The Effects of Flipped Learning on Children's Physical Activity Levels and Motivation during Physical Education Lesson

by

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Statement of Originality

I, YIP, Pak Kwan, hereby declare that I am the sole author of the thesis and the material presented in this thesis is my original work except those indicated in the acknowledgement. I further declare that I have followed the University's policies and regulations on Academic Honesty, Copyright and Plagiarism in writing the thesis and no material in this thesis has been submitted for a degree in this or other universities.

Abstract

Background: In Hong Kong, the time limitation set for physical education (PE) lessons at schools is one of the obstacles in promoting adequate physical activity (PA) levels for students. Flipped learning is a pedagogical approach that advocate more interaction between teachers and learners, in return promoting more PA participation. The present study utilised the self-determination theory (SDT) as the theoretical framework for designing flipped learning content to be applied during PE lessons, targeting the improvement of students' PA levels. The purpose of this study was to examine the effectiveness of the flipped learning unit on the PA levels and motivation of students during PE lesson.

Method: For this study, 111 Grade 5 students at a Hong Kong primary school participated in the study. They were grouped into a flipped learning group (PE lesson with flipped learning; n=57) or a traditional learning group (PE lesson with regular teaching; n=54). Participants were randomly assigned to groups followed the class they were in. The flipped learning design included an online self-learning session and an in-school learning session with more practice and discussion time allowed during the course of a four-lesson PE learning unit. The lessons for both groups were conducted in twice weekly sessions that lasted for 25 minutes each. An accelerometer (GT3X) was used to measure the PA levels of students during the four experimental PE lessons; and questionnaires were used to assess their motivation before each PE class.

Results: Using ANOVA, a significant difference in PA level was found between the traditional learning group and flipped learning group (F, [1,21] = 21.76, $p < .05$). Moderate to vigorous physical activity (MVPA) duration of the flipped lessons was higher and duration of sedentary (SED) was lower than that of the traditional lessons. At the same time, autonomous motivation

was a positive predictor of MVPA (β = 1.603, p < 0.05) in practice-oriented lessons. In addition, autonomous motivation (β = -.780, p < 0.05) was a negative predictor of the SED.

Conclusion: The present study confirmed the effectiveness of flipped learning for enhancing the PA levels of students during PE lessons. In PE lesson with flipped learning, students' PA behaviour was associated with their motivation. Correlation between motivation and MVPA was partially substantiated in this study. Correlation between motivation and SED was partially substantiated in this study. It is suggested that future studies should consider by examining a more diverse sample group of students.

Keywords: self-determination theory, autonomous motivation, MVPA, sedentary behaviour, primary students

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List of Abbreviations

BMI	Body mass index
PA	Physical activity
PE	Physical education
SDT	Self-determination theory
MVPA	Moderate to vigorous physical activity
SED	Sedentary
ANOVA	Analysis of Variance
MANOVA	Multivariate Analysis of Variance

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Chapter 1: Introduction

1.1 What is flipped learning?

Flipped learning is a pedagogical approach in which the traditional order of presenting and supplementing educational material is reversed so that a classroom becomes a dynamic, interactive space while a home is where direct instruction occurs. Instructional videos are a commonly used platform outside the classroom (Khan, 2012). The flipped learning classroom is distinguished that applies a pedagogical approach by moving learning lesson content outside a classroom. Instead of teachers' instruction during class time, content learning occurs prior to the class—which enhances the interaction opportunities between both students and teachers (Hwang et al., 2015). Flipped learning also provides students a flexible learning approach, for instance, online video viewing can be carried out at work, home, or while commuting (McDonald & Smith, 2013).

Flipped learning is a popular approach and it is widespread in most countries and regions (Bergmann & Sams, 2012)—including the People's Republic of China (PRC), Japan, and Singapore in Asia (Zhang et al., 2012; Hiroki, 2016; Ho, 2002); the United States of America (US) in North America (Finkel, 2012; Herreid & Schiller, 2013); and France in Europe (Melpomeni, 2019). In these countries, flipped learning is broadly applied to student learning activities at all educational levels and in multiple subjects.

1.2 The application of flipped learning in teaching

Flipped learning improves learning conditions (Aidinopoulou & Sampson, 2017; Kostaris el al., 2017), which has been examined by a number of researchers across different subjects, fields, and educational sectors (Lo & Hew, 2017; Bishop & Verleger, 2013). In addition, Hamdan et al. (2013) point out that flipped learning involves both student-initiated

goals and active instructional methods selected by instructors, which means learning materials can be viewed multiple times in order to fit individual learning patterns of students and maximise their learning time. At the same time, students can be benefitted from expertise of both instructors and peers while they apply what they have learnt to real-life scenarios. More specifically, flipped learning enhances students' skills development (Tanner & Scott, 2015) and motivation (Sahin et al., 2015). Another study found that using flipped learning in junior high school and high school in information and communication technology, mathematics, and humanities courses enhances students' motivation to learn (Hao, 2014).

Participating in flipped learning, students' motivation and behaviour can be formed, allowing their self-efficacy and learning strategies to develop (Lai & Hwang, 2016). It has been shown that flipped learning can enhance peer interactions in the classroom and thus have a positive impact on maintaining high levels of student engagement in coursework (Thompson & Ayers, 2015). For students in primary school, flipped learning can cultivate better problem-solving skills (Segolsson & Bäcklund, 2016). Students' participation in individualised delivery of instruction raises their levels of engagement with learning materials in which effectively leads students to learn how to teach others, instead of having their educators assign and lead them organising and presenting teaching strategies in a classroom. This results in active, or even pro-active, learning (McDonald & Smith, 2013). Student-centred learning is an element of flipped learning that successfully promotes educational interests and students' exploration (Wilson et al., 2005).

Despite differences in teaching mode and content, the application of flipped learning in physical education (PE) lesson has also been studied in a previous study (Østerlie, 2018). In the study, teachers assigned a video to students about the activity that is to be taught in the coming PE class, students are required to prepare themselves for this class by watching the assigned video in their leisure time. During the PE lesson, students are required to teach their

peers the new activity that they learned by themselves from the video. Another form of flipped learning application in PE includes an introduction of unfamiliar game rules to students (Bergmann & Sams, 2014). In addition, there was study showing academic improvement of secondary school students with flipped learning (García, et al., 2015). A flipped PE classroom could better utilised class time to practice and enhance skills because task completion and content explanation would be done in advance of the class in the form of homework. Applying flipped learning at universities, study reported that the time spent on practical activities is found to be adequate, even expanded, and the feedback from instructors is more effective (Killian et al., 2016). There was previous study examined how flipped learning applied in PE lesson, which indicated that flipped learning benefits and learning conditions for students in PE classes can be enhanced through motivation, which was positively associated with the PA levels of students (Gao et al., 2011).

Physical activity (PA) level of children in Hong Kong is inadequate. In a report with a comparison across 48 countries and regions around the world, less than 10% Hong Kong children and youth aged seven to 19-year-old reported participation in at least 60 minutes of moderate to vigorous physical activity (MVPA) a day (CUHK, 2019). Lacking time to do PA of suitable level will affect their physical development and enhance the risk to face fourth leading risk factor of global mortality (World Health Organization [WHO], 2020; LCSD, 2014). PE in school, thus, provides an opportunity to involve children in PA. The local education curriculum allocates 5 – 8% of total lesson time to PE lessons (Curriculum Development Council [CDC], 2017). With compulsory PE lessons arranged in all primary schools in Hong Kong, how the delivery of PE lessons would be influential to the children's PA. A recent report indicated that almost 80% of schools have two PE sessions scheduled per week but that, in fact, the actual length of these sessions is 20% shorter than indicated on their official schedules (CUHK, 2017).

There are professional recommendations of PA participation during PE lessons, which indicate that children (five – 17 years old) should participate in MVPA for 50% of PE lesson time in order to gain health and academic benefits (Centers for Disease Control and Prevention, 2010). However, previous study indicated that children's PA levels during PE lessons is greatly influenced by how the lesson is conducted. It was reported that the subject matter and mode of delivery are lesson characteristics related to children's PA in PE lessons (Chow et al., 2008). For example, teaching track and field in primary school, being one of the core units in PE curriculum (CDC, 2017), includes wide range of skills and knowledge within the category. When teaching relay running, there are a number of basic rules and regulations that must be taught to improve students' learning. It is common that a large part of teaching time is allocated to the lecture of the skill matter, which resulted in limited time for PA during PE lessons. Despite running is the easiest track and field sport to organise with minimal equipment required (National Health Service [NHS], 2019), using traditional approach in teaching and learning of the subject matter may hinder PA participation of the children.

1.3 Purposes of the study

The present study examine the effects of flipped learning on children's PA levels and motivation in PE lessons. The specific objectives are: 1) to examine the difference of PA behaviour between classes using flipped learning and traditional learning approach; 2) to examine the association of PA level and motivation in a PE lesson using flipped learning approach.

The current study is guided by an underlying research question: how can flipped learning approach increases the PA levels of primary school children during PE lessons? The hypothesises of the study are:

Hypothesis 1: The PA levels of children is higher during PE lesson using flipped learning approach than using traditional learning approach.

Hypothesis 2: The children's MVPA during PE lesson is positively correlated with their motivation orientation when using flipped learning approach.

Hypothesis 3: The children's sedentary (SED) behaviour during PE lesson is negatively correlated with their motivation orientation when using flipped learning approach.

1.4 Significance of the study

Quality PE teaching requires both knowledge delivery and assurance of PA time. However, limited time allocated on PE lessons is a challenge to PE teachers in Hong Kong. When teachers put focus on completing all teaching tasks that are required, activity time of students will be affected. Furthermore, PE teachers had limited information about how active the students in each lesson are. The result of this study would be useful for PE teachers to accomplish the delivery of knowledge and at the same time not to sacrifice valuable class time to achieve longer PA duration as well as higher PA level if the hypothesis were confirmed. Previous research on flipped learning focus on students' learning and lessons designed to implement flipped learning at the university level or in subjects other than PE. In addition, there is limited information about the impact of flipped learning on PA level.

The result of the study would help teachers understand how flipped learning techniques could be applied to PE teaching in Hong Kong primary schools and to provide a new perspective on increasing students' PA levels in PE lessons.

1.5 Definition of terms

Flipped classroom: Shifting learning pattern means students learn through working with others and learn independently while teachers facilitate interactions and engagement in a shared learning setting (Flipped Learning Network [FLN], 2014).

Traditional learning: Passive learning is where knowledge is disseminated from educators to learners in a fixed setting. Educators teach through demonstrating pair work and group work. Homework is required to be submitted in the following lesson in order to assess learners.

Physical activity: All kinds of body movements require energy expenditure. Be precise, "physical activity" is different from "exercise". The former includes body movements in work environment, during leisure time, and any other active time (World Health Organisation [WHO], 2021). The latter is just one activity that aims to improve or maintain fitness.

Motivation: The underlying reason behind certain behaviours. It refers to the tendency to initiate and perform a certain activity (Guay et al., 2010).

Chapter 2: Literature Review

This chapter presents literatures in relation to flipped learning and PA, which focuses on how flipped learning is associated with students' motivation and how the motivation theory can be applied in flipped learning teaching. The literature review covers: 1) pedagogical approach of flipped learning; 2) application of flipped learning in teaching; 3) association of flipped learning and motivation, in which self-determination theory (SDT) is further elaborated; 4) PA behaviour during PE lesson, 5) application of flipped learning in PE teaching; and 6) summary.

2.1 Pedagogical approach of flipped learning

The origin of the flipped classroom concept can be traced back to 1982, when Baker (2000) had a vision of using digital means to disseminate his routine teaching materials to students outside the classroom. In recent years, flipped classroom pedagogy has gained more attention because it is being studied in more depth and is becoming more publicised. In the limited body of literature on flipped learning, two key differences are identified between flipped learning and traditional learning. The major difference is the shifting of roles in classroom: from teacher-centred to student-centred. In traditional learning, a teacher is the basic, direct, and sole source of information and knowledge. In such a classroom setting, students usually sit quietly and listen to the teacher. Teaching approach in a flipped learning environment shifts the teaching role. This pedagogical approach is situated in a student-centred learning environment that focuses on the learning experience of students, instead of the classroom delivery of instruction. In flipped learning, the traditional roles are reversed—teachers act as facilitators and students learn through other media such as discussions, activities or games. Teachers become facilitators alongside with students, instead of dominating lessons.

By encouraging students from being inactive receivers of static information, they become active participants in discovering and obtaining the set learning objectives on their own in order to achieve goals (Brown, 2012).

Flipped learning provides more opportunities for students to learn from their peers (Baker, 2000). Even in activities or games, teachers are not meant to provide solutions. The FLN (2014) states that direct instruction in flipped learning is going to shift gradually from a massive learning platform with peers to individual learning spaces with learners and devices. Thus, learning is becoming more dynamic and interactive. With guidance and facilitation from educators, students can apply their own ideas and creatively engage in the learning process. Teachers design activities that engage students and motivate them to learn through an interactive learning process, and they also ensure that students are not merely learning on their own but with others. Furthermore, students in flipped classroom settings are required to take more responsibility for their learning (Weimer, 2002). This means that there is an adjustment period for some students when transitioning from traditional to flipped learning because they have learnt to rely heavily on their teachers and follow instructions under the traditional teacher-centred approach (Brown, 2012).

The flipped learning classroom applies a pedagogical approach in which the role of teaching is shifted from teachers to students. Instead of being taught directly by teachers during class time, content learning occurs prior to the class—which enhances interaction opportunities for both students and teachers (Hwang et al., 2015). With flipped learning, teachers have more time to help their students to solve the problems they have encountered and to provide guidance by assisting students' learning in order to maximise learning effectiveness and self-efficacy.

In brief, flipped learning redefines the roles of teachers and students and is a pedagogy that focuses on student-centred activities. It has been found that the usual practice—known as the "demonstrate–explain–practice"— in PE lessons in Hong Kong schools is gradually being

replaced. Likewise, in other countries, schools in Hong Kong have begun switching from teacher-centred learning approach to student-centred ones. Studies have been conducted related to behaviours of teachers and students as they work together in PE classes (Darnis & Lafont, 2015). With application of flipped learning, interaction and reflection of both teachers and students are expected to be facilitated during classroom activity time.

2.2 Application of flipped learning in teaching

Students who engage in the flipped learning approach are exposed to different materials outside of their classrooms by either reading lecture materials or listening to lectures through demonstration videos (Brame, 2013). This allows students to take control of their own learning progress, offering them a greater sense of personal responsibility in their learning process (Baker, 2000). Learning outside the classroom is one of the key differences between traditional and flipped learning. Students should learn knowledge in advance before attending lessons in class. The learning environment is changing—students are not obtaining knowledge directly from teachers but are generating knowledge themselves. Then, students make use of the new knowledge they have gained to complete the interactive learning process in the classroom. Baker (2000) finds that the use of technology and gadgets enables the sharing of materials outside classrooms. Using Internet platforms—such as Google Classroom, YouTube, or Moodle—to share learning materials is a common practice at the university level nowadays. With the advanced technology, the use of digital videos has influenced instructional practices, while other technological tools have further encouraged teachers to use different pedagogical approaches (Quillen, 2013). The Internet is essential to teaching nowadays. Teachers can make use of what they consider to be appropriate for and complementary to their teaching—and this has directly led to the development of flipped learning movement in education.

When flipped learning is used, students start to discover and recognise their subjects

from a more holistic perspective (Segolsson & Bäcklund, 2016). It has been noted that the satisfaction level of learners are enhanced and learning outcomes are more frequently achieved in flipped learning classrooms when compare with traditional classrooms (FLN, 2014; Zainuddin & Halili, 2016). A difference between flipped learning and traditional learning lies in the fact that students are not learning through their teachers but through other students. Another difference between the two mentioned approaches would be using the study materials provided by teachers, students generate their own views on the given materials. The subsequent sharing of the above differences in an interactive design provides an opportunity to allow students to think about the learnt topics more critically. In this vein, Segolsson and Bäcklund (2016) found that when flipped learning is applied in primary schools, problem-solving skills of students increase, their self-efficacy improves, and their ability to accept new learning strategies is enhanced (Lai & Hwang, 2016). At other educational levels, Long et al. (2016) pointed out that when university students carry out class preparation via videos instead of text-based sources, their engagement and coursework performance are better. Similarly, flipped learning also supports lower ability students such as those who are prevented from physically attending lessons to learn more effectively (Gross et al., 2015). However, given the wide variety of involvement and research design in relation to flipped learning, additional investigations about the applicability (Bishop & Verleger, 2013) and effectiveness (Abeysekera & Dawson, 2015) of specific methods are required.

2.3 Association of flipped learning and motivation

Motivation is an inner drive of behaviour. Goal-directed behaviour shows how enthusiasm and passion of students motivates themselves to achieve higher goals (Pintrich & Schunk, 1996). Hence, motivation is a direct cause of how students behave in order to reach learning goals and improve their learning performance. There are various theories that explain

how students' motivation affects their learning. Bandura's (1986) self-efficacy theory predicts diverse outcomes, such as academic achievements, social skills, and athletic performances. The self-determination theory is an empirically based theory on human motivation, development, and wellness (Deci & Ryan, 2008). It proposes that the basic psychological needs for autonomy, competence, and relatedness influence both type and strength of motivation. The present thesis is based on the self-determination theory and discusses how motivation affect the PA levels of learners.

Deci and Ryan (2000) suggest that students understand the purpose of their learning in a flipped classroom setting and, thus, gain a clearer picture of what their academic goals are (Baeten et al., 2010). This enables students' motivation and participation in learning process to rise. Such findings imply that, in a flipped learning PE lesson, students not only gain a better knowledge foundation but also become more motivated to reach a higher level of knowledge and proficiency in a thoughtful way.

Hattie (2009) connects feeling of satisfaction and competence to motivation. A study of visible learning finds that it facilitates an active learning process and motivates students to learn (Hattie & Yates, 2013). Flipped learning is a way in which students are able to know what they are going to learn in forthcoming classes. Roach (2014) links flipped learning to deeper learning because learning videos provide both understanding and preparation for class. Videos that are viewed outside the class provide students with a visualisation of their upcoming activities, which is linked to higher student motivation (Manger & Wormnes, 2015). Simkins (1999) also presents his recognition towards the use of online resources in some academic subjects. Both Roach (2014) and Simkins (1999) claimed that there are potential benefits of using technology on the Internet in coursework. These benefits include an increase in student participation and student motivation, with increased opportunities for students to critically analyse their work. Likewise, Bergmann and Sams (2012) and the Byron School District

(Fulton, 2012) support the theory that stipulates that increased student participation and collaboration with peers and teachers boosts motivation in learning.

Motivation is defined as the concept that affects the direction and magnitude of a behaviour in four different dimensions—namely, interest, relevance, expectancy, and satisfaction (Keller, 1983). Fairchild et al. (2005) conjecture that motivation has a significant impact on learners' attitude and learning behaviours in educational environment. When a learner has low motivation in an educational environment, learning cannot reach an ideal level (Dick et al., 2005). The reason for this, according to Keller (1979), is that motivation is far more important than one can imagine, which motivation must be taken into account in an instructional design. Even when the teaching environment is excellent, if motivation is not present in students, then the environment can be regarded as unsuccessful. The participation level and effort of students with higher motivation is undoubtedly more effective in comparison to those with lower motivation (Keller, 1979). Other research on human motivation analyses how people perform and respond when accomplishing tasks (Aron et al., 1998). Conditions that affect health and vitality are taken into account as well (Glen, 1999).

2.3.1 Self-determination theory (SDT)

Motivation is differentiated from SDT (Deci & Ryan, 2008a). SDT is an empirically based theory on human motivation, development, and wellness (Deci & Ryan, 2008). It proposes that the basic psychological needs for autonomy, competence, and relatedness influence both type and strength of motivation. Ryan & Deci (2000) also suggested several types of motivations as a sub-theory within SDT—organismic integration theory (OIT). OIT describes these motivations known as behavioural regulations and categorised them into controlled extrinsic motivation (including external regulation and introjected regulation), autonomous extrinsic motivation (including identified regulation and integrated regulation),

intrinsic motivation and amotivation. These regulations range from a lack of motivation, amotivation, to the most autonomous form of motivation, intrinsic motivation (Ntoumanis, 2001; Standage et al., 2005). As suggested by Litalien et al. (2017), individuals' characteristics and the amount of autonomy represented varies amongst the four types of extrinsic motivations. External regulation is the least autonomous form of extrinsic motivation and followed by introjected regulation. Integrated regulation is the most autonomous form of extrinsic motivation, while the autonomous level of identified regulation is in between introjected regulation and integrated regulation. External regulation refers to an individual is performing an activity in return for contingent rewards or punishments controlled by the others. Introjected regulation refers to an individual is acting to protect his or her contingent self-worthiness, or to avoid a sense of guilty or anxiety. Identified regulation appears when an activity is associated with one's personal values, and integrated regulation occurs when a task is fully embraced with a person's sense of self (Deci & Ryan, 2002).

The SDT divides human motivation into three general categories: autonomous motivation, controlled motivation, and amotivation (Hill, 2013; Niemiec & Ryan, 2009; Deci & Ryan, 2008a). Deci and Ryan (2008a) mention that the outcomes of a person's performance, relationships, and general well-being could be predicted by their levels of motivation. Ryan and Deci (2000) also point out that the SDT highlights that both motivation and personality are influenced by self-regulated behaviour and intrinsic personal development.

Self-determination, according to Reeve et al. (2003), provides learners with the ability to make choices about how to carry out tasks. The SDT (Ryan & Deci, 2000) proposes that feeling competent and independent is essential to students, so tasks should be designed to encourage to feel independent and competent. An intrinsic motivation study reinforces the notion that the self-determination of learners is intrinsically motivated—when independence and feelings of competence are stimulated, a higher level of learner motivation is more likely

to be achieved (Reeve & Deci, 1996). Sebire et al., (2013) also suggested that many children are physically inactive. As mentioned before, it is essential to understand their social, environmental, and psychological foundation, which can persuade them to increase PA through the use of SDT. Motivation is one of the main drives for a person to act and SDT is being broadly used to investigate PA and PA motivation (Teixeira et al., 2012). SDT consists of various aspects that have established relevance towards PA under a single theoretical framework including PA motivation, psychological need, social environment antecedent to motivation, as well as satisfaction of children (Dewar et al., 2013).

2.3.2 Association of SDT and PA behaviour

The present thesis is based on the SDT and discusses how motivation affect the PA levels of learners. Among which, autonomy can be regarded as an individual's need to experience a sense of willingness or readiness in his or her actions. Competence can be defined as an individual's need to experience efficacy or effectiveness in his or her interactions with others. And relatedness refers to an individual's need for connectedness with other key individuals, satisfactions with the society and sense of belonging (Ryan & Deci, 2017). If the mentioned needs are fulfilled, individuals are more likely to be autonomously motivated. Instead, when these needs are not satisfied or only fulfilled to some extent, people's behaviours would be influenced based on the controlled reasons (McDavid et al., 2014; Mouratidis et al., 2015).

Obesity crisis across the world has acknowledged and emphasised the role of PE in promoting PA and physically active lifestyle in public health (Sallis et al., 2012). Therefore, it is essential to develop strategies persuading children to maintain a sufficient level of PA and enhance their fitness. In the study of Lonsdale et al. (2009), they revealed that students had higher PA levels under both structured and free-choice condition with higher self-determined motivation when comparing with students of lower self-determined motivation. Encouraging

students in developing more internalised values and autonomous motivation are important even though it is challenging in teaching, since not all activities are intrinsically motivating (Deci et al., 1991). Controlled form of motivation, such as external regulation, may engage individuals in his or her desired activities at least in the short term when autonomous motivation is missing, while maladaptive behaviours may probably occur in the long term (Deci & Ryan, 2000). They also suggested that self-determined motivation may be particularly crucial in enhancing students' participation in PA. Another study also indicated that a higher level of autonomous motivation is related to higher level of MVPA (Aelterman et al., 2012). Taking all the above reasons, it appears imperative for PE teachers in fostering students' autonomous motivation and creating a learning environment that could promote autonomous motivation, which in turn hoping to encourage students to be more active physically. In consistent with SDT's assumptions, satisfaction of students' psychological needs positively predicted PA (McDavid et al., 2014). In their study, they found that students who reported with higher-than-average level of perceived competence, relatedness, intrinsic motivation, and identified regulation were reported with more PA. This associations implied that PE teachers may be able to influence students' PA behaviours and could foster students' needs, fulfilment and autonomous motivation in PE in promoting their PA participation with appropriate application of SDT.

Individuals are assumed to be active in nature and have instinctive tendencies to develop a sense of self (Deci & Ryan, 2002). With this fundamental assumption, SDT hypothesises that the fundamental motive for one's behaviour is the desire to meet his or her intrinsic needs. Meanwhile, environmental factors serve as essential roles in influencing the tendency to act (Deci & Ryan, 2002). According to Deci & Ryan (2000), human needs "innate psychological nutrients", which are vital for continuous psychological growth, integrity, and well-being; SDT also suggests the interactions between social setting and people is the basis for human motivation, behaviour and well-being. These suggest that SDT can be a suitable theoretical

framework to look into the learning environment of PE where teachers could provide students with more learning autonomy by creating learning opportunities for students to connect to their innate needs, and establish a learning environment for students to perceive autonomy, competence and relatedness (Reeve et al., 2004).

As observed in classrooms, there is either autonomy-supportive personalities or controlling personalities (Deci & Ryan, 2008a). The teaching approach adopted by teachers determines how active interpersonal communication becomes within their classrooms (Baeten et al., 2013). A flipped learning classroom represents a constructivist learning environment, which can be interpreted as a mechanism that encourages students to learn through activities and social interactions (Vansteenkiste et al., 2009). Under this mechanism, learners tend to be motivated by an independent learning environment (Deci & Ryan, 2008a; Harun et al., 2012; Hill, 2013; Niemiec & Ryan, 2009), and their motivation might solely be affected by their own will, sense of satisfaction, and goals (Vansteenkiste et al., 2009). Views presented by Deci and Ryan (2008a) show that learning environment can stimulate a learning style, such as a constructivist and self-motivated environment. Consequently, student performance and incentive for learning can be said to be cultivated by the flipped learning approach

SDT assumes that more self-determined regulations, such as intrinsic motivation and autonomous extrinsic motivation (i.e. integrated regulation and identified regulation), are associated to adaptive learning outcomes; while less self-determined regulations, which is known as controlled extrinsic motivation (i.e. introjected regulation and external regulation), and amotivation are linked with maladaptive outcomes (Sun et al., 2017). Many research has been conducted in PE to study the impact of the different types of motivations on positive and negative outcomes. These studies have revealed that more self-determined regulations are directly and positively related to performance measures in PE (Shen et al., 2009). According to SDT, autonomy supports perceived by students within the learning context would satisfy their

psychological needs of autonomy, competence, and relatedness, which would in turn affect their motivation toward specific learning activity (Sun et al., 2017). Ding et al. (2013) similarly suggested that PE teachers could consider applying a wide variety of motivational strategies in keeping with specific learning outcomes to promote an optimal student motivation.

2.4 PA behaviour during PE lesson

PE and sport lessons are unlikely, within their allocated limited period of time, to maximise this time sufficiently in order to influence the energy expenditure of children on a daily basis. With reference to a 2016 report written by Active Healthy Kids Hong Kong and published by CUHK, the actual length of PE lesson was actually 20% shorter in reality than originally scheduled (CUHK, 2017). Consequently, PE lessons should be prioritised by schools because it is essential to enhance the PA levels of students during their PE class time as this may, in turn, assist them in achieving the MVPA recommended by the WHO (2020).

Focusing on understanding children's activity level during the school day is important while most of their time is spent at school. Upon a closer examination, children spend most of their time being inactive (CUHK, 2019), without an opportunity to engage in PA (Morgan et al., 2007). They engage in PA primarily during break time and PE classes. These periods could, therefore, be of substantial importance for students to engage in PA during school time. Since these few PE classes appear to be one of the only chances for students to engage in high intensity PA, it is imperative that their PE lesson time should be better utilised and that their PA levels can be enhanced during PE class sessions.

To study students' PA during the school day, Gavarry et al. (1998) monitored the heart rate of 66 French children, 11 to 16 years of age. Their results indicate that the heart rate of students reached the highest point during lunch breaks and PE lessons. Similarly, using an accelerometer to study over 200 school children from ten to 12 years of age, other researchers

discovered that the highest MVPA amounts were recorded during lunch breaks in school days (Fox et al., 2004). PA during break time contributed almost 22% (39 min) and 19% (27 min) of the total daily MVPA for male and female students, respectively.

According to the studies discussed above, the contribution of PE lessons to the overall PA of students is still arguable. Traditionally, PE lessons serve as a main source of PA for children at school, although it is estimated that the syllabised PE lesson duration comprises less than 1% of their school day. Even when they have PE lessons, children may not be very active. Sleap and Warburton (1996) conducted a study on English students, five to 11 years of age, using direct observation of activity during PE class time. They find that about one-fourth of the students are engaged in physically passive activities only, while fewer than a third of the students engaged in five consecutive minutes of MVPA. Similarly, Tudor-Locke et al. (2001) report that less than one-fifth of the US PE class in their study engaged in MVPA. In this case, a 40-minute class only generated an eight-minute of MVPA. This certainly challenges the popular understanding of PE effectiveness. The contribution of PE classes to the PA levels of students is not yet confirmed. Doubts about the effectiveness of PE classes increase when considering the rate of obesity and other health-related problems among school-age children.

With little proven impact of PE lessons on students' PA levels, the existing research reinforces that curriculum time must be adjusted so that PA can be found elsewhere, apart from these lessons. Myers et al. (1996) illustrate that student who do not actively join PE lessons are found to be less physically active at other time as well. Moreover, Dale et al. (2000) examined how 76 American students, age nine, spend their day according to the information measured by the accelerometer they wore. When children only engage in computer tasks, without PE classes, their PA levels are found to be significantly lower than on those days when they have outdoor breaks and perform PE-related activities.

These studies highlight that it is important to encourage students to join and engage in

PA each school day—and that PE lessons can play a role in that. Mallam et al. (2003) conducted a study on over 200 primary school students from three different schools in order to compare their PA duration and corresponding PA levels. One of the schools was equipped with excellent sport facilities and scheduled nine hours of PE lessons for students per week, while the other two schools provided around two hours of PE lessons per week. The results of this study show that absolute PA time is not necessarily positively correlated to the PA levels achieved by students. Hence, it is suggested that educational and psychological strategies can be implemented to boost the PA levels of students and thus lessen the problem of inactivity in children.

SED refers to any waking behaviour that requires an energy expenditure of ≤1.5 metabolic equivalent of task while in a sitting, reclining, or lying posture (Tremblay et al., 2017). WHO reported that an increase in SED leads to various non-communicable illness, such as high blood pressure, elevated cholesterol levels, obesity, cardiovascular disease, and diabetes (WHO, 2010). Therefore, monitoring of both PA and SED is essential in preventing the carry-over of obesity and non-communicable illness to adulthood, in which unwanted SED should be eliminated. Continuous concern has been expressed on the SED among children, an average of around six hours SED time per day was measured on children (Matthews et al. 2008). SED has been labelled as harmful to children's health where there is a linkage between SED and a greater chance for developing harmful chronic health problems was reported (Dunstan et al., 2010). However, the provision of more PA opportunities during PE lessons not necessarily in preventing students from engaging SED at the lessons (Cheung, 2017). Participation in physically active behaviour not exactly exclude individuals' engagement in SED. It is conceivable for students to involve in high level of MVPA during PE lesson and also has long SED at the remaining time throughout the day.

PE lessons in Hong Kong are commonly taught in a traditional manner, so

demonstrations and instructions take up valuable time. The PA levels of students may be affected by teaching theories in PE classrooms. Developing opportunities for students to learn independently is recommended in Hong Kong Basic Education Curriculum Guide (CDC, 2017). According to the PE Key Learning Area Curriculum Guide (Primary 1 – Secondary 6), both learning and teaching effectiveness in PE classes can be enhanced through e-learning (CDC, 2017). Teachers can give students guidance to find information about sports on their own, thus extending their learning through video clips watching before and after lessons; and allowing them to implement further practice during their leisure time (CDC, 2017). Based on the suggestions of the CDC (2017), it is anticipated that the application of e-learning before and after classes will enable a better utilisation of PE class time by increasing the actual practice capacity of and interactions between students and teachers, instead of limited time being used for theoretical explanation and instruction. This could help students boost their PA levels during PE lessons.

2.5 Application of flipped learning in PE teaching

Flipped learning can also be applied to PE classes. For example, students can prepare classes at home by watching videos about the next topic. Østerlie (2018) uses strength training as an example—teacher explanations about and demonstrations of strength trainings were included in the content of a flipped learning video. This video also contained explanations of the physiological changes that would occur as students become stronger and how this would affect their health conditions. Subsequently, the video moved from merely explaining the content to previewing the activities that would take place during the next class and posing related questions. During the face-to-face class, students were expected to acquire a certain level of knowledge from the video clip and to know what they are expected to do in class. Some students performed the assigned activities without any additional instruction. During the lesson,

students were also expected to discuss the content of the video with their classmates and teachers. The class concluded with student presentations on key points on the given topic in class.

Flipped learning also facilitates student-centred learning activities (Heinerichs et al., 2016) because students have preparation before class, which reduces the time that teachers have to spend on explaining concepts in a classroom. In a study on flipped learning applied in university-level PE classes, Killian et al. (2016) find that PE classes that use flipped content are marked with positive outcomes due to the increased amount of time available to spend on practical exercises in classes. The flipped approach increases the feedback given by facilitators because there is more time available. At secondary school level, flipped learning can help students apply what they have learnt in orientation activities (García et al., 2015). At primary school level, however, studies about the effectiveness of flipped learning in PE lessons are limited. In other research, despite the fact that PE teachers implement flipped learning to engage students in understanding complicated regulations of unfamiliar games (Bergmann & Sams, 2014), the impact and effectiveness of this implementation remains unclear. Meanwhile, flipped learning ranks comparatively higher among different teaching modes available due to its interaction element. An increase in on-topic conversations occurs among students after they prepare outside of the classroom—thus, flipped learning promotes discussions about the topics and activities of lessons (Zainuddin & Halili, 2016).

Motivation provides a good foundation for learning (Hattie, 2009). In some research studies, PE lessons that use flipped learning exercises are found to successfully change student motivation (McLaughlin et al., 2014; Deci & Ryan, 2002). McLaughlin et al. (2014) state that students report an increase in their motivation in classes that apply flipped learning over traditional classes. Deci and Ryan's (2002) study on flipped learning in PE lessons reveals that the adoption of flipped learning affects motivation from an SDT perspective. To summarise,

flipped learning promotes a good environment in which students are motivated to learn and experience mastery.

2.6 Summary

To synthesise the findings presented in this literature review, flipped learning is a pedagogical approach that has been promoted in recent years (FLN, 2014). In this approach, the roles of teachers and students, as well as the learning modes, have changed—or flipped—making flipped learning rather different from traditional learning. Individual learning of students changes to group learning, while the learning process shifts from being teacher-centred to student-centred in a flipped classroom. Knowledge is gained outside class time through projects, discussions, practices, and debates (Brame, 2013; Khan, 2012). Assessment or homework is also completed outside of class. In a flipped learning approach, students receive knowledge from other sources in addition to books. Students learn through different media, for example, videos or audios (Brame, 2013). Students learn on their own by finding other resources using the cues provided by teachers before lessons (FLN, 2014; Mo & Mao, 2017). Hence, flipped learning provides students a holistic perspective prior to lessons, allowing them to enhance their self-efficacy and learning strategies.

If the flipped learning pedagogy is applied to PE lessons, it could facilitate student-centred activities, such as presentations, discussions, or practices, during lesson time. In flipped learning, the literature shows that students are more motivated because their knowledge on a topic increases. When students understand the materials, their motivation is higher, including learning motivation (Baeten et al., 2010; Gao et al., 2011).

Motivation can be explained by the SDT, which states that humans have a basic and inherent need for autonomy, competence, and relatedness. If people, including students, fulfil these needs, their motivation to work and perform other activities—including learning

activities—is enhanced. Applying flipped learning to PE lessons also encourages students to invest more in these lessons and to enrich their PA levels.

This literature review points out that the issue of limited time being allotted to PE classes at schools is a worldwide problem. Furthermore, the reviewed researchers confirm that students are often not active during PE lessons and that their PA levels rarely reach MVPA. To have a high PA level and maintain active learning are the key goals of PE classes in Hong Kong schools (CDC, 2017). According to the literature, flipped learning can enhance the learning motivation of students in relation to PE through the SDT lens. However, research on this topic is limited at the primary school level. To address this existing research gap, the present study applies the flipped learning approach to PE lessons in a Hong Kong primary school and assesses the effectiveness of the SDT in enhancing students' motivation in PE lessons. Furthermore, the variation in PA level that results from implementing the flipped learning approach is compared to the traditional learning approach in depth.

Chapter 3: Methodology

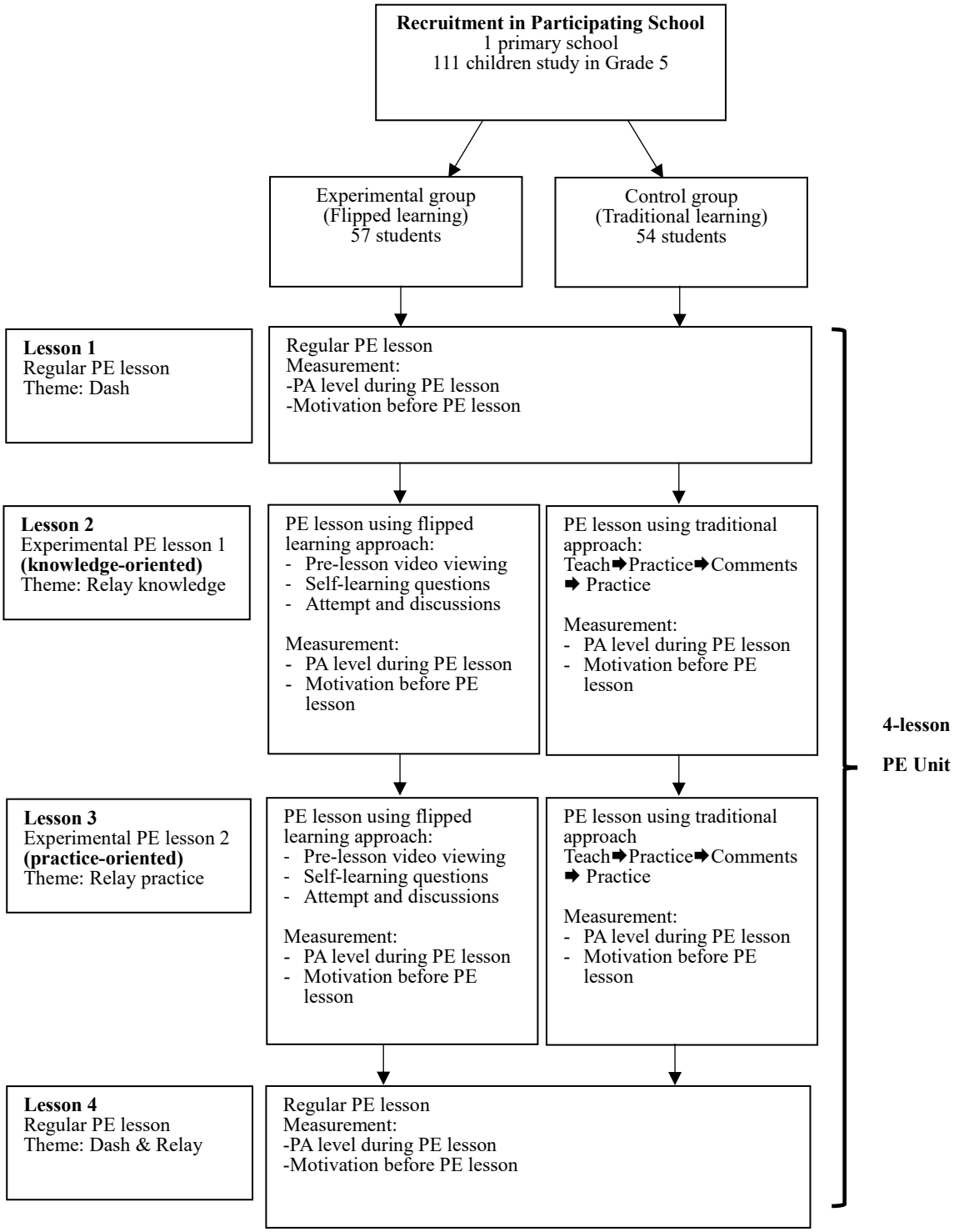
This study aimed to investigate whether the application of flipped learning approach benefits children's PA levels and their motivation during PE lessons. This chapter focused on the methodology used in the study, which include: 1) study design; 2) participants; 3) procedures; 4) flipped learning classes teaching; 5) outcome measures; and 6) data analysis.

3.1 Study design

This study used a quasi-experimental design to examine the effects of a PE unit adopted flipped learning approach on students' PA levels. Study was conducted at one primary school in Hong Kong. The design of the PE unit used a flipped learning approach with the motivation of students' learning being considered. Participants undergone a four-lesson PE unit, either in experimental group (with flipped learning) or control group (with traditional learning). In compared with their PA and motivation before and after the quasi-experimental lessons. The summary of the study design was shown in Figure 1.

Figure 1

Summary of study design



***The study was conducted under the Dash & Relay unit with 4 lessons, each lesson lasting 25 minutes.**

3.2 Participants

A total of 111 children (10 to 11 years of age) attending Grade 5 at a Hong Kong primary school were participated in the study. The sampling frame performed a convenient sampling in this study. The inclusion criteria of the children participants were set as Grade 5 children studying in the recruited school. As the study was conducted in regular PE lessons, no students in the participating classes were excluded. Following the class schedule, four classes of Grade 5 students were grouped into two groups: the flipped learning group or the traditional learning group. Each group were taught with the same unit theme (i.e., track and field) and content (i.e., dash and relay) in a four-lesson unit.

3.3 Procedures

Before the study, school permission was obtained to conduct the experimental study in regular PE lessons. After obtaining consent from the school, invitations were sent to students and their parents or guardians to obtain their consents for the selected students to participate in the study. A 15-minute briefing session was given to the students in the PE lesson in their regular class schedule, to ensure that they understood the purpose and the procedure of the study. During the briefing session, researcher explained to the participants on the procedure and measurement of the study, which included the PA level measured by accelerometers and motivation measured by a set of questionnaires.

The study was conducted in four 25-minute PE lessons by the same PE teacher. The first lesson was used to collect basic information, including body weight, height, and PA level during PE lessons. The experiment of the study was conducted in the lesson 2 and lesson 3 for both flipped learning group and traditional learning group. The teaching content of the flipped

learning classes in the lesson 2 and lesson 3 were focused on knowledge-oriented and practice-oriented respectively. The fourth lesson was conducted as a regular PE lesson and data was collected of the same procedure as in the first lesson.

During all the lessons, data collection was conducted by an assistant and the teacher conducted the teaching of PE. Data collection was performed throughout the 4-lesson PE unit. Pearson correlation was performed to confirm whether there was any significant correlation between motivation and MVPA as well as between motivation and SED amongst all the participants. The purpose for the data collection for lesson 1 was to validate the correlation changes between motivation and PA level as well as between motivation and SED were bought by implementation of flipped learning. Data collected at lesson 4 intended to reiterate the effect of flipped learning application on participants' motivation and PA levels as well as motivation and SED when flipped learning was stopped to apply.

On the day of experiment, the teacher and assistant went into the experimental class before the first lesson and started the experiment preparation. Measurement tools (accelerometer and questionnaire) were distributed to all the participants. The research assistant helped students to tie the accelerometer on their wrists and checked to ensure that the accelerometers were tied on each of the participant's wrist firmly. The accelerometers started recording the PA of the students when they were tied on students' wrists and recorded all the PA of participants during school time on the experiment day. The PA data obtained during the PE lessons was later extracted by the researcher. To minimise the interruption to the participants and the teaching schedule at school, both the teacher and assistant would leave the classroom before the start of first lesson and returned later to collect all the questionnaires. The accelerometers were collected at the last lesson on every experiment day.

The students in the flipped learning group received a self-learning video clip prior to the PE lesson. Students watched the video on their own and complete an online assessment before

attending the PE lessons. During the lesson, teaching content for flipped learning group was the same as that of the traditional learning group. The students in the traditional learning group would not receive any video clips or assessments beforehand. During the traditional learning lesson, the teacher taught the students directly.

The sampling frame performed a convenient sampling in this study. The inclusion criteria of the participants were set as Grade 5 children studying in the recruited school. This study aims to bring a new perspective on increasing students' PA levels during PE lesson, which served as a pilot scheme at the recruited school. Due to a few constraints and restrictions imposed by the invited school which agreed to join the study, including experimental periods, duration and participants with focus on safety measures, "Dash and Relay" is selected as the experimental unit in this study considering its characteristics, including (1) relatively high possibility of flipped learning implementation; (2) common exposure to students; and (3) minimal equipment required. It is understood that a longer experimental duration may give out more meaningful observations and findings. Nevertheless, the current experimental study with only two flipped lessons may not be the most optimal research design, yet it would also provide some inspirations and implications in order to understand the effect on students' PA levels and motivation with application of flipped learning PE lesson. Future study could consider a longer data collection period as suggested in section 5.7 Recommendation for further study.

3.4 Flipped learning classes teaching

To examine the effect of flipped learning on students' PA participation, there were control groups, which adopting traditional learning mode in the lesson 2 and lesson 3. Lesson plans for both groups were written in details and comparison tables were presented in Appendix II and III. To distinguish traditional learning with designed flipped learning content, following sub-sessions included i) teaching content design; ii) summary of class preparation and iii) design

of flipped learning video.

Participating students have been assigned into either a flipped learning group or a traditional learning group, and both groups have been taught by the same teacher. Therefore, it is vital to make sure that the teacher in the experiment strictly follow the study plan in conducting the PE class with flipped learning and traditional learning to the students respectively. The researcher has dual roles in this study, not only the researcher role, but also the teacher participated in the research experiment who teaches both the flipped learning group students and the traditional learning students in the experiment. As such, the quality of delivery of flipped learning and the relevant applications of flipped learning could be ensured in aligning the entire study design and research purpose as the researcher, and at the same time also the teacher participated, is the one who understands the study details the most and equipped with adequate knowledge about flipped learning application.

3.4.1 Teaching content design

The implementation of flipped learning was conducted through the four-lesson "Dash and Relay" PE unit of Grade 5. The learning aims, objectives and outcomes are briefly described as follows. Upon completion of the four lessons of the unit, students are expected to (1) apply the down-sweep baton exchange in passing the baton to teammates at the take-over zone; (2) maintain good communication with team members and give out appropriate signal at the right time to notify the next runner (the recipient) to prepare and to pre-run; and (3) start running at the right time and right pace as a recipient of the baton during the pre-run and complete the baton exchange at the take-over zone. Theoretically, students are expected to (1) explain characteristics and the uses of old track fields with old relay rules regarding the take-over zone; (2) explain characteristics and the uses of new track fields with old relay rules regarding the take-over zone; and (3) deal with falling of baton during a match. Through

learning various skills and theoretical knowledge of the "Dash and Relay" unit, students are anticipated to (1) develop their interest in team sports; and (2) encourage and show appreciation to team members and build up team's spirit. Detailed unit plan showing the teaching aims, objectives and outcomes throughout the unit is showed at Appendix V and Appendix VI as reference.

The unit of "Dash and Relay" was introduced throughout the four lessons, therefore teaching content of each lesson varied. Lesson one, as a regular PE lesson, was used as a revision class for students to refresh their memories on Dash, in which they have already equipped with basic knowledge; therefore, limited lecturing time was scheduled in the first one and a relatively longer practice time was included.

This study conducted two flipped learning lessons to examine students' PA behaviour during PE lesson. The two lessons applied the same approach with differences in the content focus, which is knowledge-ordinated (Lesson 2) and practice-oriented (Lesson 3). The two lessons were delivered with the theme of relay, but different activity time were allotted to both lessons was resulted from different teaching content designed and scheduled. The total duration of each lesson was 25 minutes with detailed class rundown about lesson 2 (knowledge-oriented lesson) and lesson 3 (the practice-oriented lesson), are listed in Table 1 and Table 2.

Flipped learning with knowledge-oriented content: Lesson 2 was the first occasion for students to learn about concept of relay at school, therefore relative basic and simple teaching content was designed.

Flipped learning with practice-oriented content: Lesson 3 was taught with more in-depth concepts and skill sets delivered. More feedback time and discussion time were scheduled in the practice-oriented lesson when compared to the knowledge-oriented lesson. Lesson 3 ensures students understood the complicated knowledge and rules of the relay unit.

During lesson 2, in comparison of the knowledge-oriented lesson for traditional learning

group and flipped learning group, it can be observed that the PA time allocated for traditional learning group was 15 minutes while the PA time allowed for flipped learning group was 20 minutes. The enhancement of PA time was contributed by the reduction of lecturing by teacher to deliver basic rules and skills set of relay knowledge.

For lesson 3, in comparison of the practice-oriented lesson between traditional learning group and flipped learning group, it can be noted that PA duration allocated for traditional learning group was ten minutes while PA time allocated to flipped learning lesson was 17 minutes. A considerable improvement in PA time was observed at the practice-oriented lesson when comparing with flipped learning group to traditional learning group. The main drive was that complex concepts were already elaborated in pre-class learning video for the flipped learning group, which allowed more practice time for the practice-oriented lesson as it was proposed. Instead, teaching content that required to be explained by teacher through lecturing in traditional learning lesson would have taken a lot of lesson time on explanation, elaboration, and demonstration in details, whereas students using traditional learning approach might not be able to understand difficult and complicated concepts at once after teacher's lecturing, this might have impact on their PA levels as their learning progress varied. The learning content for the students in both flipped and traditional learning classes was identical, whereas extra practice time was allowed with reduction in the time spent on lecturing.

Lesson four is another regular PE lesson, and all students went through a traditional learning PE lesson. Hurdling was taught as the last skill-set development session along with the four-lesson "Dash and Relay" unit.

Table 1

Comparison of teaching content between PE lesson using flipped learning and traditional learning approach (Lesson 2: knowledge-oriented lesson)

Class Activity	Time (min)	Flipped learning	Time (min)	Traditional learning
Intro-duction	5	Warm-up	5	Warm-up
	5	**Teaching: (2 min)** Ask questions based on the flipped learning video watched **Skills teaching (Part 1)** Conducted through video watching (without occupying lesson time) **Attempt (3 min):** All students try to practice skills based on the knowledge they obtained from the flipped learning video	5	**Teaching: (2 min)** Lecture by teacher to teach about relay **Skills teaching (Part 1) (3 min):** Demonstration: Select 3 students to help
Develop-ment (1)	6	**Practice: (6 min)** All students	6	**Practice: (6 min)** All students
Develop-ment (2)	6	**Skill teaching (Part 2) (1 min)** Lecturing by teacher Reinforce the main points mentioned in the video **Attempt and practice (5 min)** Students try to practice skills again based on the flipped learning video and teacher's coaching	6	**Skill teaching (Part 2) (3 min)** Lecturing by teacher Demonstration by selected team to help **Attempt and practice (3 min)** All students try to practice skills after teacher's coaching and demonstration
	2	Round-up	2	Round-up
	1	Cool-down	1	Cool-down

Table 2

Comparison of teaching content between PE lesson using flipped learning and traditional learning approach (Lesson 3: practice-oriented lesson)

Class Activity	Time (min)	Flipped learning	Time (min)	Traditional learning
Introduction	4	Warm-up	4	Warm-up
	3	**Revision (30 sec)** **Teaching (2 min, 30 sec)** Ask questions: What is pre-run (questions based on flipped learning video)?	3	**Revision (30 sec)** **Teaching (2 min, 30 sec)** Lecturing by teacher: What is pre-run?
Development (1)	5	**Skills teaching (1 min):** Lecturing by teacher; Reinforce the main points covered in the video **Attempt and practice (4 min):** All students try to practice the skills learnt in the flipped learning video. Students are reminded of the main skills and asked to observe their teammates' performances while waiting	5	**Skills teaching (2.5 min):** Lecturing by teacher **Demonstration (2.5 min):** Select three students to help
	3	**Practice (3 min):** All students can practice on their own. Teacher observes and analyses students' motions	3	**Practice (3 min):** All students can practice on their own. Teacher observes and analyses students' motions
Review / Discuss	2	Based on the observation, students can discuss with each other under the teacher's supervision and share their views on each other's (anonymous) motions	2	Based on the observation and analysis, the teacher gives feedback to students
Development (2)	5	**Practice (5 min):** All students can practice on their own with refined motions based on feedback.	2	**Practice (2 min):** All students can practice on their own with refined motions based on feedback.
Development (3)	0	Knowledge dissemination conducted through video-watching (not occupying lesson time)	3	Knowledge disseminated by teacher
	2	Round-up	2	Round-up
	1	Cool-down	1	Cool-down

3.4.2 Summary of class preparation

In the conduction of flipped learning, there were more preparation work required prior to the lessons. One of the differences on class preparation for flipped learning group and traditional learning group is the pre-class preparation for students. Students from flipped learning group are required to watch a video with flipped learning content, approximately ten minutes, two days before the flipped learning lessons (i.e., lesson 2 and lesson 3), which were not required for traditional learning group.

On the first day after releasing the video, teacher checked the viewing record and assessment result at "Edpuzzle", reminders were sent to students who have not yet completed the video watching exercise. Assessment results will be used to understand the learning progress of students after watching the video. Important concepts and areas that many students could not give the correct answer will be emphasised and discussed in the PE lesson to ensure students' thorough understanding for flipped learning group.

Despite the pre-class learning materials which describe the flow on class preparation, both traditional learning group and flipped learning group are basically the same. On the experiment day, students from both flipped learning group and traditional learning group are required to complete the pre-test questionnaires during the class teacher periods prior to the start of all lessons. Students wore the accelerometers, which started recording their physical activities data right away. Teacher went to respective classroom and lead the students to playground for the PE lesson, all the accelerometers were checked again to make sure they are tied firmly on students' wrists and function properly. Students have to return the accelerometers at the last lesson of each of the experiment day. Post-test questionnaire were completed by students upon completion of the "Dash and Relay" unit.

Table 3

Summary of class preparation

Time	Flipped learning group	Traditional learning group
Lesson before experiment	Complete the pre-test questionnaire	
Two days before the class	Students: Watch a video with flipped learning content (~10 minutes)	N/A
The morning of the lesson	Tie the accelerometers on students' wrists	
Before the experiment kick start	Check if all students have the accelerometers tied for measuring their PA levels and they function properly	
At the last lesson of each of the experiment day	Each student returns the accelerometers	
End of the unit	Finish the post-test questionnaire	

3.4.3 Flipped learning video design

An instructional video to be watched before the class is the key element of the flipped learning approach. The flipped learning group was required to watch a video, around ten minutes in length, about the relay lessons. The video provided knowledge about the rules of the relay game and suggested practice methods.

To create flipped learning content, the teaching material was recorded in video clips and these video clips were uploaded to "Edpuzzle", which is a website where the students could also find several questions designed allowing them to assess their own learning progress by themselves. The teacher could also make use of their assessment results to better understand the students' learning status. The questions were built into the video clips—students were not able to continue watching the video unless they answered all designed questions. These questions were related to the teaching aims. Student results could be assessed through

"Edpuzzle" or Google Classroom ("Edpuzzle" is allowed to plug into Google Classroom). To prevent the students in the traditional learning group from knowing about the flipped learning instructional content, the researcher explained the need for secrecy and asked the students in the flipped learning group to keep the content and related videos confidential. The videos were shared among the members of the flipped learning group through Google Classroom. The privacy setting of the Google Classroom only allowed the flipped learning group members to enter and watch the flipped learning video clips.

As mentioned, an instructional video for flipped learning group students to watch prior to the PE lessons has been the key element of flipped learning implemented in the study. The videos and the online quizzes built into the video in this research was prepared by the researcher. The researcher followed the teaching aims, objectives, and outcomes of the corresponding PE unit established by the school, followed by discussions with PE panel team to decide the content to be included in the videos and online quizzes to align with the school's teaching requirements. Therefore, video content and online quizzes were finalised subject to the agreement of all the parties involved, and thus the satisfactory internal validity of the study could be demonstrated through reviews performed by the panel team and Grade 5 PE teachers.

The content of the flipped learning video for lesson 2 and lesson 3 was summarised in Table 4.

Table 4

Summary of flipped learning video content

	Lesson 2: knowledge-oriented lesson (Relay knowledge)	Lesson 3: practice-oriented lesson (Relay practise)
Video length	~10 minutes	~10 minutes
Teaching content	- Define "relay" - Relay zone on the track - The new relay rule on an old design track - The marks and indications - The relay skill - Practice in class	- Define "pre-run" - Relay on a track court - Review the process of relay by a team - Giving a signal to teammate before handing over a baton - Practice in class
Online quiz	Questions: 1. How many "yellow ticks" are included in one relief zone? 2. How long is the relief zone ? 3. When using the down sweep pass, from which side should the runner pass the baton? 4. Which part of the baton should you hold? 5. When you are waiting to get the baton, should your palm face up or down? 6. If your team-mate uses the right hand to hold the baton, which hand you should ready? 7. If you are the last member to get the baton in the game, what do you need to do after getting the baton?	Questions: 1. If your team-mate uses the right hand to hold the baton, which hand you should get ready? 2. When should you start the pre-run? 3. When should you ready your hand to get the baton? 4. Are there any restrictions on the signal used between teammates—e.g., only "hand" can be shouted? 5. When applying new rules on an old design track, which line in the picture is assumed to be the scratch line of the relief zone? 6. If you drop the baton, what should you do? 7. When you are waiting for the baton, where you should stand?

3.5 Outcome measures

There were two outcome measures in this study: 1) PA level in PE lessons. and 2) Motivation in PE lessons.

PA Level Measurement. The participants' PA levels were measured using ActiGraph GT3X, a small triaxial accelerometer. Previous studies have shown excellent intra-model reliability of ActiGraph accelerometers for various accurate measures of PA frequency,

intensity, and duration (Evenson et al., 2008). The ActiGraph used in this study provides information on PA frequency, intensity, and duration with a built-in triaxial accelerometer. The accelerometer was tied onto the students' wrists during the data collection process.

During the teaching period, the PA levels of students was recorded by the accelerometer. All students participating in this experiment received an accelerometer to detect and record their activity intensity and the time they engaged in different levels of activity during PE classes. The data collected shows the difference in the PA level between the flipped learning and traditional learning classes. Previous studies measured the PA level by 1-minute (Trost et al.,1998; Puyau et al., 2002) or 30-second intervals (Treuth et al., 2004) for adults. Since children participants were recruited in this study who requires more frequent measurement because of their uneven movement, a 15-second interval was adopted for the current study. Data was downloaded as soon as the protocol was completed and the ActiGraph bundle software was used for analysis. The cut-points by Evenson et al. (2008) for children and youth were used to determine the total volume and activity during PE lessons. Counts per minute (cpm) was used as an estimate of overall mean intensity of PA, cut-points for SED (0–100 cpm) and MVPA (⩾2296 cpm) were defined by using age-specified criteria.

Motivation Measurement Tool. The study utilised a questionnaire to measure participants' motivation. For this purpose, a Chinese-language questionnaire was adopted, whose title translates to "Children's Motivation Scale for Physical Education" (Hsieh et al., 2018). This questionnaire included five subscales: 1) intrinsic motivation, 2) identified regulation, 3) introjected regulation, 4) external regulation, and 5) amotivation. With reference to Ryan & Deci (2000), who hold that intrinsic motivation, external regulation, introjected regulation, identified regulation, integrated regulation, and amotivation lie on a continuum of self-determination, this study will be further categorised the five subscales adopted in the questionnaire into autonomous motivation (consisting intrinsic motivation and identified

regulation), controlled extrinsic motivation (consisting introjected regulation and external regulation), and amotivation for analysis purpose. The four extra questions about students' feeling and opinion towards flipped learning were added to understand more about how the participants' thought about flipped learning. A total of 19 questionnaire items and 3 basic information items were resulted. Item 1 to Item 3 measured intrinsic motivation. Item 4 to Item 6 measured identified regulation. Item 7 to Item 9 measured introjected regulation. Item 10 to Item 12 measured external regulation. Item 13 to Item 15 measured amotivation. The additional four questions focused on the students' thought about the pre-class activities for flipped learning. Participants were expected to complete the questionnaire within eight minutes. Students completed the motivation measurement section using a 4-point Likert scale. This scale ranged from 1 (Strongly disagree) to 4 (Strongly agree). After the scores for each question were added separately, five subscale scores were obtained. Cronbach's alpha was used to measure how questions 1-15 in the questionnaire are closely related to the research questions, which represent the dependent variables. It takes values from 0 to 1, with 1 being the highest value, meaning perfect internal consistency. All 15 items in the questionnaire about motivation are measured. Cronbach's alpha test used to estimate the reliability of a questionnaire containing multiple items measuring the same construct. It was used as a measure of the internal reliability of survey data. The alpha coefficients of the motivation scale adopted are listed in Table 5 the below. All coefficients were around 0.8, indicating "acceptable" or "good" reliability (George & Mallery, 2003).

Table 5

Alpha coefficients of the motivation scale

Flipped learning group		Traditional learning group	
Lesson	Cronbach's Alpha	Lesson	Cronbach's Alpha
1	.783	1	.811
2	.841	2	.722
3	.812	3	.768
4	.850	4	.793

3.6 Data analysis

All data obtained was analysed using Statistical Package for Social Science (SPSS) version 26. The data analysis of the study included four parts. The first part comprised of descriptive data analysis. Basic information of the participants was described, such as the number of students who successfully completed the whole experiment, as well as the reasons of why some participants could not finish all parts of the experiment. Students' age, Body mass index (BMI), SED and MVPA baselines were also described. ANOVA (Analysis of Variance) and MANOVA (Multivariate Analysis of Variance) was performed to analyse any significant differences between the traditional learning group and the flipped learning group.

The second part applied ANOVA to analyse the data in relation to H_1. Differences in PA level between flipped learning group and traditional learning group were then used in further ANOVA to evaluate whether there were any significant differences in the students' PA levels during the quasi-experimental lessons (lesson 2 and lesson 3).

The third part examined the relationship between PA level and motivation. The correlation coefficient values between motivation and PA level were analysed for quasi-experimental lessons. The correlation coefficient is a statistical measure that calculates the strength of the relationship between the relative movements of two variables. The values range (r) between -1.0 and 1.0. A value greater than 1.0 or less than -1.0 indicates that there was an

error in the correlation measurement. A correlation of -1.0 shows a perfect negative correlation, while a correlation of 1.0 shows a perfect positive correlation. A correlation of 0.0 indicates that there is no relationship between the movements of the two variables. Cohen's (2013) conventions were used to interpret the effect size of correlation. A correlation coefficient of .10 is considered to represent a weak or small association; a correlation coefficient of .30 is considered to indicate a moderate correlation; and a correlation coefficient of .50 or greater is thought to represent a strong or large correlation.

The fourth part made use of linear regression to examine the relationship between motivation and PA level in quasi-experimental lessons to test H_2 and H_3. Students' PA levels were also predicted to have a given value of motivation through the use of linear regression. Different levels of motivation were used as the independent variables, and PA level was used as the dependent variable. Analysis of H_2 explored the relationship between motivation and MVPA. Prediction of MVPA was performed with a given level of motivation. Analysis of H_3 explored the relationship between motivation and SED. Prediction of SED was performed with a given level of motivation. Positive or negative β was showed as the result which refers to positively correlated relationship and negatively correlated relationship correspondingly.

3.7 Fidelity of implementation

The current study was conducted under the standard procedure set up by the graduate school of The Education University of Hong Kong (EdUHK). The design of the intervention gone through a 20-minute oral presentation, which composed of panel specialised in PE, consisting of Chair, coordinator, principal supervisor, and associate supervisor. After the presentation and upon satisfaction with rebuttal, the researcher was granted the right to carry out the experiment.

Detailed lesson plans are designed by the researcher with the professional advice provided by the principal supervisor. Through discussions with PE panel team at the participated school, experimental content is guaranteed to be aligned with teaching aims, objectives and learning outcomes established by the participated school. Feedback from the principal supervisor was also obtained throughout the intervention duration to ensure the experiment performed as it was originally intended and designed. As part of the analysis and for documentation purpose, experimental lessons were video recorded. In addition, PE panel team were invited to observe how the lessons were conducted to ensure class objectives were achieved as designed. Communications between the researcher and the principal supervisor were held on and off to assure the implementation process fidelity.

Chapter 4: Results

This chapter presents the results obtained from the data analysis and hypotheses testing, which includes: 1) Participants information; 2) Difference of PA level between PE lesson with flipped learning and traditional learning approach; 3) Correlations between MVPA and motivation in the experimental unit; 4) Correlations between SED and motivation in the experimental unit; 5) Predictor of MVPA/SED and motivation in flipped learning group in practice-oriented lesson ; 6) Research hypotheses analysis; and 7) Summary of findings.

4.1 Participants information

All participants' data was collected over a four-lesson PE learning unit. A total of 122 students in Grade 5 year at a Hong Kong primary school were recruited to participate in the study. There were overall 111 students completed all the data collection procedure, including the filling of questionnaires and attending the PE units. Some students could not finish the lessons because their time was occupied by other teachers, professional therapists, or social workers for different reasons—for instance, students needed to receive special care treatment at that time. Such treatments included speech therapy, reading and writing therapy, counselling services, and so on. Hence, final data set for analysis were: 57 participants (30 boys; 27 girls) in the flipped learning group and 54 participants (29 boys; 25 girls) in the traditional learning group.

To determine whether there were any significant differences between the two groups before quasi-experimental lessons, an ANOVA was used to determinate there were no significant differences found between the two groups in terms of their student age, BMI,

MVPA and SED. MANOVA was used to determinate there was no significant differences found between the two groups in motivation (see Tables 6 and 7).

Table 6

Baseline measurement of participants

	Traditional (*N* = 46)		Flipped (*N* = 51)		*df*			
	M	*SD*	*M*	*SD*	*Between Group*	*Within Group*	*F*	*Sig. (2-tailed)*
Age	10.07	.26	10.07	.26	1	109	.006	.937
BMI	17.66	2.81	17.36	3.77	1	109	.193	.661
MVPA	14.65	3.86	13.25	3.74	1	109	3.783	.054
SED	1.27	1.61	1.70	1.41	1	109	2.230	.138

Table 7

Baseline motivation measurement

Source	DV	*df*	Mean Square	*F*	*Sig.*	Partial Eta Squared
Group	Autonomous motivation	1	.083	.263	.609	.002
	Controlled motivation	1	.127	.259	.612	.002
	Amotivation	1	.294	.557	.457	.005
Error		109				

4.2 Difference of PA level between PE lesson with flipped learning and traditional learning approach

Descriptive data of the PA level of the flipped learning and traditional learning group in the four PE lessons was presented in Table 8.

Table 8

Students' PA levels in track and field unit

			Knowledge-oriented lesson		Practice-oriented lesson			
	Lesson 1		*Lesson 2*		*Lesson 3*		*Lesson 4*	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Flipped Learning								
MVPA	13.25	3.74	15.36	3.83	12.72	3.99	13.00	4.20
SED	1.70	1.41	1.22	1.16	1.61	1.65	1.89	1.99
Traditional learning								
MVPA	14.65	3.86	13.08	3.32	10.52	3.07	13.59	3.74
SED	1.27	1.61	1.63	1.40	2.18	1.87	1.41	1.01

An ANOVA was conducted to examine whether there were any significant differences in the PA level between the flipped and traditional learning groups during the quasi-experimental lessons. The results shown in Table 9 were reported significant effects of MVPA between flipped and traditional learning groups (F, [1,218] = 21.76, $p < .05$) during the quasi-experimental lessons.

Table 9

Differences in MVPA between the flipped learning group and the traditional learning group in quasi-experimental lessons

Source	df	Mean Square	*F*	*Sig.*
Group	1	279.197	21.758	.000
Error	218	12.832		

The result of MVPA in knowledge-oriented lesson showed that, the MVPA duration in flipped leaning group (*M*=15.36, *SD*=3.83) was higher than traditional learning group (*M*=13.08, *SD*=3.32). In practice-oriented lesson, the result found that the MVPA duration in

flipped leaning group (*M*=12.72, *SD*=3.99) was also higher than traditional learning group (*M*=10.52, *SD*=3.07).

The results shown in Table 10 was reported significant effects of SED between flipped and traditional learning (F, [1,218] = 5.56, $p < .05$) during the quasi-experimental lessons.

Table 10

Differences in SED between the flipped learning group and the traditional learning group in quasi-experimental lessons

Source	*df*	Mean square	*F*	*Sig.*
Group	1	13.224	5.564	.019
Error	218	2.377		

The result of SED in knowledge-oriented lesson showed that, the SED in flipped leaning group (*M*=1.22, *SD*=1.16) was lower than traditional learning group (*M*=1.63, *SD*=1.40). In practice-oriented lesson, the result found that the SED duration in flipped leaning group (*M*=1.61, *SD*=1.65) was also lower than traditional learning group (*M*=2.18, *SD*=1.87).

4.3 Correlations between MVPA and motivation in the experimental unit

The correlation coefficient values were calculated to assess the correlations between MVPA and motivation in the experimental unit. The results are shown in Table 11 to 14. The result in Table 12 was reported a positive correlation between MVPA and autonomous motivation ($r = .266$, n = 57, $p < .05$) in practice-oriented lesson with the flipped learning group. There was no significant correlation between MVPA and motivation in lesson 1 and lesson 4 as regular PE lessons, traditional learning group and knowledge-oriented lessons.

Table 11

Correlations between MVPA and motivation in lesson 1

	Autonomous motivation		Controlled motivation		Amotivation	
	r	*Sig. (2-tailed)*	*r*	*Sig. (2-tailed)*	*r*	*Sig. (2-tailed)*
MVPA (Lesson 1)	.151	.114	-.087	.363	-.157	.100

Table 12

Correlations between MVPA and motivation in quasi-experimental lessons of flipped learning group

	Autonomous motivation		Controlled motivation		Amotivation	
	r	*Sig. (2-tailed)*	*r*	*Sig. (2-tailed)*	*r*	*Sig. (2-tailed)*
Knowledge-Oriented Lesson (Lesson 2)	.128	.344	-.128	.342	-.063	.641
Practice-Oriented Lesson (Lesson 3)	.266	.046*	-.222	.097	-.204	.129

Table 13

Correlations between MVPA and motivation in quasi-experimental lessons of traditional learning group

	Autonomous motivation		Controlled motivation		Amotivation	
	r	*Sig. (2-tailed)*	*r*	*Sig. (2-tailed)*	*r*	*Sig. (2-tailed)*
Knowledge-Oriented Lesson (Lesson 2)	-.017	.905	.039	.782	.038	.787
Practice-Oriented Lesson (Lesson 3)	.051	.715	-.014	.920	.066	.637

Table 14

Correlations between MVPA and motivation in lesson 4

	Autonomous motivation		Controlled motivation		Amotivation	
	r	*Sig. (2-tailed)*	*r*	*Sig. (2-tailed)*	*r*	*Sig. (2-tailed)*
MVPA (Lesson 4)	-.054	.572	-.024	.806	.113	.239

4.4 Correlations between SED and motivation in the experimental unit

The correlation coefficient values were calculated to assess the correlations between SED and motivation in the experimental unit. The results are shown in Table 15 to 18. The result in Table 16, was reported a negative correlation between SED and autonomous motivation (r = -.313, n = 57, p < .05) in practice-oriented lesson with the flipped learning group. There was no correlation between SED and motivation in lesson 1 and lesson 4 as regular PE lessons.

Table 15

Correlations between SED and motivation in lesson 1

	Autonomous motivation		Controlled motivation		Amotivation	
	r	*Sig. (2-tailed)*	*r*	*Sig. (2-tailed)*	*r*	*Sig. (2-tailed)*
SED (Lesson 1)	-.084	.382	.090	.345	.059	.540

Table 16

Correlations between SED and motivation in quasi-experimental lessons of flipped learning group

	Autonomous motivation		Controlled motivation		Amotivation	
	r	*Sig. (2-tailed)*	*r*	*Sig. (2-tailed)*	*r*	*Sig. (2-tailed)*
Knowledge-Oriented Lesson (Lesson 2)	-.054	.689	.105	.437	.140	.299
Practice-Oriented Lesson (Lesson 3)	-.313	.018*	.087	.518	.213	.111

Table 17

Correlations between SED and motivation in quasi-experimental lessons of traditional learning group

	Autonomous motivation		Controlled motivation		Amotivation	
	r	*Sig. (2-tailed)*	*r*	*Sig. (2-tailed)*	*r*	*Sig. (2-tailed)*
Knowledge-Oriented Lesson (Lesson 2)	-.100	.471	.051	.716	.075	.592
Practice-Oriented Lesson (Lesson 3)	-.053	.704	.054	.701	.045	.746

Table 18

Correlations between SED and motivation in lesson 4

	Autonomous motivation		Controlled motivation		Amotivation	
	r	*Sig. (2-tailed)*	*r*	*Sig. (2-tailed)*	*r*	*Sig. (2-tailed)*
SED (Lesson 4)	-.039	.686	.010	.918	-.050	.601

4.5 Predictor of MVPA/SED and motivation in flipped learning group in practice-oriented lesson

The correlation result provided an insight about the PA level and motivation in flipped learning group in practice-oriented lesson. In this part, linear regression was carried out to investigate the relationship between the PA level and motivation in flipped learning group in practice-oriented lesson.

Table 19

The linear regression model summary between motivation and MVPA of flipped learning group in practice-oriented lesson (N = 57)

	R	*R Square*	*Adjusted R Square*	*Std. Error of the Estimate*	*t*	*Sig.*	*β*
Autonomous motivation	.266	.071	.054	3.8838	2.046	.046*	1.603
Controlled motivation	.222	.049	.032	3.9281	-1.690	.097	-1.048
Amotivation	.204	.041	.024	3.9445	-1.542	.129	-.989

The result in Table 19 showed that autonomous motivation (p = .046, R^2 = .071, $R^2_{adjusted}$ = .071) perceived the positive predictor of the MVPA (β = 1.603, p < .05). No significant predictor emerged for controlled motivation and amotivation.

Table 20

The linear regression model summary between motivation and SED of flipped learning group in practice-oriented lesson (N = 57)

	R	*R Square*	*Adjusted R Square*	*Std. Error of the Estimate*	*t*	*Sig.*	*β*
Autonomous motivation	.313	.098	.082	1.5814	-2.444	.018*	-.780
Controlled motivation	.087	.008	-.010	1.6587	.650	.518	.170
Amotivation	.213	.046	.028	1.6267	1.620	.111	.429

The result in Table 20 showed that autonomous motivation (p = .018, R^2 = .098, $R^2_{adjusted}$ = .082) perceived the negative predictor of the SED (β = -.780, p < .05). No significant predictor emerged for controlled motivation and amotivation.

4.6 Research hypotheses analysis

H_1: The PA levels of children are higher during PE lessons using flipped learning approach than using traditional learning approach.

H_1 was substantiated. Significant difference was found regarding the MVPA (F, [1,218] = 21.76, p < .05) and SED (F, [1,218] = 5.56, p < .05) between the flipped learning group and the traditional learning group. The increment in MVPA for students in knowledge-oriented lesson was M=2.28, and practice-oriented lesson was M=2.2. The reduction of SED for in knowledge-oriented lesson was M=0.41, and practice-oriented lesson was M=0.57.

H_2: The children's MVPA during PE lesson was positively correlated with their motivation orientation when using flipped learning approach.

H_2 was partially substantiated. Significant correlation was not found in MVPA in knowledge-oriented lesson while different types of motivation partially confirmed the significant amount of variance in the MVPA in practice-oriented lesson with use of Pearson correlation coefficient and linear regression. In practice-oriented lesson, autonomous motivation (p = .046, R^2 = .071, $R^2_{adjusted}$ = .054) perceived the positive predictor of the MVPA (β = 1.603, p < .05). No significant predictor emerged for controlled motivation and amotivation.

H_3: The children's SED during PE lesson was negatively correlated with their motivation orientation when using flipped learning approach.

H_3 was partially substantiated. Significant correlation was not found in SED in knowledge-oriented lesson while different types of motivation partially confirmed the significant amount of variance in the SED in practice-oriented lesson with use of Pearson correlation coefficient and linear regression. In practice-oriented lesson, autonomous motivation (p = .018, R^2 = .098, $R^2_{adjusted}$ = .082) perceived the negative predictor of the SED (β = -.780, p < .05). No significant predictors emerged for controlled motivation and amotivation.

4.7 Summary of findings

The primary goal of this study was to determine the effects of flipped learning on increasing students' PA levels during PE lessons. Another aim was to determine whether MVPA and SED were related to students' motivation with implementation of flipped learning approach to traditional learning approach. The results of the comparison on PA level changes across the quasi-experimental lessons and of the assessments of different types of statistic measurements showed that one of the hypotheses was found to be substantiated, while the other two hypotheses were found to be partially substantiated for the flipped learning group and the traditional learning group.

Chapter 5: Discussion

The present study has shown that flipped learning is effective in enhancing the PA levels of primary school students during PE lessons. However, only part of the findings for the correlations between motivation and MVPA as well as motivation and SED with implementation of flipped learning can be substantiated. The following sections discuss: 1) PA levels difference between students with flipped learning and traditional learning during PE lessons; 2) association of students' motivation and MVPA during flipped learning lesson; 3) association of students' motivation and SED during flipped learning lesson; and 4) impact of flipped learning PE lesson's teaching content and its effect on students' PA levels.

5.1 PA level difference between students with flipped learning and traditional learning during PE lessons

The present study observed a significant difference in the PA level for the group using the flipped learning approach. This finding was consistent with the conclusions of previous studies that flipped learning can facilitate students' PA levels (Østerlie, 2018). More, continuous concern has been expressed on the SED among children, a total of six hours daily SED time on average was measured on children (Matthews et al. 2008) for which a linkage between SED and a greater chance for developing harmful chronic health problems was reported (Dunstan et al., 2010). It is suggested by Strong et al., (2005) that schools serve as an important role in the PA and health related behaviour development as most youngsters spend around 40 to 45% of their walking time at school. Tudor-Locke et al., (2006) also identified that approximately 40% of children's step counts were performed at school time. School time can be structured in providing more opportunities for youths in participating in PA, among which PE lesson is one

of the lessons to be better utilised in promoting the involvement of PA. PE is considered as a cherished source of PA participation among children by providing them with knowledge and skills that fostered them to be active throughout their lifetime (Sallis et al., 2012).

Besides, it is also more common for schools nowadays to include more flipped learning elements in classes in order to facilitate student learning and to build more interactive classrooms. In a traditional learning classroom, the teacher is a basic and direct knowledge provider. In a standard or classic classroom setting, most students habitually remain in their seats in disciplined and quiet manner, listening to their teachers' lectures. When students attend traditional learning classes, teachers usually begin their lessons from scratch, assuming that students do not have much prior knowledge in relation to the teaching content. Interactions between teachers and students, or between peers, tend to be less frequent. The flipped learning approach changes this traditional classroom environment by shifting the traditional roles played by teachers and students.

PE lessons allow direct involvement of children in PA during class time, and it is not surprising to observe an overall higher level of MVPA of students at PE lesson across the whole school day (Sallis et al., 2012). Chow et al. (2008) also found that the quality and intensity of children's PA levels during PE lesson could be influenced how the lessons to be conducted, the subject matter and the approach of delivery are two lesson characteristics that have significant impact on children's PA levels during PE lessons. PE teachers are generally less likely to evaluate how much their students have learnt and understood after each lesson—until there are tests or examinations, and students decide to share that they are confused or unclear about the reasons why they have to learn what the teachers have shared through the traditional learning environment. Flipped learning is a pedagogical approach that fosters a student-centred learning environment, where the emphasis is placed on the students' learning experience and not on the delivery of instructions by a teacher in the classroom. Instead, teachers act as facilitators,

working alongside students, instead of dominating the lessons, while students learn through a variety of ways, including discussions, activities, or games. Similarly, the flipped learning PE unit designed for the present study provided video clips for student to watch prior to lessons in order to obtain pre-knowledge of the topics to be studied. Students were also encouraged to explore the topic further, according to their own interests. With such pre-class knowledge learning, students are prescribed with basic knowledge that allows them to have more interactions and discussions during class time. By inspiring students to move away from being the inactive receivers of standard information, they are encouraged to become active participants in discovering and creating their learning objectives on their own in order to achieve their goals (Brown, 2012). At the same time, flipped learning provides more opportunities for students to learn from peers (Baker, 2000). A flipped learning PE lesson thus becomes more dynamic and interactive. With the guidance and moderate facilitation of educators, students can devote their time to their own ideas and creatively involve themselves in their own learning process. The present study has indicated a new perspective on increasing students' PA levels during PE lessons using a flipped learning design that is based on SDT.

In this study, the flipped learning PE unit designed under the framework of SDT created more chances for students in the flipped learning group to make attempts and to conduct discussions. In turn, these facilitated a class with a higher degree of learning autonomy, which allowed for a higher PA level to be observed among the flipped learning group than the traditional learning group in the present study. PA acts as an essential role in children's health development where regular PA involvement is likely to lower the chance for children in becoming overweight and obese (Hills et al., 2011). It also plays a crucial role in improving the physical and mental health of children (Biddle et al., 2004).

This study showed the effectiveness of the flipped learning approach for increasing the PA levels of primary school students. The students in the flipped learning group were observed

to have an increased PA levels. The positive effect of the flipped learning approach can possibly be explained with certain SDT features (i.e., competence, relatedness, and autonomy) that were brought into the flipped learning lessons. By applying SDT components in the current study, the key components for enhancing students' PA levels shall include: 1) receiving pre-knowledge before class, 2) more attempt and practice opportunities, and 3) feedback loop amongst peers to establish a student-centred learning environment.

When content is taught directly by teachers using the traditional learning approach in classes, teachers are the basic, direct, and sole source of information and knowledge for students. With the flipped learning approach, receiving pre-knowledge before class as an advantageous condition for students in terms of creating their competence, which, in turn, stimulates students to devote themselves during the upcoming class (Estriegana et al., 2019). When students prepare before the class, they develop a picture in their mind about what is to be learnt in class and they can learn the basic theoretical knowledge about the topic beforehand. This reduces the time that teachers spend to explain concepts in the classroom and allows more time to be spent on developing additional interaction opportunities for both students and teachers (Hwang et al., 2015). With flipped learning, teachers would also have more time to solve the issues raised by students and to provide guidance to students by assisting their learning in order to maximise their learning effectiveness and self-efficacy (Hwang et al., 2015).

Attempt and practice opportunities are vital for developing students' PA levels during PE classes. Traditional PE curriculum offers limited activity time to primary students. Students spend most of their time at school, where they are mostly inactive (CUHK, 2019) and have no opportunities to engage in PA (Morgan et al., 2007). It is highly likely that PE classes represent a substantial opportunity for the students to engage in PA during school time. The nature of flipped learning classes provides ample chances for primary students to engage in high intensity activities. As mentioned, flipped learning materials that are studied by students prior to class

equip them with the basic knowledge that ultimately reduces the time that teachers spend at class to introduce and explain a topic. This allows for more time to be allotted to attempt and practice. The content of the PE flipped learning unit for this study was designed to allow the students to have more time to try, attempt, and practice—and to do so with higher autonomy—during PE lessons. These flipped classes maximised student participation in PA and, at the same time, created the potential for their PA levels to be enhanced (Vaughn et al., 2019).

Discussion and evaluation among peers assist the transformation of a PE lesson from teacher-centred to student-centred. Most importantly, student-centred classes have the potential to boost student relatedness (Ryan & Deci, 2000). Previous studies suggest that the sense of satisfaction inside each person is derived from different social experiences. Ryan and Deci (2000) also suggest that self-directed actions lead to greater intrinsic motivation. In addition, curiosity and desire for challenge are factors that induce students to positively take part in class activities—thus hopefully enriching their PA levels.

5.2 Association of students' motivation and MVPA during flipped learning lesson

The present study observed a significant difference in the MVPA for the group using the flipped learning approach, while correlation between motivation and MVPA was only partially substantiated at lesson 3 for the flipped learning group. Further analysis was performed on flipped learning group, where autonomous motivation was observed to be positively correlated with MVPA. These correlations were found in previous studies, which indicated that intrinsic motivation and external regulation was positively and negatively correlated to MVPA of adolescents at PE lessons and at leisure time(Owen et al., 2013). This result also supports past literatures and SDT where teachers can have influences on students' motivation. As suggested by Owen et al. (2013), interventions implemented to enhance students' MVPA during PE may be more effective by increasing teacher's autonomy supportive behaviours.

The extant literature reveals that there is a link between motivation and PA level (Sebire et al., 2013). It has been found that children's motivation is connected to their PA levels (Owen, 2014) and that flipped learning is associated with PA level (Østerlie, 2018). However, limited study has yet been conducted to look into the correlations between the use of flipped learning and motivation, and to examine whether enhanced motivation could raise PA level. The results of the present study proved to be consistent with those of previous studies, which have found that flipped learning enhances the PA level for the flipped learning group in comparison to the traditional learning group. Nevertheless, correlation indicated by Pearson Correlation and linear regression only partially substantiated between autonomous motivation and MVPA at lesson 3 for flipped learning group, where autonomous motivation was a positive predictor of MVPA in practice-oriented lessons.

According to Deci & Ryan (1985), intrinsic motivation was understood as the desire to do something based on an individual's inherent enjoyment or satisfaction resulting from his or her behaviour, whereas extrinsic motivation is generally defined as an individual's desire to perform behaviour based on the potential external rewards that may be accomplished consequently. Deci & Ryan (1985) further elaborated extrinsic motivation as motivation founded on external rewards, such as parental approval and physical appearance, whereas intrinsic motivation could be interpreted as motivation reflecting rational values, such as health and fitness improvement. Consistent findings of the present study also confirmed at Deci & Ryan (1985) that external motivation was negatively associated with PA. Findings by Garcia Calvo et al. (2010) also showed that intrinsic motivation was a much more influential driver of behaviour than extrinsic rewards.

The present study utilised SDT as the theoretical framework for designing flipped learning content to be applied during PE lessons, where literature pointed out that the SDT highlights that both motivation and personality are influenced by self-regulated behaviour and

intrinsic personal development (Ryan and Deci, 2000). The teaching approach adopted by teachers determines how active interpersonal communication becomes within their classrooms (Baeten et al., 2013). A flipped learning classroom represents a constructivist learning environment, which can be interpreted as a mechanism that encourages students to learn through activity and social interaction (Vansteenkiste et al., 2009). Under this mechanism, learners tend to be motivated by the independent learning environment (Deci & Ryan, 2008a; Harun et al., 2012; Hill, 2013; Niemiec & Ryan, 2009), and their motivation might solely be affected by their own will, sense of satisfaction, and goals (Vansteenkiste et al., 2009). The present study aligned with these literatures that students' PA levels could be enhanced by the flipped learning approach through student-centred activities designed where intrinsic needs of students are satisfied.

5.3 Association of students' motivation and SED during flipped learning lesson

SED refers to any waking behaviour that requires an energy expenditure of ≤1.5 metabolic equivalent of task while in a sitting, reclining, or lying posture (Tremblay et al., 2017). In order words, whenever a person is sitting or lying down, they are engaging SED. Participation in physically active behaviour does not exclude individual engagement in SED. The provision of more PA opportunities during PE lessons not necessarily in preventing students from engaging SED at the lessons (Cheung, 2017). The lack of association between students' PA levels and SED could possibly be explained by the nature of SED where an individual can be observed to be actively involved in PA and SED in the same day (Herman et al., 2015). It is conceivable for students to involve in high level of MVPA during PE lesson and also has long SED at the remaining time throughout the day. SED is emerging as a vital health issue; therefore, it is essential to enhance higher MVPA of students and at the same time lower their SED.

The present study observed a significant difference in the SED for the group using the flipped learning approach, while correlation between motivation and SED was only partially substantiated at lesson 3 for the flipped learning group. Further analysis was performed on flipped learning group, where autonomous motivation was a negative predictor of the SED. This was consistent with the study performed by Quartiroli & Maeda (2014) that SED and PA behaviour by unique motivational factors, in which intrinsic motivation and identified regulation are negatively correlated with SED. When students' autonomous motivation is satisfied, SED is believed to be reduced. Chastin et al., (2014) summarised five main reasons for people to involve in SED, including physical complaints, peer and society pressure, lack of environmental facilities and stimuli, pleasure and relaxation, and mental health reasons.

As discussed, intrinsic motivation presents when a person performs activity simply for the pleasure of experience, without anticipating for rewards or aiming to avoid punishment. (Deci & Ryan, 2000). Identified regulation is associated with valuing the benefits of an individual's behaviour that are believed to be, instead of the behaviour itself. It involves granting a conscious value to a behaviour where the action is accepted when it is personally important (Ryan & Deci, 2000).

Session 5.2 discussed that the researcher confirmed flipped learning can facilitate students' PA levels. During the 25 minutes PE lesson at the present study, as long as students are engaging in PA, chances for them to be involved in SED would be lowered, where SED can be referred to time an individual spent on non-exercising seated or reclining posture. The longer the PA time engaged by participants of the research, the lower the SED they could have maintained during the lesson time. With application of flipped learning at quasi-experimental lessons, significant difference was observed at flipped learning group comparing traditional learning group, where autonomous motivation was enhanced through flipped learning under

the SDT framework mentioned. Chastin et. al., (2014) also found that development of interventions can reduce SED when individual understand the inherent benefits.

The main objective of the present study was to introduce a new perspective in order to improve the PA levels of primary school students during PE lessons and to find out if there were any correlations between motivation and MVPA and SED. Currently, limited study has yet been conducted on this topic. If the hypothesis is substantiated, then the flipped learning approach could also be applied to other PE units in the future. Such findings would assist teachers in designing future learning programme that would promote the development of interactive classrooms and encourage the pro-active learning of students.

5.4 Impact of flipped learning PE lesson's teaching content and its effect on students' PA levels

The present study showed H_2 and H_3 only partially substantiated at lesson 3 but not lesson 2 while both lessons are implemented with quasi-experimental by applying flipped learning. It is worthwhile to note that the difference of teaching content described at session 3.4.1 could be one of the essential factors in influencing the result. Major difference of lesson 3 to lesson 2 was a more complex and in-depth rules, skills-set and knowledge were designed to be delivered, meanwhile, these complex knowledges were studied by students of flipped learning group prior to physical class. Therefore, considerable class time was then transformed from lecturing time to pro-active discussion time, feedback time and practice time. In other words, the extra time created through the implementation of flipped learning (lesson 2: 5 minutes; lesson 3: 7minutes) allowed a better utilisation of SDT theoretical concepts which better fulfil students' intrinsic needs to maximise the benefits bought by flipped learning.

The relevance of this study was discussed here with reference to past studies. Suggestions derived from the findings were also made for those educators who are interested

in using flipped learning in their PE lessons, and solutions were recommended to address the shortcomings of this study, which might be useful for future research. Meanwhile, the results of the above analysis could also provide certain useful insights for future research.

The present study has shown that flipped learning is effective in enhancing the PA levels of primary school students during PE lessons, which in turn convincing students to meet the benchmark of PA duration and intensity suggested by WHO (2020) more easily. WHO (2020) also suggests that a suitable MVPA duration could feasibly reduce the risk of several types of diseases, such as hypertension, coronary heart disease, stroke, diabetes, various types of cancer, and depression. It is worthwhile to mention that flipped learning application in Hong Kong PE curriculum is still at its initial stage, availability of resources and supports are relatively limited. Considered the benefits would be brought to students with application of flipped learning that may affect their lifelong experience, education policy makers could consider the promotion of implementation of flipped learning to the PE curriculum by dedicating more resources. For example, flipped learning could be included in the core programme of teacher education to enrich their knowledge about implementation of flipped learning by various technological aids; flipped learning database could also be set up to maintain a hub for flipped learning recourses to be collective used among different schools that might improve the efficacy in flipped classroom preparations; regular discussions or sharing sessions could also be held to assist and improve flipped learning application in a sustainable manner. When flipped learning could be widely applied and implemented in Hong Kong PE curriculum, it is hoped that students could engage in longer PA duration and higher PA levels through PE lessons, and more importantly to achieve the goal of developing a healthy lifestyle as suggested by WHO (2020).

5.5 Study limitations

The present study provides a better understanding regarding correlations between flipped learning, motivation, and PA levels of primary school students. However, certain limitations of the study should be addressed. First, all participants were from one primary school in Hong Kong, who may share similar socio-economic background. Despite, the participants' background may not be considered a crucial factor to their PA behaviour in PE lesson, future study can include participants in different school setting, so as to examine the difference of school environment on flipped learning. Second, with the aim to reflect the effect of flipped learning on the actual PE class setting, current study was conducted during the four lessons of a PE unit, which may limit the total instruction time for the study. Future study can involve other PE unit with longer durations, so as to examine the effect of instruction duration of flipped learning on students' PA behaviour. Third, owing to the practical class schedule, the lessons of both flipped learning and traditional approach were conducted by the same PE teacher. The lesson was conducted with the same teaching style and lesson plans were prepared to minimize deviation from the teaching content. Finally, the outbreak of COVID-19 pandemic during the data collection period affected the standard lesson time from 35-minute to 25-minute, while the teaching content need some modification. The situation was unavoidable and the study result can be applied to reflect students' behaviour in this "new normal" period.

5.6 Conclusions

The finding of the present study has revealed that flipped learning is a pedagogical approach for Grade 5 PE teachers to enhance their students' PA levels and lower SED during PE lessons. In this study, flipped learning was positively related to the PA levels of primary

school students. However, the evidence was only conclusive to some extent to whether students' motivation is correlated with MVPA and SED. Autonomous motivation was a positive predictor of MVPA in practice-oriented lesson. In addition, autonomous motivation was a negative predictor of SED.

In short, the research on applying flipped learning in Hong Kong primary school PE classes is still in its early stage. This study provides a foundation for future studies on flipped learning in PE with the goal of investigating the effectiveness of using flipped learning to enhance students' PA levels. Applying technology and fostering student-centred learning are the upcoming global teaching trends—and flipped learning is a way to catch up and get on board with these trends. Through flipped learning, PE teachers in Hong Kong primary schools could explore different approaches to integrate with the future teaching curriculum, thus improving their teaching strategies.

Three important implications were found during the course of the study. First, the literature review explored a new angle which interested researchers could investigate the power of the flipped learning approach in PE classes. Second, the findings suggested that the flipped learning approach creates a practical learning environment for students that allows them to participate in their PE lessons in a way that helps them meet their learning needs. Third, upon recognition of and reflection on the limitations of the study, suggestions were proposed for future research directions.

5.7 Recommendations for future studies

The findings of this study correspond to the findings of past studies in relation to the impact of flipped learning on students' PA levels during PE lessons. Although a higher increment of PA level was observed for the flipped learning group in comparison to the traditional learning group, hypotheses of correlation between motivation and PA level (MVPA

and SED) only partially substantiated. Previous research (Meece et al., 2006; Kwak et al., 2009; Blom et al., 2011) has provided insights for the researcher in terms of motivation gap. It is recommended that more deep-dive research studies can be carried out in the future with different types of students. For example, students from different schools in various areas of Hong Kong could be invited to participate, which could increase the diversity of participants. Future research can focus more on different types of students and more teaching units should be included. Grouping students with different features or characteristics is also likely to provide more indicative results when determining the performance trends of control and experimental groups. Qualitative study would be able to supplement areas which allow flexibility, natural settings, meaningful insights, and generation of new ideas that may not be able to assess by quantitative measurements.

Finally, the duration of the study period was one of the limitations of this research, therefore, a longer data collection period should be considered in future study. Similarly, future research could also include qualitative data—for example, in the form of interviews with participants from the intervention group in order to support new findings or to provide additional perspectives on the results obtained from repeated measures.

References

Abeysekera, L., & Dawson, P. (2015). Motivation and cognitive load in the flipped classroom: Definition, rationale and a call for research. *Higher Education Research and Development*, *34*, 1–14.

Aelterman, N., Vansteenkiste, M., Van Keer, H., Van den Berghe, L., De Meyer, J., & Haerens, L. (2012). Students' objectively measured physical activity levels and engagement as a function of between-class and between-student differences in motivation toward physical education. *Journal of Sport & Exercise Psychology*, 34, 457–480. http://dx.doi.org/10.1123/jsep.34.4.457

Aidinopoulou, V., & Sampson, D. G. (2017). An action research study from implementing the flipped classroom model in primary school history teaching and learning. *Journal of Educational Technology & Society*, *20*(1), 237–247.

Aron, A., Norman, C. C., & Aron, E. N. (1998). The self-expansion model and motivation. *Representative Research in Social Psychology*, *22*, 1–13.

Baker, J. W. (2000). The "Classroom Flip": Using web course management tools to become the guide by the side. In J.A. Chambers (Ed.), *Selected papers from the 11th International Conference on College Teaching and Learning* (pp. 9–17). http://www.classroomflip.com/files/classroom_flip_baker_2000.pdf

Baeten, M., Struyven, K., & Dochy, F. (2013). Student-centred teaching methods: Can they optimize students' approaches to learning in professional higher education? *Studies in Educational Evaluation*, *39*, 14–22.

Baeten, M., Kyndt, E., Struyven, K., & Dochy, F. (2010). Using student-centred learning environments to stimulate deep approaches to learning: Factors encouraging or discouraging their effectiveness. *Educational Research Review*, *5*, 243–260.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice-Hall.

Bergmann, J., & Sams, A. (2012). *Flip your classroom: Reach every student in every class every day*. International Society for Technology in Education.

Bergmann, J., & Sams, A. (2014). *Flipped learning: Gateway to student engagement*. International Society for Technology in Education World.

Biddle, J. H., Gorely, T. & Stensel, D. (2004). Health-enhancing physical activity and sedentary behaviour in children and adolescents. *Journal of Sports Sciences, 22*(8), 697-701. https://doi.org/10.1080/02640410410001712412

Bishop, J. L., & Verleger, M. A. (2013). *The flipped classroom: A survey of the research*. International Society for Technology in Education.

Blom, L.C., Alvarez, J., Zhang, L., & Kolbo, J. (2011). Associations between health-related physical fitness, academic achievement and selected academic behaviors of elementary and middle school students in the state of Mississippi. *Journal of Research*, *6*(1), 13–19. https://eric.ed.gov/?id=EJ936015

Brame, C. J. (2013). *Flipping the classroom*. http://cft.vanderbilt.edu.guidessub-pages/flipping-the-classroom/

Brown, A. (2012). *A phenomenological study of undergraduate instructors using the inverted or flipped classroom model* (UMI Number: 3545198) [Doctoral dissertation, Pepperdine University]. ProQuest Dissertations Publishing. https://search.proquest.com/openview/f8e8165f517566525358f49bbc0198ca/1?pq-origsite=gscholar&cbl=18750&diss=y

Centers for Disease Control and Prevention. (2010). Strategies to Improve the Quality of Physical Education. U.S. Department of Health and Human Services. https://www.cdc.gov/healthyschools/pecat/quality_pe.pdf

Chastin, S. F., Fitzpatrick, N., Andrews, M., & DiCroce, N. (2014). Determinants of sedentary behavior, motivation, barriers and strategies to reduce sitting time in older women: a qualitative investigation. *International journal of environmental research and public health, 11*(1), 773–791. https://doi.org/10.3390/ijerph110100773

Cheung, P. (2017). School-based physical activity opportunities in PE lessons and after-school hours: Are they associated with children's daily physical activity? *European Physical Education Review*, *25*(1), 65–75. https://doi.org/10.1177/1356336X17705274

Chow, B. C., McKenzie, T. L., & Louie, L. (2008). Children's Physical Activity and Environmental Influences during Elementary School Physical Education, *Journal of Teaching in Physical Education, 27*(1), 38-50. http://journals.humankinetics.com/view/journals/jtpe/27/1/article-p38.xml

Cohen, J. (2013). *Statistical Power Analysis for the Behavioral Sciences*. Academic Press.

The Chinese University of Hong Kong (CUHK). (2017). *The 2016 Active Healthy Kids Hong Kong Report Card on Physical Activity for Children and Youth*. Department of Sports Science and Physical Education, The Chinese University of Hong Kong (CUHK). http://activehealthykidshongkong.com.hk/document/HK%20Report%20Card%20Long%20Form%202016.pdf

The Chinese University of Hong Kong (CUHK). (2019). *The 2018 Active Healthy Kids Hong Kong Report Card on Physical Activity for Children and Youth*. Department of Sports Science and Physical Education, The Chinese University of Hong Kong (CUHK). http://www.activehealthykidshongkong.com.hk/document/2018%20Short-form%20Report%20Card%20English%20version.pdf

Curriculum Development Council (CDC). (2017). *Physical education key learning area curriculum guide (primary 1–secondary 6)*. Curriculum Development Institute, Education Bureau. https://www.edb.gov.hk/attachment/en/curriculum-development/kla/pe/curriculum-doc/PEKLACG_e.pdf

Dale, D., Corbin, C. B., & Dale, K. S. (2000). Restricting opportunities to be active during school time: Do children compensate by increasing physical activity levels after school? *Research Quarterly for Exercise and Sport*, *71*, 240–248.

Darnis, F., & Lafont, L. (2015). Cooperative learning and dyadic interactions: Two modes of knowledge construction in socio-constructivist settings for team-sport teaching. *Physical Education and Sport Pedagogy*, *20*, 459–473.

Dewar, D. L., Plotnikoff, R. C., Morgan, P. J., Okely, A. D., Costigan, S. A. & Lubans, D. R. (2013) Testing Social-Cognitive Theory to Explain Physical Activity Change in Adolescent Girls From Low-Income Communities, *Research Quarterly for Exercise and Sport*, *84*(4), 483-491. https://doi.org/10.1080/02701367.2013.842454

Deci, E. L., & Ryan, R. M. (1985). The general causality orientations scale: Self-determination in personality. *Journal of Research in Personality, 19*(2). 109-134. https://doi.org/10.1016/0092-6566(85)90023-6

Deci, E. L., & Ryan, R. M. (2000). "What" and "why" of goal pursuits: Human needs and the self-determination of behaviour. *Psychological Inquiry, 11*(4). 227-268. https://doi.org/10.1207/S15327965PLI1104_01

Deci, E. L., & Ryan, R. M. (2002). *Handbook of self-determination research*. University of Rochester Press.

Deci, E. L., & Ryan, R. M. (2008a). Facilitating optimal motivation and psychological well-being across life's domains. *Canadian Psychology/Psychologie canadienne*, *4*(1), 14–23.

Deci, E. L., & Ryan, R. M. (2008). Self-determination theory: A macrotheory of human motivation, development, and health. *Canadian Psychology/Psychologie canadienne*, *49*(3), 182–185.

Deci, E. L., Vallerand, R. J., Pelletier, L. G., & Ryan, R. M. (1991). Motivation and education: The self-determination perspective. *Educational Psychologist*, 26(3– 4), 325–346. http://dx.doi.org/10.1080/00461520.1991.9653137

Dick, W., Carey, L., & Carey, J. O. (2005). *The systematic design of instruction*. Pearson.

Ding, H., Sun, H., & Chen, A. (2013). Impact of expectancy-value and situational interest motivation specificity on physical education outcomes. *Journal of Teaching in Physical Education*, 32, 253–269. doi:10.1123/jtpe.32.3.253

Dunstan. D. W., Barr. E. L., Healy. G. N., Salmon. J., Shaw. J. E., Balkau. B., Magliano. D. J., Cameron. A. J., Zimmet. P. Z., Owen. N. (2010). Television viewing time and mortality: the Australian Diabetes, Obesity and Lifestyle Study (AusDiab). *Circulation.121*(3):384-91. doi: 10.1161/CIRCULATIONAHA.109.894824

Estriegana, R., Medina-Merodio, J-A., & Barchino, R. (2019). Analysis of competence acquisition in a flipped classroom approach. *Computer Applications in Engineering Education*, *27*(1), 49–64. https://doi.org/10.1002/cae.22056

Evenson K. R., Catellier D. J., Gill K., Ondrak K. S. & McMurray R. G. (2008) Calibration of two objective measures of physical activity for children. *Journal of Sports Sciences 26*(14): 1557–1565. doi: 10.1080/02640410802334196.

Fairchild, A. J., Jeanne-Horst, S., Finney, S. J., & Barron, K. E. (2005). Evaluating existing and new validity evidence for the academic motivation scale. *Contemporary Educational Psychology*, *30*(3), 331–358.

Finkel, E. (2012). Flipping the Script in K12. *District Administration*, *48*(10), 28–30.

Flipped Learning Network (FLN). (2014). *Definition of flipped learning*. http://flippedlearning.org/domain/46

Fox, K. R., Cooper, A., & McKenna, J. (2004). The school and the promotion of children's health enhancing physical activity: Perspectives from the UK. *Journal of Teaching Physical Education*, *23*(4), 338–358.

Fulton, K. (2012). Upside down and inside out: Flip your classroom to improve student learning. *Learning & Leading with Technology, 39*(8), 12–17. http://ezproxy.csusm.edu/login?url=http://search.proquest.com/docview/1238188642?accountid=10363

Gao, Z., Amelia, M. L., Xiang, P., & Kosma, M. (2011). Effect of learning activity on students' motivation, physical activity levels and effort/persistence. *CHPER-SD Journal of Research*, *6*(1), 27–33.

García, I. G., Castro, L. N., & Morales, P. T. (2015). Las flipped classroom a través del smartphone: Efectos de su experimentación en educación física secundaria [The flipped classroom through the smartphone: Effects of their experimentation in secondary physical education]. *Prisma Social: Revista de ciencias sociales*, (15), 296–351.

Garcia Calvo, T., Cervelló, E., Jiménez, R., Iglesias, D., & Moreno Murcia, J. A. (2010). Using self-determination theory to explain sport persistence and dropout in adolescent athletes. *The Spanish journal of psychology*, *13*(2), 677–684. https://doi.org/10.1017/s1138741600002341

Gavarry, O., Bernard, T., Giacomond, M., Seymat, M., Euzrt, J. P., & Falgairette, G. (1998). Continuous heart rate monitoring over 1 week in teenagers aged 11–16 years. *European Journal of Applied Physiology*, *77*, 125–132.

George, D., & Mallery, P. (2003). *SPSS for Windows Step by Step: A Simple Guide and Reference* (4th ed.). Pearson Education.

Glen, S. (1999). Health Care Education for Dialogue and Dialogic Relationships. *Nursing Ethics*, 6(1), 3–11. https://doi.org/10.1177/096973309900600102

Gross, D., Pietri, E. S., Anderson, G., Moyano-Camihort, K., & Graham, M. J. (2015). Increased preclass preparation underlies student outcome improvement in the flipped classroom. *CBE Life Sciences Education*, *14*(4), 1–8.

Guay, F., Chanal, J., Ratelle, C. F., Marsh, H. W., Larose, S., & Boivin, M. (2010). Intrinsic, identified, and controlled types of motivation for school subjects in young elementary school children. *British Journal of Educational Psychology*, *80*(4), 711–735.

Hamdan, N., McKnight, P., McKnight, K., & Arfstrom, K. M. (2013). *The flipped learning model: A white paper based on the literature review titled "A review of flipped learning."* Flipped Learning Network. https://flippedlearning.org/wp-content/uploads/2016/07/WhitePaper_FlippedLearning.pdf

Hao, Y. (2014). Students' Attitude towards a Flipped Classroom and its Relationship with Motivation Orientations in an Undergraduate Course. In M. Searson & M. Ochoa (Eds.), *Proceedings of SITE 2014--Society for Information Technology & Teacher Education International Conference* (pp. 2835-2840). Jacksonville, Florida, United States: Association for the Advancement of Computing in Education (AACE). Retrieved April 5, 2021 from https://www.learntechlib.org/primary/p/131225/

Harun, N. F., Yusof, K. M., Jamaludin, M. Z., & Hassan, S. A. H. S. (2012). Motivation in problem-based learning implementation. *Procedia Social and Behavioral Sciences, 56*, 233–242. https://doi.org/10.1016/j.sbspro.2012.09.650

Hattie, J. (2009). V*isible learning: A synthesis of over 800 meta-analyses relating to achievement*. Routledge.

Hattie, J., & Yates, G. C. R. (2013). *Visible learning and the science of how we learn*. Taylor and Francis.

Heinerichs, S., Pazzaglia, G., & Gilboy, M. B. (2016). Using flipped classroom components in blended courses to maximize student learning. *Athletic Training Education Journal, 11*(1), 54–57.

Herman, KM, Sabiston, CM, Mathieu, M. (2015) Correlates of sedentary behaviour in 8- to 10-year-old children at elevated risk for obesity. *Applied Physiology, Nutrition & Metabolism*, *40*(1). 10–19.

Herreid, C. F., & Schiller, N. A. (2013). Case studies and the flipped classroom. *Journal of College Science Teaching*, *42*(5), 62–66.

Hills, A. P., Andersen, L. B., Byrne, N. M. (2011).Physical activity and obesity in children. *British Journal of Sports Medicine, 45*, 866-870.

Hill, A. P. (2013). Motivation and university experience in first-year university students: A self-determination theory perspective. *Journal of Hospitality, Leisure, Sport & Tourism Education*, *13*, 244–254. http://dx.doi.org/10.1016/j.jhlste.2012.07.001

Hiroki, Y. (2016). Perceived usefulness of "flipped learning" on instructional design for elementary and secondary education: With focus on pre-service teacher education. *International Journal of Information and Education Technology*, *6*(6), 430–434.

Ho, W. K. (2002) English language teaching in East Asia today: An overview. *Asia Pacific Journal of Education*, *22*(2), 1–22.

Hsieh, Y. C., Wang, T. C., & Chou, H. S. (2018). Validation of the Chinese version in children's physical education motivation scale. *Journal of Taiwan Sport Pedagogy*, *13*(2), 1–18.

Hwang, G. J., Lai, C. L., & Wang, S. Y. (2015). Seamless flipped learning: A mobile technology-enhanced flipped classroom with effective learning strategies. *Journal of Computers in Education*, *2*(4), 449–473.

Keller, J. M. (1979). Motivation and instructional design: A theoretical perspective. *Journal of Instructional Development*, *2*(4), 26–34.

Keller, J. M. (1983). Motivational design of instruction. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: An overview of their current status. Hillsdale*. pp. 386-434. Lawrance Erlbaum Associates Inc.

Khan, S. (2012). *The one world schoolhouse: Education reimagined*. Hodder and Stoughton.

Killian, C. M., Trendowski, T. N., & Woods, A. M. (2016). Students' perceptions of flipped instruction in a university physical activity course. Paper presented at the *2016 AIESEP International Conference*, Laramie, WY, USA.

Kostaris, C., Sergis, S., Sampson, D. G., Giannakos, M. N., & Pelliccione, L. (2017). Investigating the potential of the flipped classroom model in K–12 ICT teaching and learning: An action research study. *Journal of Educational Technology & Society*, *20*(1), 261–273.

Kwak, L., Kremers, S. P., Bergman, P., Ruiz, J. R., Rizzo, N. S., & Sjostrom, M. (2009). Associations between physical activity, fitness, and academic achievement. *The Journal of Pediatrics*, *155*(6), 914–918. https://doi.org/10.1016/j.jpeds.2009.06.019

Lai, C.-L., & Hwang, G.-J. (2016). A self-regulated flipped classroom approach to improving students' learning performance in a mathematics course. *Computers & Education, 100*, 126–140.

Leisure and Cultural Services Department (LCSD). (2014). *Know Your Physical Activity Level Booklet*. Leisure and Cultural Services Department. https://www.lcsd.gov.hk/en/sportforall/common/pdf/leaflet_e.pdf

Litalien, D., Morin, A. J. S., Gagné, M., Vallerand, R. J., Losier, G. F., & Ryan, R. M. (2017). Evidence of a continuum structure of academic self-determination: A two-study test using a bifactor-ESEM representation of academic motivation. *Contemporary Educational Psychology*, 51, 67–82. http://dx.doi.org/10.1016/j.cedpsych.2017.06.010

Lo, C. K., & Hew, K. F. (2017). A critical review of flipped classroom challenges in K–12 education: Possible solutions and recommendations for future research. *Research and Practice in Technology Enhanced Learning*, *12*(1), 4.

Long, T., Logan, J., & Waugh, M. (2016). Students' perceptions of the value of using videos as a pre-class learning experience in the flipped classroom. *TechTrends, 60*, 245–252.

Lonsdale, C., Sabiston, C.M., Raedeke, T.D., Ha, A.S., & Sum, R.K. (2009). Self-determined motivation and students'physical activity during structured physical education lessons and free choice periods. *Preventive Medicine*, 48(1), 69–73. doi:10.1016/j.ypmed.2008.09.013

Mallam, K. M., Metcalf, B. S., Kirkby, J., Voss, L. D., & Wilkin, T. J. (2003). Contribution of timetabled physical education to total physical activity in primary school children: A cross sectional study. *British Medical Journal*, *327*, 592–593.

Manger, T., & Wormnes, B. (2015). *Motivasjon og mestring: utvikling av egne og andres ressurser [Motivation and mastery: development of own and others' resources]*(2nd ed.). Fagbokforl.

Matthews, C. E., Chen, K. Y., Freedson, P. S., Buchowski, M. S., Beech, B. M., Pate, R. R., & Troiano, R. P. (2008). Amount of time spent in sedentary behaviors in the United States, 2003-2004. *American journal of epidemiology*, *167*(7), 875–881.

McDonald, K., & Smith, C. M. (2013). The flipped classroom for professional development: Part I. Benefits and strategies. *The Journal of Continuing Education in Nursing*, *44*(10), 437–438.

McDavid, L., Cox, A. E., & McDonough, M. H. (2014). Need fulfilment and motivation in physical education predict trajectories of change in leisure-time physical activity in early adolescence. *Psychology of Sport and Exercise*, 15, 471–480. http://dx.doi.org/10.1016/j.psychsport.2014.04.006

McLaughlin, J. E., Roth, M. T., Glatt, D. M., Gharkholonarehe, N., Davidson, C. A., Griffin L. M., Esserman D. A., & Mumper R. J. (2014). The flipped classroom: A course redesign to foster learning and engagement in a health professions school. *Academic Medicine*, *89*(2), 236–243.

Meece, J. L., Glienke, B. B., & Burg, S. (2006). Gender and motivation. *Journal of School Psychology*, *44*(5), 351–373. https://doi.org/10.1016/j.jsp.2006.04.004

Melpomeni, P. (2019). Flip the flipped classroom: Experiential reason and new technologies in adults' education. *Journal of Systemics, Cybernetics and Informatics (JSCI*), *17*(3), halshs-02357028. https://halshs.archives-ouvertes.fr/halshs-02357028/document

Mo, J., & Mao, C. (2017). An empirical study on the effectiveness of college English reading classroom teaching in the flipped classroom paradigm. *Revista de la Facultad de Ingeniería U.C.V.*, *32*(10), 632–639.

Morgan, C. F., Beighle, A., & Pangrazi, R. P. (2007). What are the contributory and compensatory relationships between physical education and physical activity in children? *Research Quarterly for Exercise and Sport*, *78*(5), 407–412.

Mouratidis, A., Barkoukis, V., & Tsorbatzoudis, C. (2015). The relation between balanced need satisfaction and adolescents' motivation in physical education. *European Physical Education Review*, 21, 421–431. http://dx.doi.org/10.1177/1356336X15577222

Myers, L., Strickmiller, P. K., Webber, L. S., & Berenson, G. S. (1996). Physical and sedentary activity in school children grades 5–8: The Bogalusa Heart Study. *Medicine and Science in Sport and Exercise*, *28*(7), 852–859.

National Health Service (NHS). (2019). *Running tips for beginners*. https://www.nhs.uk/live-well/exercise/running-tips-for-beginners/

Niemiec, C. P., & Ryan, R. M. (2009). Autonomy, competence, and relatedness in the classroom: Applying self-determination theory to educational practices. *Theory and Research in Education*, *7*(133), 133–144.

Ntoumanis, N. (2001). A self-determination approach to the understanding of motivation in physical education. *British Journal of Educational Psychology*, 71, 225–242. http://dx.doi.org/10.1348/000709901158497

Østerlie, O. (2018). Can flipped learning enhance adolescents' motivation in physical education? An intervention study. *Journal for Research in Arts and Sports Education*, *2*(1), 1–15.

Owen, K. B., Smith, J., Lubans, D. R., Ng, J. Y. Y., & Lonsdale, C. (2014). Self-determined motivation and physical activity in children and adolescents: A systematic review and meta-analysis. *Preventive Medicine*, *67*, 270–279. https://doi.org/10.1016/j.ypmed.2014.07.033

Owen, K. B., Astell-Burt, T. & Lonsdale. C. (2013). The Relationship Between Self-Determined Motivation and Physical Activity in Adolescent Boys. *Journal of Adolescent Health, 53*(3), 420-422.

Pintrich, R. R., & Schunk, D. H. (1996). *Motivation in education: Theory, research, and practice*. Prentice Hall

Puyau, M. R., Adolph, A. L., Vohra, F. A., & Butte, N. F. (2002). Validation and calibration of physical activity monitors in children. *Obesity Research*, *10*(3), 150–157. https://doi.org/10.1038/oby.2002.24

Quartiroli, A., & Maeda, H. (2014). Self-determined Engagement in Physical Activity and Sedentary Behaviors of US College Students. *International journal of exercise science*, *7*(1), 87–97.

Quillen, I. (2013). *Video transforms teaching practices: But it is still a challenge for educators to identify quality digital content*. Education Week: Digital Curricula. www.edweek.org/go/digital-report

Reeve, J., & Deci, E. L. (1996). Elements of the competitive situation that affect intrinsic motivation. *Personality and Social Psychology Bulletin*, *22*(1), 24–33. https://doi.org/10.1177/0146167296221003

Reeve, J., Deci, E.L., & Ryan, R.M. (2004). *Self-determination theory: A dialectical framework for understanding sociocultural influences on student motivation*. In D.M. McInerney & S. Van Etten (Eds.), Big theories revisited (pp.31–60). Information Age Press.

Reeve, J., Hamm, D., & Nix, G. (2003). Testing models of the experience of self-determination in intrinsic motivation and the conundrum of choice. *Journal of Educational Psychology*, *95*(2), 375–392.

Roach, T. (2014). Student perceptions toward flipped learning: New methods to increase interaction and active learning in economics. *International Review of Economics Education*, *17*, 74–84.

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivation: Classic definitions and new directions. *Contemporary Educational Psychology*, 25, 54–67. http://dx.doi.org/10.1006/ceps.1999.1020

Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. Guilford.

Sahin, A., Cavlazoglu, B., & Zeytuncu, Y. E. (2015). Flipping a college calculus course: A case study. *Educational Technology & Society*, *18*(3), 142–152.

Sallis, J. F., McKenzie, T. L., Beets, M. W., Beighle, A., Erwin, H., & Lee, S. (2012). Physical education's role in public health: steps forward and backward over 20 years and HOPE for the future. *Research quarterly for exercise and sport*, *83*(2), 125–135. https://doi.org/10.1080/02701367.2012.10599842

Sebire, S. J., Jago, R., Fox, K. R., Edwards, M. J., & Thompson, J. L. (2013). Testing a self-determination theory model of children's physical activity motivation: A cross-sectional study. *International Journal of Behavioral Nutrition and Physical Activity*, *10*, Article number 111. https://doi.org/10.1186/1479-5868-10-111

Segolsson, M., & Bäcklund, J. (2016). *Flippa mellan skolämnen: En forskningsstudie om Flippad undervisning i skolår 6 och 7[Flip between school subjects: A research study on Flipped teaching in school years 6 and 7]*. http://www.diva-portal.org/smash/get/diva2:952886/FULLTEXT01.pdf

Shen, B., McCaughtry, N., Martin, J., & Fahlman, M. (2009). Effects of teacher autonomy support and students' autonomous motivation on learning in physical education. *Research Quarterly for Exercise and Sport*, 80, 44–53. doi:10.1080/02701367.2009.10599528

Simkins, S. P. (1999). Promoting active-student learning using the world wide web in economics courses. *Journal of Economic Education*, *30*(3), 278–287. https://doi.org/10.2307/1183067

Sleap, M., & Warburton, P. (1996). Physical activity levels of 5- to 11-year old children in England: Cumulative evidence from three direct observation studies. *International Journal of Sports Medicine*, *17*(4), 248–253.

Standage, M., Duda, J. L., & Ntoumanis, N. (2005). A test of self-determination theory in school physical education. *British Journal of Educational Psychology*, 75, 411– 433. http://dx.doi.org/10.1348/000709904X22359

Strong. W. B., Malina. R. M., Blimkie. C. J., Daniels. S.R., Dishman. R.K., Gutin. B., Hergenroeder. A. C., Must. A., Nixon. P. A., Pivarnik. J.M., Rowland. T., Trost. S. & Trudeau. F. (2005). Evidence based physical activity for school-age youth. *The Journal of Pediatrics.*146(6),732-737. doi: 10.1016/j.jpeds.2005.01.055.

Sun. H. C., Li.W. D. & Shen. B.(2017). Learning in Physical Education: A Self-Determination Theory Perspective. *Journal of Teaching in Physical Education.* 36, 277-291.

Tanner, M., & Scott, E. (2015). A flipped classroom approach to teaching systems analysis, design and implementation. *Journal of Information Technology Education: Research*, *14*, 219–241.

Teixeira, P. J., Carraça, E. V., Markland, D., Silva, M. N., & Ryan, R. M. (2012). Exercise, physical activity, and self-determination theory: a systematic review. *The International Journal of Behavioral Nutrition and Physical Activity, 9*(78). https://doi.org/10.1186/1479-5868-9-78

Thompson, G. A., & Ayers, S. F. (2015). Measuring student engagement in a flipped athletic training classroom. *Athletic Training Education Journal, 10*(4), 315–322.

Tremblay, M.S., Aubert, S., Barnes, J.D., Saunders, T. J., Carson. V., Latimer-Cheung. A. E., Chastin. F. M., Altenburg. T. M. & Chinapaw J.M. (2017).Sedentary Behavior Research Network (SBRN) – Terminology Consensus Project process and outcome. *Int J Behav Nutr Phys Act, 14*(75). https://doi.org/10.1186/s12966-017-0525-8

Treuth, M.S., Schmitz, K., Catellier, D. J., McMurray, R. G., Murray, D. M., Almeida, M. J., Going, S., Norman, J. E., & Pate, R. (2004). Defining accelerometer thresholds for activity intensities in adolescent girls. *Medicine and Science in Sports and Exercise*, *36*(7), 1259–1266.

Trost, S. G., Ward, D. S., Moorehead, S. M., Watson, P. D., Riner, W., & Burke, J. R. (1998). Validity of the computer science and applications (CSA) activity monitor in children. *Medicine and Science in Sports and Exercise*, *30*(4), 629–633. https://doi.org/10.1097/00005768-199804000-00023

Tudor-Locke, C., Ainsworth, B. E., & Popkin, B. M. (2001). Active commuting to school: An overlooked source of children's physical activity? *Sports Medicine*, *31*(5), 309–313.

Tudor-Locke, C., Lee, S. M., Morgan, C. F., Beighle, A. & Pangrazi, R. P. (2006). Children's pedometer-determined physical activity during the segmented school day. *Medicine and Science in Sports and Exercise*, *38*(10). 1732–1738.

Vansteenkiste, M., Sierens, E., Soenens, B., Luyckx, K., & Lens, W. (2009). Motivational profiles from a self-determination perspective: The quality of motivation matters. *Journal of Educational Psychology, 101*(3), 671–688.

Vaughn, M., Hur, J. W., & Russell, J. (2019). Flipping a college physical activity course: Impact on knowledge, skills, and physical activity. *Journal of Pedagogical Research*, *3*(3), 87–98. https://doi.org/10.33902/jpr.vi0.126

World Health Organization (WHO). (2010). *Global Recommendations on Physical Activity for Health*. World Health Organization. https://apps.who.int/iris/rest/bitstreams/52834/retrieve

World Health Organization (WHO). (2020). *Physical activity*. https://www.who.int/news-room/fact-sheets/detail/physical-activity

World Health Organization (WHO). (2021). *What does "physical activity" mean?* https://www.euro.who.int/en/health-topics/disease-prevention/physical-activity/news/news/2011/02/being-physically-active-helps-prevent-cancer/what-does-physical-activity-mean

Weimer, M. (2002). *Learner-centered teaching: Five key changes to practice*. Jossey-Bass.

Wilson, D. K., Evans, A. E., Williams, J., Mixon, G., Sirard. J. R., & Pate. R. (2005). A preliminary test of a student-centered intervention on increasing physical activity in underserved adolescents. *The Society of Behavioral Medicine*, *30*(2), 119–124.

Zainuddin, Z., & Halili, S. H. (2016). Flipped classroom research and trends from different fields of study. *The International Review of Research in Open and Distributed Learning*, *17*(3), 313–340.

Zhang, J., Wang, Y., & Zhang, B. (2012). *Introducing a new teaching model: Flipped classroom*. http://dej.zjtvu.edu.cn

Appendixes

Appendix I

香港教育大學
The Education University of Hong Kong

「翻轉教室」體育課研究

研究邀請

敬啟者:

有效的體育課教學模式，不但能提高學童活動的興趣，更可以增加他們的活動量。香港教育大學健康與體育學系現正進行「『翻轉教室』體育課研究」，目的為了解使用不同的教學方法，對學童於體育課期間活動量的幫助。研究結果將有助日後體育堂的教學設計。

是項研究對象為四班五年級學生，研究會於本學年其中四節體育課進行，其中兩班學生會體驗以「翻轉教室」為教學方法的體育課，期間所有參加者會進行活動量測量及填寫問卷。學生只需按照正常時間表上課，毋需特別練習或準備。所有活動均不會對學童造成不良影響。研究詳情，請參見附頁。

研究結束後，數據會整合成整體體育課堂活動量（不記名），並可提供予參加者。且研究所收集的資料只用於研究及學術發表且絕對保密，所得之數據於分析後將會銷毀。

現希望得到 貴校之同意及協助招募參加者。研究得以順利進行，實有賴 貴校之參與及支持。如對是次研究有任何查詢，可致電 [redacted] 與本人聯絡。

此致

[redacted]

並祝教安

Appendix II

「翻轉教室」體育課研究

學校參與同意書

本人已詳閱並了解「『翻轉教室』體育課研究」所述研究有關資料，並理解收集的資料只用於有關研究和學術發表且絕對保密。

本校（同意 / 不同意[#]）參與是次研究。

學校名稱：[redacted]

校長姓名：[redacted]校長

校長簽署：

日期：

[#] 請刪去不適用者

Appendix III

香港教育大學
The Education University of Hong Kong

「翻轉教室」體育課研究
研究邀請(家長)

敬啟者：

有效的體育課教學模式，不但能提高學童活動的興趣，更可以增加他們的活動量。香港教育大學健康與體育學系現正進行「『翻轉教室』體育課研究」，目的為了解使用不同的教學方法，對學童於體育課期間活動量的幫助。研究結果將有助日後體育堂的教學設計。[redacted]小學支持這項計劃，並派[redacted]老師負責參與研究。現邀請　貴子女參加是次研究，詳情可參見附頁資料。

是次研究對象為五年級學生，研究會於本學年其中四節體育課進行，學生只需按照正常時間表上課，毋需特別練習或準備，所有活動均不會對學童造成不良影響。研究結束後，數據會整合成「整體體育課堂活動量」(不記名)，提供予學校參考。而研究所收集的資料只用於研究及學術發表且絕對保密，所得之數據於分析後將會銷毀。

研究得以順利進行，實有賴　閣下的支持，在此謹表致謝及希望同學能踴躍參與。如　閣下同意　貴子女參與是次研究，敬請填妥下列回條，由貴子弟交回班主任。如　閣下對是次研究有任何查詢，可致電[redacted]與[redacted]老師聯絡。

此致

貴家長

Ref: R001(20/21)

負責老師：[redacted]

「翻轉教室」體育課研究
參與同意書（家長）

本人已詳閱並了解以上所述及研究有關資料，並

☐同意　讓本人子女參與是次研究。

☐不同意　讓本人子女參與是次研究，原因_____。

(　　)班學生 _____ (　　)

家長姓名：_____

家長簽署：_____

二零二零年九月 _____日

Ref: R001(20/21)

負責人：[redacted]老師

Appendix IV

「翻轉教室」體育課研究 - 問卷調查

第一部分：基本資料
性別： 男 / 女 (請**圈出**合適選項)
班別：五年級( )班 學號：_____

第二部分：體育課個人意見
以下句字是描述個人對體育課的意見。答案並無對錯，你只需就你最近一年上體育課的情形，在每句句子，選擇最適合的描述，並在□內打✓。

題號	問題	非常不同意	不同意	同意	非常同意
我會上體育課是因為……					
1	……課堂很有趣	□	□	□	□
2	……我喜歡學習新事物	□	□	□	□
3.	……我很享受上體育課的感覺	□	□	□	□
4.	……我想學習如何做新事物	□	□	□	□
5.	……在體育課有好的表現對我來說是很重要的	□	□	□	□
6.	……我想在這方面做得更好	□	□	□	□
7.	……我想讓別人認為我很擅長體育	□	□	□	□
8.	……如果我不參與我會有罪惡感	□	□	□	□
9.	……我想讓別人覺得我很厲害	□	□	□	□
10.	……我不上課我會有麻煩	□	□	□	□
11.	……我沒有其他選擇	□	□	□	□
12.	……這是學校規定的	□	□	□	□
13.	……，但我不知道為什麼我們應該要上這堂課	□	□	□	□
14.	……，但我認為我是在浪費時間	□	□	□	□
15.	……，但我不知道上這堂課有甚麼意義	□	□	□	□

第三部分：翻轉教室內容意見		非常不同意	不同意	同意	非常同意
16.	網上視頻容易理解	□	□	□	□
17.	上體育課我會感到開心	□	□	□	□
18	預先觀看視頻令我對課堂內容更感興趣	□	□	□	□
19	預先觀看視頻令我更有信心完成課堂的技術	□	□	□	□

已完成問卷，謝謝！

Appendix V

教案內容比較

第二課節

田徑單元
課節二
課節主題：接力賽 - 傳接棒 <下壓式傳接(一)>
學生已有知識：已掌握正確的短跑動作
單元目標：
技能：
1. 能在接棒區內展示出正確的下壓式傳接棒方法。
2. 能與組員有良好的溝通，傳棒員在合適的時間發令叫接棒員準備及預跑。
3. 接棒員能在合適的時間開始，及運用合適的速度預跑，在正確的區域內完成接棒。

認知：
1. 能說出舊線舊例接棒區線的特徵和用途。
2. 能說出在舊線新例接棒區線的特徵和用途。
3. 跌棒的處理方法。

情意：
1. 對團體運動產生興趣。
2. 能鼓勵和欣賞隊友，建立團隊精神。

本節目標：
教學目標：
1. 學生能使用下壓式傳接棒。
2. 對團體運動產生興趣。
3. 能鼓勵和欣賞隊友，建立團隊精神。

預期學習成果：
1. 大部分學生能做到以上項目

課節前的準備：

	傳統教學 – 對照組 (Traditional Learning Group)	「反轉」教學 – 實驗組 (Flipped Learning Group)
準備內容		
上傳教學影片到YOUTUBE	沒有	不少於兩天前
打印及分析學生於網上小測的答案	沒有	課堂進行前的早上

教學內容：

課堂活動	時間(分鐘)	傳統教學 – 對照組 (Traditional Learning Group)	時間(分鐘)	「反轉」教學 – 實驗組 (Flipped Learning Group)
引入活動	5	暖身活動： 原地高抬腳 30 次 伸展運動： 靜態伸展活動: 大腿，小腿，手部伸展。左右各 10 秒。 運用上一課節所學，在固定距離短衝 (約 20M) (提示：用抬腿摺腿跨腿蹬腿，擺手，起號手和腳的位置。 老師在旁觀察學生有沒有需要改善的地方。	5	暖身活動： 原地高抬腳 30 次 伸展運動： 靜態伸展活動: 大腿，小腿，手部伸展。左右各 10 秒。 運用上一課節所學，在固定距離短衝 (約 20M) (提示：用抬腿摺腿跨腿蹬腿，擺手，起跑時手和腳的位置。 老師在旁觀察學生有沒有需要改善的地方。
	5	課堂講解： 認識接力(2 分鐘) - 講解什麼是接力跑 - 先帶學生到接棒區，認識地上的標記。引導學生思考和討論標記的作用 - 解釋一個正常的接棒區有多長，以及它的作用和限制。 技巧傳授(一)：(3 分鐘) 示範原地接力練習的方法：(3 分鐘) - 抽出三名學生作原地交接棒示範 - 要求左手交右手，右手交左手	5	課堂講解： 認識接力 (2 分鐘) 因學生已看過相關教學影片，因而教學模式會由老師提問，引導學生回想及要求學生回答： - 交棒的方向? (上而下) - 左手交左手? 右手交右手? (錯，左交右 或 右交左) - 應在什麼區域內進行交接棒? 該區域有何特色和標記? 有多長? 技巧傳授(一)：(3 分鐘) 因學生已在網上看過練習的方法，所以老師會直接提問： - 是否記得原地練習的方式 - 略提要點 (原地按正常分組間距，由最後一名同學開始，左手交右手，右手交左手，到最前一位同學為完成) 請所有學生直接分組作嘗試，同時老師從旁修正及發令。
發展活動(一)	6	分組練習交接棒：(6 分鐘) - 根據示範練習原地交接棒 - 學生在原地進行練習不用走動但可交接棒的位置進行交接練習。 - 老師從旁指導、修正及發令。	6	分組練習交接棒：(6 分鐘) - 根據修正，練習原地交接棒 - 學生根據剛剛修正後的動作，進行練習。 - 老師從旁指導、修正及發令。

發展活動(二)	6	技巧傳授(二)： 講述：(1 分鐘) 請學生把原地練習距離拉闊，一組內的同學間約有五步距離： 示範：(2 分鐘) - 先選一組作示範 - 活動在每名同學有五步距離的分隔空間下進行。由最後一名同學開始，一開始揮臂模擬跑步，聽到哨子聲後，向前跑，把接力棒交給前一位同學。而前一位同學聽到哨子聲後，要做好準備接棒的動作。 - 最尾的同學右手握棒，尾二的同學用左手接棒。聽到哨子聲後，把接力棒交到前一位同學。尾三的同學用右手接棒，如此類推，直到第一位同學接到接力棒。 練習：(3 分鐘) - 根據示範其他組別進行練習 - 老師從旁指導，修正及發令。	6	技巧傳授(二)： 講述：(1 分鐘) 因學生已在網上看過練習的方法，所以老師會直接提問：同學是否記得長距離練習的指示。 - 略提要點：同學有五步距離的分隔空間下進行，聽到哨子聲才向前跑及交棒。 - 前一位同學要做好準備接棒的動作。 - 請同學按影片指示，自行分隔後直接開始。 - 由右手開始，右交左，左交右，如此類推，直到第一位同學接到接力棒。 練習：(5 分鐘) - 老師從旁指導，修正及發令。
	2	總結課堂 總括學生表現 (1 分鐘) - 抽老師模仿不良的動作，請學生說出問題，及要改善的地方。 引導思考，銜接下一節課：(1 分鐘) - 交棒留意下壓，不要直插 - 如何可以使前面的組員在合適的時間提手準備? - 如何可以在接棒時已到最高速度?	2	總結課堂 總括學生表現 (1 分鐘) - 抽老師模仿不良的動作，請學生說出問題，及要改善的地方。 引導思考，銜接下一節課：(1 分鐘) - 交棒留意下壓，不要直插 - 如何可以使前面的組員在合適的時間提手準備? - 如何可以在接棒時已到最高速度?
	1	- 伸展使用過的肌肉 - 執整服裝，飲水 - 返回課室	1	- 伸展使用過的肌肉 - 執整服裝，飲水 - 返回課室

Appendix VI

教案內容比較
第三課節

田徑單元

課節三
課節主題：接力賽 - 傳接棒 <下壓式傳接(二)>
學生已有知識：已掌握正確的短跑動作，能使用下壓式傳接棒
單元目標：
技能：

1. 能在接棒區內展示出正確的下壓式傳接棒方法。
2. 能與組員有良好的溝通，傳棒員在合適的時間發令叫接棒員準備及預跑。
3. 接棒員能在合適的時間開始，及運用合適的速度預跑，在正確的區域內完成接棒。

認知：
1. 能說出在舊線新例接棒區線的特徵和用途。
2. 跌棒的處理方法。

情意：
1. 對團體運動產生興趣。
2. 能鼓勵和欣賞隊友，建立團隊精神。

本節目標：
教學目標：

1. 能與組員有良好的溝通，傳棒員在合適的時間發令叫接棒員準備及預跑。
2. 接棒員能在合適的時間開始，及運用合適的速度預跑，在正確的區域內完成接棒。
3. 能懂得處理跌棒
4. 能說出在舊線新例接棒區線的特徵和用途。
5. 對團體運動產生興趣。
6. 能鼓勵和欣賞隊友，建立團隊精神。

預期學習成果：
大部分學生能做到以下項目

課節前的準備：

	傳統教學 – 對照組 (Traditional Learning Group)	「反轉」教學 – 實驗組 (Flipped Learning Group)
準備內容		
上傳教學影片到YOUTUBE	沒有	不少於兩天前
打印及分析學生於網上小測的答案	沒有	課堂進行前的早上

教學內容：

課堂活動	時間(分鐘)	傳統教學 – 對照組 (Traditional Learning Group)	時間(分鐘)	「反轉」教學 – 實驗組 (Flipped Learning Group)
引入活動	4	暖身活動： 原地高抬腳 30 次 伸展運動： 靜態伸展活動: 大腿，小腿，手部伸展。左右各 10 秒。 在固定距離短衝 (約 20M) (提示：用抬腿摺腿跨腿蹬腿，擺手，起號手和腳的位置。 老師在旁觀察學生有沒有需要改善的地方。	4	暖身活動： 原地高抬腳 30 次 伸展運動： 靜態伸展活動: 大腿，小腿，手部伸展。左右各 10 秒。 在固定距離短衝 (約 20M) (提示：用抬腿摺腿跨腿蹬腿，擺手，起跑時手和腳的位置。 老師在旁觀察學生有沒有需要改善的地方。
	3	重溫知識：(30 秒) 提問： - 交棒的方向? (上而下) - 左手交左手? 右手交右手? (錯，左交右 或 右交左) - 應在什麼區域內進行交接棒? 該區域有何特色? 技巧傳授(一) (2 分 30 秒) 講解及討論： - 講解預跑的概念 (為何要預跑?)(可加快到達最高速度) - 何時開始預跑? (看到隊友快要到來) - 何時準備接棒? (聽到隊友發令)	3	重溫知識：(30 秒) 提問： - 交棒的方向? (上而下) - 左手交左手? 右手交右手? (錯，左交右 或 右交左) - 應在什麼區域內進行交接棒? 該區域有何特色? 技巧傳授(一) (2 分 30 秒) 請學生根據影片內容，回答以下關預跑及問題： - 交棒前，手持接力棒的學生應該在準備交棒前做什麼? (叫：手，提示同學預跑) - 準備接棒的同學，又應該在準備接棒前留意什麼和做什麼?(看到同學快要到來便開始預，聽到「手」後把接棒手伸出。)

發展活動(一)	5	技巧傳授(一)：(5 分鐘) 講解長距離練習的流程：(2.5 分鐘) (第 1 位同學跑回來交棒給第 2 位同學後，第 2 位同學向前跑，而第 1 位同學離開賽道，返回隊伍尾。第 2 位同學向前跑。第 3 位同學在第 2 位同學交棒後，到接棒區等待。第 2 位同學跑回來交棒後，第 3 位同學向前跑，第 2 位同學返回隊伍尾。) 抽出三位同學作示範，講解等等的長距離接棒練習及整個練習的運作事宜。(2.5 分鐘)	5	技巧傳授(一)：(1 分鐘) 因同學已看過影片，向同學提問是否記得影片中的長距離練習方法。 - 略提要點 - 第 1 名同學起跑後，第 2 名同學立即到接棒區準備。第 1 位同學跑回來交棒給第 2 位同學後，第 2 位同學向前跑，而第 1 位同學離開賽道，返回隊伍尾。第 3 位同學在第 2 位同學交棒後，到接棒區等待。第 2 位同學跑回來交棒後，第 3 位同學向前跑，第 2 位同學返回隊伍尾。 練習：(3 分鐘) 全部同學作嘗試，老師從旁指導、修正和發令。 快速重提要點，要求學生在等待時按要點觀察同組同學的表現(1 分鐘)
	3	正式練習： 長距離交接棒練習： - 根據示範進行練習。 - 老師從旁指導及修正。 老師從旁觀察學生可以改善的地方	3	正式練習： 長距離交接棒練習： - 根據指導和修正進行練習。 - 老師從旁指導及修正。 老師從旁觀察學生可以改善的地方
檢討/討論	2	根據學生表現，由老師分析和說出做得好，或是有需要改善的地方。	2	讓學生透過觀察所得，說出認為同學做得好的地方，亦讓同學不公開他人姓名的情況下，說出個別出現的問題，及討論出解決的方法。
發展活動(二)	2	繼續進行長距離交接棒練習，但需要按檢討內容作出改善。	5	繼續進行長距離交接棒練習，但需要就討論內容作出改善。
發展活動(三)	3	講解： 講述「舊線新例」知識及跌棒的處理方法	/	不用講解 已在網上練習完成相關部份
	2	總結課堂 抽出表現好的學生作示範，及模仿錯誤動作提議要如何改善。 老師引導： - 留意預跑問題 - 留意發令問題 - 跌棒的處理方式	2	總結課堂 抽出表現好的學生作示範，及模仿錯誤動作提議要如何改善。 老師引導： - 留意預跑問題 - 留意發令問題 - 跌棒的處理方式
	1	- 伸展使用過的肌肉 - 執整服裝，飲水 - 返回課室	1	- 伸展使用過的肌肉 - 執整服裝，飲水 - 返回課室