DEVELOPMENTAL PATHWAYS OF MALAYSIAN YOUTH ATHLETES IN THE NATIONAL SPORTS SCHOOLS

ANGELINA TAN LI SAN

SULTAN IDRIS EDUCATION UNIVERSITY

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- God

ABSTRACT

The main objective of this research was to examine the development of the Malaysian youth athletes in the national sports schools. Athletes (n=117) from eight sports (squash, archery, athletics, fencing, swimming, netball, hockey, volleyball) participated in the study. The first study examined the athletes practice history prior being selected into the institutions. Data on sport specific milestones, type and amount of practice engaged and involvement in other sports were obtained using the Athlete Developmental Pathway Questionnaire. The individual sport athletes (squash, archery, athletics, fencing, swimming) achieved most of the sports milestones later but went on to higher levels of competitions earlier, compared to team sport athletes (p<.05). For their main sport, both individual and team sport athletes accumulated more hours on structured activities, and more activities were conducted during specialising stage, compared to sampling stage (p<.05). All the athletes engaged in a few other sports, especially sports that were very different from their main sport. The second study examined the microstructure of practice of six sports (squash, archery, athletics, netball, hockey, volleyball). The individual sports (Mdn=27.85) differed from team sports (Mdn=20.54) for the amount of time spent in transition activity (Z=1.41, p=.03, r=.47). During practice, the athletes consumed more time on training form activities (59%), compared to playing form. The observed microstructure of practice activities validated the reported coach-led practice hours, and identified the lack of competition-like practice activities that are necessary to develop expertise in sports. This research concludes that there is no singular pathway to develop athletes. Current scientific knowledge is still not being applied in practice.

LALUAN PERKEMBANGAN ATLET REMAJA SEKOLAH SUKAN MALAYSIA

ABSTRAK

Objektif utama kajian ini adalah untuk memperihalkan laluan perkembangan atlet remaja Sekolah Sukan Malaysia. Atlet (n=117) dari lapan sukan (skuasy, memanah, olahraga, lawan pedang, renang, bola jaring, hoki, bola tampar) terlibat dalam kajian ini. Kajian pertama meneliti sejarah latihan atlet sebelum dipilih ke Sekolah Sukan Malaysia. Soal Selidik Laluan Perkembangan Atlet digunakan untuk mendapatkan maklumat berkaitan peristiwa penting sukan spesifik, jenis dan jumlah latihan sukan utama, dan penglibatan sukan lain. Atlet sukan individu (skuasy, memanah, olahraga, lawan pedang, renang) mencapai kebanyakan peristiwa penting lebih lambat, tetapi mencapai tahap pertandingan yang lebih tinggi terdahulu, berbanding dengan atlet sukan pasukan ($p<.05$). Untuk sukan utama, kedua-dua atlet sukan individu dan pasukan menggunakan lebih banyak masa untuk aktiviti berstruktur berbanding dengan aktiviti tidak berstruktur, dan lebih banyak aktiviti dijalankan pada tahap pengkhususan berbanding tahap permulaan ($p<.05$). Kesemua atlet terlibat dalam beberapa sukan lain, terutamanya sukan yang berbeza dengan sukan utama masing-masing. Kajian kedua memperihalkan aktiviti mikrostruktur semasa latihan untuk enam sukan (skuasy, memanah, olahraga, bola jaring, hoki, bola tampar). Sukan individu (Mdn=27.85) berbeza dengan sukan pasukan (Mdn=20.54) dalam jumlah masa yang digunakan untuk aktiviti peralihan ($Z=1.41$, $p=.03$, $r=.47$). Semasa latihan, atlet menggunakan lebih banyak masa untuk aktiviti berbentuk latihan (59%) berbanding dengan aktiviti berbentuk permainan. Aktiviti mikrostruktur semasa latihan yang diperhatikan mengesahkan latihan bersama jurulatih yang dilaporkan, dan didapati bahawa aktiviti latihan yang mirip pertandingan sebenar dan diperlukan untuk mengembangkan kepakaran dalam sukan masih kekurangan. Kajian ini mendapati bahawa bahawa tiada laluan tunggal untuk mengembangkan atlet. Pengetahuan saintifik semasa masih belum dipraktikkan.

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LIST OF ABBREVIATIONS

ADPQ	athlete developmental pathway questionnaire
CI	confidence interval
DMSP	developmental model of sport participation
ICC	intra class correlation
MOE	Ministry of Education Malaysia
OS-TS	other sports that are team sports
PA	percentage agreement
PHQ	participation history questionnaire
SSM	national sports school(s)

APPENDIX LIST

LIST OF PUBLICATIONS AND PRESENTATIONS

Publications

Tan, A. L., Malik, Z. A., & Low, J. F. (2019). Developmental pathways of Malaysian national sports school athletes. Pertanika Journal of Social Sciences & Humanities, *27*(S3), 121 – 133.

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Presentations

Tan, A. L. S. (2016). Developmental pathways of high-performing youth athletes and coaches in Malaysian sport schools. Physical education and sports science skill acquisition symposium (incorporating the 9th Australasian skill acquisition and research group, ASARG). National Institute of Education, Nanyang Technological University, Singapore.

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CHAPTER 1

INTRODUCTION

This chapter provides a brief description of contemporary deficiencies regarding expertise in sports and the aspirations of this research. Early specialisation and diversification in sports have both been identified as prospective pathways to develop expert athletes but nothing conclusive have been construed. Further descriptions of practice activities that improve performance are still lacking.

1.1 Background of study

Studies examining the process to become an expert in a specific field are growing extensively. From chess to music to sports, many have postulated on how expert performers in those fields developed. Simon and Chase (1973) initiated the first study that popularized the ten-year rule. They studied the development histories of chess

grandmasters and found that a ten year effort is required in order to become a master in chess, requiring approximately 10 000 hours of practice or ten years' duration. Ericsson, Krampe, and Tesch-Römer (1993) identified a similar pathway for musicians, coining the term deliberate practice as a relevant, effortful, and unenjoyable activity specifically undertaken to improve performance. These activities are suggested to account for expert performance. The theory of deliberate practice states that the accumulated hours of deliberate practice is the main contributing factor for the development of expertise (Ericsson et al., 1993). If a person aspires to be a world champion, he or she must accumulate incremental hours of deliberate practice activities. If possible, this accumulation of deliberate practice should be done in the soonest time possible, so as to out-perform others who are also engaging in deliberate practice activities (Baker, Cobley, & Fraser-Thomas, 2009; Hill & Hansen, 1988; Torres, 2015; Wiersma, 2000). In other words, this is known as early specialisation. The earlier a person specialises in a sport, or the sooner he or she engaged in more deliberate practice, the better they are, compared to others.

Many researchers have since examined the application of the deliberate practice theory in sports (for example, Helsen, Starkes, & Hodges, 1998; Hodges, & Starkes, 1996; Starkes, 2000; Starkes, Deakin, Allard, Hodges, & Hayes, 1996). These studies looked at different sports and found that most athletes conform to the theory of deliberate practice, albeit not in entirety. A recent study (Coutinho, Mesquita, Fonseca, & Martin-Silva, 2014) compared the first and second league players from the Portuguese premier league volleyball and found that the more skilled athletes have accrued more practice hours than the less skilled athletes throughout all developmental stages (from 6-18 years old).

Baker and Young (2014) reviewed past research that has supported the theory of deliberate practice. The review highlighted some questions that remain to be established. The notion that deliberate practice accounts for performance questions the use of play, unstructured training and competition in developing expertise. Similarly, 10 years or 10 000 hours of deliberate practice have yet to be ascertained as the threshold required to become an expert. The authors emphasised on the need for better theoretical models and study designs in future research to answer these queries.

Although deliberate practice is necessary for performance, deliberate practice alone does not account for expertise. Hambrick, Oswald, Altmann, Meinz, Gobet, and Campitelli (2014) reanalysed past studies of expertise in chess and music, as per the initial studies of expertise, and correlated performance with the amount of deliberate practice accumulated. They found a varied range of time spent in deliberate practice for experts. In terms of years, one player took two years while another player took 26 years to reach a master level in chess. In terms of hours, a few players accumulated more than 50 000 hours of deliberate practice while others had approximately 15 000 hours of deliberate practice before becoming a grandmaster in chess. These variations indicate that there is other factors at work in the development of expertise.

To account for other ways to develop expertise in sports, the developmental model of sport participation (DMSP) describes two pathways to achieve elite performance, either through early specialisation involving deliberate practice, or through late specialisation involving deliberate play (Côté, Baker, & Abernethy, 2007; Côté & Fraser-Thomas, 2007). In contrast with deliberate practice, deliberate play refers to activities done for enjoyment (Côté, 1999; Côté & Hay, 2002). Early

specialisers engage many hours of deliberate practice in a single sport, from the time they commence a sport. Late specialisers go through three stages; they would spend their childhood playing many different sports, spend their youth in a few select sports, before choosing a single sport to specialise in subsequently. These three different phases are described as the sampling stage, specialising stage, and investment stage. The late specialisation pathway is also known as early diversification or sampling, to infer the various sports that one engages in prior to specialising. If late specialisation is an advantage, as advocated by the DMSP, it can be said that those who specialise later will achieve higher success than those who specialise earlier.

Güllich and Emrich (2014) conducted a longitudinal study of 1558 athletes in 47 Olympic sports from the German national teams. Those who specialised earlier were successful when they were younger, but this early success did not guarantee success in later years. Those with early success continued to engage in their sports but only up to the national level whereas the late specialisers advanced to international success. The elite ones are those who played, trained, and competed in other sports from childhood up to adulthood, and started specializing in their main sport at a later age. There was no significant difference in amount of practice hours.

Hornig, Aust, and Güllich (2016) compared the development of 52 professional football players, which also includes national team players, and 50 highest level-amateur football players. The elite players spent more time playing football than training as children, played more other sports as youths and specialised in football as adults (that is, late specialisation), compared to the amateur players.

Although it seems like deliberate play explains what deliberate practice does not, one study found both play and practice to be important. Forsman, Blomqvist, Davids, Konttinen, and Liukkonen (2016) analysed three different team sports and observed that children who had more sport-specific games and practices, had more of the same activities during youth, were more skilful, and more likely to be selected for the national youth teams. Of interest to note, that study analysed both practice and play and concluded that higher amount of both types of activities aid the development of skilled players.

Despite much support for both sampling and specialising, yet others found neither pathway to be significantly helpful. A study on 193 athletes in 33 sports across three skill levels showed that early specialization and early diversification did not differentiate expertise in sports (Hopwood, Farrow, Baker, & MacMahon, 2012). The main difference found between elite athletes and lesser-skilled athletes was that elite athletes were more successful in other sports. The elite athletes participated in higher levels of competition in other sports.

Rees et al. (2016) reviewed what is currently known about developing the best talent in sports. They looked into key topics that contribute to expertise according to the quality of the study design, consistency of evidence, and directness of evidence. Anthropometrics and physiological factors had the highest rating based on the three criteria. This was followed by psychological skills, birthplace, and volume of sport-specific practice and training; these factors had a high rating for two out of the three criteria. The other factors had a lower rating. They discussed all the factors and commended on multidisciplinary studies to examine the multifarious factors.

Coutinho, Mesquita, and Fonseca (2016) reviewed pathways to expertise and found that both deliberate practice and DMSP can lead to expertise in sports but neither framework can describe exactly what type of activities should be done when, and with whom. They proposed the need to expand research methods beyond what have been done, such as using a systematic observation on the microstructure of different learning activities and using mixed-method designs. This review identified three recent studies using a systematic observation of practice activities that shed light on specific activities that helps to develop talent. Two out of the three studies identified in the review used only a single method, that is, systematic observation alone (Ford, Yates, & Williams, 2010; Low, Williams, McRobert, & Ford, 2013). The remaining study combined systematic observation and interpretive interviews to gather information (Partington & Cushion, 2013).

Many studies have used a systematic observation to identify specific coach behaviours but very few have used this method to look at specific practice activities. Ford, Yates, et al. (2010) were the first to categorise practice activities into training form and playing form. Training form refers to drill-like physical or technical activities while playing form refers to game-like activities resembling the actual competition. They observed 25 youth soccer coaches and found that 65% of the time spent in practice was used on training form, 35% on playing form. Similarly, Low et al. (2013) found that youth cricket players spent the bulk of practice on training form (69%), a small portion on playing form (19%), and the remaining time was identified as transition (activities unrelated to cricket, like water break).

In another similar study, Harvey, Cushion, Cope, and Muir (2013) used systematic observations and interpretive interviews to study the behaviour of coaches during different practice states of three team sports. These practice states were similar to the training form and playing form by Ford, Yates, et al. (2010) with the inclusion of 'other' for activities that did not fit into either training form or playing form. The coaches in that study spent about half the practice time on training activities, almost a quarter of the time in other activities, and the remaining time left on playing activities. There was no comparison made between the different team sports. All these earlier studies depicted a larger proportion of time spent on training form activities.

Subsequently, Hall, Gray, and Sproule (2016) found only four studies, all described above, using a systematic observation of practice activities, and proceeded to do a single case study on rugby using this method for a year-long observation. More than half the practice activities were on playing form (58.5%). As the season progressed towards an annual international championship, the proportion of playing form increased up to 83.8%. Despite this finding, the study did mention that not only should the type of practice activities be examined, but also, how the practice activities were conducted, such as practice design and implementation.

Later studies provided support for more playing form activities being conducted during practice sessions (Hall et al., 2016; Hornig et al., 2016; O'Connor, Larkin, & Williams, 2018; Stonebridge & Cushion, 2018). Apart from rugby mentioned in the previous paragraph (Hall et al., 2016), the other studies only included football (Hornig et al., 2016; O'Connor et al., 2018; Stonebridge & Cushion, 2018). However, all the football studies also presented different proportions of time spent in each activity,

despite playing form activities utilising the majority of practice time. One study reported more than half the time spend on playing form (57%), followed by training (21%) and others (22%; Stonebridge & Cushion, 2018), another reported less than half the time employed on playing form (41%), followed by others (37%), and training form (22%; O'Connor et al., 2018), and yet another reported the most time consumed on game play, followed by skills activity and physical conditioning, throughout different age groups, regardless of their playing level (Hornig et al., 2016).

1.2 Problem statement

Despite what is currently known concerning expertise in sports, there is still a need to identify the ideal pathway to nurture athletes, for better research designs and methods that are able to provide more information, to determine the role of sports schools in producing expert athletes, and to ascertain how Malaysians develop as an athlete. These deficiencies are illuminated in the following paragraphs.

Although developmental pathway in sports such as specialising and diversifying have been identified, the ideal pathway to nurture future talent is yet to be ascertained. Neither the specialising nor the diversifying pathway differentiates between expert and non-expert athletes (Hopwood et al., 2012). At the same time, both specialising and diversifying pathways can lead to expertise in sports (Coutinho, Mesquita, & Fonseca, 2016). Furthermore, there are multiple unique pathways that lead to expertise (Gulbin, Weissensteiner, Oldenziel, & Gagné, 2013; Huxley, O'Connor, & Larkin, 2017; Storm, Kristoffer, & Krogh, 2012). Many studies have attempted to examine the development

of top athletes but results are still inconclusive; no study adequately explained how to be a champion (Baker & Young, 2014; Rees et al., 2016).

Current research methods do not provide sufficient answers. There is a need to look into multidisciplinary approach because one factor alone does not explain a phenomenon (Haugaasen, 2015; Rees et al., 2016). It is also necessary to move beyond a single measure of information and to use additional ways to collect data (Coutinho, Mesquita, & Fonseca, 2016). The use of mixed methods is certainly more far-reaching than a single method. However, multidisciplinary or mixed methods research is labour-intensive and may constraint the scope of study due to limitation on resources. This could be resolved by modifying the study design and asking different questions, as proposed by Baker and Young (2014). As other sports may be a significant factor that contributes to the development of expertise, more attention could be accorded for further exploration (Vaeyens, Güllich, Warr, & Philippaerts, 2009).

In addition, there is still a dearth of information on the actual activities engaged during coach-led practices. Better research designs are needed to study the type of activities that truly accounts for expert performance (Baker & Young, 2014). The importance of practice to develop expertise has been determined (Baker & Horton, 2004; Rees et al., 2016), but there is still a lack of knowledge on which type of activities should be conducted when, in order to be elite adult athletes. Sport researchers implored the need to explore the microstructure of practice activities (Coutinho, Mesquita, & Fonseca, 2016; Güllich, 2014). Not much research has been conducted using a systematic observation of practice activities. Some studies analysed the microstructure of practice activities but did so through retrospective recall, instead of actual

observation (Hornig et al., 2016). What is reported may differ from what actually happens (Coutinho, Mesquita, & Fonseca, 2016; Hall & Getchell, 2014; Haugaasen, 2015). Studies utilizing a systematic observation on the microstructure of practice activities are limited, and did not involve multiple sports (Hall et al., 2016; Low et al., 2013; O'Connor et al., 2018). By applying two quantitative methods of data collection (that is, a systematic observation on the microstructure of practice activities and a questionnaire), research may be able to look for significant activities. Some studies have used two quantitative methods but none involved systematic observation on the microstructure of practice activities.

Apart from that, no research has used a combination of these two quantitative methods to examine multiple sports. This can be improved by involving athletes of various sports. It is common to find studies regarding athlete development for a single sport (Drake & Breslin, 2017; Ford, Low, McRobert, & Williams, 2010; Fraser-Thomas, Côté, & Deakin, 2008; Haugaasen, Toering, & Jordet, 2014a; Huxley et al., 2017; Roca, Williams, & Ford, 2012; Sieghartsleitner, Zuber, Zibung, & Conzelmann, 2018). However, there are very few multi-sport researches (Gulbin, Weissensteiner, et al., 2013; Güllich & Emrich, 2014; Hopwood et al., 2012), especially those involving youth athletes. Some studies on athlete development involving youth athletes consists of a few sports, but mostly within the same category, such as team sports only (Baker, Côté, & Abernethy, 2003b; Forsman et al., 2016; Hopwood, Farrow, MacMahon, & Baker, 2011; Memmert, Baker, & Bertsch, 2010).

It is also unclear if sports schools are really beneficial for the development of expert athletes. Many countries invest in sports schools (Kristiansen & Houlihan, 2017;

Radtke & Coalter, 2007). As the name implies, sports schools combine education and sports in one environment to support aspiring junior athletes in their dual career pursuit. It would be expected of sports schools to be beneficial to student athletes, as per the function of such schools. Some found that sports schools would be an advantage for sports that require specific facilities or locations, like skiing (Flatau & Emrich, 2011). Yet others found that athletes from sports schools did not perform significantly better, either in sports or education, compared to athletes from non-sports schools (van Rens, Elling, & Reijgersberg, 2015). This was concluded by collecting retrospective data on academic and sporting performance from 242 former talented athletes of six different sports. 70% of the 242 athletes did not attend a sports school but reported achievements that were equivalent to the 30% of that figure who attended a sports school. Scrutinising the activities conducted in sports schools may present factors to explain these findings.

Moreover, cultural differences may implicate findings from other studies (Baker, Horton, Robertson-Wilson, & Wall, 2003; Suppiah, Low, & Chia, 2015). Majority of the published studies were based on the western culture, which may be interpreted differently in Asian cultures. For example, one study examined the application of the DMSP in a cultural context among elite Danish athletes (Storm et al., 2012). It was found that developmental pathways are unique to individuals and that cultural contexts play a significant role. Similarly, another study illustrated how country specific differences affected the development of Finnish youth athletes (Forsman et al., 2016).

Malaysia invests a considerable amount of money into sports development with the hope of winning an Olympic gold medal that is still elusive to date. As part of the

national effort to produce elite athletes, the national sports schools (SSM) select talented student athletes and enrich them with the hopes of subsequent senior success at the world arena. The SSM provides sports facilities, specialised training, sports science and sports medicine support, and a lot of competition exposure as part of a holistic programme to nurture sporting talent. The SSM's focus is to cultivate world-class student athletes and to emphasise on a sports career (Ministry of Education Malaysia [MOE], 2016a). To accomplish these goals, the SSM were established to systematically involve prospective young people in structured sports activities. The SSM programme involves voluminous hours of sports practice, likened to the many hours of deliberate practice required of expert performers.

Currently, there are five SSM in the country (MOE, 2016a). The first SSM has been in operation for more than twenty years. With an annual intake across all SSM, many athletes would have been through the SSM; some have achieved senior success whilst others may have retired or dropped out of sports since. Sports schools are meant to produce athletes but there is no information on what to do before getting into a sports school. The SSM operates on a selection basis; only those who display athletic proficiency get in to the SSM. No research has been done on how athletes developed their sports skills prior to enrolling at the SSM and how athletes are developed upon entering the SSM.

It is unknown if the sports development in Malaysia is in line with current literature findings. The National Football Development Plan commenced in 2014 (Ministry of Youth & Sports Malaysia, 2014). There was no National Football Development Plan before, but Malaysia qualified for football in the 1972 Munich and

1980 Moscow Olympics (Ministry of Youth & Sports Malaysia, 2014). There were no sports schools prior to 1996 but the country has produced world-renowned athletes. There is no empirical data on how Malaysian athletes became experts in their field. The activities undertaken by the athletes during their developmental years are unknown. The ideal pathway to nurture future talents is yet to be ascertained. Gaps in scientific knowledge as mentioned earlier warrants the need for this research. As more research is needed to further comprehend the development of expertise in sports, especially in Malaysia, this study investigated how athletes in the Malaysian sports schools elevate their performances and their interaction with the school environment. The use of two quantitative methods (questionnaire and systematic observation) provided a rich and comprehensive data for deeper evaluation.

1.3 Research purpose

The purpose of this research was to further evaluate factors that contribute to the development of expertise in sports, guided by the theoretical framework of deliberate practice and DMSP, applied in a local context.

1.4 Research objective

The main objective of this research was to describe how youth athletes developed, by identifying the developmental pathway taken by the SSM athletes, from the time they first started engaging in sports, up to their present age, while still being in the SSM.

1.5 Research questions

This research was directed by the following questions:

What type and amount of sports activities the SSM athletes engage in:

i) Before and after they enrolled at the SSM?

ii) During practice hours in the SSM?

As the SSM serve various sports, comparisons were made between individual sport and team sport athletes. The objective for comparison was to provide a holistic view of athletes from multiple sports. This research was accomplished through two studies; developmental pathway of athletes, and systematic observation of the microstructure of practice activities.

The first study on the developmental pathway of athletes was designed to answer the first research question, using a retrospective questionnaire. This study aimed to determine whether youth athletes in the SSM follow the early specialisation or early diversification pathway. In addition, this study probed the effects of other sports involvement on the development of expertise in the main sport engaged in by the athletes. The objective of study one was to identify the developmental pathways of youth athletes in the SSM and to compare between individual sport and team sport athletes.

The second study on the microstructure of practice activities was designed to answer the second research question, using a systematic observation. This study aimed to ascertain the current type and amount of coach-led practice activities conducted in the SSM. This presented information pertaining to training form and playing form activities. The objective of study two was to examine the microstructure of the practice activities engaged by the athletes in their respective sports and to compare between individual sport and team sport athletes.

The second study provided further details to complement the first study. The information acquired from both studies was then combined to identify what underlies the development of Malaysian youth athletes in their respective sports, that is, what sport activities did they engage in to attain their present level of expertise. The outcome of this research was to provide recommendations for athlete development based on empirical information, and to expand the currently inconclusive evidence base for expertise in sports.

1.6 Research hypotheses

As this research was descriptive in nature, no specific hypothesis could be addressed. However, the comparison between individual sport and team sport athletes allowed for inferential testing. Therefore, the null hypothesis was assumed for all studies for comparison between individual sports and team sports. For the first study, it was hypothesised that there is no significant difference on the developmental pathway of youth athletes in the SSM between team and individual sports (H_1). Similarly, for the

second study, it was hypothesised that there is no significant difference on the microstructure of practice activities of youth athletes in the SSM between team and individual sports (H_2). Additionally, based on initial research findings, it was hypothesized that the SSM athletes would employ more practice time on training form activities, compared to playing form activities (H_3; Ford, Yates, et al., 2010; Harvey et al., 2013; Low et al., 2013; Partington & Cushion, 2013).

1.7 Theoretical framework

The theoretical background for this research (Figure 1.1) was based on Ericsson's theory of deliberate practice (1993) and Côté's Developmental Model of Sport Participation (2007). Deliberate practice is exemplified through early sport specialisation. The DMSP portrays the early sampling pathway.

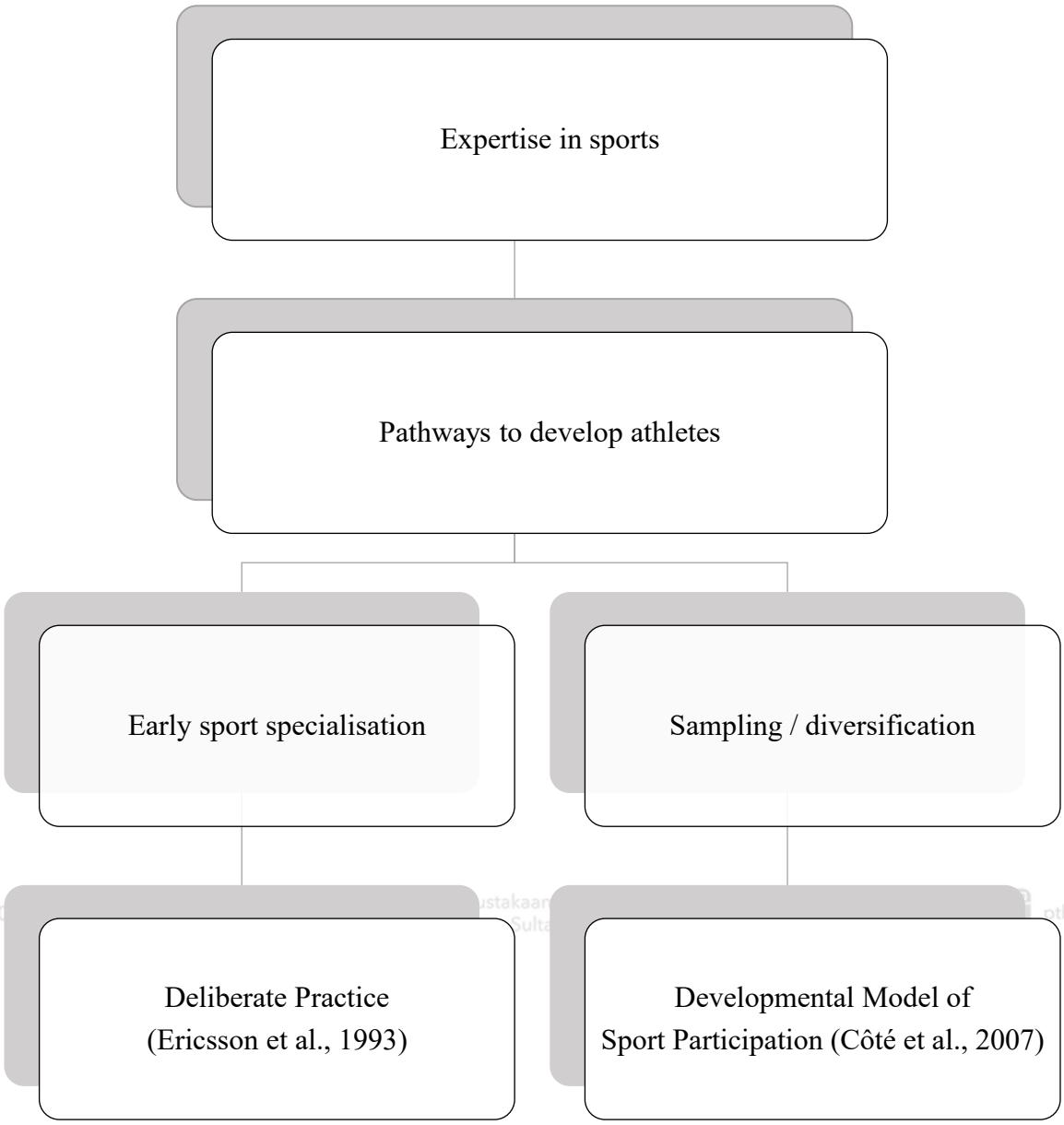

Figure 1.1. Theoretical framework

1.8 Operational definitions

For this study, the following were defined:

Expert and elite

Ericsson (1993) defined deliberate practice as a means towards expert performance, whereas Côté (2007) presented the DMSP pathway as a means to elite performance.

The terms elite and expert denotes two different concepts. However, the end product may be similar, that is, to be so highly skilled (expert) while elite is belonging to a special group (e.g.: top athletes) in the field. For clarity and consistency, this research will employ the term expert. In the context of this study, an expert in sports is someone who is highly skilled in their sport. The term elite may be used for discussion purposes, but the participants in this study are yet to be defined as elite, as it is uncertain if they will progress to become the top athlete in their field.

Developmental pathways

The term developmental pathway refers to sporting activities in the past and present. This includes when and what sport activities the athletes engaged in while growing up, and at the present time. Practice activities are a segment of sports activities, and the microstructure of practice described specific sport activities. In summation, all of these sports activities present a picture of how athletes developed their sporting abilities.

Sports schools

Malaysian sports schools consist of state and national sports schools. A state sports school consists of school-aged athletes selected from the state where the sports school is located. A national sports school (SSM) consists of school-aged athletes selected from the entire nation, with some percentage from the respective state where the school is located. All sports schools provide boarding and sports training facilities for the students. The state sports school was engaged for pilot study alone. Actual study involved only SSM.

Types of sport activity in the questionnaire

Competition refers to organized tournaments or events, participated with formal governing rules and regulations, with rewards and recognitions (for example, Malaysian School Sports Council, Malaysian Games). Training with coach was defined as practice activity supervised by either coaches or adults with the purpose of improving athletes' performance (for example, physical, technical, or tactical skills). Self-training was defined as sport related activity engaged by the athlete individually, again with the intent to improve performance (for example, taking penalty flicks in hockey, long runs to improve fitness). Playing with friends refers to unstructured games with rules determined by the participants themselves, with the main purpose of gratification and leisure (for example, three a side volleyball or squash match among friends).

Types of practice activity during observations

Fitness comprises any physical conditioning exercises, to develop fitness qualities of the game, such as strength, power, speed, endurance, or flexibility, for example, warm-up, cool-down, strength and conditioning. Skills encompasses any sport-specific activity with anticipated results, which does not involve fitness or competition conditions, such as technical skills, drills, practicing one part of a skill, repetitive activities, activities with no variations, conducted individually or with a group. Any activity directly related to the skills being practiced, is required for, or is a part of the learning process, such as waiting for their turn, setting up equipment, or collecting equipment, conducted during the skills task, was included as skills. Games incorporates any activity resembling the actual competition, which contains tactical aspects, and may involve customised rules, fewer or more athletes, small group games, or typical competition situation. Any activity directly related to the games being conducted, is

required for, or is a part of the learning process, such as receiving feedback or changing player's positions, conducted during the games task, was included as games. Transition included any (in)activity, such as water or prayer break, resting, any activity that does not fit exclusively into fitness, skills, or games, or any activity which had no sport specific movements.

1.9 Limitations of study

This research was limited by the design and methods used. Descriptive studies cannot imply causality, the purpose is to describe what happened, but it does not explicate why it happened so. Possible explanations were supplemented in the discussion section. Retrospective recalls are an estimation of the type and amount of activities engaged in; they only represent actual events. Measures were taken to ensure reliability and validity of recalled information, as explained in the methods section. This study only involved athletes from the national sports schools. A minimum age of 16 was set to ensure sufficient data to describe the developmental pathway.

For the systematic observation, the practice activities were based on what the group was doing at any one time, as opposed to observing the activities of each individual. Only coach-led practice was observed; competition, self-practice, and peer-led play was excluded. Transition time was expected to be higher than reported, because any inactivity that was conducted in the midst of skills or games activity was considered as skills or games, rather than transition, clarified in the methods section.

For this study, it was assumed that:

i. The participants are representative of youth athletes in Malaysia.

ii. The participants understand and answer the questionnaire to the best of their ability.

iii. The observed practice sessions are representative of all practice sessions, without any behaviour alteration due to the presence of research elements.

iv. All coach-led practices are deliberate practice as such practices are deliberate, require effort, and conducted with the aim to improve performance.

v. The SSM athletes started specialising in their main sport upon enrolling into the SSM.

1.10 Importance of research

The knowledge gathered from this thesis would assist to develop an empirical based guideline for the development of future athletes. Findings from these studies could be used to facilitate the learning of essential sport skills for budding athletes. Similarly, the understanding of the mechanisms underpinning the development of expert performance are pertinent to the stakeholders involved such as parents, schools, national sport bodies, and policy makers. The findings describe the types of sport related activity engaged in, the amount of such activity, and the time frame when such activity is engaged. Knowledge on the pathways will assist sport practitioners to make informed decisions as whether to specialize, diversify, or whether certain investment will be worthwhile in the process of producing expert athletes. Knowledge on the microstructure of practice presents information that may be utilized by coaches to design practices.

The items determined in the developmental pathways provide systematic and objective approaches that can be utilized practically. Parents may use the knowledge to determine when they want their children to start playing or training in certain sports. Coaches may design their coaching programs to encourage young athletes to enjoy participating in sport and progress into a career, especially in making decisions and systemic choices to meet the young athlete's needs. Schools and national sports associations may consider employing the findings to integrate into their respective talent identification and development system. Sport practitioners who are involved in developing young talents to achieve their dreams will benefit by knowing the mechanisms that underpin the expert performance in sports.

In addition, this thesis covered gaps in existing literature as described next. The combination of two quantitative methods (retrospective questionnaire and real-time observation of microstructure of practice activities) allowed for more detailed analysis of activities engaged in during the development of an athlete. This was the first study to utilize a systematic observation of microstructure of practice activities in a multiple sports context. The inclusion of multiple sports in research involving youth athletes complemented past studies of multiple sports which mostly involved adults. The microstructure of practice activities defined which type of activities is prioritized more during practice sessions for various sports. Knowledge of the Malaysian developmental pathway of athletes was added to the current, western dominated literature. The identification of a different pathway for athletic development has expanded the pathways documented so far.