THE EFFECTS OF TECHNOLOGY SUPPORTED BRAIN BREAKS ON PHYSICAL ACTIVITY BEHAVIOUR AMONG MALAY PRIMARY SCHOOL CHILDREN: A TRANSTHEORETICAL PERSPECTIVE

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by

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LIST OF ABBREVIATIONS

BMI	Body Mass Index
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
df	Degree of freedom
GBD	Global Burden of Disease
MoE	Ministry of Education
METs	Metabolic Equivalent
NCDs	Non communicable diseases
NL-1000	New Lifestyle 1000
RMSEA	Root Mean Square Error of Approximation
SDG	Sustainable Developmental Goals
SRMR	Standardised Root Mean Square Residual
TLI	Tucker Lewis Index
TTM	Transtheoretical model
TSBB	Technology supported brain breaks
USM	Universiti Sains Malaysia
WHO	World Health Organisation

KESAN TEKNOLOGI BRAIN BREAKS TERHADAP TINGKAH LAKU AKTIVITI FIZIKAL DALAM KALANGAN KANAK-KANAK MELAYU SEKOLAH RENDAH: DARI SUDUT PERSPEKTIF TRANSTEORETIKAL

ABSTRAK

Teknologi berasaskan rehat minda (TSBB) ialah video aktiviti fizikal berstrukturkan sesawang yang direka bentuk secara spesifik untuk digunakan di kawasan sekolah dan mampu merangsang kesihatan dan pembelajaran para pelajar. Tujuan kajian ini adalah (1) untuk mengesahkan proses tingkah laku, keberkesanan diri dan keseimbangan keputusan soal selidik model transteoretikal (TTM) (fasa pertama kajian) dan (2) mengukur kesan TSBB ke atas peringkat-peringkat perubahan, kelebihan dan kekurangan perubahan, perubahan kognitif dan tingkah laku, keberkesanan diri dan penglibatan dalam aktiviti fizikal (senaman sewaktu masa lapang) dalam kalangan kanak-kanak Melayu sekolah rendah (fasa kedua kajian). Dalam fasa pertama kajian, soal selidik TTM versi original telah diterjemah kepada Bahasa Melayu menggunakan terjemahan ke hadapan dan belakang dan telah disahkan menggunakan analisis pengesahan faktor ke atas 381 kanak-kanak (188 lelaki and 193 perempuan) berumur 10 hingga 12 tahun, purata (sisihan piawai) = 10.94 (0.81). Satu ujian perintis menggunakan ‘accelerometer’ (ujian pengesahan untuk TSBB) juga telah dijalankan ke atas 32 kanak-kanak; 16 kanak-kanak dalam setiap kumpulan TSBB dan bukan-TSBB. Pada fasa kedua kajian, seramai 159 kanak-kanak lelaki dan 163 kanak-kanak perempuan berumur 10 hingga 11 tahun, purata (sisihan piawai) = 10.53 (0.50), telah direkrut daripada dua buah sekolah di Kelantan, Malaysia. ‘Purposive sampling’ telah digunakan untuk membahagikan kanak-kanak kepada kumpulan intervensi (n = 177) dan kawalan (n = 163). Kanak-kanak dalam kumpulan intervensi melakukan aktiviti TSBB satu hingga tiga kali seminggu selama

empat bulan (setiap sesi berlangsung selama 15-30 minit) manakala kanak-kanak dalam kumpulan kawalan tidak terlibat dalam intervensi TSBB. Pengukuran tinggi dan berat badan serta soal selidik TTM dan skala senaman sewaktu masa lapang turut diberikan kepada semua kanak-kanak dalam kedua-dua kumpulan pada pra dan pasca-ujian. Analisis varians (ANOVA) campuran telah digunakan untuk menganalisis perubahan signifikan pada dua titik masa tersebut. Untuk fasa pertama kajian, soal selidik TTM versi terakhir untuk kanak-kanak Melayu sekolah rendah mengandungi 24 item untuk proses perubahan, 13 item untuk keberkesanan diri, dan 10 item untuk keseimbangan keputusan. Tambahan pula, ujian perintis telah memberikan pengesahan terhadap TSBB untuk digunakan dalam fasa kajian yang berikutnya. Untuk fasa kedua kajian, ANOVA campuran telah menunjukkan perubahan interaksi yang signifikan bagi; peringkat perubahan, $F(1, 319) = 7.861$, p-value, $(\eta_{p2}) = 0.005$ (0.024); kelebihan perubahan, $F(1, 316) = 31.311$, p-value $(\eta_{p2}) = 0.001$ (0.090); perasaan dalaman, $F(1, 312) = 4.692$, p-value $(\eta_{p2}) = 0.031$ (0.015) dan proses tingkah laku $F(1, 313) = 7.312$, p-value $(\eta_{p2}) = 0.007$ (0.0023). Tambahan pula, proses kognitif, $F(1, 320) = 5.768$, p-value $(\eta_{p2}) = 0.017$ (0.018), proses tingkah laku, $F(1, 313) = 5.736$, p-value $(\eta_{p2}) = 0.017$ (0.018) serta perasaan dalaman, $F(1, 312) = 6.050$, p-value $(\eta_{p2}) = 0.014$ (0.019) menunjukkan perubahan signifikan bagi kesan masa. TSBB telah berjaya dalam meningkatkan perubahan aktiviti fizikal; memperbaiki perasaan dalaman (keberkesanan diri); memperbaiki perubahan kognitif dan tingkah laku serta meningkatkan manfaat yang dirasakan terhadap aktiviti fizikal. Oleh itu, TSBB adalah disarankan untuk diterapkan di sekolah-sekolah seluruh Malaysia.

THE EFFECTS OF TECHNOLOGY SUPPORTED BRAIN BREAKS ON PHYSICAL ACTIVITY BEHAVIOUR AMONG MALAY PRIMARY SCHOOL CHILDREN: A TRANSTHEORETICAL PERSPECTIVE

ABSTRACT

Technology supported brain breaks (TSBB) is a web-based structured physical activity video that is specifically designed for school settings and can stimulates student's health and learning. The purposes of this study are (1) to validate the processes of change, self-efficacy and decisional balance scales of the transtheoretical model (TTM) questionnaire (phase one) and (2) to measure the effects of TSBB on stages of change, decisional balance, processes of change, self-efficacy and physical activity participation among Malay primary school children (phase two). In phase one, the original version of TTM was translated into Malay language using forward and backward translation and validated using confirmatory factor analysis on 381 children (188 males and 193 females) aged between 10 to 12 years old, mean (SD) = 10.94 (0.81). A pilot test by using accelerometer (validity test of the TSBB) was also carried out with 32 children; 16 children in each TSBB and non-TSBB groups. In phase two, a total of 159 male and 163 female children aged 10 to 11 years old, mean (SD) = 10.53 (0.50), were recruited from two schools in Kelantan, Malaysia. Purposive sampling was used to divide the children into intervention (n = 177) and control (n = 145) groups. Children in the intervention group underwent TSSB activity one to three times per week for four months (each session lasting 15-30 minutes) while children in the control group were not involve in the TSBB intervention. Body height and weight measurements, as well as TTM questionnaires and leisure-time exercise scale were administered to all of the children in both groups at pre and post-test. Mixed analysis of variance (ANOVA) was used to analyse significant changes at these two time points.

For phase one of the study, the final Malay version of TTM questionnaires for Malay primary school children consisted of 24 items for process of changes, 13 items for self-efficacy and 10 items for decisional balance. In addition, the pilot test had provided good validity of the TSBB. For phase two, mixed ANOVA showed significant interaction effect for; stages of change, $F(1, 319) = 7.861$, p-value, $(\eta_{p2}) = 0.005$ (0.024); pros, $F(1, 316) = 31.311$, p-value $(\eta_{p2}) = 0.001$ (0.090); internal feeling, $F(1, 312) = 4.692$, p-value $(\eta_{p2}) = 0.031$ (0.015) and behavioural process $F(1, 313) = 7.312$, p-value $(\eta_{p2}) = 0.007$ (0.0023). In addition, cognitive process, $F(1, 320) = 5.768$, p-value $(\eta_{p2}) = 0.017$ (0.018), behavioural process, $F(1, 313) = 5.736$, p-value $(\eta_{p2}) = 0.017$ (0.018) and internal feeling, $F(1, 312) = 6.050$, p-value $(\eta_{p2}) = 0.014$ (0.019) were also significant for time effect. TSBB was successful in improving the progression of physical activity change; improve internal feeling (self-efficacy); cognitive and behavioural changes as well as; heightening perceived benefits towards physical activity. Thus, TSBB should be recommended to be used throughout the schools in Malaysia.

CHAPTER 1

INTRODUCTION

1.1 Background of the study

School administration often cites budget restrictions and the need to spend more time on academic subjects rather than physical education (Sibley & Etnier, 2003). Increased emphasis on standardised test performance has led many educators to believe that more time needs to be spent in the classroom specifically preparing for these tests. However, physical educators believe that education should take up a more holistic approach, which includes both mental and physical learning. Physical education contributes to the process of research in education: as evidence of social and ethical personal development, and addressing the holistic education of children in physical, cognitive, emotional and social aspects (De Souza, Posada-Bernal & Lucio-Tavera, 2017). This creates a need for educators to equip students with a holistic education that emphasises life skills like communication, cross-cultural collaboration, and critical thinking (Teo, 2019). Recently, some researchers have proven that physical activity in school settings has helped to improve cognitive abilities, attitudes and subsequently academic performance (Uzunoz, Chin, Mok, Edginton & Podnar, 2017). Therefore, collective international and local efforts must be made to provide more access to regular physical activity.

The United Nation's Sustainable Development Goals (SDGs), which were adopted in 2015, sought to galvanise various international efforts have faster progress towards the SDGs' bold aims (Global Burden Disease, 2018). Current projections show that many health-related SDG indicators, on non-communicable diseases (NCDs), NCD-related risks, and violence-related indicators will require a concerted shift away from what might have

driven past gains-curative interventions in the case of NCDs-towards multi-sectoral, prevention-oriented policy action and investments to achieve SDG aims (Global Burden Disease, 2018). One of the goals of SDG is goal three, good health and well-being, which has initiated the Global Community Health (GCH) foundation, and in collaboration with HOPSports, introduced Brain Breaks Physical Activity Solutions or technology supported brain breaks (TSBB).

TSBB is an exercise video which can assist students' development in learning and health. The aim of the GCH foundation is to expand successful implementation of globally recognised, evidence-based health and wellness programs in communities while respecting local culture and customs (Global Community Health, 2017). They also select leaders who can educate and empower children to become premier agents of change, guiding them to create, share and practice health strategies that transform and improve the quality of life for others and themselves. The GCH foundation uses Centres for Disease Control's (CDC) and Whole School Whole Community Whole Child (WSCC) model to utilise interventional strategies, expand projects and empower children respectively.

However, the mechanism of physical activity behaviour using comprehensive frameworks is required to understand the factors that influence the acquisition of youth physical activity behaviour (Kim & Cardinal, 2010). The transtheoretical model (TTM) helps individual continue their motivational habits primarily in physical activities through cognitive strategies in the beginning phases and the adaptions of behavioural in the later stages (Prochaska & Marcus, 1993). The TTM allows for categorisation of motivation based on stages of change, which allows better predictions of physical activity behaviour.

In short, there is an increasing need to further understand physical activity behaviour from a transtheoretical standpoint.

However, the implementation of such a model on younger participants such as children and adolescents may pose additional difficulties as other factors may affect their motivations. These include peers, families, school environment and even morality. This is because children are not as independent as adults and are bound by certain rules and culture determined by their environments. Kohlberg's second level of moral reasoning on conventional morality stated that people make decisions based on what actions will please others (McDevitt & Ormrod, 2013). For example, the influence of peers, parents and teachers emphasise academic achievement over skill or physical related developments. Therefore, these uncontrollable external factors may act as limitations in understanding the effects of TSBB as a physical activity intervention among Malay children.

1.2 Problem statement

Research has been conducted to see the effects of using TSBB on physical activity attitudes among children (Glapa et al., 2018; Hajar, Rizal, Kueh, Muhamad & Kuan, 2019; Popeska et al., 2018; Uzunoz et al., 2017). These studies are important to support school-based physical activity initiating policies to promote changes at decision-making levels aimed at providing children with more regular access to physical activity in school settings (Uzunoz et al., 2017).

Furthermore, the effect of physical activity on a holistic development of mental and physical wellbeing can be extrapolated in school settings. This not only improves health but also can further enhance learning development and cognitive functioning more so than

just emphasising on core academic subjects (Sibley & Etnier, 2003). In addition, physical activity can reduce diseases such as diabetes, cancer, osteoporosis and cardiovascular diseases (Kueh, Kuan & Morris, 2017). However, research in policies driven to improve physical activity in Malaysian schools is still lacking.

A growing number of studies show a trend of decreasing physical activity level among children (Popeska et al., 2018). More worryingly, physical activity has also been found to decline with age (Van Mechelen & Kemper, 1995; Schoenborn, 1986). Therefore, TTM may help to explain changes in a person's physical activity behaviour. This model has yielded positive validity in explaining exercise behaviour, both internally and externally (Kim, 2007). Therefore, the incorporation of TTM as a coherent framework may help understand the TSBB in school-settings towards physical activity behaviour.

1.3 Research questions

1. Are the factor structures of the Malay version of TTM (processes of change, decisional balance and self-efficacy) valid and reliable among Malay primary school children?
2. Are there any effects of TSBB on physical activity behaviour from a TTM perspective among Malay primary school children?

1.4 Study objectives

1.4.1 General objective

To test the construct validity of the Malay version of TTM among Malay children and to evaluate the effects of using TSBB on physical activity behaviour among Malay primary school children from a transtheoretical perspective.

1.4.2 Specific objectives

1. To test the validity of the TTM constructs among Malay primary school children.
2. To test the validity of TSBB among Malay primary school children.
3. To investigate the effect of TSBB on TTM among Malay primary school children.
4. To investigate the effects of TSBB on leisure-time exercise among Malay primary school children

1.5 Study hypotheses

H_O1: There is no significant effect of TSBB on TTM among Malay primary school children.

H_A1: There is a significant effect of TSBB on TTM among Malay primary school children.

H_O2: There is no significant effect of TSBB on leisure-time exercise among Malay primary school children.

H_A2: There is a significant effect of TSBB on leisure-time exercise among Malay primary school children.

1.6 Conceptual framework

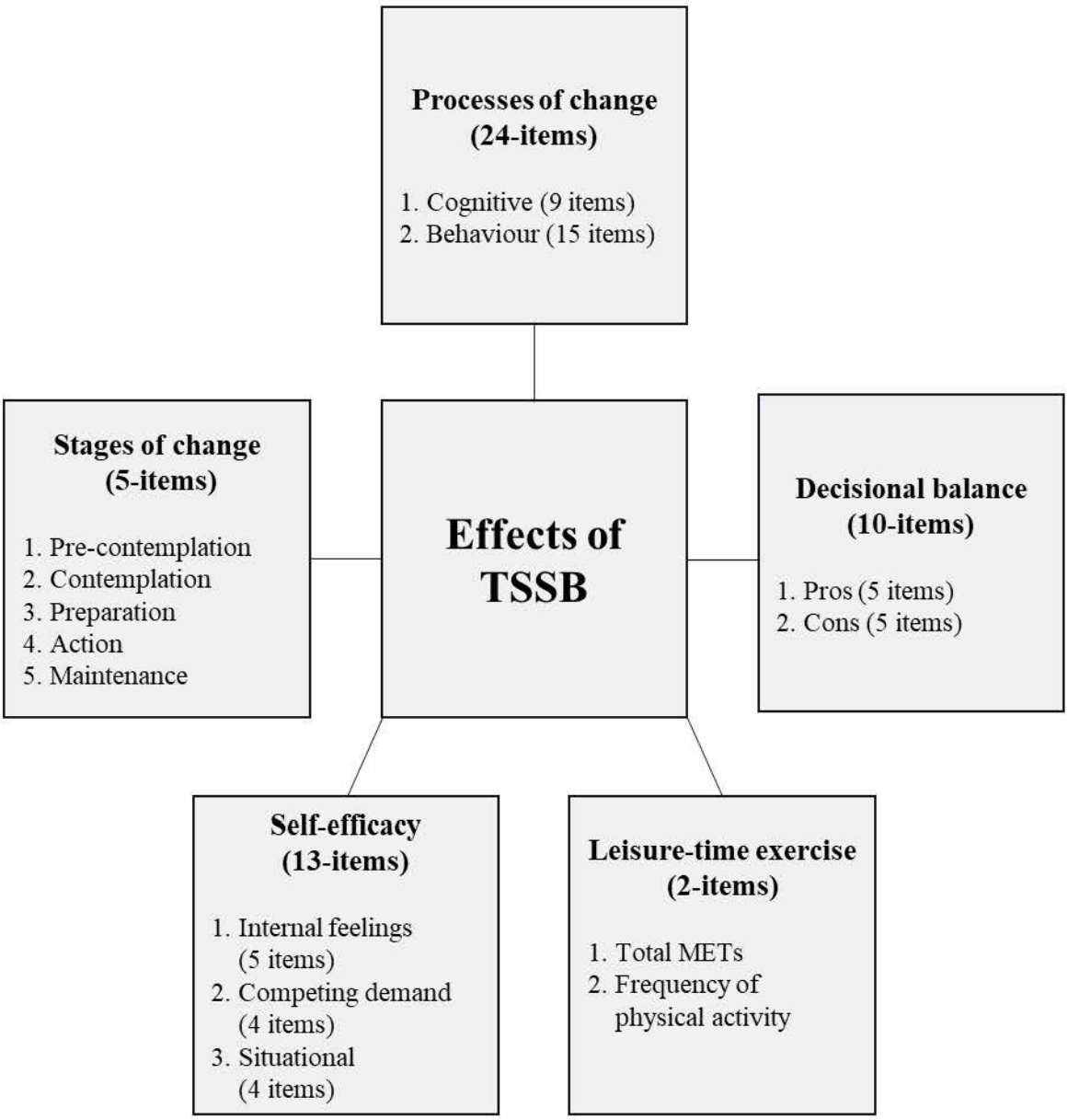

Figure 1.1: Conceptual framework of TTM model post-validation

1.7 Significance of the study

A movement started by the United Nations known as the GCH foundation introduced TSBB in collaboration with HOPSports, a school-based, video-exercise intervention that stimulates students' health and learning (Uzunoz et al., 2017). Present research on school-based physical activity interventions have shown positive improvement of cognitive skills and attitudes, academic performance and behaviour with only a few studies indicating otherwise (Mura et al., 2015). The relationship between physical activity and cognitive functions has become a particular interest in the school system as large portions of the schooling hours are spent working in the cognitive domain (Sibley & Etnier, 2003). Students and teachers can both participate and benefited from the increased physical activity to improve their health and cognitive functions.

Furthermore, we found limited literature available on the model school, which had successfully implemented TSBB among children to enhance their physical activity level during school hours. In this regard, more research on the implementation of TSBB is needed to support the initiatives of policy-makers to implement more physical activity programs during schooling hours. This intervention can be brought up to the education ministry of Malaysia to provide research-based evidence to promote more regular access to physical activity. TSBB not only improves health but also enhance learning of different cultures and ideas as well as stimulate cognitive learning through movement (Mura et al., 2015; Uzunoz et al., 2017).

TTM may also provide a psychological framework to identify physical activity behaviours and classify them under a motivational profile. This will allow for better

explanation and prediction of a person's success or failure in achieving a proposed behaviour change. It has been proven successful in a wide variety of health intervention including physical activity and exercise acquisition (Prochaska et al., 1994). Adams and White (2005) argued that the evidence for the importance of the transtheoretical constructs is mostly cross-sectional. Therefore, more convincing evidence based on longitudinal data and experimental research are still needed (Vet, Nooijer, Vries, & Brug, 2005; Sutton, 2000).

In addition, previous TTM validation data on physical activity in Malaysia was in English and conducted on University undergraduates (Liu, Kueh, Arifin, Kim, & Kuan, 2018) with another study conducting the TTM on smoking cessation among adults (Yasin, Taib, & Zaki, 2011). Translation and validation process to assess both content and construct validity of the Malay version of TTM for physical activity is therefore needed. Literature findings suggest that school-level intervention of the TTM as a theory-based framework has yet to be conducted in a Malay population. Hence, TTM as a theory-based framework can be used to assess physical activity behaviour with TSBB as the physical activity intervention in the school-setting environment.

1.8 Operational definitions

1.8.1 Technology supported brain breaks (TSBB)

A web-based structured physical activity breaks that stimulate student's health and learning as well as being specifically designed for the classroom setting to motivate students 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).

1.8.2 Transtheoretical model (TTM)

TTM is essentially a theory of behavioural change that occurs in a series of stages (Miller & Rollnick, 2002). The core constructs of this theory include 1) stages of change, 2) processes of change, 3) decisional balance and 4) self-efficacy.

1.8.3 Confirmatory factor analysis (CFA)

Defined as a quantitative data analysis and structural equation modelling (SEM) technique. Kline (2011) further defines it as a factor analysis that is used to analyse the structural relationship between the measuring variables and its respective latent constructs. In this study, CFA was applied to measure the construct validity of processes of change (higher factors: cognitive and behavioural processes), decisional balance (pros and cons) and self-efficacy (internal feeling, situational and competing demand).

1.8.4 Child, adolescent and youth

The United Nations Convention on the Rights of the Child defines a child as a person below the age of 18 years old unless under the law applicable to the child, majority is attained earlier (UNICEF, 2017). Youth is defined by the United Nations as those persons between the ages of 15 and 24 years old whereas adolescents are categorised in the age group of between 10 to 19 years old by the World Health Organisation (WHO) and The United Nations Children's Fund (UNICEF) (Secretary-General UN, 1981; UNFPA, 2016). The age of participants in the present study ranges from 10-11 years old. Hence, children, adolescents and students are used interchangeably to describe the participants in this study.

CHAPTER 2

LITERATURE REVIEW

2.1 Physical activity in schools

Physical activity is characterised as any movements produced by any skeletal muscles that results in the expenditure of energy (Caspersen, Powell & Christenson, 1985; Westerterp, 2013). Similarly, exercise is a subset of physical activity that is planned, structured, and repetitive with the intention of improving or maintaining physical fitness. The domains of physical fitness may represent either health- or skill-related. It is increasingly known that the lack of physical activity has been associated with many chronic diseases such as diabetes, obesity, hypertension and cardiovascular diseases. Over the past three decades, the number of people with diabetes mellitus has increased more than doubled globally (Chen, Magliano & Zimmet, 2012); while worldwide prevalence of overweight and obesity has risen to 39% and 13% respectively in almost the same amount of time (World Health Organization, 2018). Physical inactivity is also claimed to be the leading cause of hypertensive illness and is estimated to cause two million deaths per year (World Health Organization, 2018).

Furthermore, physical sedentariness is also associated with increased risk of coronary heart disease (CHD) because it also increases the risk for diabetes and high blood pressure (WebMD, 2014). However, active in physical activity has shown promising links to the prevention and treatment of all the stated diseases as well as others such as cancer, osteoporosis and even depression (Kueh, Kuan & Morris, 2017). Regular exercise or habitual physical activity has been consistently reported to provide significant benefits to both physically and psychologically ranging from cardiovascular health, body composition,

weight management, musculoskeletal fitness and bone health as well as stress management, mood alteration, improve self-efficacy and enhanced self-concept (World Health Organization, 2003). Academically, it has been found that children and adolescents who are more physically active showed higher academic performance (Grierson, 2005; Sigman, 2007). Therefore, physical education in school should not only provide physical activity programs but should also prepare students for a lifetime of habitual physical activity (Kee, Ong, & Wee, 2010).

The school environment is ideal for implementing physical activity interventions due to the possibility to reach a wide number of children who are spending most of their time in schools (Hills, Dengel, & Lubans, 2015). Presently, research on the implementation of school-based physical activity programs indicates a positive improvement of cognitive skills and attitudes, academic performance and academic behaviour with only a few studies indicating negative relationship (Mura et al., 2015). In this regard, more research is required to investigate the effect of school-based physical activity to support the effort of initiating policies to promote changes at decision-making levels aimed at providing children with more regular access to physical activity in school settings (Uzunoz et al., 2017). In addition, emphasis must be placed on finding new ways to promote physical activity and encourage behaviour change to perpetuate physical activity participation among children by making it interactive, fun, as well as engaging.

2.2 Technology supported brain breaks

One promising intervention brought forward by HopSports (2014), is a school-based, video-exercise known as the Brain Breaks® Physical Activity Solutions or brain

breaks for short. It is a web-based structured physical activity breaks that stimulate student's health and learning as well as being specifically designed for the classroom setting to motivate students 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). In the GCH foundation website, educators from all across the world contribute by uploading exercise videos which suit their respective customs and cultures. Each brain breaks video typically ranges from moderate to vigorous intensity physical activity and aims to improve health-related fitness such as cardiovascular endurance, muscular strength, muscular endurance, flexibility and body composition (Kuan, Rizal, Hajar, Chin & Mok, 2019).

These videos are then shared online and are accessible to anyone that would like to implement these short exercises during class. Of particular note, Malaysian educators have even uploaded their own exercise video, using 'silat' as a medium for exercise. By contributing these videos, educators from all over the world with access to an internet connection can implement physical activity and simple exercises to promote cognitive development and health. This movement is also endorsed by the United Nations as part of the 17 Sustainable Developmental Goals under the goals of good health and well-being (Global Community Health, 2017).

Physical education is often misinterpreted as a way of only improving physical fitness such as cardiovascular fitness, flexibility and muscular strength. However, it should be noted that physical education advocates a holistic approach to human development which emphasises the mind and body as one entity, and that anything that happens to one will affect the other (Sibley & Etnier, 2003). In other words, physical educators believe that

a child comes to school to be educated, both mentally and physically. Additionally, there are many educators that believe physical activity and physical education may have a positive effect on concentration, learning and academic success. These traits are often traced back to the general term coined as cognitive ability or functioning. Cognitive functioning reflects a number of underlying mental processes such as perception, attention, executive functioning, intelligence, academic achievement, memory and concentration (van der Niet, 2015).

There are many mechanisms that have been considered to interpret the relationship between physical activity and cognition. These mechanisms can be categorised into physiological and learning/developmental mechanisms (Sibley & Etnier, 2003). The physiological mechanism consists of increased blood flow, alterations in brain neurotransmitters, and structural changes in the central nervous system as well as modified arousal levels due to physical activity. On the other hand, learning or developmental mechanism suggests that physical activity is required in order for proper cognitive development to occur. However, there are still conflicting results, with some studies showing a facilitative effect on physical activity, some reporting cognitive impairment, and others reporting no difference (Tomporowski & Ellis, 1986). Despite these research findings, a strong relationship between physical activity and cognitive performance has yet to be established (Sibley & Etnier, 2003). In recent years, the overall quality of the studies pertaining to the relationship between academic achievement and physical activities especially in the western countries has increased, but the results continue to be inconsistent (Howie & Pate, 2012).

In a much later meta-analysis study, limited evidence has pointed towards a positive effect of physical activity on cognitive functioning in young to middle-aged adults (Peng et al., 2016). Furthermore, studies that examine the effects of exercise on children's intelligence, cognition, or academic achievement were reviewed and results were discussed in light of (a) contemporary cognitive theory development directed toward exercise, (b) recent research demonstrating the salutary effects of exercise on adults' cognitive functioning, and (c) studies conducted with animals that have linked physical activity to changes in neurological development and behaviour (Tomporowski et al., 2008). Cognitive functioning which is defined as a process of selecting, organising and initiating actions that are goal-oriented, is facilitated by exercise. Exercise may prove to be a simple, yet important, method of enhancing those aspects of children's mental functioning central to cognitive development (Tomporowski et al., 2008). As a conclusion, however, studies have still proven that children and adolescents who are more physically active showed higher academic performance (Grierson, 2005; Sigman, 2007).

Despite these numerous health benefits, Poh et al. (2010) found that most Malaysians do not adequately participate in physical activity. Since 1991, the Malaysian Ministry of Health has conducted the Healthy Lifestyle Campaign with different themes, such as promotion of exercise and physical activity (Tee, 1999). However, the campaign has shown little success as most Malaysian adults have remained generally sedentary, with only 14% reporting being adequately active (Poh et al., 2010). In addition, the Malaysian School-Based Nutrition Survey 2012 and Nutrition Survey of Malaysian Children classified that more than half of the children and adolescents in Malaysia as having low levels of physical activity and high levels of sedentary behaviour (Baharudin et al., 2014;

Lee et al., 2014). Malaysian children reportedly have a higher likelihood of being overweight as they age (Naidu et al., 2013). Individuals who were physically inactive during adolescence are more likely to be inactive as adults (Gordon-Larsen et al., 2004).

For these reasons, researchers, health professionals, and policy-makers have all sought to explore why some people are physically active, whereas others are not (Molanorouzi, Khoo & Morris 2014). Therefore, there is a need for a theory-based framework to improve physical activity behaviour and reduce sedentary behaviour as the children and adolescents grow older, targeting specifically at the Malaysian population. Hence, the TTM can provide useful guidance for the health and education ministry to develop key plans to promote the importance of regularly physical activity (Liu et al., 2018).

2.3 Transtheoretical model (TTM)

The TTM is a psychological structure that ventures to describe the adoption and maintenance of healthy behaviours as a process that occurs over time (Prochaska & DiClemente, 1983). The central aim of the TTM is to offer a clear understanding of the stages and processes of behaviour change (Prochaska & DiClemente, 1983). It is an important issue for public health to understand why the majority of adults in industrialised countries are insufficiently active (Caspersen, Merritt & Stephens, 1994). A recent meta-analysis has shown that the majority of studies focused on the effectiveness of TTM as a behavioural change management, and supporting the hypothesis that TTM can be applied in the prevention of chronic diseases (Hashemzadeh, Rahimi, Zare-Farashbandi, Alavi-Naeini & Daei, 2019). Exercise researchers have recommended the TTM be applied to

assess exercise behaviour in view of its applicability and generalisability to measure exercise behaviour time and again (Marcus, Rossi, & Selby, 1992a; Marcus, Selby, Niaura & Rossi, 1992b).

As the name suggests, the TTM model comprises of different interconnecting models. The models are; 1) the stages of change, 2) processes of change, 3) decisional balance, 4) self-efficacy and in studies that require cessation from a particular behaviour or substance, temptations. The TTM is cyclical rather than linear, meaning that it can move forward and backwards between stages. Several psychological constructs of the TTM have been associated with exercise behaviour, namely; processes of change, decisional balance as well as self-efficacy (Prochaska & Marcus, 1993). The hypothesis is that people at different stages use distinct processes of change. Therefore, based on the stage a person is in, cognitive, behavioural or a combination of both adoptions can be employed to increase the likelihood of behavioural change and maintenance.

TTM suggests that changes in healthy behaviour occur in a number of stages, and that mechanisms of change include the cognitive and behavioural processes that individuals engage in different stages of change as stated similarly earlier (Kim & Cardinal, 2009). In addition, individuals will weigh the pros and cons of engaging in physical activity, and will generally experience increased self-efficacy as they advance through the stages of physical activity behaviour change (Levy & Cardinal, 2006). In Malaysia, the TTM model has also been translated and validated to be used on the cessation of smoking (Yasin et al., 2013; Yasin et al., 2011). TTM application in Malaysia was also studied on the reduction of body weight (Johari & Sutan, 2016) and physical activity levels in women (Omar-Fauzee, Lian, Loon, Nazaruddin, & Rashid, 2009). In addition, the TTM has also been translated and

used in exercise behaviour among Malaysian Secondary school students in a cross-sectional study (Kee et al., 2010), however, the validity of the questionnaires were not reported. A transtheoretical framework may help in identifying the levels of the students' motivation of students in wanting to participate in physical activity; however, limited studies have been conducted using the transtheoretical model on the younger population (Rizal, Hajar & Kuan, 2019).

2.3.1 Stages of change

The first construct of TTM, the stages of change, is essential in part because it represents a temporal dimension (Prochaska & Velicer, 1997). It was developed by Marcus et al. (1992a). There are six stages in this construct, beginning with 1) pre-contemplation, followed by 2) contemplation, 3) preparation, 4) action, 5) maintenance and finally 6) termination. During the first stage, individuals have no intent of changing their health behaviours within the upcoming six months. People in this stage are content with their current behaviour and are not aware of the consequences of their behaviour. The next stage is contemplation which people are intending to change their health behaviour within the upcoming six months (Prochaska & Velicer, 1997). During this stage, individuals are weighing the relative benefits of changing their health behaviour over the cons. The balance between these opposite spectrums will determine whether they will move towards a change rather than remain stagnant with their behaviour.

The third stage is the preparation stage in which individuals are preparing to take steps towards changing their health behaviour within the following month. People at this stage tend to have made progress towards change within the past year such as reading self-

help books, attend health education programs, plan of action and met with a consultant or physician. In this stage, the emphasis or process of change has shifted from a cognitive aspect to a more behavioural or action-oriented one. The fourth stage is the action stage, in which people have overtly made changes in their lifestyle, primarily within the past six months. The actions committed in this stage are observable, and the steps taken must surpass a criterion in order to be sufficient enough to reduce the risks for disease (Prochaska & Velicer, 1997).

The fifth stage is the maintenance stage in which people are working to prevent relapse in their behavioural change. In this stage, people tend to be more confident and less likely to relapse as compared to the people in the action stage. The estimated time for the maintenance stage lasts from six months to approximately five years. Finally, the last stage in the stages of change construct is termination. In this stage, people have zero temptations and have 100% self-efficacy. Since the termination stage has no practical value, it is omitted from this study.

2.3.2 Processes of change

The processes of change for physical activity was developed by Nigg, Norman, Rossi and Benisovich (1999). The construct is defined as the internal and external methods that an individual adopts to advance through the stages of healthy behavioural change (Prochaska & Velicer, 1997). The processes of change act as an independent variable that have an impact on the progress of change in which it will determine the smoothness of progression and the likelihood of relapse. The ten processes that make up this construct are divided into two subsets; cognitive (covert) and behavioural (overt). The processes that

occur cognitively are covert, meaning it is not observable by other people and that the changes made occur in their mind rather than in their action. This process of change occurs during the early stages of change such as pre-contemplation, contemplation and preparation. Contrarily, behavioural processes are the observable changes that others can see (Prochaska & Velicer, 1997). This process of change occurs during the later stages of change, including preparation, action and maintenance. The shift between these two processes are overlapping and may occur simultaneously depending on what stage an individual is in.

2.3.3 Decisional balance

The next construct in the TTM is decisional balance. Janis and Mann (1977) introduced the construct of decision making consisting of pros and cons. For pros, the categories are instrumental gains for self and others as well as approval for self and others. For cons, the categories are an instrumental cost for self and others as well as disapproval form self and others. However, a simpler way of viewing the construct is as the pros and cons of change (Prochaska & DiClemente, 1983).

Plotnikoff, Blanchard, Hotz, and Rhodes (2001) later revised the scale into the 10-item decisional balance scale. This scale looks at positive and negative aspects of physical activity. The decisional balance score calculated by subtracting the average con score from the average pro score; the larger the score, the more pros the individual perceived compared to the cons (Marcus & Forsyth, 2003). Healthy behavioural change will most likely occur when an individual perceives more benefits of changing as compared to the cons (Kim, 2007). For physical activity, Prochaska and Marcus (1993) stated examples of pros that

include the benefits of health such as relief of stress, improved sleeping patterns as well as higher levels of energy. Whereas, examples for cons include time constraint, other commitments such as work and family and inclement weather that may exercising.

2.3.4 Self-efficacy

The fourth construct in the TTM is self-efficacy which was integrated from Bandura's self-efficacy theory (Bandura, 1977). It is characterised as a situation-specific confidence that individuals have to confront risky scenarios without regressing to their previously unhealthy behaviour (Bandura, 1982). The scale was later revised by Kim (2007) into the Korean version and applied to an adult population consisting of three factors; internal feeling, situational and competing demand. The scale was then validated among Malaysian university students and showed sound validity and reliability (Liu et al., 2018).

As stated earlier, the scale has three factors; (1) internal feeling includes items related to represented mental distress, such as anxiety and depression, which affect an individual's confidence regarding physical activity performance; (2) situational includes items related to personal perceptions and cognitions of any situation or context and interpersonal communications that can facilitate or impede confidence of the person to perform physical activity, and finally; (3) competing demand includes items related to situations on which the individuals could have less influence, such as family support for doing exercise (Noroozi et al., 2011).

According to the perspective of TTM, it is hypothesised that individuals in the different stages of exercise behaviour have varying perceived self-efficacy regarding the

positives and negatives of exercising; and thus have varying confidence in their ability to maintain its benefits and to overcome its barriers (Marcus et al., 1994). Presently, data suggest that individuals with high levels of self-efficacy are able to confidently exercise in spite of challenges they may face (Kim, 2007). In addition, they are more rehearsed in engaging in higher levels of exercise as compared to those with low self-efficacy.

2.4 Criticism and limitations of previous TTM studies

The use of the TTM in many health researches has been published and proven to successfully explain and predict changes of behaviour whether it is for changes to a healthier behaviour such as increased physical activity and eating healthier foods, or for the cessation of unhealthy behaviours such as smoking cessation, substance abuse and fat abundant diets. However, Adams and White (2005) argued that stage-based activity promotion interventions are not applicable to physical activity for a number of reasons. Their insight would provide an understanding of the limitations of the TTM as a psychological framework for physical activity interventions.

Firstly, physical activity is a complex category of different specific behaviours such as transport behaviours, work-related physical activities, home-making activities, gardening and other leisure-time activities, including sports (Johannes et al., 2005). Since staging algorithms are usually based on self-assessment, these people are then regarded as being in the maintenance stage, while in fact their actions are not in line with recommended activity levels and they show no motivation to change (Johannes et al., 2005). Therefore, Lechner et al. (1998) have then suggested that it would be useful to distinguish between

aware pre-contemplators and unaware pre-contemplators to distinguish people who know and do not know that they are inactive and therefore direct their intentions towards change.

Secondly, various algorithms are used to allocate people to the TTM stages of change in which there is no "gold standard" with which to compare different staging algorithms (Adams & White, 2005). Therefore, there is a lack of validity of these measures. Besides that, stage stability over time has also been studied on dietary behaviours in people who were not exposed to a behaviour intervention and the results showed that stage transitions were common, especially among people in contemplation and preparation, even within as short a time interval as three days (Nooijer et al., 2005; Vet et al., 2005). In short, such stage instabilities can of course reflect true stage transitions, but may also indicate low test-re-test reliability of the staging algorithms which will lead to a non-reliable staging tool and true stage instability and will therefore, result in mismatching of stage-based interventions (Johannes et al., 2005).

The argument now is that complex health behaviour should be assessed more objectively in the algorithms (Greene et al., 1999; Ronda, Assema & Brug, 2001). However, this will reduce the attractiveness of the model as measuring the physical activity patterns is difficult as well as a potential burden on the respondents which will lead to a much harder stage allocation (Johannes et al., 2005). In the end, such a more objective and thus comprehensive measurement of behaviour can and has been applied in individually tailored interventions (Kreuter & Skinner, 2000). To circumvent this issue, Godin et al. (2004) showed that a staging algorithm for physical activity, based on a 2x2 matrix of intention and recent past behaviour, outperformed the TTM stages of change algorithm in terms of cross-sectional differences between stages in attitudes and perceived behavioural

control. Currently, the leisure-time exercise questionnaire is used in conjunction with the stages of change construct for physical activity intervention studies (Godin, 2011).

Other arguments include that the evidence for the core constructs in the TTM are mostly comprised of cross-sectional data while more convincing evidence based on longitudinal data or experiential research is mostly lacking (Sutton, 2000; Vet et al., 2005). Besides that, stage-targeted activity promotion interventions, like most interventions are almost all short-term and are mostly restricted to educational strategies. In this regard, educational facilities that require health intervention require legislation in order to maintain long-term effects (Baranowski, Cullen, Nicklas, Thompson & Baranowski, 2003; Rothschild, 1999). Furthermore, individualised health education interventions that go beyond stage targeting, which are referred to as tailored interventions (Kreuter & Skinner, 2000), may be better suited to induce changes in complex behaviours than mere stage matching, since such interventions provide people with personalised feedback and advice that directly matches their individual behaviour, motivation, perceived pros and cons, and self-efficacy beliefs (Brug et al., 2003).

In short, Adams and White (2005) are right to argue that the validity of the TTM has not been fully established for complex health behaviours. However, recent studies have proved that TTM has been successfully implemented as a framework for improving health behaviours in physical activity (Peng et al., 2016). Future studies are warranted for more long-term physical activity interventions that go beyond health education, incorporating environmental changes strategies to improve opportunities for physical activity (Johannes et al., 2005).

2.5 Previous validation of TTM

Several studies have supported stage-matched intervention as being useful for physical activity behaviour change (Blissmer & McAuley, 2002; Griffin-Blake & DeJoy, 2006; Lippke, Ziegelmann & Schwarzer, 2004). However, for the most part, these studies have been conducted in Western countries. Kim (2007) has already attempted to generalise and test the external validity of the TTM on Asian populations, specifically Koreans. Other countries such as Japan and Iran has also been applied (Mahmoodabab, Mohammadi & Abad, 2013; Nakamura, 2009). Before generalising the findings from such studies to other nations and cultures, it is imperative to determine their external validity (Nishimura & Chikamoto, 2005). Furthermore, TTM validation in the Malaysian population has also been found for smoking cessation (Malay version) (Yasin et al., 2011) and physical activity (English version) (Liu et al., 2018). However, no studies have validated the Malay version for physical activity. Previous validation studies used CFA to validate the TTM constructs.

CFA is a quantitative data analysis method that belongs to the family of structural equation modelling techniques (Mueller & Hancock, 2001). CFA allows for the assessment of fit between observed data and an *a priori* conceptualized, theoretically grounded model that specifies the hypothesised causal relations between latent factors and their observed indicator variables (Mueller & Hancock, 2001). The following fit indices were used to assess the CFA model fit: comparative fit indices (CFI) and Tucker and Lewis index (TLI) with the desired value of more than 0.92; and root mean square error of approximation (RMSEA) and standardised root mean square (SRMR) with the desired value of less than 0.08 (Kim & Cardinal, 2009).