THE EFFECT OF BRAIN BREAKS ON MOTIVATION TO PHYSICAL ACTIVITY, SUSTAINED ATTENTION, SHORT-TERM MEMORY, AND ACADEMIC PERFORMANCE AMONG MALAY PRIMARY SCHOOL CHILDREN

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By

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TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

Page

LIST OF ABBREVIATIONS

AGS	Average Grade Score
DST	Digit Span Test
DVT	Digit Vigilance Test
PA	Physical Activity
PALMS	Physical Activity and Leisure Motivation Scale
PALMS-Y	Physical Activity and Leisure Motivation Scale Youth version
PALMS-Y-M	Physical Activity and Leisure Motivation Scale Youth-Malay version
REMM	Recreational Exercise Motivation Measure
WHO	World Health Organisation

KESAN BRAIN BREAKS KE ATAS MOTIVASI KEPADA AKTIVITI FIZIKAL, PERHATIAN BERTERUSAN, INGATAN JANGKA PENDEK DAN PRESTASI AKADEMIK DALAM KALANGAN KANAK-KANAK MELAYU SEKOLAH RENDAH

ABSTRAK

‘Brain breaks’ adalah video aktiviti fizikal (PA) yang digunakan untuk merangsang kesihatan dan pembelajaran kanak-kanak serta direka bentuk untuk tetapan sekolah. Tujuan kajian ini adalah untuk mengukur kesan penggunaan ‘brain breaks’ terhadap motif penglibatan dalam PA, perhatian yang berterusan, ingatan jangka pendek, dan prestasi akademik dalam kalangan kanak-kanak Melayu sekolah rendah di Kelantan. Intensiti ‘brain break’ yang diguna pakai merupakan berintensiti rendah hingga sederhana. Seramai 159 kanak-kanak lelaki dan 176 kanak-kanak perempuan berumur 10 hingga 11 tahun (min umur = 10.51 ± 0.50) dari dua sekolah di Kelantan telah direkrut dalam kajian ini. Pensampelan purposif digunakan untuk membahagikan kanak-kanak kepada kumpulan intervensi (n = 183) dan kawalan (n = 152). Sesi ‘brain breaks’ berlangsung satu hingga tiga kali seminggu, selama empat bulan, di mana setiap sesi mengambil masa selama 15-30 minit. Instrumen-instrumen yang digunakan adalah Skala Motivasi Aktiviti Masa Lapang versi Belia-Melayu (PALMS-Y-M), Ujian Jarak Digit (DST), Ujian Kewaspadaan Digit (DVT) dan Skor Gred Purata (AGS). Ujian ini dijalankan sebanyak dua kali, pra-ujian dan pasca-ujian. Analisa varians (ANOVA) campuran digunakan untuk menganalisis data. Hasilnya menunjukkan perubahan yang signifikan dalam motif PA untuk kesenangan, F (1, 243) = 5.162, nilai p = 0.024; penampilan, F (1, 243) = 3.998, nilai p = 0.047; ciri-ciri psikologi, F (1, 243) = 6.243, nilai p = 0.013; tumpuan yang berterusan bagi nombor 6: jumlah masa, F (1, 332) = 8.151,

nilai p = 0.005; dan 9: jumlah masa, F (1, 327) = 9.778, nilai p = 0.002 dan frekuensi kesalahan yang dibuat: F (1, 329) = 38.725, nilai $p < 0.001$; memori jangka pendek, F (1, 301) = 38.381, nilai $p < 0.001$. Kesimpulannya, ‘brain breaks’ berjaya meningkatkan daya ingatan jangka pendek kanak-kanak dan perhatian yang berterusan sambil mengekalkan motif penyertaan dalam PA. Kajian masa depan harus mempertimbangkan untuk menambah ujian-ujian lain untuk mengukur domain kognitif kanak-kanak untuk wawasan yang lebih komprehensif.

THE EFFECT OF BRAIN BREAKS ON MOTIVATION TO ENGAGE IN PHYSICAL ACTIVITY, SUSTAINED ATTENTION, SHORT-TERM MEMORY, AND ACADEMIC PERFORMANCE AMONG MALAY PRIMARY SCHOOL CHILDREN

ABSTRACT

Brain breaks is a physical activity (PA) video that is used to stimulate student's health and learning and was designed for school settings. The purpose of this study was to measure the effects of brain-breaks on motives of participation in PA, sustained attention, short-term memory, and academic performance among Malay primary school children in Kelantan. The intensity of brain breaks implemented was low to moderate intensity. A total of 159 male and 176 female children aged 10 to 11 years old (mean age = 10.51 ± 0.50) from two schools in Kelantan were recruited in this study. Purposive sampling was used to divide the children into intervention (n = 183) and control (n = 152) groups. The brain breaks intervention was conducted one to three times per week for four months with each session lasting 15-30 minutes. The instruments used were PA and Leisure Motivation Scale Youth-Malay version (PALMS-Y-M), Digit Span Test (DST), Digit Vigilance Test (DVT) and Average Grade Score (AGS). These tests were carried out at two time-points, pre- and post-tests. Mixed analysis of variance (ANOVA) was used to analyse the data. The results showed significant changes in PA motives for enjoyment, F (1, 243) = 5.162, p-value = 0.024; appearance, F (1, 243) = 3.998, p-value = 0.047; psychological, F (1, 243) = 6.243, p-value = 0.013; sustained attention for numbers 6: total time F (1, 332) = 8.151, p-value = 0.005; and 9: total time F (1, 327) = 9.778, p-value = 0.002 and frequency of error made: F (1, 329) = 38.725, p-value < 0.001; short-term memory F (1, 301) = 38.381, p-value < 0.001. In conclusion,

brain breaks was successful in improving children's short-term memory and sustained attention while maintaining motives for PA participation. Future research should consider adding other tests to measure the cognitive domains of students for a more comprehensive insight.

CHAPTER 1

INTRODUCTION

1.1 Background of study

It was reported that worldwide obesity has increased more than doubled since 1980. In 2014, more than 1.9 billion adults, aged 18 years old and above were overweight while over 600 million adults were obese (WHO, 2016). Meanwhile, 41 million children under the age of five were reported as being overweight or obese, and half of them are from Asia (WHO, 2016). Recently, Malaysia is known for having the highest obesity prevalence in South-east Asia (Rashid, 2017). Besides, the Economist Intelligence Unit's "Tackling Obesity in Asian" reported that the obesity prevalence among adults was 13.3% while overweight was at 38.5% (Rashid, 2017). This scenario would increase the risk of non-communicable diseases such as cardiovascular disease, mainly heart disease and stroke, which were the leading cause of death in 2012; diabetes; musculoskeletal disorders such as osteoarthritis; and cancer (WHO, 2015).

Epstein, Paluch, Consalvi, Riordan, and Scholl (2002) also found that television viewing promotes weight gain and increase energy intake as this activity displaced physical activity (PA) among adolescents and children. Children spend most of their time in the school environment. Therefore, by implementing PA intervention in the school environment may be an ideal way to increase PA. However, academic curriculum that stresses too much on academic performance, lack of school leadership support, resources, and poor teaching quality are barriers to promote PA in school (Hills, Dengel, & Lubans, 2015).

Hence, the Global Community Health or GCH foundation (2017) introduced Brain Breaks® PA Solutions, known as brain breaks by HOPSports® as an intervention to promote PA among children during school days. The GCH foundation's aim is to expand the successful implementation of globally recognised, evidence-based health and wellness programs in the communities while respecting local cultures and customs (Uzunoz, Chin, Mok, Edginton, & Podnar, 2017). Besides, it is also aiming to educate and empower children to become the premier agents of change, guiding them to create, share and practice health strategies to transform and improve the quality of life for others and themselves (Uzunoz et al., 2017). This foundation uses the Centres for Disease Control's (CDC) Whole School Whole Community Whole Child (WSCC) model (GCH foundation, 2017).

Brain breaks is a web-based structured PA breaks with a duration from three to five minutes and is designed for the classroom setting. The selected videos of PA breaks were low-to-moderate intensity. It helps teachers to have an instant additional resource tool to revitalise the classroom environment and activate participants' learning. This application could save time and money. Moreover, brain breaks helps to improve test scores and fulfil mandates for increased PA education without compromising valuable instructional time (HOPSports®, 2017).

1.2 Problem statement

A study by Rideout, Foehr, and Roberts (2010) reported that young people spend more time with social media, and it is the leading activity for children and teenagers other than sleep. This results in a lack of participation in PA. Being inactive leads to a sedentary lifestyle, which potentially increases the risk of obesity and other non-communicable diseases (Reilly

et al., 2003). This is due to the reduction in body movement and energy expenditure (WHO, 2017).

A recent study by Uzunoz et al. (2017) investigating the effect of using brain break among Turkish primary school children had found positive response on attitudes towards beliefs, self-efficacy, self-confidence, and increased in motivation on PA. However, research related to the effect of using this technology on PA participation, sustained attention, short-term memory, and academic performance is still lacking. Therefore, this study attempt to implement the brain breaks to attract the children to participate in PA while examining its effect on their sustained attention in class, short-term memory, and academic performance.

1.3 Study justification

The relationship between PA and cognitive functions has becoming particular interest in the school system as large portion of school day is spent working in the cognitive domain (Sibley & Etnier, 2003). However, nowadays, physical education is being cut from schools in favour of core academic subjects. School administrators often restrict budget on physical education (PE) and highlight the needs of spending more time on academic subjects compared to PE. These are due to the high act of maintaining the facilities and equipment, the need of specialist instructors, and insurance coverage for PE makes it is more expensive to be maintained compared to other subjects. Therefore, more evidence-based research is needed in implementing school-based interventions as initiative for policy-makers to empower physical education as the core academic subjects (Uzunoz et al., 2017).

Some important cognitive skills for learning are sustained attention and memory (Betts, McKay, Maruff, & Anderson, 2006; Cohen, 2011). It becomes one of the primary

elements of attention process which enables the maintenance of vigilance, selective and focused attention, response persistence and continuous effort despite changing condition (Cohen, 2011). Literature findings on sustained attention among children is still lacking compared to the adult population and there is still ongoing debate pertaining to relative sustained attention capacities of children especially those in the first year of schooling (Betts et al., 2006). In addition, more complex task parameters and smaller display size which affect sustained attention in children, results in poor performance on high load tasks compared to low load tasks (Betts et al., 2006). Same goes to short-term memory, which shows better result if associated with frequent PA, leads to better academic performance (Hashim & Zainol, 2015). This research is in line with GCH foundation movement to promote healthy living, and to provide extensive literature of significant effects of PA participation towards health and cognitive functions.

1.4 Conceptual framework

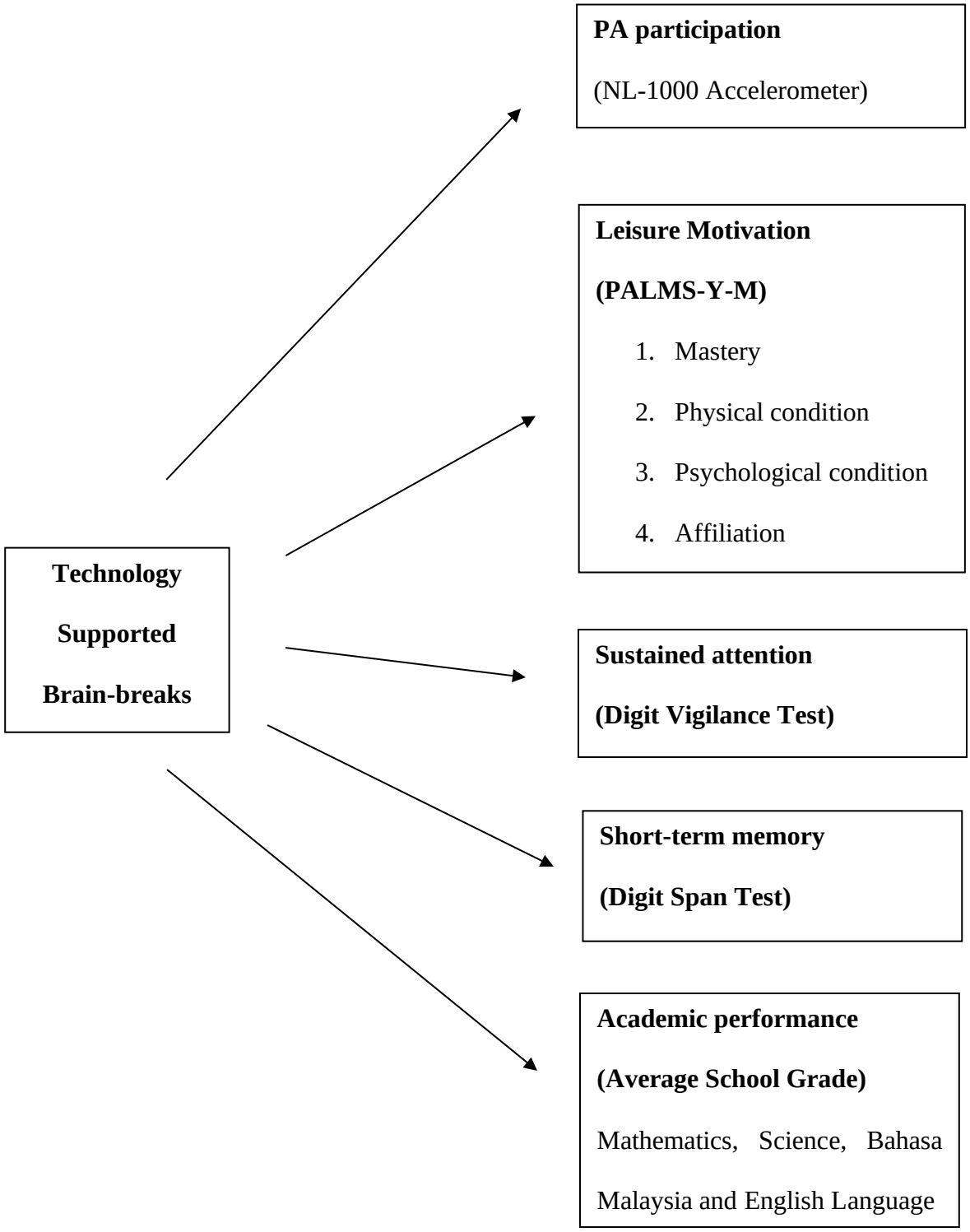

Figure 1.1: Conceptual framework

1.5 Objectives

1.5.1 General objective:

The purpose of the research is to examine the effects of using brain breaks on motives of participation in PA, sustained attention, short-term memory, and academic performance among primary school children.

1.5.2 Specific objectives:

1) To evaluate the effects of using brain breaks on motives of participation in PA among primary school children.
2) To evaluate the effects of using brain breaks on short-term memory among primary school children.
3) To evaluate the effects of using brain breaks on sustained attention among primary school children.
4) To evaluate the effects of using brain breaks on academic performance among primary school children.

1.6 Hypotheses

H_o: There is no significant effect of using brain breaks on motives of participation in PA among primary school children.

H_A: There is a significant effect of using brain breaks on motives of participation in PA among primary school children.

H_o: There is no significant effect of using brain breaks on short- term memory among primary school children.

H_A: There is a significant effect of using brain breaks on short-term memory among primary school children.

H_o: There is no significant effect of using brain breaks on sustained attention among primary school children.

H_A: There is a significant effect of using brain breaks on sustained attention among primary school children.

H_o: There is no significant effect of using brain breaks on academic performance among primary school children.

H_A: There is a significant effect of using brain breaks on academic performance among primary school children.

1.7 Research questions

1 Does brain breaks have any effect on the motives of participation in PA among primary school children?

2 Does brain breaks have any effect on sustained attention among primary school children?

3 Does brain breaks have any effect on short-term memory among primary school children?

4 Does brain breaks have any effect on academic performance among primary school children?

CHAPTER 2

LITERATURE REVIEW

2.1 Physical activity

Physical activity is defined as any bodily movement produced by the skeletal muscles that requires energy expenditure, including activities undertaken while doing house chores, engaging in recreational activities and climbing stairs (WHO, 2017). This term differs from exercise as it is a subcategory of PA that is planned, structured, and aims to improve or maintain one or more components of physical fitness (WHO, 2015). Physical inactivity is claimed to be the leading cause of hypertensive illness and is estimated to cause two million deaths per year (WHO, 2015). Over the past three decades, the number of people with diabetes mellitus has increased more than doubled globally (Chen, Magliano, & Zimmet, 2012). Worldwide prevalence of overweight and obesity has risen to 39% and 13% respectively in almost the same amount of time (WHO, 2016).

Overweight and obesity are defined as having abnormal or excessive fat accumulation that presents a risk to health (WHO, 2016). A cross-sectional study by Trost, Kerr, Ward, and Pate (2001) pertaining to physical inactivity found that most obese children in a district in the United States spend less time in both moderate and vigorous PA compared to non-obese children. In addition, a study by Epstein et al. (2002) found that television viewing promoted weight gain and increase energy intake as this activity displaced PA among children. The author further added that there is a direct relationship between physical inactivity and media viewing; resulting in increased complication risks and non-communicable diseases such as hypertension, diabetes mellitus and heart disease. WHO (2016) estimated that nearly half of the 41 million children under the age of five living in

Asia are overweight and obese. Furthermore, a meta-analysis studying the health consequences of childhood obesity found various type of health risks including psychological consequences especially among girls, developing asthma symptom, cardiovascular risk factor in childhood, increase risk in Type 1 diabetes, low grade of systemic inflammation, and abnormalities in foot structure (Reilly et al., 2003).

The relationship between regular PA and psychological and physical health has been thoroughly established in past studies (Butt, Weinberg, Breckon, & Claytor, 2011). The takeaway message is that regular PA provides essential health benefits, one of which is the reduction of non-communicable diseases and reduction of mortality rate (Celis-Morales et al., 2012; Williams, 2012). In addition, regular PA could contribute to increased mental health and academic performance, lower stress and depression levels (Rasberry et al., 2011), demonstrated improvement in mathematics skills, cognitive flexibility, improved memory and creativity when engaged in sufficient PA such as aerobic exercise (Chaddock, Pontifex, Hillman, & Kramer, 2011; Hillman, Erickson, & Kramer, 2008).

Nonetheless, in Malaysia, people are not active enough to take advantage of the health benefits provided by regular PA; rather, are living a sedentary lifestyle (Poh et al., 2010). Furthermore, individuals who were physically inactive during adolescence are more likely to be inactive in their adulthood (Gordon-Larsen, Adair, Nelson, & Popkin, 2004). For these reasons, researchers, health professionals, and policymakers have all sought to explore why some people are physically active, whereas others are not (Molanorouzi, Khoo, & Morris, 2014). Although the factors for participating in regular PA is highly complex, studies have pointed out motivation as a driving factor not only for PA participation, but also for its adherence (Aaltonen et al., 2012; André & Dishman, 2012).

2.2 Brain breaks

Children spend most of their time in the school environment. Therefore, by implementing PA intervention in the school environment could be an ideal way. However, putting too much stress on academic performance, lack of school leadership support, lack of resources, and poor teaching quality are barriers to promote PA in school (Hills et al., 2015). As a solution, the GCH foundation suggests Brain Breaks® PA Solutions by HOPSports® as an intervention to promote PA among participants during school days. The aim of the intervention is to expand the successful implementation of globally recognised, evidence-based health and wellness programs in their communities while respecting local culture and customs (Uzunoz et al., 2017). Brain breaks is a web-based structured PA breaks with duration of two to five minutes designed for classroom setting (GCH foundation, 2017). In addition, brain breaks can be used to educate and empower children to become the premier agents of change, guiding them to create, share and practice health strategies and transform and improve the quality of life for others and themselves (Uzunoz et al., 2017).

The GCH foundation uses the WSCC (Whole School, Whole Community, Whole Child) model as a framework (Lewallen, Hunt, Potts-Datema, Zaza, & Giles, 2015). It helps teachers to have an instant additional resource tool to revitalise the classroom environment and activate participants' learning. Moreover, it helps to improve test scores and fulfil mandates for increased PA nutrition education without compromising valuable instructional time (HOPSports®, 2017). Using this application indirectly attracts children to engage in PA without waiving their interest towards internet-based and video technology. This PA intervention, which was introduced by HOPSports, is used to motivate participants to enhance their theoretical lessons and provide opportunity not only to be physically active

during breaks, but also learn new motor skills, language, art, music and different cultures (Chin, Edginton, & Tang, 2013).

The programme is supported by the United Nations as part of the 17 Sustainable Developmental Goals under the goals of good health and well-being (Kuan, Rizal, Hajar, Chin, & Mok, 2019). To access the resource (https://brain-breaks.com/), users only required an internet connection and a projector to display the PA videos. More studies are needed in identifying the motives of younger people for participating and/or abstaining from PA to alter the increasing trend of physical inactivity among youth in many countries (Kueh, Abdullah, Kuan, Morris, & Naing, 2018). Collaboration between researchers and schools are needed to provide PA to the participants once a day, in between or during class sessions.

A study by Glapa et al. (2018) investigated the effectiveness of brain breaks in changing attitudes towards PA among school children in Poland. A total of 326 participants aged 9 to 11 years old were recruited. They were randomly divided into experimental and control groups. Attitudes toward PA scale (APAS) was used as an assessment. The findings suggested that the program helps to improve self-efficacy on learning among school children. Another similar study by Popeska et al. (2018) also conducted brain breaks in Macedonia to examine its effects on school children's attitudes and interest in PA participation. This study also found positive results on children's attitudes for PA, motivations for PA as well as internalisation of movement habits as good personality.

2.3 Physical activity and cognitive functions

The relationship between PA and cognitive functions is becoming increasingly important in the school system as large portions of the school day is spent working in the cognitive

domain (Sibley & Etnier, 2003). Physical educators believe that children come to school to be both physically and mentally educated. They also believe that physical education and PA should not interfere with children's learning, attention, and cognitive functioning. However, recently, physical education is not emphasised in schools in favour of core academic subjects. School administrators often restrict the budget on physical education (PE) and highlight the needs of spending more time on academic subjects compared to PE (Sibley & Etnier, 2003). These are due to the expensive maintenance in terms of facilities and equipment, specialist instructors, and insurance coverage for PE compared to other subjects. This ultimately leads to lack of support for children to involve in PA and sports, thereby reducing their motivation to stay active.

2.4 Motivation to engage in physical activity

Research had demonstrated the link between motivation and PA (Slovinec D'Angelo, Pelletier, Reid, & Huta, 2014). Researchers have used motivational theories such as self-determination theory (Deci & Ryan, 2000) and achievement goal theory (Nicholls, 1989) to act as guidelines in studying human motivation in PA. For example, in the self-determination theory, individuals who are intrinsically motivated to undertake PA are motivated by factors, including enjoyment, challenge, skill development, and mastery (Frederick & Ryan, 1993; Kilpatrick, Hebert, & Bartholomew, 2005), whereas individuals who are extrinsically motivated to undertake PA are motivated by factors that are not related to the activity itself, including rewards, improved health, and appearance (Frederick & Ryan, 1993; Kilpatrick et al., 2005). Hence, understanding people's motives for participation in PA is crucial given its role in determining whether individuals will initiate and maintain PA programs (Kueh et al., 2018).

One such tool that can be used to measure the motives for participating in PA is the Recreational Exercise Motivation Measure (REMM), developed by Rogers and Morris (2003b). However, due to the sizeable length of the questionnaire (73 items), a newer version; the PA and Leisure Motivation Scale (PALMS) (Rogers & Morris, 2003a) was made. It contained 40 items stipulated into eight separate factors; enjoyment, mastery, competition/ego, appearance, affiliation, others' expectations, psychological condition and physical condition; and used for adults. For children, Hu et al. (2015) shortened the scale to 28 items comprising of seven factors, removing others' expectation and reducing the least strong item from each motive factor to produce a shorter scale suitable for younger people (PALMS-Y). The scale was later translated and validated using confirmatory factor analysis into the Malay language (PALMS-Y-M), and the results indicate sound validity and reliability (Kueh et al., 2017).

The low and reducing prevalence of PA in younger people is of particular concern (Chaddock et al., 2011; Hu et al., 2015). The past study suggested that the ideal interventional strategy for PA promotion that was identified as cost-effective is a school-based intervention for children and adolescents (Abu-Omar et al., 2017). The school environment is ideal for implementing PA interventions due to the possibility to reach a wide number of children who are spending most of their time in schools (Hills et al., 2015). Presently, research on the implementation of school-based PA programs indicated positive improvements on cognitive skills and attitudes, academic performance and academic behaviour with only a few studies indicating negative relationship (Mura et al., 2015). Therefore, more research is required to investigate the effect of school-based PA to support the effort of initiating policies for promoting positive changes at decision-making levels

aiming at providing children with more regular access to PA in school settings (Uzunoz et al., 2017).

Past studies have used the Attitudes toward PA Scale (APAS) (Glapa et al., 2018; Mok et al., 2015; Popeska et al., 2018; Uzunoz et al., 2017) to measure children's attitude and perceptions regarding various aspects of engagement in PA including brain breaks (Glapa et al., 2018). These studies have shown positive findings regarding promoting PA in school children (Glapa et al., 2018; Mok et al., 2015; Popeska et al., 2018; Uzunoz et al., 2017). The understanding of motivated behaviour of adolescence and young adults is important to encourage their persistence in sport and PA participation, which is advantageous to the development of their physical and psychological well-being (Fox & Boucher, 2000). Previous study used REMM motives for taking part in recreational exercise/sporting activities (Caglar, Canlan, & Demir, 2009). However, to our knowledge, studies using PALMS are limited, and we found no study using PALMS-Y-M as a measure of motivation in a longitudinal study to date. Therefore, this study attempts to identify the motives for PA, particularly among Malaysian children while using brain breaks as a mean of PA intervention.

2.5 Short-term memory

Short-term memory is also referred to as primary memory, short-term store, and immediate memory. Short term memory is capable of storing information on a temporary basis. Up to 7 pieces of information can be retained for approximately 20 seconds. That is why short-term memory is known for its fragile characteristic and the information stored is easily forgotten as when direct attention is re-directed or disrupted (Rudland, 2017). One of the many alternatives to improve short-term memory storage besides cognitive functioning is

PA (Sibley & Etnier, 2003). It is also supported by Zainol and Hashim (2015) which reported that exercise habit has a positive effect on short-term memory. However, research done on the relationship between PA effects on short-term memory among children is lacking were most studies have been conducted on adults and senior citizens.

Research by Javan, Framarzi, and Abedi (2014) investigating the effects of rhythmic play on intellectually disabled children's attention and memory functioning at the age range of nine to sixteen years old found that the rhythmic play has a remarkable effect on the children's short-term memory. This result is contradicted with another study that was conducted in the same year, but among middle-aged participants. The study investigated the effects of an acute high-interval training on short-term memory tasks (Alves et al., 2014). They found that high-interval training exercise did not improve their short-term memory performances. This result is line with the previous study by Coles and Tomporowski (2008) which their aim was to evaluate the effects of a brief bout of exercise on executive function, short-term memory, and long-term memory among young adults. The result on short-term memory showed that there was no significant difference between exercises conditions delivered.

In a separate study by Leong, Moghadam, and Hashim (2015), the researchers studied the effect of combined effects of mild aerobic exercise and milk supplementation on the short-term memory among female secondary school participants. The result showed that the combination group (milk and exercise) and exercise group performed significantly better in short-term memory compared to the milk and control groups. The mixed and inconsistent results will obscure the advantages of PA to the short-term memory. These inconsistent findings might be attributed to different types, duration and frequency of physical

activity/exercise employed and different assessment tools used in each study. Furthermore, most studies that have obtained negative results are those studies conducted on adults. According to Montoya et al. (2019), verbal short-term memory in addition with response inhibition, predicted all the early numeracy (number identification, verbal counting and applied problems) and literacy skills (receptive vocabulary and decoding) among pre-school children. Same goes with visual-spatial short-term memory, which predicted most of the skills except for early decoding.

There are many mechanisms to be considered to interpret the relationship between PA and cognitive functions; physiological and learning, and developmental mechanisms (Sibley & Etnier, 2003). The physiological mechanisms include increased in blood flow, brain neurotransmitters alterations, structural changes in central nervous system, and modified arousal levels due to PA. Meanwhile, the developmental mechanism proposes that PA is essential for proper cognitive development to occur.

The Digit Span Test (DST) has been used as a tool to measure short-term memory (Gray, 2003). For this test, all participants are required to memorise the presented digits and write them down on the paper provided. For each correct answer, one point will be given while zero point is given when error is made with a maximum possible score of 17. The test is divided into two sections; digit forward and digit backwards. The digit forward ranges from 0 to 16 while the digit backward range from 0 to 14.

2.6 Sustained attention

Sustained attention is a process that enables sustained performance on tasks over an extended period. It becomes one of the primary elements of attention process. It also enables the

maintenance of vigilance, selective and focused attention, response persistence and continuous effort despite changing condition (Cohen, 2011). In addition, Kumar, Wheaton, Snow, and Millard-Stafford (2015) also states that sustained attention is the ability to focus on one or more items for necessary time duration to solve problem, plan, or draw a conclusion. This cognitive function is crucial for a child in process of gathering information, and instruction. A study by Betts et al. (2006) found that sustained attention improved until aged ten then, plateaus with minor improvement. Those children who have difficulty in sustaining their attention may appear to be day dreamy, fidgety, disorganised and bored. In the worst case, it may result to attention deficit-hyperactivity disorder (ADHD). The impacts include low in academic achievement, poor school performance, retention in grade, anxiety, depression, as well as difficulty in social relationship (Medina et al., 2010).

However, research on PA influence on sustained attention among children is not researched as much as compared to adults and there is ongoing debate pertaining to relative sustained attention capacities of children especially those in first year of schooling. There are several studies that have proven the effectiveness of PA on sustained attention. A study by Medina et al. (2010) related to the impact of PA on sustained attention among 25 ADHD children suggest positive result with increased surveillance, decreased impulsivity, increased reaction speed and more stable. Another study by Ballester, Huertas, Yuste, Llorens, and Sanabria (2015) studied the effect of participation in sports on sustained attention among children aged 13 to 15 years old. They found that athletes responded faster and with fewer lapse than non-athletes. Interestingly, motivation or perceived activation prior to task did not seem to influence the vigilance capacities in between-group although both groups have significantly differed in these two measures.

A cross-sectional study conducted by Geertsen et al. (2016) attempted to identify the association between motor skills, exercise capacity and cognitive functions. The results showed that performance in both the fine and gross motor skill task as well as higher exercise capacity was significantly associated with better performance in sustained attention with fewer errors. Furthermore, Chou and Huang (2017) in another study investigated whether a yoga exercise intervention influenced the sustained attention and discrimination function in children with ADHD. They found that there was a significant improvement in accuracy rate and reaction time by exercise group over time compared to control group.

However, there are also some studies that receive null hypotheses where there is no positive interaction found. A study by Leong et al. (2015) investigated the combined effects of milk supplementation and aerobic exercise on short-term memory and sustained attention of female participants aged 16 years old. They found no significant difference between experimental groups and control group in sustained attention, and no interaction as well. Another study by Wilson, Olds, Lushington, Petkov, and Dollman (2016) investigated the impact of a brief activity bout outside the classroom on boys' attention and on-task behaviour in the classroom setting. They found no impact on participants' sustained attention after a short activity break between lessons. However, this study did not employ a specific level of PA for the intervention in which probability for some participants to engage in low-level PA is higher thus affect the results.

In a quite recent study, the Digit Vigilance test (DVT) was used as a tool to measure the sustained attention and visual-motor tracking (Hashim & Zainol, 2015). This test was developed by Lewis and Rennick in 1979 and now there are some extensive norms available (Kelland & Lewis, 1996). It consists of two full pages of single digits ranging from 0 to 9.

There are total of 59 rows and 35 columns, and the numbers are arranged randomly. In 2 trials, participants were required to find the 9 and 6 numbers and the scores were averaged to gain the sustained attention's index. For reliability and validity, this test has been supported by Kelland and Lewis (1996) study for measuring sustained attention.

2.7 Academic performance

Academic performance is defined as a child's success and performance in school and can be measured by average grade score (AGS), as a cluster of achievement tests, or using specific test for reading or arithmetic skills including reading speed, fluency and comprehension, and the ability to solve arithmetic problem (Donnelly et al., 2016). Previous study by Ahamed et al. (2007) examined the effectiveness of a school based PA intervention known as, Action Schools! British Columbia model (AS! BC), for maintaining academic performance among elementary school children, and to determine whether boys' and girls' academic performance changed similarly after participation in AS! BC intervention. This intervention includes different type and intensity of PA which is not fixed. However, the findings suggested that academic performance total test scores were not significantly different between groups. Meanwhile, boys' and girls' academic scores were similar at baseline and changed similarly during the intervention period.

Next research was aiming to assess efficacy of a 6-week pilot active break program (ACTI-BREAK) on academic achievement, classroom behaviour and PA (Watson, Timperio, Brown, & Hesketh, 2019). This intervention consisted 5-minutes moderate intensity active breaks, three times daily in their classrooms for six weeks in which also did not fix the type and intensity level of PA delivered. The result showed no significant effect on participants' reading and mathematics score after post-intervention. There are some

findings that suggest a positive relationship between PA and academic performance. For example, a study conducted by Egger, Benzing, Conzelmann, and Schmidt (2019) aimed to study the effects of qualitatively different PA breaks on children's cognitive outcomes. Participants were divided into three different groups: (a) high physical exertion and high cognitive engagement (combo group); (b) high physical exertion and low cognitive engagement (aerobic group); and (c) low physical exertion and high cognitive engagement (cognition group). They found that both combo group and cognition group performed better in mathematic than aerobic group.

In the same year, another study was conducted to investigate the effect of a multicomponent PA intervention (MOVI-KIDS) on improving cognition in school children and to analyse the mediator role of motor fitness between MOVI-KIDS and cognition (Sánchez-López et al., 2019). This program consisted of: (a) 3 weekly after-school sessions of recreational non-competitive PA lasting 60 minutes during one academic year; (b) educational materials for parents and teachers; and (c) school playground modifications. This holistic and one-school-year multicomponent intervention helps to improve the participants' cognition. Moreover, the findings showed that the intervention on cognition was mediated by changes in motor fitness.

As reported in a review paper by Haapala et al. (2014), there was a significant association between PA specifically in cardiorespiratory fitness, and academic scores among children. However, Santana et al. (2017) found that this review is not systemic enough as well as did not considered all components of physical fitness which is comprised of cardiorespiratory fitness, muscular strength and endurance, balance, coordination, agility, flexibility, reaction time, power, and body composition. This study concluded that PA and

exercise have a positive relationship with academic performance in both cross-sectional and longitudinal studies. However, there were also findings that showed a weak relationship between PA and academic performance (Eveland-Sayers, Farley, Fuller, Morgan, & Caputo, 2009; Kantomaa et al., 2013; Keeley & Fox, 2009). However, many studies do not apply the FITT principle (frequency, intensity, type and time/duration) in their intervention because it was prone to produce insignificant results which may have led to misleading the PA effectiveness to improve cognition and academic performance (Santana et al., 2017).

In the present study, AGS scores of mid-term and final-term examination were compared as a measure of academic performance as these examinations conducted at the appropriate time with the duration of the intervention granted. The subjects chosen for analysis were Bahasa Melayu, Mathematics, Science, and English language.

CHAPTER 3

METHOD

3.1 Study design

This study is an experimental design with pre- and post-tests measurements. The duration of the intervention period started from June 2018 until November 2018. This intervention period included all the examination periods, school breaks and school activities.

3.2 Study location

Sekolah Kebangsaan (SK) Sri Wakaf Bharu was randomly selected during the first random selection. Since SK Sri Wakaf Bharu is a high performance primary school, another high performance primary school was randomly selected which is the SK Kubang Kerian 3. Thus, this study took place at two high performance primary schools (Sekolah Berprestasi Tinggi; SBP) in Kelantan. SK Sri Wakaf Bharu was selected as the intervention group, whereas, SK Kubang Kerian 3 was selected as the control group. The school hall was designated as the place to administer the pre and post-tests at both schools as well as to conduct the brain breaks sessions for the intervention group.

3.3 Sampling frame

The inclusion criteria were healthy primary school children in standards four and five (age 10-11 years old) who can read, write and comprehend the Malay language. Meanwhile, the exclusion criteria are those in the intervention group that are not able to participate and commit to the brain breaks session due to extra-curricular activities and/or have physical conditions such as heart problem and physical injury.

3.4 Sample size calculation (G*Power 3.1.9.2.)

This study used a mixed analysis of variance (ANOVA) design at two time points; pre- and post-tests. The largest sample size calculated based on the stated objectives is 250. Cohen's classification of effect size with equivalent values of eta squared ($0.01 \leq \eta^2 < 0.06$ = small, $0.06 \leq \eta^2 < 0.14$ = medium, $\eta^2 > 0.14$ = large (Kinnear & Gray, 2006) was used as a benchmark for this study. After estimating a dropout of 20%, the total sample size calculated was 300. However, a total of 455 participants were recruited for this study in which 120 dropped out due to not following the study protocol and absence during the test's measurement. Hence, the final sample acquired in this study was 335 participants (N=335).

3.4.1 Objective 1: Motives of participation in PA

Based on a previous study (Kueh, Abdullah, Chin, Morris, & Kuan, 2019), a power of 0.80, error probability of 0.05 and an effect size of 0.089 were applied, and the calculated sample was 250.

3.4.2 Objective 2 and 3: Sustained attention and short-term memory

Based on a previous study (Leong et al., 2015), a power of 0.95, error probability of 0.05 and an effect size of 0.20 were applied and the calculated sample was 84 for the combined tests.

3.4.3 Objective 4: Academic performance

Based on a previous study (Egger et al., 2019), a power of 0.95, error probability of 0.05 and an effect size of 0.12 were applied and the calculated sample was 228.

3.5 Sampling and recruitment process

Purposive sampling was conducted to select two SBP primary schools in Kelantan. SK Sri Wakaf Bharu was chosen as the intervention group, whereas, SK Kubang Kerian 3 was chosen as the control group. An approval letter from the State Education Department and Ministry of Education were obtained prior to the recruitment process. The recruitment has been done by approaching the school's headmaster of the respective schools.

The participants recruited were from standards four and five. The students placed in each class according to their previous year's academic scores. To avoid bias and to ensure equal distribution of student's academic achievement, participants were recruited from every alternate class, i.e. Class 4A, 4C, 4E, etc. The headmaster, teachers, and students were informed and explained clearly about the objectives and the study protocols. Consent from parents are needed hence, students were asked to bring home the participant information sheet and consent form (Appendix A). The parents could contact the researchers should they have any questions. Once completed and signed, the consent form was returned to the researchers.

3.6 Procedures of the study

The procedure of the present study is summarised in Figure 3.6.1. Firstly, ethical approval was acquired from USM Human Research Committee (USM/JEPeM/18020104; Appendix B). Approval was then acquired from the Malaysian Education Ministry (Appendix C) and Kelantan State Education Department (Appendix D) for data collection in primary schools in Kelantan.