide context into how the teachers implemented the bicycles, and to note of any issues that arose during this process.

*Elementary school.* The elementary teacher mentioned that she had students learn the proper way to document their log sheet within the first few days of having the bicycle in the classroom. The elementary teacher also noted that when the bicycle was first placed in the classroom, she felt that students who had difficulty sitting still for longer periods of time gravitated toward using the bicycle almost immediately.

School personnel noted various suggestions they believed would help with the implementation of the Spark Bike in other classrooms or future research studies. The first suggestion was the addition of a timer or a clock to assist students with tracking time spent on the bicycle, which could eliminate any chance of a lineup occurring. The elementary teacher also mentioned that incorporating a schedule for initial usage, where she could show each student how to operate and adjust the bicycle, would help each student to be more comfortable with using and adjusting the height of the bicycle seat.

One major issue put forth by the teacher with respect to implementation in the elementary classroom was the constant need for supervision of children who require additional support. The teacher found that students that required one on one support during instructional time also needed it when utilizing the bicycle. The teacher noted that another major issue that came to light when implementing the bicycle into the grade three/four classroom was a jealousy factor from other teachers and parents within the school. The teacher indicated that there was a fair amount of dissatisfaction from other teachers and parents that their classrooms did not have a Spark Bike.

It was also suggested by the teacher that the use of a standing desk in conjunction with the bicycle would be beneficial to have from the start to allow students to become comfortable with doing work while using the bicycle. As well, developing a strategy for the bicycle to be accessible for multiple classrooms in the school was an additional suggestion from the teacher. This proposed strategy by the elementary school would see three bicycles placed in consecutive grades to allow students to have access to the bicycle for multiple years within the school.

*Secondary school.* The secondary school group implemented their bicycle in a different way in comparison to the elementary group. Their bicycle was located in the school's resource room rather than a specific classroom to target access to students who utilized the resource room for various subjects throughout their school day. They also implemented the Spark Bike with an additional accessory of a stand-up table to allow students to complete schoolwork while still using the bicycle.

The secondary school teachers had multiple suggestions for implementing the bicycle within a secondary school environment in the future. They stated that it would be beneficial to have two bicycles within the school; one to keep in the resource room and one to loan out to different classrooms during the school year. By incorporating two bicycles into their school, they felt this would allow one to be always available in the resource room, while the bicycle loaned out to different classrooms would allow access to other staff and students within the secondary school.

The secondary school teachers noted that they felt that awareness of the bicycle could be more widespread within their school community to allow more students, teachers, and parents to become aware of the Spark Bike in the school. Suggestions to

increase awareness included lending the bicycle to each classroom for multiple days at the start of the school year, advertise the bicycle, or hold an information session on the Spark Bike. They also mentioned that walking breaks, which is a strategy currently used by students to calm down during high stress moments throughout the day, could be substituted with time spent on the bicycle. The secondary staff stated that they felt that this could also help to eliminate the occurrence of students loitering within the halls while taking these walking breaks from class. The two staff also noted that incorporating a different form of physical activity besides the exercise bicycle could provide different options for students to choose from.

The secondary school staff also mentioned that there would be a few major changes they would consider if they chose to continue using Spark Bikes in their school. They felt that these changes would help to address challenges the bicycle presented within the resource room. First, they mentioned that they would like to implement the bicycle so that students would be required to try the bicycle. In addition, they stated that they were interested in increasing the number of tools used for facilitating self-regulation in their resource room (e.g., wobble or pedal boards).

**Placement considerations.** In addition to the implementation process, the topic of placement of the bicycle within the room was discussed with the school staff. This topic was covered in the debriefing session in order to understand what the teachers felt needed to be considered when thinking about the placement of the bicycle.

*Elementary school.* In the elementary school, the teacher mentioned that she tried multiple placements initially for the bicycle but settled on one specific location for the remainder of the semester. She noted that the placement that she found worked best for

students was to have the bicycle turned toward and in the line of instruction. She believed that this allowed the student to be continually engaged in the instructional content. She also mentioned that the best placement was away from other students' desks so the student on the bicycle could still focus on what was taking place within the classroom. She suggested not to place the bicycle near a pathway because it created added risk for those walking past the bicycle when it was in use. Other safety issues she noted that arose with the bicycle's placement were also discussed. It was noted by the teacher that having students use electronics such as laptops or tablets near the bicycle created a hazard for the student who was using the bicycle. This became evident when the laptops and tablets need to be charged and the cords had to be plugged in within the vicinity of the bicycle. The teacher felt that this increased the risk of cords getting caught in the bicycle or a student tripping over them.

In addition to placement issues, the teacher noted that the bicycle would shift forward after it was used due to the force exertion from the student pedalling. She stated that this created an issue as it moved into the pathways used to get around the classroom. This proved to be problematic as the bicycle was too heavy for any student to move, so it then required the teacher to move it constantly back into its proper place throughout the data collection period.

***Secondary school.*** The staff at the secondary school had different considerations regarding of bicycle placement compared to the elementary school staff. They found that because it was in the resource room where multiple students could be working at the same time, the Spark Bike had to be placed behind a partition. They stated that this allowed for privacy for individuals using the bicycle while they were in the resource

room. The secondary school staff noted that blocking off the bicycle proved to be beneficial for adolescents as the staff felt it allowed for greater focus on the task and minimized social factors that could be deterring the student from using the bicycle (e.g., being worried about what they look like on the bicycle, feeling worried about who may see them use it, the possibility of being bullied for using the bicycle). The staff also mentioned that the partition made the bicycle less visible to the other students and suggested that the partition be movable/foldable to provide students using the bicycle with an option for privacy.

The major concern that was mentioned by the secondary school was in regard to the placement of the bicycle and the use of electronics. As they had students utilize the bicycle when they were working on school work, completing assignments or tests, safety hazards were of concern. A stand-up desk was placed in front of the bicycle to allow students to complete work. As a result, there were additional safety precautions that needed to be considered with respect to the table itself and cords from electronic devices (e.g., laptops) being used by the student.

**Which students benefited.** Both schools were asked to provide the research team with their perceptions of which students benefited the most from the inclusion of a Spark Bike within their classroom environment.

***Elementary school.*** The teacher from the elementary school felt that students who had difficulty sitting found the bicycle to be of benefit. She thought that the bicycle allowed the students to continue to move, but also allowed them to pay attention to her instruction. She also felt that students who were unable to let go of various issues, either social or emotional, seemed to find the bicycle effective at aiding them to increase or

decrease their energy levels. Lastly, she noted that she felt that students who had difficulty with transitions in classes or going from unstructured to structured activities, found the bicycle to be useful.

***Secondary school.*** The secondary school group thought that students that used the bicycle did not respond to other strategies for self-regulation in order to be able to complete their work. The staff mentioned that they noticed that the students who used the bicycle did not respond to traditional techniques, like prompting, yet responded very well to the use of the Spark Bike.

**Avoidance of the bicycle.** This discussion topic was covered to understand where the teachers noted any avoidance of the bicycle within their classrooms.

***Elementary school.*** The teacher at the elementary school mentioned that there were some students who felt they did not need to use the bicycle. In addition, she felt that some students avoided using the bicycle because they were unaware that they were allowed to use it. The teacher highlighted an example of this, where that multiple students asked each time if they could use the bicycle rather than using it without asking first.

***Secondary school.*** At the secondary school level, the staff noticed that students who chose not to use, or avoided, the bicycle were concerned about being judged for using it. The staff mentioned that it appeared that students were worried that they would be viewed negatively by their peers, making this a major deciding factor in their avoidance of the bicycle.

**Engagement levels.** This section was included in the debriefing session to gain an understanding of the student engagement with the bicycle and to note any trends of engagement that the teachers may have seen occur.

***Elementary school.*** The elementary school teacher noted that she saw changes in engagement levels throughout the time the bicycle was in the class. The teacher stated that initially students were extremely excited, and everyone wanted to use the bicycle. After this initial phase was over, the teacher noticed that the use of the bicycle stopped abruptly. However, towards the end of the school year, she noted that she used prompting techniques to recommend bicycle use to students that she thought would benefit from it. She felt that this increased the bicycle usage, but only with the students who had been actively using the bicycle previously. The teacher stated that eight students out of a possible 24 students utilized the bicycle consistently throughout the school year.

***Secondary school.*** The staff at the secondary school found engagement levels to be very different from the elementary school, as they saw the same students use the bicycle consistently from its introduction to the resource room. They stated that two students out of a possible 30 students who used the resource room at the secondary level utilized the Spark Bike.

***Research methods.*** For future research into the use of Spark Bikes within classrooms to aid in facilitating self-regulation, we asked both school groups to share suggestions they had for any alterations to the research process.

***Elementary school.*** The elementary school teacher stated that she found the email correspondence to be beneficial because she could reflect on the past month and any trends or issues. It was noted, however, that more structure for the observation correspondence would be effective for the teacher to track progress over the school year. She also shared suggestions for how to modify the research method for the benefit of all parties involved. One suggestion was the inclusion of a survey for the students to



complete at the end of the study so that the students could rate effectiveness, detail their own experience, and even share suggestions. The teacher also thought discussions among the other teachers/administrators utilizing the Spark Bike would allow these individuals to share what works and learn new ways to facilitate the bicycle's usage. A final suggestion from the teacher was to incorporate a clock to allow for greater accuracy with the log times as she noted that the children in the younger grade had a hard time logging the correct time.

***Secondary school.*** The secondary school staff highlighted guidelines that they would continue doing and some suggestions to aid in the application of the bicycle within a secondary school setting. The staff found the introductory information session was beneficial and that having the background knowledge of self-regulation and bicycle safety guidelines was useful. It was also mentioned that the log book was simple and easy to use. Finally, the staff mentioned that the use of email correspondence was effective because it made them review the log sheets to check the progress of the individuals using the bicycle. The teachers suggested that adapting the log sheet into a digital form would be an effective change for adolescents as this would allow students to gain access to a log sheet via an iPad or a tablet of their choice. They suggested this type of adaptation because they felt that most older students within a secondary school setting prefer to use technology to record their bicycle use over a logbook.

***Overall impact.*** During the debriefing session, both school teachers were asked to give their personal insight into what impact they believed the bicycles had within their classroom. Each school was also asked to include any modifications they would recommend for future bicycle usage.

*Elementary school.* The elementary teacher felt that the bicycle assisted with decreasing overall class distraction to an extent. She noted that she felt that there were improvements in the written work completed by students who used the bicycle consistently. The teacher, however, found that it was hard to measure the impact the bicycle had on the students when only the log sheet documentation was available. She suggested that after one month of bicycle use in the classroom, specific students who utilized the bicycle could be selected to track their individual progress more closely in the future

*Secondary school.* The secondary school teachers felt that the bicycle was impactful for students who had difficulty with test taking. They also felt that some students found the bicycle helped with alertness and focus while writing a test. They thought that the bicycle allowed students to develop self-awareness of when they needed to self-regulate. A main concern of the teachers was that they felt that some students would be using the bicycle as an avoidance measure to evade completing required work.

### **Discussion**

The aim of this study was to explore the facilitation of self-regulation through physical activity via access to a stationary bicycle placed in both an elementary and secondary school classroom. Upon review of the quantitative data collected from the student participants and the qualitative data collected from the teacher participants via observations and the debriefing session, multiple key findings were apparent.

#### **Student Usage of the Exercise Bicycle**

The current study sought to explore the following questions regarding student bicycle usage: 1) Who is using the bicycle during the school day, 2) Why is the student

using the bicycle, and 3) When is the bicycle being utilized during the day?

**Elementary school.** Approximately 50% of the students used the bicycle frequently throughout the course of the study. In the elementary classroom, the bicycles were used for the majority of the time within the afternoon. This could be attributed to the shift in our circadian rhythm, where there can be a strong dip around 1-3 pm, which can result in a biological shift in energy production where an individual may experience an *afternoon slump* (National Sleep Foundation, 2019). This biological shift could possibly explain the higher amount of documented bicycle usage within the afternoon session of the elementary school day. The students also used the bicycle most frequently during the French and Snack/Lunch periods. These are periods where the student has a change in their routine, either changing the language of instruction or moving to no instruction during an eating period. The elementary student logs indicated that 63% of logged uses were to get rid of energy, whereas 40% of logged uses were to help them get energy. Therefore, the elementary school student logbooks had more entries where the student identified the use as ‘get rid of energy’ than entries that identified the use as ‘get energy.’

**Secondary school.** Only 6% of the students who utilized the resource room during the data collection period accessed the exercise bicycle. Similar to the elementary students, the secondary students utilized the bicycle most often in the afternoon, which might be linked to the students’ experiencing an *afternoon slump* in energy (National Sleep Foundation, 2019). The secondary school students used the bicycle most frequently when working on math and science. It is possible that this is related to increases in cognitive performance. Research shows that exercise is beneficial because it might allow

students to process information in a more effective way (Tomporowski, McCullick, Pendleton & Pesce, 2015). Of the two secondary students who used the exercise bicycle, one student noted in their logbook that they identified the reason for using the bicycle as ‘get rid of energy’ only, whereas the second student documented in their logbook that they identified the reason for using the bicycle as ‘get energy’ only.

### **Teacher Observations**

Thematic analysis of the teacher observations collected via the email correspondence showed three main themes: usage of the bicycle, individual differences with bicycle usage, and challenges with the bicycle in the classroom.

**Elementary school.** The teacher stated that the usage of the bicycle was high in the beginning, when the teacher first introduced the bicycle to the students. However, she noted that there was a sharp decrease in overall usage noted towards the end of the data collection period. With this decrease, the teacher then decided to prompt students to use the bicycle. This suggests the bicycle might have been a novelty item, with large amounts of interest initially that decreased over the course of time.

Another theme that was apparent was that of individual differences associated with bicycle usage. The elementary teacher noted that she felt that the bicycle worked well for some students more than others, specifically students who had difficulty sitting still. The elementary teacher stated that she felt that students who had difficulty with attention or focus seemed to benefit from the bicycle within the classroom more so than students without these difficulties.

The final theme that emerged with respect to challenges with the bicycle in the classroom, was the decline of bicycle usage. The elementary teacher stated, “In the last

month I have noticed the usage of the bike decline.” At the debriefing session, the elementary teacher stated that approximately three months into the data collection period, she had no students utilizing the bicycle, until she began the task of prompting students to use it. This challenge noted lends support to the notion that the bicycle may have been a novelty item to the elementary students, where the students used the bicycle in the first few months followed by a sharp decline as the interest in the ‘new’ classroom equipment dissipated.

**Secondary school.** The secondary teacher noted that she experienced difficulty getting students to try or utilize the bicycle, as only two students used the bicycle during the data collection period. The secondary teacher did not note any specific differences between the two students in her email correspondence. However, during the debriefing session the secondary teacher did make a comment about the two students who used the bicycle and those who avoided it altogether. She thought that the major challenge they faced was recruitment of students to utilize the bicycle. Since the bicycle was placed within the resource classroom of the secondary school and students did not spend their entire school day within the classroom, there was limited access to the bicycle.

### **Debriefing Session**

The main findings from the debriefing session are in the following areas: 1) implementation, 2) placement considerations for the bicycle, 3) perceptions of which students benefited, 4) avoidance of the bicycle, and 5) engagement levels, 6) research methods, and 7) perceived overall impact. During the debriefing session, teachers made it clear that implementation of an exercise bicycle in a school environment is not a simple feat.

**Elementary school.** The elementary teacher noted that in order to implement an exercise bicycle into a classroom, it is imperative to ask questions such as: where do we place the bicycle or how can students track their time on the bicycle? She also noted that although the students were provided with the training, which they received at the start of the data collection period, how could they ensure that all students were able to use the bicycle safely. Therefore, the reflections from the elementary teacher showed that there are factors and variables that are different from classroom to classroom and need to be taken into consideration prior to the implementation of an exercise bicycle.

As well, the elementary teacher noted that placement of the bicycle was important. She felt that the bicycle had to be placed so that students could focus on the instruction occurring and not be distracted by the bicycle. As well, she noted that the bicycle had to be in a place that eliminated any safety hazards (e.g., cords for computers). The elementary teacher felt that the bicycle was a great tool for certain students within their classroom. Specifically, she thought that students who could not sit still or were constantly moving in the classroom, had a higher incidence of social-emotional problems, or had difficulty with transitioning from activities or lessons benefited the most.

In reference to engagement with the bicycle, the pattern of high to low engagement over the data collection period resulted in the elementary teacher trying different types of prompts to increase engagement levels. This pattern of engagement suggests that there was an element of novelty with the bicycle so that it received a great deal of attention first, only to lose its appeal quickly. Overall, the elementary teacher believed that the students appeared to improve on written work and experience a decrease in overall class distractions. However, the elementary teacher noted that impact was hard

to measure objectively as there were many other factors that could have been contributing to the improvements she felt were occurring.

**Secondary school.** The secondary school teacher noted that implementation of the bicycle was different in a secondary school compared to an elementary due to the difference in organizational structure. As secondary schools follow a rotary classroom schedule, students are not in the same classroom all day. Therefore, the secondary school teacher thought that placement of the bicycle would be a major decision when it came to the implementation process of an exercise bicycle in a secondary school setting. She stated that in a secondary setting, the placement of bicycle is critical to ensure the greatest number of students would use it.

Avoidance of the bicycle was noted as an issue by the secondary teacher. The teacher mentioned that when they asked students why they did not use the bicycle, the students stated that they were worried about being judged for using the bicycle. She thought that it was possible that the students may have felt self-conscious using the bicycle or being visible to others, which might have acted as a major deterrent for some secondary school students. The secondary teacher felt that worries over judgment could have resulted in avoidance of the bicycle and explain why only two students used the bicycle for the whole period of data collection. Overall, the teacher stated that she felt that the two secondary students who used the bicycle seemed to have better concentration while taking a test on the bicycle.

### **Summary and Future Directions**

This study explored the facilitation of self-regulation via access to an exercise bicycle within an elementary and secondary setting. The teacher observations and student

usage data suggest a ‘novelty effect’ with the exercise bicycle in the elementary classroom. The exercise bicycle was new and different initially; however, it lost its appeal over time. Students used the bicycle more so within the first month compared to the subsequent months. As well, the teachers noted that the novelty of a foreign object in the class is what they felt drove the bike’s initial usage. Therefore, it would be important to examine the best way to mitigate the novelty effect that can occur when new items are integrated into a classroom environment and ensure regular or consistent use of the item.

Teachers noted that although they felt that the bicycles were positive additions to their classrooms for the most part; there were multiple factors that needed to be taken into consideration in order to understand the bicycle’s impact. There were a number of extraneous variables within the classroom setting that could have played a role in the differentiated experiences with the bicycles across both schools and all participants. These variables include but are not limited to how the bike was implemented, where it was placed, and the level of engagement that was being exhibited. In order to proceed with further research, it would be important to consider these factors when designing follow-up studies.

The current study was a preliminary one, using both quantitative and qualitative measures. For the purposes of the current study these types of data are useful for exploring personal experiences, however specific conclusions about the impact exercise bicycles can have on students and their ability to self-regulate cannot be conclusively determined. Future research is required that examines specific classrooms over a longer period of time to track consistency across the school year using pre and post measures of self-regulation, as well as a randomized design to test the bicycle’s efficacy on



facilitating self-regulation within a classroom environment.

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**Appendix A**  
**Elementary School Logbook**

Log Book for: \_\_\_\_\_

Date	Subject	Time on	How do you feel? Circle one!	Time off	How do you feel? Circle one!	Reason why you used the bike Circle one!
			<input type="radio"/>  <input type="radio"/> 		<input type="radio"/>  <input type="radio"/> 	GET ENERGY  GET RID OF ENERGY
			<input type="radio"/>  <input type="radio"/> 		<input type="radio"/>  <input type="radio"/> 	GET ENERGY  GET RID OF ENERGY
			<input type="radio"/>  <input type="radio"/> 		<input type="radio"/>  <input type="radio"/> 	GET ENERGY  GET RID OF ENERGY
			<input type="radio"/>  <input type="radio"/> 		<input type="radio"/>  <input type="radio"/> 	GET ENERGY  GET RID OF ENERGY
			<input type="radio"/>  <input type="radio"/> 		<input type="radio"/>  <input type="radio"/> 	GET ENERGY  GET RID OF ENERGY

**Appendix B**  
**Secondary School Log Book**



1600 West Bank Drive  
 Peterborough, ON Canada K9J 7B8  
 Telephone: (705) 748-1011 x7535

Log Book for: \_\_\_\_\_

Date	Subject	Time on	Time off	Reason why you used the bike Circle one!
				GET ENERGY GET RID OF ENERGY
				GET ENERGY GET RID OF ENERGY
				GET ENERGY GET RID OF ENERGY
				GET ENERGY GET RID OF ENERGY
				GET ENERGY GET RID OF ENERGY

**Appendix C**  
**Information Session Agenda**



## Spark Bike Information Workshop

February 10, 2017

### Tentative Agenda

**9:00-9:30 a.m.** - Study purpose and rationale

**9:30-11:30 a.m.** – Introduction to self-regulation

**11:30-1:00 p.m.** - Lunch provided

**1:00-2:00 p.m.** - Tips on introducing the bike to the classroom

**2:00-2:30 p.m.** - Log books/informational letters/consent forms

**2:30-3:00 p.m.** - Bike safety/set up and data collection protocols

**Appendix D**

**Elementary School Debriefing Session Summary**



SECTION	GREEN	YELLOW	RED
IMPLEMENTATION	<p>Not disruptive to classroom learning, enhancement rather than a disruption</p> <p>Bikes focused toward instruction</p> <p>Students were the ones logging the bike uses and not the teachers</p> <p>Simple log sheet, useful to look at who is using the bike and why (time of day/subject)</p> <p>Students in a constant state of motion benefitted</p>	<p>Using a timer, in case of a lineup</p> <p>Rotate students through a rotation at the beginning to allow for the students to become accustomed to the bike</p> <p>Students asked to use the bike when no one was using the bike</p>	<p>High needs, need supervision on the bike</p> <p>Jealousy factor, want of bikes in every room (parents/teachers)</p> <p>Add stand up desk</p> <p>3-year plan, developing a strategy to have the bike accessible, be able to track 4 to 5, 5 to 6</p>
Notes: Distraction factor- fidget toys			
PLACEMENT CONSIDERATIONS	<p>Needed to be in line of instruction</p> <p>Away from other students or stand up table</p> <p>Would be nice to move the bike around, i.e. Near a window</p>	<p>Bike required to be moved back into place after multiple uses</p> <p>Not to place a bike in a pathway</p> <p>Rotate the bike</p>	<p>Using a laptop, double checking the use of electronics and the cords used</p> <p>Mixture of the cords and a pathway</p>
<p>Engagement levels:</p> <p>Beginning: all excited, everyone excited to use the bike</p> <p>Middle: stopped completely</p> <p>End: Recruitment to use the bike</p> <p>8/24 used consistently</p>			
<p>Who Benefits:</p> <p>Students who are constantly in a state of arousal, allow them to move but also be paying attention</p> <p>Students who cannot let go of various issues (social/emotional) were benefitting from the bike</p> <p>Students coming from unstructured (recess) breaks back into classroom</p> <p>Transitions specifically *U of Guelph: movement of feet does not interfere with the ability to engage in cognition, hand movement does</p>			

RESEARCH METHODS	Informal observations were beneficial More structure around the feedback, what should be given as feedback Include survey at the end for the students of their experience	Do more discussion with other teachers/principals Need a clock, for more accuracy with log book times	Accuracy of times on the log book sheets with younger students hard Use of a hanging folder to book log sheets into
<p>Avoidance: Some students felt they did not need to use the bike A lack of attention/knowing that they could use the bike Another regulated differently, 1 student did not like the bike – he preferred regulation with an adult How do we set goals to get the student to be using the bike, potential concern: ownership of the bike</p>			
IMPACT	More direct instruction as to what is happy or sad Log didn't measure impact Another tool in the toolkit Lessen whole class distraction Track specific marker students, wait 1 month then select Written input well improved	Hard to measure No teacher observations could be done in French class, therefore was it French that caused the increases in use or time of day?	Test taking, does the bike help or hinder?
NEXT STEPS	Tracking students via a longitudinal approach, how can the benefits continue (teacher use/use/efficacy?)	Biweekly attitudinal survey, what would you do if you couldn't use the bike?	Can students ride the bike and complete assignments simultaneously?

**Appendix E**

**Secondary School Debriefing Session Summary**

SECTION	GREEN	YELLOW	RED
IMPLEMENTATION	2 students specifically implemented Access in resource, ideally to have one loan out to classrooms Stand up table as an accessory	Increase awareness, lend the bike or advertise the bike, share the bike through the classrooms at the beginning of the year Substitute walking breaks for bike breaks	More direct approach, has been voluntary in nature, include self-reg tools Wobble boards?
Notes: Distraction factor- fidget toys			
PLACEMENT CONSIDERATIONS	Blocked off is beneficial for adolescents	Consider moving it to make it visible to other students Use of a moveable foldable screen for certain students	Using a laptop, double checking the use of electronics and the cords used
Notes: Engagement through out 2/30 possible students used consistently (however targeted support within the resource room)			
Who benefits: When consistent prompting techniques do not work, they need a shift in activity Students who have tried everything else and nothing has worked *U of Guelph: movement of feet does not interfere with the ability to engage in cognition, hand movement does			
RESEARCH METHODS	Simplicity of the log book tool Workshop beneficial Check in emails helpful to evaluate the log book	Use google form to specify their log times Use specific iPads to Find a way to have older students want to log their bike usage	N/A

<p>Avoidance:  Students who were concerned about the judgement of the bike, social stigma  Perceived they would be viewed differently</p>			
<p>IMPACT</p>	<p>Some students that used the bike for getting energy came as a surprise  Test taking, some students found the bike helped with alertness/focus during testing  -helps with test anxiety?  Allowed for collaboration  Self-awareness, students could recognize when they needed to use the bike  Time on bike couldn't be restricted during the test</p>	<p>Bike could be used as an avoidance measure</p>	<p>Test taking, does the bike help or hinder?</p>
<p>Next Steps:  Wider access for the bike, put the bike in either an open space, would it be then an open space or a loitering area.  Put a bike within a self-reg focused classroom  Expanding the use of the bike within the school</p>			

**Appendix F**

**Email Correspondence (Elementary and Secondary School)**

**Elementary School****March 3, 2017**

Things are going well. I am doing it organically as the students feel the need to use it. I have almost everyone in my class with parent permission forms signed for you.

First Day - I let students try the bike for 5 minutes each, to get the novelty of it. Below are their observations in their own words:

Feb. 15<sup>th</sup> – First Day

-good workout not too hard or too easy

-“the sound is soothing for my ears”

-“I had no clue that a person was even on the bike”

-it is quiet

Each student has their log sheet to complete and below are some of the observations noted:

One student (male) used it once for three minutes to get energy.

One student (female) used it for French for 4 minutes to get rid of energy (this makes sense for this student)

One student (male) used it for Math for 3 minutes to get energy.

One student (female) used it twice during French for approximately 5-6 minutes for both getting energy and getting rid of energy

One student (female) used it during French for 10 minutes to get energy

One student (female) used it after morning recess for 3 minutes to get rid of energy, during French for 9 minutes to get rid of energy, and during a in class dance assignment for 3 minutes to get energy

One student (female) used it during French for 15 minutes to help get rid of energy

Just to let you know French is a common subject that they are using the bike for, French is after last recess. What is interesting to me is that the students who are getting rid of energy are students that I feel need the bike for that exact reason.

**March 30, 2017**

In the last month I have noticed the usage of the bike decline. Often the bike is being used for getting rid of energy rather than getting energy. Trends are still noted in the afternoon especially after last recess. After our lunch recess we do meditation and soft

music so that generally tends to help those with self-regulation issues. What I am trying now is to assist students with times when they need the bike...e.g., students who have difficulty sitting for instructions, students are not paying attention or fidgety or who are talking a lot I am asking them to try the bike and explaining why to them. They are often indicating that they do feel better after using the bike and I would have to agree that it is leading to more focus.

**April 28, 2017**

In looking through my log notes again I am seeing a trend of the bike being used in the afternoon mostly. After lunch and after last recess are the most typical times of use. This makes sense as we often notice a dramatic change in our students behaviour in the afternoon as they have had a long 40 minute time of unstructured activities. Typical use for the bike is to get rid of their energy. Average range of time is 5-10 minutes. My most active (hyper or fidgety) kids are using it. Indoor recess is another time that it is being used frequently. Most students indicate that they are happy when they begin using it and happy after they use it. I do notice that when one person asks to use it I will get a few more after asking to use it. I use it for kids that can't sit during instruction or are distracted. I find it helps them and me. Hope this is helpful!

**May 26, 2017**

I haven't noticed any change since the last time I wrote. However, another teacher purchased a bike with his class and he is finding that if there is a workspace with it students will use it more. I will try it this week and let you know of my observations.

**Secondary School****March 3, 2017**

So far, so good.

I am having a little trouble getting permission forms back from students, but some are in and we have started filling out the tracking sheets.

I like the format of the sheets, they are very easy for students to use. It is great that the sheet directs them to choose between needing energy/getting rid of energy. The students are very capable of identifying for which reason they have accessed the Whisper Bike.

**March 30, 2017**

The good news is that for the students who have returned the paperwork to participate in



the study the Spark bike is working out beautifully. These students use the bike regularly to up-regulate/down-regulate. We don't have a large number of students accessing the bike. However, I will continue to offer the use of the bike for those students who I feel would benefit.

April 28/May 26 - No comments returned