DEVELOPMENT AND VALIDATION OF A PHYSICAL ACTIVITY GAMES PLAYABILITY SCALE

BY
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DISsertation
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ABSTRACT

For the past three decades, the prevalence of childhood obesity has been on the rise and correspondingly engagement time in sedentary activities has escalated. In contrast, interest, and participation rates in physical education classes are declining. Fun and interesting physical activity (PA) games could help to prevent the decline and possibly reverse inactivity. The purpose of this study was to develop and validate a Physical Activity Playability Scale (PAGPS) in order to provide more detailed “game information” assisting end users (e.g., policy makers, PE teachers, et al.) in choosing the “best possible” children’s PA games. A two-stage development and validation process was employed for this study. Five content experts (N=5) were recruited to draft and develop the PAGPS scale. By applying the heuristic approach, content experts selected, reviewed, commented, evaluated, and eventually determined the relevant PA games factors/subscales, which helped in establishing the content validity evidence for the PAGPS. Ten factors that were identified to represent game domain were Fun, Social, Cognitive, Physical, Skills, Game Structure, Language, Environment, Game Difficulty, and Player’s Characteristics, and a total of 116 items were developed for these factors. Two hundred PE teachers (N=200) were recruited in Malaysia to further determine the most suitable items for the PAGPS. Principal Component Analysis (PCA) was chosen to systematically trim the large amount of variables but maintain as much of the information from the PAGPS (draft) data set. A six-factor construct (with 99 items), including fun and social, cognitive, physical and skills, games structure and environment, game difficulty and player’s characteristics and language were confirmed for the PAGPS. Rasch
Analysis, an item response theory approach, was then chosen for the item reduction process by taking advantage of the analysis (i.e., invariance, ability to locate all facets on a same scale, and additive) over the classical testing theory based approach. Items were deleted based upon three criterions: goodness-of-fit statistics, item difficulty (logits), and content balance. As a result, four shorter PAGPS versions were created, with 51-item, 36-item, 28-item and 20-item, respectively. The 51-item version was chosen because of its high correlation ($r = .98$) with the original 99-item version and its balanced content coverage. Cronbach’s alpha analysis was also performed to determine the internal structural consistency. Ten Malaysian PA games were selected to validate the 51-item PAGPS (Game Rating Scale), including One-Leg, Kali-Tui, Blind Man’s Bluff, Simon Says, Eagle and Hen, Hopscotch, Police and Thief, Duck Duck Goose, Monkey in the Middle, and Mr. Wolf. Sixty children ($N=60$) consisting of two age-groups (Grade 2: $n=30$, Grade 5: $n=30$) were recruited to play all ten PA games, their reactions towards each game were video-recorded for rating purposes. Ten raters ($N=10$) scored each PA game video (10 videos for Grade 2 and 10 videos for Grade 5, respectively) using the 51-item PAGPS. The rating scores were analyzed for inter-rater reliability evidence, discriminant evidence ($P$ and $K$ coefficient), and game descriptive statistics (validity evidence). Interrater reliability was found to be within a good range of .70-.91, $P$ coefficient from .15-1.00 and $K$ coefficient from -.70-1.00. Together, reliability evidence (i.e., internal structure reliability and inter-rater reliability) and validity evidence (content validity, discriminant validity and games’ descriptive statistics) provided preliminary support for the psychometric quality of the PAGPS (Game Rating Scale). This study also illustrated that, with a combination of the convent balance, Rasch analysis can be used effectively
for item reduction while maintaining the psychometric properties of the original measure.

More PA researchers should take advantage of this method when developing and constructing measures.
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“What doesn’t kill you, makes you stronger” (Kelly Clarkson)
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CHAPTER 1
INTRODUCTION

Background

The National Health and Nutrition Examination Survey (NHANES) reported that 17% (12.5 million) of U.S. children and adolescent aged 12-19 years in 2007-2008 were obese as compared to just 5.0% in 1971-1974 (NHANES, 2007/2008 in Ogden & Carroll, 2010). From the period of 1976-1978 to 2007-2008, NHANES found that obesity prevalence increased among preschooler (2-5 years) from 5% to 10.4%, pre-teens (6-11 years) from 6.5% to 19.6%, and adolescents (12-19 years) from 5% to 18.1% (Figure 1).

Obesity prevalence also showed signs of significant disparities across race and ethnicity in children and adolescents population (NHANES, 2007/2008). In the period of 1988-1994 and 2007-2008, non-Hispanic black girls aged 2 to 19 years were more obese (16.3% to 29.2%) than Hispanic-American (13.4% to 17.4%) and non-Hispanic white girls (8.9% to 14.53%). On the other hand, Hispanic-American boys were more obese (14.1% to 26.8%) than non-Hispanic black (10.9% to 19.8%) and non-Hispanic white boys (11.6% to 16.7%).

In addition, an obese child is believed to possess a 70% chance of developing into an obese adult, and if one or both parents are obese, the chances increased to 80% (Freedman, Khan, & Serdula, 2005; Whitaker, Pepe, Wright, Seidel, & Dietzl., 1998). Childhood obesity is linked to various overweight related diseases later in life such as high cholesterol, some forms of cancer, sleep apnea, orthopedic problems, high blood pressure, Type 2 diabetes and many other related diseases (United States Department of Health and Human Services [USDHHS], 2001). Another consequence associated with the obesity epidemic is the effect on the U.S. economy; annual

Many negative effects and financial burdens related to obesity prompted the World Health Organization (WHO) to launch the “Commission of a Global Strategy on Diet and Physical Activity” (CGSDPA) during the 56th World Health Assembly (2004). CGSDPA raised several major health concerns, including obesity and over-nutrition, diabetes, osteoporosis prevention, cancer prevention, weight control and the benefits of physical activity (PA) on cardiovascular disease (WHO/FAO, 2002).

Based upon past health data, scientists have found substantial correlation between obesity epidemic and lack of physical activity, unhealthy eating patterns, or a combination of the two, while genetics, environment, socioeconomic status, culture and lifestyle make up other important factors in determining a child’s weight (Center for Disease Control and Prevention [CDC], 2011; USDHHS, 2001). In addition, the recommendation by the CDC (2011) and the Surgeon General’s Report (2001) of at least 150 minutes (30 minutes x 5 days) of exercise per week was achieved by only 65% of adolescents with most adolescents spending at least two hours or more watching television or playing video gaming everyday (USDHHS, 2001).

The Centers for Disease Control and Prevention, Pediatric Nutrition Surveillance System (PedNSS), and World Health Assembly (WHA) in one voice have identified physical activity as the single most important and effective strategy to combat obesity (Vanio & Bianchini, 2002; WHA, 2004). The CDC (1996) and PedNSS (2009) further recommended reduction of TV viewing time, easier access to sports facilities, a healthier diet (e.g., increase in fruits and vegetable intake and reducing energy dense, sugary, or fatty food), and positive physical activity (PA) mindsets as some of the many ways to keep children healthy and active. Among children
and adolescents, physical education (PE) classes and adult role-modeling (e.g., parents, teachers), are also a great way to make a change. School is the “agent of change” that could provide children from kindergarten through Grade 12 with quality daily physical activity education that helps develop the knowledge, attitudes, skills, and behaviors needed to be physically active for life (Gallagher, 2004; Surgeon General’s Report, 2001).

![Figure 1. Prevalence of obesity among children and adolescents: United States, trends 1963-1965 through 2007-2008](image)

**Promotion of Physical Activity and Healthy Lifestyle in School**

With almost 90-95% of children and adolescents between five and nineteen years old in the US attending public or private schools, the educational system offers an ideal platform for encouraging lifelong active lifestyle (CDC, 2008). Many studies have shown that well-developed and systematically implemented school programs can positively promote physical activity, healthy eating, and reduced television viewing time (CDC, 1996/1997; Gortmaker et al., 1999; Robinson, 1999). The large amount of hours children spend in school daily, together with the availability of PA professionals (e.g., PE teachers, coaches, or gym instructors), and accessibility
of fitness and sports facilities (Carter, 2002; CDC, 1997; Wechsler, Devereaux, Davis, & Collins, 2000) should make school an ideal place to promote physical activity.

On average, children in the US spend almost 7-8 hours daily, five days a week engaging in various educational activities such as classroom learning and extra curriculum programs including PE classes. Various school periods, such as recess time (McKenzie et al., 1997; Verstraete, Cardon, De Clercq, & De Bourdeaudhuij, 2006) and PE classes (Heath, Pratt, Warren, & Kann, 1994; Sallis, Owen, & Glanz, 1997; Simons-Morton, Parcel, Baranowski, Forthofer, & O’Hara, 1991) have been identified as a pivotal time frame for physical activity promotion. In other words, school presents an ideal and unique platform for health and fitness enhancement via physical activity (CDC, 1997).

However, children’s interest and participation rates in daily PE declines with age (CDC, 2008). For example, 68% of ninth grade students attended PE class compared to only 41.5% of twelfth grade students (Child Health USA, 2009). Nationally, enrollment in PE classes in high school averaged about 30% yearly from 1988 to 2003 (National Center for Educational Statistics, 1996). Youth Risk Behavior Surveillance System (YRBSS, 2007 in CDC 2008) further reported that only 34.7% of high school students met the minimum level of PA recommendation of 300 minutes per week (Eaton et al., 2008).

In contrast, engagement time on sedentary activities such as watching television and computer gaming has escalated (CDC, 2009; Hancox & Poulton, 2006; Robinson, 1999). High school students reported using their computer for non-school-related work (25%) and watching television (35.4%) for three or more hours daily (CDC, 2009; Child Health USA, 2009). The amount of time spent on sedentary activities indirectly affects the amount of available time to engage in healthy PA.
Over the past two decades, the computer games industry launched numerous innovative physical activity-oriented computer games called “exergames” to promote fitness, targeting the health conscious community. Exergames such as NeoRacer, Yourself! Fitness, ExerStation /Kilowatt, Expresso Fitness S2, Sony EyeToy-Kinetic (Rand, Kinzony, & Weiss, 2004), PlayMotion, Dance Dance Revolution (Hindery, 2005; Unnithan, Houser, & Ferhall, 2005), Nintendo Wii, and Gamercize claimed to promote physical activity (Daley, 2009; Graves, Ridgers, Atkinson, & Stratton, 2010; Mhurchu et al., 2008). However, there are certain barriers in implementing exergames. For example, not every school or home owns an exergames machine; besides with only limited exergames machines available in schools, participation rates per student during PE classes using exergames may be somewhat limited. From another perspective, members of the low-income community, who also happen to be the most likely to adopt sedentary lifestyles and need help (CDC, 2009; Colorado Health Foundation, 2008), could barely afford exergames (Scibelli, 2010), making the traditional children PA games a rational choice.

Sallis (2011), the director of the Active Living Research Program at San Diego State University, commented that exergames possess certain potential and benefits. For example, students are able to exercise in a limited space; no trained PE teachers are needed, and it may improve children’s concentration and attention (Shasek, 2005). However, Sallis cautioned that exergames should not be blindly included in PE classes, because the aim of PE classes is to teach children basic gross motor and fitness skills that might be absent in exergames. Although exergames might be better than no PE or bad PE sessions, exergames is never as good as or should be a substitute for PE (Scibelli, 2010).

Note. *PA games in this dissertation refers to physical activity children games, unless otherwise specified.
Rationale

In line with our goal to reduce childhood obesity and promote an active lifestyle, interesting and fun PA games could hold the key to achieving this goal. Caillois (1961) suggested that PA games could lead to better health, fun, enjoyment, relaxation and a chance to develop skills. It is the health benefits of PA games that has our utmost interest.

However, many past studies related to physical activity promotion during PE mainly focused on factors such as the quality of PE programs (Simon-Morton, Parcel, Baranowski, Forthofer, & O’Hara, 1991), the decrease in PE class time, the quality of qualified PE teachers (Sallis et al., 1997), active lifestyle physical activity promotion (Dale, Corbin, & Cuddihy, 1998), change in education policies (Chad, Humbert, & Jackson, 1999; Trost, Pate, Ward, Saunders, & Riner, 1999), refocus from physical fitness to physical activities (Koslow, 1988; Morrow, Jackson, & Payne, 1999) and many others. Nevertheless, the research on PA games themselves (product), and what constitutes a fun and interesting PA game, has been neglected especially in the context of PE.

Even though children’s PA games (e.g., playground games, street games, party games, or traditional games) have long been incorporated into PE classes and other recreational settings, little work has been focused on how to select fun or interesting PA games. Many children PA game books, classified games based upon a few basic elements such as age, origin, objective, level of experience, and equipments needed. Only a handful of books included more detailed game information like level of difficulty (e.g., easy, moderate, hard). In fact, information in many game books are based on authors’ personal opinions or experience as PE teachers; thus, systematic evaluations were rarely carried out to quantify their claims.
In contrast, the computer games industry has developed systematic frameworks to evaluate computer games (Desurvire, Caplan, & Toth, 2004; Hasiah & Azizah, 2010; Korhonen, Paavilainen, & Saarenpa, 2009; Nacke, Drachen, Kuikkaniemi et al., 2009). The commonly used systematic framework in computer game evaluation is based upon a heuristic evaluation. Heuristic evaluation uses readily accessible views and experiences of experts (e.g., programmer, games developer, games engineers) to assist in solving computer game problems. Heuristic evaluation is inexpensive, cost efficient, time saving, and easy to apply (Hasiah & Azizah, 2010; Korhonen et al., 2009; Nacke et al., 2009; Pinnelle, Wong & Stach, 2008).

Nevertheless, the theoretical backbone of heuristic evaluation is based upon the Classical Test Theory (CTT), in which evaluation elements (e.g., fun, human computer interaction, graphics, and sound effects) are summed up to a total score for the evaluation. Total scores based on such sum-up practices have been criticized as inappropriate (Zhu, 1996). In order to overcome CTT’s weakness, this study proposed an evaluation approach that maintains the benefits of heuristic evaluation, and at the same time, incorporates the advantages of Item Response Theory (IRT), such as unidimensionality and local independence (i.e., common scale, same calibration equation, additive). IRT is able to transform different evaluation values into the same measurement unit called log-odds unit or logits and then puts them on a common scale (see Chapter 2 for more details).

The purpose of this study was to take the advantages of heuristic evaluation and IRT to develop a physical activity game rating scale called Physical Activity Games Playability Scale (PAGPS), and validate PAGPS by collecting related validity and reliability evidence. Heuristic evaluation was used to identify the PAGPS factors or categories with the input of panel PA game
experts, while the IRT approach, specifically a Rasch model, were used to analyze data fit and validate the PAGPS to provide a better and more accurate evaluation scale.

**Specific Aims**

The specific aims of this study were:

1. Define major elements and factors of PA games;
2. Develop the Physical Activity Game Playability Scale (PAGPS) based upon the heuristics evaluation playability approach;
3. Evaluate and validate the proposed PAGPS on existing PA games in Malaysia.

**Significance**

The results from this study ought to provide the missing PA games information including, (a) the factors of PA games playability, (b) the PA game evaluation heuristics/guidelines, and (c) a game evaluation tool (PAGPS scale) to rate children’s PA games. The creation of PAGPS provides more in-depth PA games information to physical educators, school administrators, and even parents, in order to select appropriate and fun PA games. Without such a tool, an inappropriate game may occasionally be selected, which could discourage students’ involvement and engagement in the game (e.g., an extremely easy game could bore students, while extremely difficult PA games could inhibit their interest). Upon completion of a valid and reliable PA game evaluation system, we should be able to:

1. Determine the guidelines and factor of PAGPS PA games elements
2. Develop a reliable and validated PAGPS scale/tool
3. Employ the PAGPS scale/tool to evaluate existing PA games, and
4. Provide detailed information about PA games so that users could employ the PAGPS scale/tool to help choose the “best possible” children’s PA games.
CHAPTER 2

LITERATURE REVIEW

The field of modern physical activity (PA) game studies was pioneered by Huizinga (1955) in his book *Homo ludens*, which comprehensively described the nature of play. Later, Caillois (1961) *Man, play, and games* also presented an in-depth discussion of play and PA games, suggesting game classification guidelines and social analyses of game concepts. This was followed by *Study of games* (Avedon & Sutton-Smith, 1971), which dealt with the history of PA games and the structural elements of games (Barr, Noble, Biddle, & Khaled, 2006).

The early 1980s saw an “invasion” of a new form of recreational electronic games called video or computer games (although not related to any form of physical activity). These new electronic games transformed how society perceived and categorized leisure activities. Later, books like *Cybertext* (Aarseth, 1997) and *Half-Real* (Juul, 2006a) helped further shape the discipline of electronic games.

These days, computer games capture the interest of the younger generation, at the same time their participation in PA games is on the decline. Due to this decline, there is a need to develop a scale/questionnaire (PAGPS) to evaluate and understand the core factors that define an interesting PA game and to help persuade the younger generation to be physically active again. This chapter discusses games, play, sports and computer games from the perspective of definitions, characteristics and elements, classifications, history, and play-related theories.

Games

Many scholars believed Ludwig Wittgenstein is probably the first academician to define the word “games.” In his book *Philosophical investigations*, Wittgenstein (1953) suggested that
the universe of games is too wide, whereby the concept of play, rules, and competition all fail to adequately define what games are. Although it is impossible to fully define games, many other scholars believe that there are some core-characteristics of games that are universally accepted and agreed upon (Abt, 1970; Avedon & Sutton-Smith, 1971; Caillois, 1961; Morris & Stiehl, 1999; Ridell, 1975). This section discusses the definition of games, elements, and characteristics of games and common classifications of games.

**Definition.** A plethora of definitions have been proposed to define games but collectively, most games are subject to a set of rule(s), whereby penalties are normally imposed for defeat or violation of rules, and the action (game play) proceeds in a regular manner until it reaches a climax (i.e., victory) based on skill superiority, speed, or strength (Bancroft, 1949).

Caillois (1961) strongly believed that games offer definable goals of excellence, social participation, health benefits, fun, enjoyment, relaxation, and offer players a chance to repeatedly develop skills. Most competitive game related activities fulfill the requirement of *agon* (everyone has an equal chance of winning). Another term proposed by Caillois is *alea* (chance) and with *agon* these two words suggest that every player has an equal chance to win, for example, in gambling (Alderman, 1974).

In 1970, Abt defined game as an activity between two or more players trying to achieve a goal in some limiting conditions. Other scholars described the playing of games as an “exercise of voluntary control systems in which there is an opposition between forces, regulated by procedures and rules in order to produce a disequilibria outcome” (Avedon & Sutton-Smith, 1971, p. 405).

Games are activities “structures with rules, temporal and spatial limits, and acceptable behavior…providing opportunities for players to establish superiority over others and
environment” (Ridell, 1975, p. 32). Suits (1978, p. 41) defined games as “voluntary attempt to overcome unnecessary obstacles” bounded by rules, penalty and limits by time constraint. In addition, games are defined as activities governed by implicit rules, in which there is a voluntary contest between players or groups in order to produce a predictable outcome (win). Games are structured play with pre-set goals and rules that limits one’s freedom, space, and time (Morris & Stiehl, 1999). According to Maroney (2001), game is a form of play with goals and structure. A game is an art whereby players make decisions (rules) in order to manage resources through game in pursuit of a goal (Costikyan, 2002). Lastly, game is a system, where players sometimes engage in an artificial conflict, defined by rules that result in a quantifiable outcome (Salen & Zimmerman, 2003). Table 1 summarizes commonly used definition of game in literature.

Table 1

<table>
<thead>
<tr>
<th>Scholar(s)</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avedon and Sutton-Smith (1971)</td>
<td>Voluntary participation, a conflict between forces, regulated by rules, objective to produce a disequilibria outcome (climax).</td>
</tr>
<tr>
<td>Suits (1978)</td>
<td>Voluntary attempt to overcome unnecessary obstacles limited by rules, penalty and time constraints.</td>
</tr>
<tr>
<td>Morris and Stiehl (1999)</td>
<td>Activities governed by rules, voluntary contest to produce unpredictable outcomes (win), structured with pre-set goals, limitation of freedom, space, and time.</td>
</tr>
</tbody>
</table>

**Elements and characteristics of games.** Bancroft (1949) proposed that games possess certain core elements: (a) formation (e.g., circle form, line form, or opposing group); (b) mode of contest (individuals or teams); (c) skill in play (e.g., speed, strength, agility, reaction time, loco
motor skills, fine skills, memory, or combination); (d) methods of determining victory (e.g.,
tagging, wrestling, miss a ball, etc.); (e) element of concealment, chance, or guessing, and (f)
combination of any core elements.

Caillois in his book *Les jeux et les hommes*, which was later translated to English titled
*Man, play and games* (1961), suggested six core game elements: free or voluntary, unproductive
activities (i.e., creates no wealth and ends as it begins), separate (i.e., from normal routine of life),
uncertainty (i.e., outcome is unpredictable), governed by rules, and is fictitious or make believe.
While, Robert, Arth, and Bush (1959) described game as a recreational activity that consists of
organized play or competition between two or more sides, whereby criteria for determining a
winner is based upon pre-set rules.

**General classification of games.** Although there are many ways to classify games, three
of the earliest and most commonly accepted classifications of games are introduced below.

Caillois (1961) classified games into four categories and two attitudes. The four categories are
*agon* (competition), *alea* (chance), *mimesis* (mimicry) and *ilinx* (vertigo), while attitudes
normally exist in the form of *paidia* (frolic) and *ludus* (concentration). For example, (a) poker
games feature both *agon* (strategic decisions of discarding cards and betting) and *alea* (the
random shuffling of cards); (b) collectable card games, for example, the Pokemon card game
combine *alea* (random shuffling and distribution of cards), *agon* (competition) and *mimesis*
(cards referring to imaginary beings players control in an imaginary world); (c) pin the tail of the
donkey is a combination of *ilinx* activity which combined with *mimesis* to portray characters
(donkey), or with *agon* (competition between groups). Multiple categories/forms sometimes exist
in a single game as shown in Table 2.
Table 2

Caillois classification of games

<table>
<thead>
<tr>
<th>Type of games</th>
<th>Agon (competition)</th>
<th>Alea (chance)</th>
<th>Mimecis (mimicry)</th>
<th>Ilinx (vertigo)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>PAIDIA</em> noise agitation laugher</td>
<td>Not regulate</td>
<td>counting out rhymes heads or tails</td>
<td>childish imitation mask costumes</td>
<td>swings merry-go-round teeter totter waltz outdoor sports</td>
</tr>
<tr>
<td>dance hoop solitaire games of patience crossword puzzles</td>
<td>boxing fencing football checkers chess</td>
<td>betting roulette</td>
<td>theatre</td>
<td>skiing mountain climbing</td>
</tr>
<tr>
<td><strong>LUDUS</strong></td>
<td></td>
<td>****</td>
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<td></td>
</tr>
</tbody>
</table>

**Note.**

- a. PAIDIA (frolic) element constantly decreases,
- b. LUDUS (concentration) element constantly increases.

From *Man, play, and games* by Caillois (1961).

Table 3

Games classification

<table>
<thead>
<tr>
<th>Type of games</th>
<th>Elements</th>
<th>Skill</th>
<th>Strategy</th>
<th>Chance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Required</td>
<td>Possible</td>
<td>Possible</td>
</tr>
<tr>
<td>Skill</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strategy</td>
<td></td>
<td>Absent</td>
<td>Required</td>
<td>Possible</td>
</tr>
<tr>
<td>Chance</td>
<td></td>
<td>Absent</td>
<td>Absent</td>
<td>Required</td>
</tr>
</tbody>
</table>

**Note.** Adapted from *Games in Culture* by Roberts, Arth, and Bush (1959).

On the other hand, Roberts, Arth, and Bush (1959) classified PA games based on three elements: (a) physical skill, (b) strategy, and (c) chance. Roberts and colleagues (1959) suggested that some outcomes are determined primarily by the physical abilities of the players (e.g., skill, strength) or by a series of strategic moves (strategy), each of which represents a player’s choice among alternatives, and other moves are made either by non-rational guesses.
(chance) or by reliance on the operation of mechanical chance devices such as a dice. However, some are determined by combinations of these elements as shown in Table 3. For example, in a strategy type of game such as chess, the element of physical skill is normally absent and may or may not include element of chance. However, to qualify as a strategy game, the element of strategy is required, which is what chess is about.

**Classification of games in physical education.** In the 1970s and 80s the idea to classify games based on a framework to assist selecting and teaching games were initiated to promote a well-balanced and standardized curriculum. In the 1980s the effort to classify physical education games was championed by Mauldon and Redfern (1981), Ellis (1983), and Thorpe, Bunker, and Almond (1986). In the book *Developmental physical education for all children*, Gallahue and Cleland-Donnelly (2003) discussed a few types of PE game classifications: For example, Games for understanding classification (Werner & Almond, 1990), Core content games classification (Allison & Barrett, 2000), and Developmental games classification (Gallahue & Cleland-Donnelly, 2003).

The Games for understanding classification system (Figure 2) focused on a few core elements such as body management (BM), equipment-handling skills (EH), and motor skills (MS) that are required in playing certain games (Werner & Almond, 1990). This classification system is widely used in the United Kingdom and British Columbia (Hopper & Bell, 1999). Games are grouped into four main categories: (a) Target games which include essential BM, MS, and EH skills, for example: bowling, darts, archery, golf, or lawn bowl; (b) Net or wall games which include essential BM and MS skills (e.g., running, jumping, and guarding) and essential EH skills (e.g., throwing and catching), for example: tennis, squash, racquetball, or volleyball; (c) Invasion or territory games which include BM skills and MS skills (e.g., running, jumping,
turning, and guarding) with essential EH skills (e.g., throwing, trapping, retaining), for example: ice hockey, basketball, soccer, football; and (d) Striking or field games which include essential BM and MS skills (e.g., running, jumping, turning, and guarding) with essential EH skill (e.g., throwing and catching), for example: cricket, baseball, or softball.

Allison and Barrett (2000) introduced the Core content games classification system (Figure 3) that categorized games around four broad interrelated content areas: (a) games form, conventional games, or current existing games (e.g., basketball or soccer), and original games:

**Note.** Adapted from *Models of game education* by Werner and Almond (1990).

**Figure 2.** Games for understanding classification.

**Note.** Adapted from *Constructing children's physical education experiences* by Allison and Barrett (2000).

**Figure 3.** Core content of games classification

Allison and Barrett (2000) introduced the Core content games classification system (Figure 3) that categorized games around four broad interrelated content areas: (a) games form, conventional games, or current existing games (e.g., basketball or soccer), and original games:
traditional or games created by teachers, children, or both; (b) movement skills (e.g., locomotor, stability, and manipulative); (c) movement concepts (e.g., body, space, effort), relationships (movement awareness), and game tactics; and (d) game criteria. A more recent games classification by Gallahue and Cleland-Donnelly (2003) suggested that Developmental progression approach is part of an overall educational strategy of applying, reinforcing and implementing sports skills to fit and enhance children’s developmental readiness for such activity (Figure 4).

<table>
<thead>
<tr>
<th>Developmental Level IV (Official Sports Games)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Involved official team sports, dual sports, and individual sports</td>
</tr>
<tr>
<td>- Sports governed by a set of rules by an official governing body</td>
</tr>
<tr>
<td>- Not appropriate for the instructional physical education program</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Developmental Level III (Lead Up Games)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Use combinations of motor skills and or movement concepts</td>
</tr>
<tr>
<td>- Use two rules of official sports</td>
</tr>
<tr>
<td>- Employ slightly more complex strategies</td>
</tr>
<tr>
<td>- May involve skill challenge games (e.g., how far, how fast)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Developmental Level II (Complex Games)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Also known as small sided games (e.g., six aside soccer, three-on-three basketball)</td>
</tr>
<tr>
<td>- Majority of the official sport rules used</td>
</tr>
<tr>
<td>- Several motor skills and movement concepts involved</td>
</tr>
<tr>
<td>- Required certain degree of physical fitness</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Developmental Level I (Low-level Games)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Use limited or no equipment</td>
</tr>
<tr>
<td>- Easily perceived boundaries</td>
</tr>
<tr>
<td>- Employ limited rules</td>
</tr>
<tr>
<td>- Focus on single skills or movement concepts</td>
</tr>
<tr>
<td>- Are playable by one person alone or by a small group (three)</td>
</tr>
<tr>
<td>- Emphasize low level competition</td>
</tr>
<tr>
<td>- Involved fundamental movement skills</td>
</tr>
<tr>
<td>- Utilized one or two game strategies</td>
</tr>
</tbody>
</table>

Note. Adapted from Developmental physical education for all children by Gallahue and Cleland-Donnelly (2003).

Figure 4. Development games classification.

The importance of games. According to Morris and Stiehl (1999), many basic and important physical and non-physical skills are acquired through child play and games. Development of these basic skills is vital to help children develop physically and perform more
complex tasks later in life. Basic locomotor (e.g., running, jumping, throwing, catching, reflexes respond) and social skills (e.g., communication, teamwork and conflicts adaptations) learned through game play might help children to function more efficiently. Even though there is no universal agreement when it comes to the benefits of PA games, Morris and Stiehl (1999) believe PA games contribute richly towards character development, self-esteem, overall well-being, delinquency reduction, and possibly leadership development later in life. Play is not only an enjoyable and spontaneous activity but also contributes extensively towards a child’s mental, physical, and social growth (Verenikina, Harris & Lysaght, 2003). Children ages six years or younger generally do not prioritize winning, nor care about game rules.

Table 4

<table>
<thead>
<tr>
<th>Stages of play</th>
<th>Stage 1 0-2 years</th>
<th>Stage 2 2-5 years</th>
<th>Stage 3 6 years &amp; above</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Imitation</td>
<td>Symbolic Play</td>
<td>Games with rules</td>
</tr>
<tr>
<td></td>
<td>1. Use of reflexes</td>
<td>1. Play that distorts reality; pretend; pure assimilation</td>
<td>1. Institutional, hide and seek, hopscotch</td>
</tr>
<tr>
<td></td>
<td>2. Repetition of sounds and movements</td>
<td>2. Implies representation of absent object</td>
<td>2. Board games</td>
</tr>
<tr>
<td></td>
<td>3. Beginning of symbolic imitation</td>
<td>3. Parallel play</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Practice and mastery</td>
<td>4. Compensatory play</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Sensory play-tasting, smelling, making sounds</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Ritualistic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Simple make-believe</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. From The house of make-believe by Singer and Singer (1990).

Singer and Singer (1990) proposed three stages from play to games to illustrate the process of children’s physical and mental development shown in Table 4. As children outgrow these stages physically and mentally at 7-12 years of age, their mental development enables them to comprehend simple rules, leading to more complex play, and slowly evolving into a game...
(Bancroft, 1949) in Table 5. This explained why younger children (Grade 2) are less likely to comprehend and adhere to game rules compared to children in Grade 5 as revealed later in the PA games videos.

Table 5

<table>
<thead>
<tr>
<th>Age, skills development, and games</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>6-7 years</strong></td>
</tr>
<tr>
<td>1. Games involve lots of repetition, music/singing, impersonation/ imagination (e.g., animals), but requires minimum skills.</td>
</tr>
<tr>
<td>2. Games achieved climax easily, slight attention, and has few rules except taking turns.</td>
</tr>
<tr>
<td><strong>8-10 years</strong></td>
</tr>
<tr>
<td>1. Start to understand simple rules and different possible modes of play, risk taking, and begins to develop courage.</td>
</tr>
<tr>
<td>2. ‘Nominees’ hurled defiant challenges at opponents.</td>
</tr>
<tr>
<td>3. Individual initiative instead of waiting for his/her turn begins.</td>
</tr>
<tr>
<td>4. Players band together in many games (choosing sides).</td>
</tr>
<tr>
<td>5. Neuromuscular, agility, and endurance skills increase.</td>
</tr>
<tr>
<td><strong>11-12 years</strong></td>
</tr>
<tr>
<td>1. Tendency for ‘nominees’ and simple game of chasing (tag game) declines.</td>
</tr>
<tr>
<td>2. Closer group organization or team play, cooperation takes precedence.</td>
</tr>
<tr>
<td>3. Children learn distribution of duty (all working together for a common goal e.g., winning)</td>
</tr>
<tr>
<td>4. Environment of play demands perceptive power and rapid reaction to shifting conditions, quick thinking, reasoning and judgment.</td>
</tr>
</tbody>
</table>

*Note. From Games by Bancroft (1949).*

**Games and culture.** Many play activities were recorded in ancient times in China (4000 BC), Egypt (2000-3000 BC) and Greece (2700-1450 BC) resemble our modern play and games, and many scholars acknowledged the importance of play, especially during childhood (Gascoigne, 2001). Most times, play, games, and sports transcend cultural barriers and foster goodwill and friendship within and between social groups or even countries that are geographically far apart. For example, in the 15th and the early 16th century Malaya (now Malaysia), which was strategically located along the middle trade route between the East (e.g., China, Japan, Thailand, India) and West (e.g., Portugal, Holland, Britain, Spain) was a major stopover for many merchants. Not only did foreign merchants sell their trades, they brought...
along their language, culture, religion, and shared their traditional pastime activities with local Malaysian including games.

As a result, Malaysia is blessed with many unique games due to the influence of foreign merchants and visitors. Some of the more popular children games are kite-flying, spinning tops, congkak, sepak trakraw, marbles, hopscotch, and many other games. For the purpose of this study, ten Malaysian children’s games (e.g., One-Leg, Kali-Tui, Blind man’s bluff, Simon says, Eagle and hen, Hopscotch, Police and thief, Duck duck goose, Monkey in the middle, and Mr. Wolf) are described in detail in Chapter 3.

In summary, games are voluntary and structured activities governed by agreed upon rules. Limited by constraints of space and time, they engage between individuals and or groups with a predetermined goal leading towards climax (victory). Occasionally, games might involve certain forms of penalty for defeat or violation of rules. Rules can be used as an agent of change in games and are often used as tools to teach, discipline, and socialize children. Alderman (1974) pointed out that sometimes society use games as an instrument to nurture, civilize, and instill upon younger generations the importance of abiding by the rules and regulations.

**Play**

**Play and game.** Although scholars, physical educators, philosophers, sociologists, and psychologists often defined play differently based upon on their professional field of studies but the core-characteristics of play are in general well-preserved and agreed upon. In the book *Homo ludens*, Huizinga (1955) defined play as:

Play is a free activity, experienced as make believe, and situated outside of everyday life, nevertheless capable of totally absorbing the player, an activity entirely lacking in material interest and in utility. It transpires in an explicitly circumscribed time and
space, is carried out in an orderly fashion according to given rules, and gives rise to group relationships which often surround themselves with mystery or emphasize through disguise their difference from the ordinary world. (p. 34-35)

Huizinga (1955) identified five major characteristics of play: (a) free, (b) not ordinary, (c) distinct from ordinary life both in locality and duration, (d) creates order, and (e) connected with no material interest and no profit.

Play is usually spontaneous, not predetermined, and is subjected to individual impulse, unorganized with no fixed rules, no formal mode of procedure, and with no climax to achieve (Bancroft, 1949). More play concepts were further discussed by Brian Sutton-Smith (1997) in *The ambiguity of play*. Sutton-Smith suggested seven play concept and rhetoric, (a) progress, (b) fate, (c) power, (d) identity, (e) imaginary, (f) self, and (e) frivolity.

Rhetoric play activities can be related to some relevant patterns of play as highlighted on the National Institute for Play’s website (“National,” n.d.) as “attunement play, body play or movement, object play, social play, imaginative play, storytelling-narrative play, and transformative-integrative play and creative play.” Play is spontaneous, self-initiated, and self-regulated activity which is comparatively low in risk and not inevitably goal oriented. Play intrinsically motivates individuals, especially children, to develop an internal desire and interest to engage in play activities, to be actively involved in creating their play and to be in control of it, meaning that children can stop play at will (Leontiev, 1981; Nikolopolou, 1993).

Play sometimes refers to voluntary, intrinsic or extrinsic motivated activities that are more often than not, associated with pleasure and enjoyment (Garvey, 1990). According to Garvey, play may consist of amusing pretense or imaginary interpersonal and intrapersonal
interactions. Play may take different forms and is closely linked to cognitive development and socialization processes, especially among young children.

Generally, play neither exhibits a clear goal, rule, nor clear structure. However, when play starts to involve obvious defined goals and somewhat administer with stricter rules, play will instantaneously transform into game. Although Garvey (1990) agreed with Leontiev (1981) that the core motivation of play might be intrinsically motivated, Garvey insisted that play can sometimes be extrinsically sustained.

Hence the relationship between play and games is that, play is voluntary, unstructured, with no predetermined goal but when play becomes more structured with rules, with certain restriction in terms of time, space, and a predetermined goal to achieve (victory), play transforms into a game. In short, a game is a unique part of the play with structured (rules) and a determined goal.

**Elements and characteristics of play.** Morris and Stiehl (1999, p. 8) illustrates play as “enjoyable, sometimes serious, voluntary activity that participants consider to be apart from the external world.” Play is “enjoyable” because it is mainly engaged in for the sake of having fun. Play is “serious” because it provides an avenue to display and enhance one’s skill. Play is “unreal” because at times children are transported into an imaginary world during play. Morris and Stiehl claimed that individuals sometimes play to “lose” themselves (relaxation), but oddly enough some individuals “find” themselves through play (p. 8).

Elements of play can be summarized but not limited to physical activity that is spontaneous, unorganized with no fixed rules, voluntary, self-initiated, and self-regulated physical activity, mostly intrinsically motivated, closely related to enjoyment and fun, sometimes imaginary (unreal), not predetermined, and subject to individual impulse with no pre-planned
climax or ending (Table 6). Further explanation on play will be described under theories and models of play.

**Theories and Models of Play and Games**

Due to the non-existence of physical activity game theory, and the close connection and progression between play and games, the following discussion will adopt theories of play as the theoretical framework of the study. Theories of play enable us to understand the role of play in child development and the ways in which children are able to develop meaning through play and games. Classical and contemporary theories of play have identified many ways in which play may affect children’s wellbeing and advancement of their cognitive, social, and emotional development (Vygotsky, 1977). As they grow, children acquire physical skills, self-reflection, abstract thinking ability, communication skills, emotion management, role play exploration, and understanding of common rules of functioning in adult society. Many socio-cultural and sport pedagogy experts believe the overarching role of play and games is one of the most significant activities of early childhood development (Bodrova & Leong, 1996).

Table 6

**Definitions of play**

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Definition and elements of play</th>
</tr>
</thead>
<tbody>
<tr>
<td>Huizinga (1955)</td>
<td>Non ordinary or distinct from ordinary life, creates order, no material interest and no profit gained from it.</td>
</tr>
<tr>
<td>Bancroft (1949)</td>
<td>Spontaneous, not predetermined, subject to individual caprice, unorganized, no fixed rules, no formal mode of procedure, no climax to achieve.</td>
</tr>
<tr>
<td>Garvey (1990)</td>
<td>Voluntary, intrinsic or sometimes extrinsic, associated with pleasure and enjoyment, pretense/imaginary, not confined to human.</td>
</tr>
<tr>
<td>Leontiev (1981) and Nikolopolou (1993)</td>
<td>Spontaneous, self-initiated, self-regulated, not goal oriented, player in control when to play and stop.</td>
</tr>
</tbody>
</table>
Classical Theories of Play and Games

The era of classical play theories dates back to the late nineteenth century when most classical theorists based their scholarship of play on perspectives of physicality and instinct (Dockett & Fleer, 1999; Verenikina, Harris, & Lysaght, 2003).

**Surplus energy theory.** Schiller (1875) a German philosopher pioneered the classical theories of play proposed Surplus Energy Theory (SET). Schiller considered play as “aimless expenditure of exuberant energy” (Schiller, 1875 in Dockett & Fleer, 1999, p. 24). Children play because they have excess energy. In contrary, adults’ finite amount of energy is channeled toward the two most fundamental yet important activities in life; work and survival. Schiller (1875 in Dockett & Fleer, 1999) proposed since most children do not work nor are burdened with survival activities, children possess a greater surplus of energy and time that enable them to play more than adults. Children discharged this excess energy in the form of play or games until energy balance is restored. Although SET acknowledges the role of play as a holistic human activity, it focuses extensively only on the physicality aspects of play (Dockett & Fleer, 1999).

**Recreation theory.** In the contrast to the Surplus Energy theory, other play theoreticians such as Lazarus (1883), and Patrick (1916) argued that play is commonly used to restore energy in what they called the Recreation or Relaxation Play Theory. Recreation theorists suggest that play serves to regenerate energy that was spent working or completing daily activities.

**Recapitulation theory.** In 1904, Gulick proposed a theory called the Recapitulation Theory. Gulick (1904) argued that the individual and its character are established through interpersonal relations and that values are a collective phenomenon to a large extent.
Gulick believed in the role of play and other social activities in nurturing team spirit, team bonding, and team work. In line with the Recapitulation Theory, Hall (1906) stressed that during play and games, children relive their evolutionary past. For example, children sometimes engage in an “animal stage” of evolution by climbing, swinging, or rolling on the floor. Hall also pointed out that play provides the perfect platform for children to freely express their aggressive or animal-like instincts and by playing it weakens the urge (animal instinct). For example, children who engage in fake sword fighting will eventually weaken their drive to fight as an adult, and Hall believed this behavior will fade out as children mature (Hall, 1906).

**Alternative classical theory.** In contrast, Alternative Classical Theory (ACT) distances itself from the physical aspect of play. Groos (1898/1901) suggested that play prepares children for adulthood by helping children develop their physical and mental capacities that will be useful in later life. ACT focuses on play types other than physical play, for instance, children pretending to be adults donning adult roles (e.g., doctor, fireman, mother). Groos insisted that ACT theory focused on the intellectual or cognitive benefits of play. On the same line of thought, Dewey (1910/1916) defined play as a form of preparation or subconscious activity that helps an individual develop both mentally and socially. However, Dewey suggested that play should be separated from work as play facilitates a child growth and maturation into the working phase of life. When children become young adults, they slowly cease playing but seek pleasure from their working life or occupation. Dewey believes play prepares children to become a healthy, socially functional, working adult.

In short, classical theories of play are seen as the “stepping stone” towards understanding child’s play. In doing so, the importance of childhood play is acknowledged and foundations were laid for further advances as evidence later in contemporary theories of play.
Contemporary Theories of Play

The philosophical thinking of later classical theorists, especially from the early 20th century, influences contemporary theorists which switched their focus from the physical domain (classical) to the psychological domain of play. Current contemporary theories greatly influence many early children programs at pre- and elementary-school levels and are used as a resources to nurture child development across various domains.

*Psychoanalytic theory.* One of the famous contemporary theories is psychoanalytic theory that focuses on the emotional domain of development pioneered by Freud (1959) and later Erikson (1963). Psychoanalytic theory explained the concept of play in terms of catharsis (therapy or emotional release). In his book, *Beyond the pleasure principle,* Freud (1920) described play as a child’s mechanism by repeatedly working out a previous traumatic experience in an unconscious effort to correct, adjust, eventually mastered the event to his/her satisfaction. Psychoanalysts suggest that play provides a safe platform to express these negative emotions (traumatic experiences) and in the process, gain a sense of control. Psychoanalysts believed that repetition of play is vital so that children can replay the same situation time and again in the process of “mastering” their stressful or negative experiences.

*Arousal theory.* The Arousal Modulation theory is another popular contemporary theory based on behaviorist stimulus-and-response. According to Arousal theory, play is a medium to balance a child’s excessive arousal (Berlyne, 1960; Ellis, 1973). Arousal theory proposed that play can either increase or decrease a child’s levels of arousal depending on whether the child is under- or over-stimulated. Through play, children are presented with unique, uncertain, and complex experiences at optimal levels that are believed to be conducive for future individual functioning.
Ellis (1973) added that play is caused by the need of an individual to be in a state of optimal arousal. Ellis cites Schultz who called the process sensoritis or drive. Ellis (1973) went on to suggest that stimulus seeking and play have much in common. Both activities involve discovery, investigation and manipulation of the play environment or play experience. “Play is clearly stimulus seeking behavior yet not all stimuli seeking behavior is play” (Ellis, 1973, p. 93). Ellis defined play as “the behavior that is motivated by the need to elevate the level of arousal towards optimal” (Ellis, 1973, p. 93). He then defined work as the behavior to reduce the level of stimulation. Stimulus seeking activity may be dispelled by other needs in life (e.g., work) or the fear of punishment. In real life, “pure play” can only occur when all extrinsic consequences are eliminated, whereby play behavior is solely motivated by intrinsic motivation. Hence a pure form of play probably only exists theoretically.

**Behaviorist theory.** Role playing is another important aspect of play, although it is not directly related to physical activity. Children often mimic the roles of others (mimicry) for example a mother, policeman, or doctor during play. Mead (1934) viewed role play as an important platform to develop children’s sense of self. Many behaviorist studies found that dramatic play in children allows them to explore the roles and rules of functionality in an adult’s world.

**Drive reduction theory.** Behavior theorist, Hull (1940), introduced the Drive Reduction Theory (Stimulus Response Theory). Drive theory integrates secondary reinforcement to explain the motivation to play. Primary and secondary drive reductions are what that motivates child play. Hull posits children often learn quickly to associate good performance/behavior with results in recognition, praise, or even bring prestige from adults and peer groups. Berlyne (1954/1960) proposed exploratory play behavior as an attempt to reduce
conflict within the individual by acquiring more information about his/her environment. The attractions to novelty, changes, or uncertainty in one’s environment drive children towards exploration play. Children will receive positive feedback from his/her actions, and experience a feeling of self-efficacy or self-competence by exhibiting a high level of competency with one’s physical and social environments (White, 1959). In general, society strives towards success and getting ahead of others and play is by far no exception. Many parents perceive play activities as a vessel to success or stardom as evident in many organized sports for children (e.g., mini league). As a result, the drive for excellence play or performance becomes an end product and outweighs the “means.”

**Cognitive development theory.** Piaget (1962) diverted his attention from social and emotional play concepts to cognitive development. Piaget conceived play in cognitive development through two sub-processes; assimilation and accommodation. Assimilation is the use of previously learned information to make sense of a new environment; while accommodation is readjusting one’s previously learned information to fit the new information or environment. During child’s play, Piaget argued that assimilation is dominant as children tried to make sense to what they know or assimilate with; for example, a stick as a sword or gun. Piaget delineated the significance of symbolic play in cognitive development and abstract thinking, which was later developed into socio-cultural theories of play (Leontiev, 1981; Vygotsky, 1978). Stages of child development is one of Piaget’s most famous contributions to cognitive development theory. These stages are directly related to play; as children get older their intellectual growth goes through stages of assimilation (manipulating), meeting their needs through playacting, and accommodation or readjusting views/thoughts to conform to the needs of social circles, work or new environments.
Socio-cultural theory. Vygotsky (1977/1978) proposed play as a highly significant activity contributing towards personal development. “Play contains in a concentrated form, as in the focus of a magnifying glass, all developmental tendencies (Vygotsky, 1978, p. 86).” Vygotskians viewed play as the most significant activity of early childhood years (Bodrova & Leong, 1996; Vygotsky, 1977). According to many Vygotskians, engaging in social play induced significant psychological achievements during early childhood. Vygotsky (1978, p. 86) coined the notion “Zone of Proximal Development (ZPD).” ZPD defined what a child can achieve alone, with, and without the assistance of an adult. Play is believed to create a broader zone of proximal, cognitive, and socio-emotional development (Vygotsky, 1978). Vygotskians believe children sometimes perform above their own cognitive abilities (i.e., logical thinking, memory, and attention) when they engaged in imaginative play. In a make-believe play mode, their ability for deliberate behavior and self-regulation is at a level beyond their everyday norm.

Vygotsky (1978, p. 79, 91) introduced another terminology known as “pretence.” In pretence type of imaginative play, children substitute things and acts for example substituting a stick (pivot) as if it is a riding a horse. While in pretence mode, children transform the literal meaning of an object into an imaginary form, leading toward the start of abstract thinking (Vygotsky, 1978). As a true social culturist, Vygotsky strongly believed that make-believe play is socially and culturally determined for example playing the roles of real-life characters (e.g., a mother, soldier, or fireman) children achieve a mental representation of social roles and the rules of society. The association of props and gestures in which the real-life characters are associated with is seen as a significant and meaningful artifact in their social and cultural settings. Pretence is evidence in the games that will be played later in this study in the case of Eagle and hen, whereby players pretend to be either eagle, hen, or chicken.
In summary, different play theories highlighted different but equally important theoretical concepts on play, however, there is no one dominant theory that can rightfully be claimed as the most influential in understanding and interpreting play. Children’s and adolescents’ desire to play is influenced by a combination of their physical, physiological, cognitive, and social needs. The paradigm shifts from classical theories (instinct and physical development) to more contemporary theories (cognitive and social development) reflect the progression of beliefs and thoughts of scholars of their time, which not only affects the studies of play, but extends to other areas of scientific research. Currently, studies of play have branched out in even more directions; aspects of the classical and contemporary theories are still imperative and remain the core theories in understanding play.

**Sports**

**Games and Sports**

Loy (1968, p. 1) commented that sport is best discussed as “an institutionalized game, social institution or as a social system.” Loy (1968, p. 1) went on to define sports as “any form of playful competition whose outcome is determined by physical skill, strategy, or chance employed singly or in combination.” In general, most games require minimum skill. On the other hand, most sporting activities require physical and mental skill at the maximum. Hence, Loy (1968) summed that the more organized a game becomes, the more it becomes a sport.

The following elements and definitions are by no means exhaustive and are proposed by various scholars to define sport. Sport is “a challenge taken on before the assembled crowd” (Jeu, 1972, p. 163); “a systematic effort for the domestication of one’s own body and any free open-air activities” (Jeu, 1972, p. 151); “an art form of kinetic play, most frequently developed within a context of the broader-ranging social play forms” (Carlton, 1975, p. 18); “physical exercises
leading to all-round development, practiced by the masses and marked by high motoric tensions and the resulting effort” (Ponomarev, 1974, p. 122); “the habitual cult of intensive muscular exercise based on the desire for progress and capable of going to the point of risk” (Groves, 1972, p. 34); “any activity... engaged in for personal excellence and its reward” (Luschen, 1968, p. 51); “a form of game which can be described as a voluntary satisfaction of non-material needs of an individual in physical and aesthetic activity in the form of a creative, socially meaningful activity” (Ponomarev, 1974); “a distorted frame of play and a tool for titillation” (Ingham & Loy, 1974, p. 50-51); and “a secular, quasi-religious institution” (Edwards, 1973, p. 21). Meier (1995) summed it up:

...all sports are indeed games. That is, a game may also correctly be termed a sport if it possesses the additional characteristics of requiring physical skill or prowess to be demonstrated by participants in the pursuit of its goal. (p. 31-32)

The two major elements that were highlighted by Meier (1981) in defining sport are physical prowess and institutionalization. The characteristics of physical prowess in sports were mentioned by other scholars with introduction of terminologies such as physical exercise, “kinetic ability” (Ibrahim, 1975, p. 37), or “kinetic play” (Carlton, 1975, p. 18). Edwards (1973, p. 55) goes on to stress that “…without physical exertion there is simply no sport activity.”

Institutionalization of sport refers to imposing external governance and regulation upon previously more internally regulated sports activities (Watson, 1976). Gruneau (1975) and Ingham (1975) characterized the institutionalization of sports as a widespread formalization, regulation, rationalization, professionalization, and bureaucratization event. Another group of sports scholars suggested as spontaneity and freedom of expression progressively decreases,
formalization, regulation, achievement orientation, habituation increases, and finally becomes institutionalized (Edwards, 1973; Gruneau, 1975; Ingham, 1975).

On the other hand, Zurcher and Meadow (1970) proposed that there might be a legitimate continuum between play, games, and sports. Sports apparently start from aimless, repetitive basic play movements, progressively becoming more challenging and rule regulated (i.e., games) to the highest degree of formality and complexity as seen in organized sport. However, another group of scholars argued against the concept of sports continuum. Roochnik (1975, p. 36) proposed that “sport is a genus of which games are species”, while Mercer (1975, p. 4) pointed out that “… that all sports are games however we cannot say that all games are sports.” Thomas (1976, p. 37) concurred that “although sports and games often overlap, neither can be realistically posited as a subset of the other; in short, not all sports are games and not all games are sports” (Figure 5).

Two other attractive concepts were proposed, the element of motivation and work to explain the relationship between play, game sports and intrinsic or extrinsic rewards derived through participation determine the location of sports activities on the continuum (Figure 6). An additional terminology “work” is added to assist the understanding of this proposal. The more an activity is driven by extrinsic rewards (e.g., money, rewards) the more the activity tends to be work; the less it is externally motivated (intrinsic motivation e.g., enjoyment, fun) the more it tends to be play (Figure 6). From sports psychology point of view, Meier (1978) claimed that if sports are voluntarily pursued for intrinsic reasons, they are play; however, when sports are pursued purely for extrinsic rewards they are work or a livelihood (e.g., professional sportsman).
In summary, the definition of sport is inconclusive and is open to future scholastic debate, thus providing a potential source of future studies. However, our discussion on play, games, and sports requires a discussion of how electronic games have transformed the meaning of play and games.

**Games and Computer Games**

Prior to the late twenty century, the study of physical activity (PA) games was uncommon until the early 1900s. Culin (1907) was one of the earliest PA game scholars to compile a comprehensive catalog of gaming and PA games of Native American tribes in northern Mexico. Later, Huizinga (1955) and Caillois (1961) explored the importance of games and play as a basic human activity that helps define PA game studies. However, in the early 1980s when the video game revolution started, video games like Pac-Man (NAMCO) and Donkey Kong (NINTENDO) had redefined the word game and transformed leisure activities to
an entirely new perspective, “… something that would have been perceived as impossible if not somewhat magical a few decades before (Pesce, 2000, p. 170).”

As Sydnor (1993, p. 1) pointed out, these virtual and simulated sports and games called for a new “cultural adaptation” to the ever-changing world we live in. Sydnor (2001) added that we are experiencing tremendous changes in cyber technology in terms of websites, video/computer games, online virtual, simulation and cyber games. Many centuries ago, the goal of play and games were vastly different. Half decade ago, play activities were used as a tool for “enculturation”, or survivorship while cyber games (e.g., computer games) were predominantly aimed at creating entertainment or a leisure experience (Roberts, Arth, & Bush, 1959). Crawford (2003), a computer game expert and designer defined computer game as:

Computer games are considered an entertainment plaything if it is interactive, without goal associated with the plaything, it is just a toy...When a goal is present, the plaything becomes a challenge... However if a challenge has no active agent against whom player compete, it a puzzle and if there is a challenge involve it becomes a conflict...finally, if a player can outperform its opponent but not attack or interfere with opponent performance, the conflict is called a competition but if attacks are allowed, then the conflict qualifies as a game. (p. 8)

Crawford (2003, p. 8) summarized that computer games are “an interactive, goal-oriented activity with active agents (players) to play against, in which active agents can interfere with each other.” In line with this definition, Crawford further classified computer games according to the type of tools, confined by rules, nature of the game (e.g., skill, strategy, or chance), and number of players (i.e., single, double, groups).
Caroll (2003, p. 3) suggested another interesting analogy: “computer components, equipment or apparatus is the hardware; the rules (game) are the software, both define the computer game… both can exist independently from one another, but separately they are not a game.” Although computer games are a mere three decades in the making, the way they have developed and evolved in perfect synchrony with consumers’ need has much to teach us about how to “repackage” and evaluate traditional PA games to appeal to the younger generation.

In many industries, especially computer game developers, inspection methods are commonly employed to evaluate the potential of a product, system, or service (e.g., effectiveness and cost-efficiency). One of the most popular and widely used methods under the domain of inspection methods is the “heuristic evaluation” or “expert review method.” Hence evaluators’ experience and framework of knowledge is of high importance and will highly correlate with the quality of evaluation (Jacobsen, Hertzum, & John, 1998).

**Operant Definition**

A few related and fundamental operant terminologies in the field of computer games are defined in order to facilitate better understanding of heuristic evaluation:

**Usability.** In the field of human-computer interaction, usability can be defined as “the capability to be used by humans easily and effectively” (Shackel, 1991, p. 21, 22), “quality in use” (Bevan, 1995, p. 115), and “effectiveness, efficiency and satisfaction with which users experience in particular environments” (Hasiah & Azizah, 2010, p. 211).” Hence, usability is an umbrella term which includes a multitude of products and services even beyond the realm of computer science. In a more computer game context, usability is sometimes used interchangeably with the term playability.
**Playability.** Egenfeldt-Nielsen, Smith, and Tosca (2008) stated when computer games are easy to use, fun, and challenging at the same time then it is considered to possess a high playability rating. In general, the term playability can be summed up as the ease of play experience, or the duration that a game can be played; in short, the quality of gameplay. Hence, the element of playability is a vital heuristics component in evaluating computer game experience. Nacke and colleagues (2009) proposed a simple diagram to explain game playability based on the interfaces between players, game, and game design (Figure 7). Playability is directly connected to the game and the game design, while players experience is analyzed from the interaction between game and player. Good playability of a game should be the precondition for evaluating game experience (Nacke, Drachen, Kuikkaniemi, Niesenhaus, Korhonen, Hoogen, et al., 2009). Computer game designers highlighted several elements in game evaluations such as likeability, user friendliness, challenge, stimulate curiosity, enough control, challenging story (Fabricatore, Nussbausm, & Rosas, 2002; Malone, 1982; Payulayan, Keeker, Wixon, & Romero, 2003).

![Diagram](image)

*Note. Adapted from Playability and player experience research by Nacke et al. (2009).*

**Figure 7.** Relationship between design, computer game, and players

**Gameplay.** Gameplay is the interaction between player(s) with a particular computer game (Salen & Zimmerman, 2003) through its rules (Egenfeldt-Neilsen, Smith, & Tosa, 2008), connection between player and the game (Laramee, 2002), challenges (Adams &
Rollings, 2003) and overcoming challenges (Adams, 2006), game plot and the player's connection with it (Laramee, 2002). Often the game designer will seek to provide challenges for players through the design of game mechanics to hopefully be entertaining to players (Table 7).

Heuristics evaluation. Heuristic or heuristics refers to experience-based techniques in problem solving, learning, and discovery. According to Nielsen and Molich (1990), heuristic method is a universal engineering method used to speed up the process of finding a “good enough solution”, when an exhaustive search is impractical (i.e., in this dissertation, it would be impossible to study every children games around the world). In short, heuristics evaluation uses readily accessible expert views and experiences to assist in problem solving.

Table 7

<table>
<thead>
<tr>
<th>Definitions of gameplay</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Definition</td>
</tr>
<tr>
<td>Bjork and Holopainen (2005)</td>
<td>The structures of player interaction with the game system and with other players in the game.</td>
</tr>
<tr>
<td>Adams and Rolling (2003)</td>
<td>One or more causally linked series of challenges in a simulated environment.</td>
</tr>
<tr>
<td>Adams (2006)</td>
<td>…consist of the challenges and actions that a game offers: challenges for the player to overcome and actions that let her overcome them ... The essence of gameplay remains the relationship between the challenges and the actions available to surmount them.</td>
</tr>
<tr>
<td>Lindley, Nacke, and Sennersten (2008)</td>
<td>The experience of gameplay is one of interacting with a game design in the performance of cognitive tasks, with a variety of emotions arising from or associated with different elements of motivation, task performance and completion.</td>
</tr>
<tr>
<td>Nacke et al. (2009)</td>
<td>Gameplay is seen as the interactive gaming process of the player with the game.</td>
</tr>
</tbody>
</table>

Heuristics Evaluation

Heuristics is also defined as design guidelines which serve as a useful evaluation tool for both product designers and usability professionals (Desurvire et al., 2004; Nielsen, 1994). The
execution of heuristic evaluation involves a small number of evaluators inspecting a system, product or issues according to heuristics guidelines that are relevant to the product or object of interest (Nielsen & Molich, 1990). Thus, heuristic evaluation is a “minimalist” process that can be inexpensive, fast and easy to apply throughout an evaluation process (Hasiah & Azizah, 2010; Pinelle, Wong, & Stach, 2008).

**History of heuristic evaluation in computer games.** The study of computer game usability/playability in education was pioneered by Malone (1982). Later, Nielsen and Molich (1990) created a set of 249 general heuristics (guidelines) aimed to evaluate engineering software, a revised framework was republished in Nielsen’s (1994) book *Usability Engineering* to accommodate evaluation in other fields. Nielsen summarized evaluation heuristics into ten general principles for user interface: (a) visibility of system status, (b) match between system and real world, (c) user control and freedom, (d) consistency and standards, (e) error prevention, (f) recognition rather than recall, (f) flexibility and efficiency of use, (g) aesthetic and minimalist design, (h) help users recognize, (i) diagnose, and (j) recover from errors and help and documentation. Since then, a few groups of researchers have extended the original usability heuristics for different application domains. Based on Malone’s (1982) study, Clanton (1998) created a set of game design principles that can be applied to commercial computer games.

In 2003, Federoff combined Neilsen’s (1994) and Clanton’s (1998) studies to develop the first “computer games playability heuristics” framework based on game interface, game mechanics and game playability. In conjunction with Federoff’s work, another group of scholars, Fabricatore and colleagues (2002) studied players and their preferences that are believed to affect the playability of action videogames, which were indirectly corresponded with game heuristics.
Federoff (2002) worked on productivity and play testing heuristics that were structured to evaluate video, computer, and board games.

Later, Desurvire, Caplan, and Toth (2004) developed the Heuristic Evaluation for Playability (HEP), a comprehensive set of heuristics for playability, which is quite similar with Clanton’s (1998) work. Validated studies indicated that Desurvire and colleagues’ heuristics framework are useful at identifying playability issues in the early development phases with prototype or mock-up games especially when combined with the “user studies method”, HEP offers a new evaluation method for the HCI game community resulting in a more user-friendly and playable game. Desurvire and colleagues (2004) suggested that four major heuristic categories, gameplay, game story game mechanics and game usability, addresses the interface and encompass the elements the user utilizes to interact with the game (e.g., mouse, keyboard, controller, game shell, etc.).

In conjunction with the on-going development of playability heuristics, Korhonen and Koivisto (2007) published a playability framework for mobile games. The advantage of Korhonen and Koivisto’s (2007) framework is that their playability heuristics are applicable to evaluating games in other non-mobile platforms due to their general modular structure. Their playability heuristic set can be extended or limited based on the needs of the evaluation and are well validated in several studies. In addition, the number of the heuristics is smaller than in two previous sets by Desurvire and colleague (2004) or Federoff (2002).

More recently, Pinelle, Wong, and Stach (2008) published game usability heuristics that are based on 108 PC games reviews, developing12 problem categories which was later merged into ten usability heuristics. Their computer games heuristics are well-validated in a few preliminary studies involving evaluation of game usability (user interface). Other guidelines that
are targeted for game developers in order to make games more engaging and usable for the players are found in Snow (2007).

**Advantages of heuristics evaluation.** Many notable computer scholars recommend heuristic approach as inexpensive or cost efficient (Hasiah & Azizah, 2010; Nacke et al., 2009; Pinnelle et al., 2008), time saving (Hasiah & Azizah, 2010) so inspection can used iteratively during process design; easy to apply (Hasiah & Azizah, 2010) and can be applied iteratively in early stages of game development using a prototype or mock up (Desurvire et al., 2004; Korhonen et al., 2009; Pinnelle et al., 2008).

The heuristic approach is considered one of the more effective and efficient techniques to evaluate playability, especially by the computer games community (Korhonen et al., 2009; Nacke et al., 2009), since it does not need early user participation (user-testing) and can be successfully carried out with mock-up or prototypes (Fullerton, Swain, & Hoffman, 2004). Heuristic evaluation does not make assumptions about the task and purpose of an application, hence it give the evaluator freedom to decide how to conduct the study (Neilsen & Mack, 1994). Lastly, heuristics evaluation helps designers to identify important problems that are not always visible using user-testing approach (Jeffries, Miller, Wharton, & Uyeda, 1991; Karat, Campbell, & Fiegel, 1992).

Computer designer teams normally execute the heuristic method by using a “search tree” (Figure 8). The rationale being instead of generating all possible solutions, heuristic evaluation selects branches that are more likely to produce outcomes. This process consists of careful selection at each decision point, picking branches that are more likely to produce solutions (Newell & Simon, 1976).
However, heuristics evaluation is not without its limitation. For example, Johnson and Wiles (2003) argued that current heuristic studies disregard computer games experience in the more traditional usability heuristics. Their study led to many game designers and researchers to start incorporating a user interface (i.e., using real gamer to test prototype) and gameplay in future game heuristics development to assist game developers addressing playability issues.

While Cockton, Lavery, and Woolrych (2002) pointed out that heuristic evaluation does not encourage evaluators to take a comprehensive view on how computer games will be used, and that analyst must pick sample tasks and system features at random which could cause evaluators to miss problems and identify false problems (Desurvire et al., 2004). Desurvire and colleagues (2004) concluded that heuristics evaluation is best suited to use in early design iterations rather than as a summative evaluation technique. Another concern in heuristics evaluation as well as evaluation in other fields, is the practice of treating ordinal data as either interval or ratio data and the summation of data from different units that was used directly (without proper data treatments). From the perspective of testing and measurement, this is an undesirable practice yet, common. The basis of this malpractice and its consequences were discussed in the topic of rating scale construction.

![Figure 8. Search tree](image-url)
Measurement Theories and Rating Scale Construction

According to Zhu (1996), a rating scale contains ordered response categories and is one of the preferred measurement scales in the fields of exercise science (Kerner & Kalinski, 2002), motor development (Bailey, Burchinal, & McWilliam 1993; Folio, & Fewell, 1983) and physical education (Barkoukis, Rodafinos, Tsorbatzoudis, & Grouios, 2005). In general, a rating scale can be divided into two different formats, one of which being a summed rating scale (fixed) where all of the items share a common scale. The second format uses different scales (varied) for each grouping of items. The former is commonly used in motor skill assessment (e.g., basketball, badminton), while the latter is common in motor development assessment (e.g., gross motor function) as shown in Table 8.

Table 8
Type of rating scales

<table>
<thead>
<tr>
<th>Scale</th>
<th>Measurement</th>
<th>Scale Score</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed</td>
<td>Badminton *</td>
<td>1</td>
<td>Below average ability (perform below ability of children of the same age and sex).</td>
</tr>
<tr>
<td>(Service)</td>
<td></td>
<td>2</td>
<td>Average ability (typical performance of children of the same age and sex).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>Above average ability (perform well above children of the same age and sex).</td>
</tr>
<tr>
<td>(Smashing)</td>
<td></td>
<td>1</td>
<td>Below average ability (perform below ability of children of the same age and sex).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Average ability (typical performance of children of the same age and sex).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>Above average ability (perform well above children of the same age and sex).</td>
</tr>
<tr>
<td>Varied</td>
<td>Locomotor b</td>
<td>1</td>
<td>Take off on one foot and land on the opposite foot.</td>
</tr>
<tr>
<td>(Leap)</td>
<td></td>
<td>2</td>
<td>A period where both feet are off the ground longer than running.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>Forward reach with the arm opposite the lead foot</td>
</tr>
<tr>
<td></td>
<td>(Catch)</td>
<td>1</td>
<td>Preparation phase where hands are in front of the body and elbows are flexed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Arms extend while reaching for the ball as it arrives.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>Ball is caught by hands only.</td>
</tr>
</tbody>
</table>

Note. * Adapted from Measurement for evaluation in physical education and exercise science by Baumgartner and Jackson (1995)

b Adapted from Test of gross motor development by Ulrich (1985).
Although studies on physical activity rating scale construction were well-established (Baumgartner & Jackson, 1995; Safrit & Wood, 1995), Zhu (1996) was surprised that not much effort has been taken to determine proper procedures to analyze a rating scale. Consequently, many rating scales are treated as either interval or ratio scales resulting in summation of total score (all responses) and used directly. Zhu (1996) cautioned that this common practice might be statistically inappropriate. Since the main purpose of this study was to develop and validate a physical activity game scale, this measurement issue became upmost important to address.

Zhu (1996) added that in order to better understand why ordinal total scores should not be used directly, one has to understand the basic classification scale system. Based on Steven’s (1946) system there are four type of scale: nominal, ordinal, interval, and ratio (Table 9). This classification system is based upon three features of real-number system: order, distance, and origin (Safrit, 1981). Order or rank refers to arrangement of numbers ascending whereby lower number representing lower ability and vice versa; distance refers to equal distance between measurement units; and origin refers to absence of attributes or the presence of absolute zero.

Table 9

<table>
<thead>
<tr>
<th>Scale</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal</td>
<td>None</td>
</tr>
<tr>
<td>Ordinal</td>
<td>Order</td>
</tr>
<tr>
<td>Interval</td>
<td>Order, equal distance</td>
</tr>
<tr>
<td>Ratio</td>
<td>Order, equal distance and origin</td>
</tr>
</tbody>
</table>

Note. From On the theory of scales of measurement by Stevens (1946).

For example, an ordinal rating scale of 1 to 5 (e.g., Very bad, Bad, Neutral, Good, and Excellent) has a certain order, but there is no known distance or origin. We know that 3 (Neutral) is better than 2 (Bad) but the actual difference between 3 and 2 is unclear, 3 could represent a
location from one to three standard deviation or more away from the underlying ability continuum, beside there is no known origin in this scale. When the criterion of equal distances and no origin are not met, this scale should never be treated as an interval or ratio scale. In addition, the distance or ordinal data is unequal and origin is unknown hence should not be added or not “additive” (Zhu, 1996). Besides, when ordinal total scores are used directly to determine validity and reliability without equal measurement units it will without doubt fail to fulfill acceptable standards for reliability or validity. This insight was highlighted by Crocker and Algina (1986) and reiterated by Zhu (1996, p. 364), “… when this happens one cannot determine whether or not the failure was caused by inappropriate numeric properties of the scale or inadequate validity and reliability of the instrument.”

In general, there are a few methods that were proposed to analyze rating scale and in the process solved this issue: (a) data analysis as an ordinal scale follow by transformation to interval/ratio scale or (b) transformation to ratio scale before conducting data analysis. The former procedure can be conducted by summing all the raw scores from the ordinal scale (not additive) and analyzed it using order statistics (Clogg & Shihadeh, 1994). For example, Eom and Schutz (1992) used the loglinear model to analyze the ordinal volleyball rating scale (Zhu, 1996). The later method is by transforming raw score from ordinal to interval or ratio before further data analysis. There are two models under the later method; deterministic model and probability models.

The deterministic model assumes that the model itself is free of error and that all variations in responses can be fully accounted for by subjects and items variation (Torgerson, 1958). However, one limitation of deterministic model is the omission of analysis of goodness-of-fit (see Chapter 3) in which the decision regarding whether to apply this model is subjective.
In contrast, the probabilistic model also known as latent-structure model (Torgerson, 1958) assumes that there is a certain amount of error in the model in which the decision to apply this model is strictly dependent on goodness-of-fit analysis. Some major procedures under the probabilistic model are latent-distance model (Hays & Borgatta, 1954; Lazarsfeld, & Henry, 1968), normal-ogive model (Ferguson, 1943; Lord, 1952), and Rasch model (Rasch, 1960/1980). The Rasch model is the IRT model employed in this study and is described as followed.

**Item response theory (IRT) and rating scale.** Rasch model (Rasch, 1960/1980) is a one-parameter logistic model which described the relationships between examinee’s ability ($\beta$) and item difficulty ($\delta$). The Rasch model for ability-difficulty relationship can be expressed as:

$$P_i (\beta_n) = \frac{\exp (\beta_n - \delta_i)}{[1 + \exp (\beta_n - \delta_i)]}$$

(1)

where $\beta_n$ represent examinee $n$’s ability, $\delta_i$ denotes item $i$ denotes difficulty, exp denotes exponent of the natural constant $\exp = 2.71828$, and $P_i (\beta_n)$ denotes the probability that examinee $n$ will complete item $i$ successfully. This one-parameter Rasch model has a simple dichotomous scoring system meaning that there are only two possible scored responses (e.g., true/false, pass/fail, correct/ incorrect, endorsed/not endorsed, etc.). Hence it is also known as the “Rasch Dichotomous Model” or “one-step” item. If this one step is successfully completed, the examinee will be assigned a score of “1”, likewise if an examinee failed, a score of “0” will be assigned.

The Item Characteristic Curve (ICC) or Item Response Function (IRF) in Figure 9 shows the probability of correct response corresponding to the ability of examinee. Hypothetically, when the ability of examinee is at 0 the same as item difficulty ($\beta_2=\delta_i$) the probability to answer an item correctly is at .50 (50%). Likewise, if the ability of examinee is higher ($\beta_3$) than the
difficulty of the item ($\beta_3 > \delta_i$) at 2, the probability to answer an item correctly will increase to .875.

The Rasch model defines the probability of an examinee $n$ scoring $x$ on an item $i$ ($\pi_{nx}$) as:

$$\pi_{nx} = \frac{\exp \sum_{j=0}^{x} (\beta n - \delta_j)}{\sum_{k=0}^{m} \exp \sum_{j=0}^{x} (\beta n - \delta_j)}$$  \hspace{1cm} (2)$$

where $m$ denotes step, $x$ denotes category, and $\delta_{ij}$ denotes steps difficulty. For a dichotomous model, $m = 1$, $x = 1$ or 0 and the step difficulty is the same as item difficulty hence the parameter $\delta_{ij}$ can be written as $\delta_i$ (Zhu, 1996). In addition to the dichotomous one-parameter Rasch model, Rasch modeling has also been extended for multiple responses (with a set of polytomous) models including the Partial Credit model (Masters, 1982), Poison Counts (Rasch,
The Rasch Rating Scale model (Andrich, 1978) can be potentially applied to measure a trait or ability in which items are scored in ordered response categories or successive integers. An examinee that completed the \( j \)\textsuperscript{th} step on an item of a rating scale can be thought of as scoring the \( j \)\textsuperscript{th} category of the item. For example, completing the first step on a one-step item (0 and 1 levels) will be awarded 1 point, while completing the second step of a two-step item (0, 1, and 2 levels) will be awarded 2 points. Rasch Rating Scale model can be mathematically expressed as:

\[
\pi_{i,x,n} = \frac{\exp \left( \sum_{j=0}^{n-1} [\beta n - (\alpha_i + \tau_j)] \right)}{\sum_{k=0}^{n} \exp \left( \sum_{j=0}^{k} [\beta n - (\alpha_i + \tau_j)] \right)}
\]  

(3)

This formula describes the probability of examinee \( n \) responding in category \( x \) to item \( i \).

The difference between the Rating Scale and Dichotomous model is that a new parameter \( \tau_j \), which represents the “threshold” is added in the new formula. It is assumed that the threshold is the same across items in the scale which means that item differ only in their location, but not in the corresponding response categories (see Zhu, 1996). The application of IRT in this study can be explained as the children’s abilities (respondents’ abilities) and the game difficulty (item difficulty) that was evaluated in accordance to a set of proposed PA games elements or factors by raters. Procedure of IRT data analysis was further explained in Chapter 3.

**Advantages of Rasch analysis rating scale.** One of the major advantages of Rasch analysis rating scale is that the estimates of item difficulty and examinee ability are put on the same scale using log-odds scale or “logits.” Logits is a probability unit comparable to a z-score. Besides, any differences between examinee and any items anywhere along the scale possess the
same stochastic consequences (Zhu, 1996). This characteristic is a major advantage over Classical Test Theory (CTT) leading many scholars to suggest that this is one of the most “powerful” IRT features because it allows data analysis and data interpretation to be carried out within a same framework (Kulinna & Zhu, 2001; Zhu, 1996).

Secondly, Rasch rating scale is “invariance” or independent. Invariance refers to the estimation of parameters (e.g., item difficulty and examinee ability) and is statistically independent. As illustrated by Zhu (1996), a measuring tape should maintain its length calibrations irrespective of what object it is measuring and in the same theoretical concept, examinees should perform at the same level of competency or “true” ability regardless of which tests or items are administered.

Thirdly, values on the scale represent equal interval scales hence test score are additive, meaning that all scores can be added (Brogden, 1977; Luce & Tukey, 1964; Perline, Wright, & Wainer, 1979). Fourthly, raw scores are considered “sufficient statistics” for item and examinee parameters, meaning that total raw scores that had been used by researchers over the years can still be analyzed using Rasch analysis (Zhu, 1996). Finally, the precision of measurement can be determined and not limited by the level of examinee ability because IRT approach is not a sample dependent, but rather a response dependent approach.

In summary, based on the literature review, the heuristic expert review is the preferred method for determining the core elements/factor for PAGPS scales because to the many advantages offered by heuristic evaluation. By taking advantages of IRT, PAGPS scale was further developed (more details in Chapter 3) based upon data fit suggested by Rasch analysis. Overall, this chapter discussed the definition; characteristics/elements and classification of
games; play; sports and computer games; theories of play; operant terminologies and rating scale theories to aid in the understanding of the following chapter.
CHAPTER 3

METHODS

This chapter describes the research design, methodology, and data analysis used in this study. The research design consisted of two stages: the development and validation of PAGPS scale. Each stage is described in detail later in this chapter. The development stage entailed the process of a scale development, which included the recruitment of panel of experts (development of playability guidelines using heuristics, discussion and decision making by panel of experts) and PE teachers. Next, the validation stage entailed recruitment of participants (i.e., school children, and raters), data collection and data analyses. The procedures for data analyses addressed the specific aims outline in Chapter 1 and the rationale of each procedure was also ratified.

Participants

Four groups of participants were recruited for the entire study covering the development and validation stages. A panel of game experts and PE teachers were recruited for the development stage while school children and raters were recruited for the validation stage. Prior to recruitment permissions were garnered from University of Illinois, at Urbana-Champaign’s Institutional Review Board.

Development Stage

Content experts. Five content experts were invited to form our content expert panel. These experts were recruited from this dissertation's committee members and from other known experts in the field of physical education, statistics, games and play, childhood research, or child development in the US. The number of members serving on the experts panel is based on Nielsen’s (1992) and Nielsen and Landauer's (1993) suggestions. Three to five experts are
typically recommended, however, due to the pioneering nature of this project of setting
guidelines and factors of PA games, additional experts were advisable. Potential
expert panelists were approached after reviewing their available information and publications
(published articles, journals, vita, books, etc.). Formal invitations were sent via e-mail inviting
experts to participate as panel and follow-up phone calls were made if positive responses were
received. The inclusion criteria for experts panel was at least a doctorate degree in the one of the
above mentioned fields, with a minimum of three years of teaching or research experience as
faculty and a verbal/written consent.

**Physical education teachers.** Permission to conduct this study was first obtained from
the Prime Minister Department and Ministry of Education. PE teachers’ name list was requested
from the Ministry of Education, Malaysia, State Education Departments or Physical Education
Association of Malaysia. Two hundred elementary, middle, or high school PE teachers were
recruited. The sample size of PE teachers recruited was based IRT studies conducted by previous
psychometrics experts (Bartlett, Kotrlik, & Higgins, 2001; Linacre, 1994; Orlando & Marshall,
2002; Thissen, Steinberg, & Gerrard, 1986) that the sample size should not be less than 100. PE
teachers were recruited via e-mails, phone calls, or face-to-face meetings followed by an official
e-mail invitation (which includes their online consent). The inclusion criteria for PE teachers
were at least a diploma in PE, child care, child psychology, pedagogy, kinesiology, or sports
science, and with at least two years of PE teaching experience in a school setting.

**Validation Stage**

There are two different groups of participants in the validation stage which included
school children, and raters. Each group was recruited via specific recruiting process as explained
in detail below.
**School children.** Sixty Malaysian school children, Grades 2 \(n = 30\) and 5 \(n = 30\) approximately 8 and 11 years old were recruited from local primary school in the state of Kuala Lumpur, Malaysia. E-mails and official letters were sent to the Ministry of Education for permission to speak and visit potential schools (a list of elementary schools and contact numbers of headmasters in the designated area). The recruitment processes included formal phone calls to headmasters follow by official visits to the targeted schools. Announcements pertaining to PAGPS study were made during the schools weekly general assembly, and/or by word of mouth through physical education teachers. The inclusion criteria were: (a) student’s assent and parent/guardian's consent, (b) citizen of Malaysia, (c) registered student in local primary school, (d) between 8-11 years old, (e) able-bodied and healthy [exclusion criteria: on medication, diabetic, cardiovascular condition (e.g., cardiac arrhythmia, cardiac failure), renal disorder, respiratory disorder (e.g., asthma, lung fibrosis), high blood pressure, epilepsy, stroke, seizures] - such information if needed could be garnered from the students’ health records, (f) screening measure and protocol which include passing the Physical Activity Readiness Questionnaire (PAR-Q), and checking birth certificate for identification. Adherence to the underlined inclusion criteria were verified by researcher with the help of PE teachers. Students who answered “No” to all PAR-Q questions, would have their PAR-Q answers (no foreseeable disease or illness) cross-checked with their school health record for any discrepancy conditions prior to recruitment.

The rationale in recruiting Malaysian children as opposed to U.S. children was based on several factors. Currently there is a plethora of research targeting overweight and obese children in US; however there is a lack of awareness and efforts to evaluate the health conditions of overweight and obese children in Malaysia. Since 1996, only two adult national health surveys were administered in Malaysia: the Malaysian National Health and the Morbidity Survey.
(NHMS-3) sampled 21,391 individual 18-59 years old, and found a prevalence of overweight (20.7%) and obese (5.5%) adults but there are no nationwide overweight or obesity evaluation targeting children. Existing children related health studies were administered mostly by individuals or small groups of self-sponsored researchers. These studies found that, in less than 10 years obesity rate nearly tripled from 7.8% (Bong & Jaafar, 1996) to 23.1% (Radzali & Nasir, 2007). These statistics calls for Malaysian to be more aggressive in initiating nationwide PA and fitness evaluations for children. Currently only one type of nationwide students’ fitness test (formerly UDTA and now SEGAK) is administered in schools. Unfortunately, no actions were taken in analyzing these tests results and no follow-up programs have come out of their fitness results. Hence to be able to plan Malaysia’s PE curriculum and PA activities effectively, educators first need to understand the PA pattern and types of PA games that are popular in Malaysia. Because of the dire need, background and experience of the author (six years of teaching physical education), this study decided to use the Malaysian children population to validate the PAGPS questionnaire.

**Raters.** Ten Malaysian raters were recruited from the 200 PE teacher participants. The recruitment process of raters was in the form of an invitation at the end of the PAGPS survey to the participating PE teachers (online survey) to consider extending their involvement in the study as a rater. The inclusion criteria for raters includes all the criteria of PE teachers mentioned previously plus at least one year of rating experience, and attending a required rater training course conducted by the author.
Procedures and Research Design

PAGPS Development Stage

The key steps in developing the PAGPS included: (a) intensive literature review, (b) determining PA game factors/subscales, and (c) developing items for each factor. The literature review focused on the history of play and PA games, the roles of PA games in physical education, the decline in interest in PA games in PE, playability research in computer/video games, and playability features of PA games. Based on a preliminary literature review, draft PAGPS questionnaires (Draft 1 with 116 items; Table 10) included these factors, but were subjected to change based on recommendations from the panel of experts.

Table 10

PAGPS category or factors (Draft 1)

<table>
<thead>
<tr>
<th>Factor/subscale</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fun</td>
<td>Verbal reaction, non-verbal reaction, postural reaction, behavioral reaction</td>
</tr>
<tr>
<td>Social</td>
<td>Encouraging integration/unity, teamwork, improving communication, cooperation</td>
</tr>
<tr>
<td>Cognitive</td>
<td>Basic strategic thinking/planning, basic math, creative thinking, memory</td>
</tr>
<tr>
<td>Physical</td>
<td>Locomotor, multiple locomotor, manipulative movement, stability</td>
</tr>
<tr>
<td>Skills</td>
<td>Gross/fine skills, open/closed skills, discrete/serial/continuous skills, single/ dual or multi skills; difficulty level</td>
</tr>
<tr>
<td>Games structure</td>
<td>Formation (e.g., circle, line, or face-to-face), mode of contest (individual, dual, groups), fitness component (i.e., speed, power, agility, balance, reaction time, or any combination), method of determining victory (e.g., tagging, catching a ball, concealment, guessing, etc.) and/or combination of any of the mentioned elements</td>
</tr>
<tr>
<td>Language</td>
<td>Clarity, correct speed, language barrier</td>
</tr>
<tr>
<td>Environment and equipment</td>
<td>Space (i.e., small, medium, large), indoor/outdoor, availability of special facility</td>
</tr>
<tr>
<td>Game Difficulty</td>
<td>Easy, moderate, moderate difficult, difficult</td>
</tr>
<tr>
<td>Players’ characteristics</td>
<td>Mobility [physically able / special population (inclusive)], number of students per class, gender, age</td>
</tr>
</tbody>
</table>
The panel of experts engaged in round table discussions to determine the factor of PA games and playability heuristics. The purpose of this practice was to improve on items' representations, or collect the content validity evidence. Panel of experts selected, tested, reviewed, commented and determined whether the suggested items sufficiently represent PA games domains (Foxcroft, Patterson, Roux, & Herbs, 2004). The determined game heuristics served as the guidelines to identify key factors (category) for evaluating games “playability.” Based on the agreed upon playability heuristics, PAGPS (Draft 1) was developed. The panel of experts further collectively suggested at least 5-7 items for each factor and as a result the Draft 2 of PAGPS (with 152 items) was developed. Next, each expert rated and evaluated the appropriateness of each item of PAGPS (Draft 2) using the 4-point Likert scale (i.e., Not important at all = 1, Not important = 2, Important = 3, Very Important = 4) individually to ensure independent and unbiased evaluation of item (Nielsen, 1994). After all individualized expert evaluations were completed; the panel of experts discussed and justified their evaluation with fellow panel members. Further discussion and agreement lead to creation of version PAGPS (Draft 3 with 116 items).

Two hundred elementary PE teachers were recruited to rate the importance of each factor and items in PAGPS (Draft 3). Short introduction and briefing regarding the purpose of this study were e-mailed (including an online approved informed consent) to participating PE teachers. This email also contained a secure survey link managed by Survey Gizmo.com. PE teachers were asked to rate the importance of each item according to 4-Likert scale (i.e., Not important at all, Not important, Important, Very Important). The PE teachers' demographic information, including age, gender, teaching level, and years of teaching physical education were also collected. All survey information was securely maintained, and the safety of the information
was guaranteed by Survey Gizmo.com. After all data (PE teachers) was collected, the data were moved to a secure external hard disk and all information on the Survey Gizmo was promptly deleted. The PAGPS (Draft 3) online survey link was available for two weeks to allow the PE teachers’ sufficient time to respond; the survey was automatically closed after the deadline.

**PAGPS Validation Stage**

In addition to the content validity evidence established in the development stage, two other validity evidences, internal structure evidence and discriminant evidence (American Educational Research Association, American Psychological Association, and National Council of Measurement in Education, 1985) were collected in this stage to validate the PAGPS (Draft 3). Besides that, related reliability evidence (inter-rater reliability and internal consistency) was collected and games descriptive statistics were computed.

After been granted permission from parents or guardian to participate, interested students answered the Physical Activity Readiness Questionnaire (PAR-Q) under the guidance of PE teachers and researchers. All participants were required to pass the PAR-Q screening and fulfilled all the other criteria before participating. PAR-Q is a common self-screening tool that can be used by anyone who is planning to start an exercise program. PAR-Q is used to determine the safety or possible risk of exercising for an individual based upon their answers to specific health information.

The students who met all the participating criteria are divided into two groups according to grades $n = 30$ Grade 2 (~8 years old) students (15 males, 15 females) and $n = 30$ Grade 5 (~11 years old) students (15 males, 15 females). Ten PA games were played by both recruited groups. Their physical performance and reaction while playing the ten PA games were video-recorded. The videos were uploaded to private Dropbox for rating purposes.
For the purpose of this study, ten common PA games in Malaysia were selected: One-Leg, Kali-Tui, Blind man’s Bluff, Eagle and Hen, Hopscotch, Simon Says, Duck Duck Goose, Hide-and-Seek, Monkey in the Middle, and Mr. Wolf. Locomotor skills required for each game are not specified on the sources provided but motor skills required were casually mentioned under “how to play each game” section. These games were described briefly below.

**Game1. One-Leg (Satu kaki).** One-Leg is a traditional Malaysian hopping game, played within a square (lines) marked either on dirt or indoors with white chalk. All players determine the boundary of this square before the game starts. One-Leg is akin to American One-Leg challenge but at an advance level whereby IT (person on One-Leg) has to balance his/her self on One-Leg at the same time hop around the predetermined square to tag other players. Other players try to avoid being tagged but must remain in the boundaries of the pre-determined square at all time. The tagged player or player that dodges beyond the agreed upon boundaries will become the new IT (Figure 10). Basic skills involved in this game are hopping, balancing, tagging (IT), running, and dodging. No reference or documentation is available because this game has never been documented.

![Figure 10. One-Leg](image)

**Game2: Kali-Tui (Galah panjang).** Players are divided into two teams (tagger and runner). Team tagger is in black and the runner team in white. The goal of team runners is to run from the start line to the end line navigating safely back to start line untagged (Figure 11). In
contrast, the goal of the team tagger is to prevent team runner from achieving their goal. If any member from the runner team is tagged then the game will restart (both teams switch role). The number of the horizontal dotted lines depend on how many players are in play (team), a minimum of 8 players are recommended (4 players per team), and there will be four horizontal dotted lines. If a member of the runner team succeeds in completing their run by returning to the beginning line untagged then runner team wins.

![Figure 11. Kali-Tui](image)

The captain of the tagger team (black triangle) is allowed to move horizontally and vertically on the dotted line to tag any unaware runner team member(s). While other tagger team members can only move horizontally along the rougher dotted lines blocking runner team from crossing their horizontal lines. Basic skills involved in this game are strategy (cognitive), teamwork, tagging (IT), running, and dodging (http://www.webbiz2u.com/09-11/10UpinIpin.html).

**Game 3: Blind Man’s Bluff (Cari cucu).** Blind man's bluff is played in a spacious area, such as outdoors or in a large room, in which one player is designated as "IT" (Blind man). At the start of the game, IT is blindfolded and turned round and round (to disorient him/her). Blind man’s task is to tag any players while still blindfolded, while the other players scatter in the predetermined square and trying to avoid being tagged (Figure 12). The play area must be free of
dangerous obstacles, or pot holes. Once Blind man successfully tag a player, then Blind man has to guess the name of that person (this rule is optional). The tagged player will become the next IT. Skills involved in this game are orienteering/balance (IT), cognitive/strategy (IT), voice recognition (IT), tagging (IT), running, and dodging (http://en.wikipedia.org/wiki/Blind_man%27_bluff%28game%29)

![Predetermined square / line](image)

**Legend**
- IT (blindfolded)
- Players

*Figure 12. Blind man’s bluff*

**Game 4: Simon Says.** Simon says or also known as “turn back” is played with three or more players. Players need to listen and do (act out) what Simon (IT) says. If "Simon says jump", all players must jump (players that fail to jump are eliminated). However, if Simon (IT) says simply "jump" (invalid command), without first uttering, "Simon says", players must not jump; players that jump are eliminated. In general, it engages cognitive ability to distinguish valid and invalid commands and perform the valid command. This game can be used as a form of small play after PE teachers have taught some basic skills, for example jump, crawl, slide, hop, skip, and others to test children’s understanding of what was taught in class earlier (Figure 13). In this study the researcher encourages the use of common physical or loco motor skill to be performed for younger players. The player(s) that perform the wrong skills will either be chosen as the next Simon (this is preferred to promote inclusion) or eliminated from the game. Basic skills involved in this game are basic locomotor skills, strategy (cognitive), listening, and command recognition skills (http://en.wikipedia.org/wiki/Simon_Says).
**Game 5: Eagle and Hen (Helang dan ibu ayam).** This is a simple game based on the behavior of animals; it originated from China. A player will be randomly chosen as Hen and another player will be chosen as the Eagle (IT). The hen (protector) expands his/her hands horizontally shielding or protecting chickens (players) from being tagged by the Eagle (Figure 14). The hen cannot be tagged. One chicken tries to hold on to the body of the hen, while the next player in line will hold on to the body of the player (chicken) before him/her, forming a human line. The role of the Eagle is to maneuver itself to tag chicken (players). The role of the hen is to provide protection for her babies (chickens) while the role of the chickens is to dodge and avoid being tagged. Once tagged chicken maybe eliminated or to promote inclusion, the “tagged” chicken will be the next Eagle. Basic skills involved in this game are shielding (hen), dodging, and running ([http://chineseculture.about.com/library/weekly/aa112498.htm](http://chineseculture.about.com/library/weekly/aa112498.htm)).

**Game 6: Hopscotch (Teng teng).** The first player tosses the marker (e.g., a stone, coin, or bean bag) into the first square of the hopscotch as shown on Figure 15. The marker must land...
within the designated square without touching a line or bouncing out. The player then hops through the course, avoiding the square with the marker on it. Single squares must be hopped on one foot. For the first single square, either foot may be used. Side by side squares are straddled, with the left foot landing in the left square, and the right foot landing in the right square. Upon successfully completing the sequence, the player continues the turn by tossing the marker into square number two, and repeating the pattern. If player steps on a line, misses a square, or loses balance, his/her turn immediately ends. Players begin their turns where they last left off. The first player to complete one course for every numbered square on the court wins the game. Basic skills involved in this game are hopping/leaping, cognitive (counting), balancing, and tossing/throwing the pebbles (http://en.wikipedia.org/wiki/Hopscotch).

![Hopscotch](http://en.wikipedia.org/wiki/Hopscotch)

*Figure 15. Hopscotch*

**Game 7: Police-Thief (Ringolevio).** This game is also known as cop and robbers or “ringolevio.” In this game there are two teams (police and thief). Team thieves hide while team police counts to a certain number for example 30 to 50 counts, before they start searching for the thieves. The role of team police is to catch members of team thieves by grabbing hold of them and shouting "Liak" (caught). The captured thief is taken to the prison (Figure 16). If the thief(s) that are caught break free at any point during this brief recitation, the thief is free to go. Prison is any small area (normally a small shed) where members of the thief team are “imprisoned.” Any
member of a thief team can at any time free all captured thieves in prison by barging into the prison without being caught, tagging the captured thief(s) shouting "All in! Free all!" meaning that all captured thieves members that are in prison are now free. Thieves that are hiding in the thief den are safe from the police. This game is normally played in a large area with lots of hideouts. Basic skills involved are running, tagging, hiding, strategy (cognitive), and teamwork (http://en.wikipedia.org/wiki/Ringolevio).

![Diagram of Police and Thief]

**Figure 16. Police and thief**

**Game 8: Duck Duck Goose (Saputangan & bulatan).** In Duck Duck Goose, or Circle Handkerchief, the players sit in a circle facing inward, while another child, the 'picker', walks around the outside of the circle carrying a rag or handkerchief until finally dropping it behind one child (Figure 17). This child (goose) then rises, grabs the rag, and chases and tries to tag the picker. The picker tries to return to the spot where the picked child had been sitting and sit in that spot. If the picker succeeds, the goose is now the new picker and the process begins again. If the child with the dropped rag (goose) succeeds in tagging the picker, the same child may return to sit in the previous spot and the picker resumes the process. In some versions, the one who is tagged is 'out' and must sit in the center of the circle; when the resulting circle becomes too small, a new game may be started. Basic skills involved are running/walking and tagging (http://en.wikipedia.org/wiki/Duck,_duck,_goose).
**Game 9: Monkey in the middle (Monyet).** Monkey in the middle or Keep away is some common names given to this game in United States. Monkey in the middle is a game in which two or more players must pass a ball to one another, while Monkey (tagger) in the middle attempts to intercept it. The basic game is played with players forming a circle (Figure 18). The Monkey stands in the center and the rest stand in a circle (dotted line). A player outside the circle must then throw/pass the ball to another person across the circle with the goal of preventing Monkey from getting to the ball. Monkey is allowed to rush towards any player that possesses the ball. This continues on until an intended recipient (catcher) fails to catch the ball or if the ball was intercepted midair (monkey jumping) then the player (thrower) will becomes the new monkey. The ball cannot be torn out of any of the players’ hands. Basic skills involved are throwing, catching, jumping, strategy (cognitive) ([http://en.wikipedia.org/wiki/Keep_Away](http://en.wikipedia.org/wiki/Keep_Away)).

**Figure 18. Monkey in the middle**

**Game 10: Mr. Wolf (En. Serigala).** What time is it, Mr. Wolf (IT) or Mr. Fox? One player is chosen to be Mr. Wolf (male/female). Mr. Wolf stands at the opposite end of the
playing field away from other players, facing away from other players (Figure 19). A call-and-
response then takes place: all players except Mr. Wolf chant in unison "What's the time, Mr. Wolf?", and Mr. Wolf answers in one of two ways:

(1) If Mr. Wolf calls a time of day for example Five o'clock! All the players will then take five steps towards Mr. Wolf players count out loud as they move forward "One, two, three, four, and five." Then players will repeat the question again. What’s the time Mr. Wolf?

(2) On the other hand, Mr. Wolf may reply "Dinner time, Lunch time or Supper time.” Mr. Wolf will then turns and chase the other players. Players will run back to their starting line. If Mr. Wolf successfully tagged any player, that player will become the new Mr. Wolf. Basic skills involved are strategy (cognitive), running, tagging, and understanding instruction (language) (http://en.wikipedia.org/wiki/What%27s_the_time,_Mr_Wolf%3F).

Ten raters recruited from the earlier PAGPS online survey (PE teachers) underwent intensive training especially on how to rate the videos using PAGPS (GRS). Rating exercises were conducted to familiarize them with rating procedures. After completing rater’s training, every rater was issued a Dropbox link to the 20 videos (10 game videos for Grade 2, 10 games videos for Grade 5) including detailed rating instructions. The raters were assigned to rate the appropriateness of each games using the PAGPS (Draft 4 with 51 items) or game rating scale
(GRS). The PAGPS-GRS for raters (see Appendix A) items are based upon a slightly different 4-point Likert scale (i.e., Disagree, Strongly disagree, Agree, and Strongly Agree).

**Data Analyses Procedures**

Collected data of the various types of reliability and validity evidence were analyzed using appropriate statistical procedures. They were described by stage.

**Development Stage**

**Content evidence.** Content validity refers to a non-statistical type of validity that involves “the systematic examination of the test content (factors and items) to determine the chosen items are representative of the domain to be measured” (Anastasi & Urbina, 1997, p. 114; Foxcroft, Paterson, le Roux & Herbst, 2004, p. 49). A more recent understanding, validity refers to “the degree to which evidence and theory support the interpretations of test scores entailed by proposed uses of tests (AERA et al., 1999, p. 184).” The content validity evidence of PAGPS was determined based upon extensive literature review, experience and suggestions from the panel of experts. The initial PAGPS (Draft 1) developed by the author through extensive literature review was presented to the panel of experts for further discussion. At the end of the discussion, PAGPS (Draft 2) was developed. Thereafter, the heuristic evaluation approach was employed whereby each panel member evaluate and critique the PAGPS (Draft 2) individually followed by another round table discussion on items and any possible disagreement. Any disagreements were discussed until agreements were achieved and additional changes were made, leading to the creation of PAGPS (Draft 3). These systematic steps helped to establish the content validity evidence.

**Principal component analysis (PCA).** Due to the multitude possible factors or factors that defined the universe of physical activity games based on intensive literature review, content
experts’ advices and PE teachers’ feedback throughout PAGPS development process, PCA was chosen to mathematically derive a relatively small but important number of variables that can account for variance found in the large measures but at the same time maintained as much information from the original set of variables (Leech, Barrett, & Morgan, 2008). Hence PCA is also considered as a data reduction method.

PCA was introduced and popularized by Karl Pearson in 1901. In general, PCA is a form of orthogonal transformation, changing a group of observations of probably related variables into a set of values linearly uncorrelated called “principal components.” This transformation is arranged orderly whereby the first principal component (factor) account for the largest possible variance, follow by the succeeding next highest component and so on. A first loading (variance) of 20% or more usually confirmed the data set’s unidimensionality property (Reckase, 1979). The results of a PCA are usually discussed in terms of component scores, or factor scores, and loadings (Shaw, 2003). PCA is believed to be the simplest form of true eigenvector-based multivariate analyses.

In general, PCA’s procedure reveals the internal structure of the data set in a way that paramount explains the variance in the data. However, to assure PCA results’ are valid the assumption of normal distributed data must be fulfilled. Therefore, PCA will provide the internal structure evidence needed for PAGPS questionnaire. In order to verify the number of factors and items and obtain a better understanding of the underlying structure based on the suggested PAGPS (Draft 3), internal structure validity evidence is necessitated. Internal structure validity evidence statistically evaluates the factors suggested by the panel of content experts. The collected PE teacher data were analyzed using PCA. PCA data analysis is similar to factor
analysis procedure allowing user to explore and determine the numbers of factors required to represent the data with all measured variables related to every possible variable accounted for.

**Rasch analysis.** After PAGPS-PE teacher’s data was reduced using PCA procedures, the data were then analyzed using Rasch analysis for the calibration of PAGSPS, in which items’ difficulties were determined. Data analysis was completed using WINSTEPS software. Thereafter, anchored on the original long version, short versions of PAGPS (GRS) were created and their correlations with the original long version were computed. Specifically, the following three steps were taken to create the short versions:

1. The goodness-of-fit are examined based upon Infit and Outfit weighted mean square statistics indexes provided by WINSTEPS software. Infit is a measure of the information-weighted mean square fit (MnSq) highly influences by response patterns and usually harder to diagnose hence a great threat to measurement. While Outfits display characteristics of sensitivity to outliers, comparatively easier to diagnose and remedy, hence are a lesser threat to measurement. When the data fits the model, the expected value for mean squared statistics is equal or close to 1.0. According to Winsteps and Rasch measurement (2010), mean square fit statistics between .5 and 1.5 is recommended (productive for measurement). For item reduction process, always examine high mean-square fit statistics first before checking low mean-square fit. Our study was based on criterions suggested by Winsteps and Rasch as shown (Table 11).

2. Item difficulty (logits) can be arranged according to difficulty values in each category or factors. For example, Item A (-1.05), Item B (.23), Item C (.24), Item D (.55), and Item E (.67), in this hypothetical example prior to decision making (deletion consideration), the item difficulty should be arranged descending manner (.67, .55, .24, .23, -1.05). Normally item with the highest (.67) and lowest difficulty (-1.05) values will be maintained. Hence, either Item B or C might be
deleted since their difficulties were almost the same. The deletion will likely be decided based on their content representation.

Table 11

*Interpretation of mean-square fit statistics (goodness-of-fit)*

<table>
<thead>
<tr>
<th>Interpretation of parameter-level mean-square fit statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 2.0</td>
</tr>
<tr>
<td>1.5 - 2.0</td>
</tr>
<tr>
<td>.5 - 1.5</td>
</tr>
<tr>
<td>&lt; .5</td>
</tr>
</tbody>
</table>

*Note.* From *Misfit diagnosis: Infit outfit mean-square standardized* by Winsteps and Rasch measurement software (2010).

3. Finally, content relevance is another consideration criterion in item deletion process. Content relevance is not directly related to Rasch analysis, but many a times, content relevance are taken into account during item deletion process especially in item deletion related analysis (i.e., Rasch modeling or PCA). If by deleting an item, “destroy” the entire factor or category then logical thinking and practicality should be practiced. For example, Factor “Skill” has three interrelated items: discrete skill, serial skill and continuous skill. Even though results from Rasch analysis suggested the deletion of one or two items due to data misfit issues, vigilance must be practiced since by deleting any of those items, the entire factor/sub-category “Skills” would become meaningless or reduced to less than three items (should be avoided).

In this study the rating scores of PE teachers (i.e., “Very important,” “Important,” “Not important,” “Not important at all”) was calibrated using WINSTEPS software (Linacre, 1994) with the following two facets being defined in the calibration: PE teachers (P), and items (I) on the rating scale.
The equation of the facet model is defined as follow:

\[ \log \left( \frac{P_{lm}}{(P_{lm}-1)} \right) = P_l - I_m \]  

(4)

where, \( P_{lm} \) is the probability of PE teacher \( l \) rating Item \( m \) in contrast \( P_{lm-1} \) is the probability of PE teacher \( l \) unsuccessfully rating Item \( m \) and Rating Scale \( p-1 \); \( P_l \) is the ability of the PE teachers \( l \), \( I_m \) is the difficulty of the item \( m \) and Rating Scale in relative to \( p-1 \). The PE teacher facet will be chosen as the non-center facet so that other facet were constrained to have a mean element measure to zero, hence setting all facets on the same continuum of framework.

Finally, the PAGPS (Draft 3) scale was modified, according to the input from PCA, Rasch data analyses and a final feedback of expert discussion to create another refined version of the PAGPS-Raters (Game Rating Scale or GRS). These inputs were collected to serve as the evidence of the content validity and internal structure validity.

**Reliability or objectivity evidence.** Another important evidence is reliability or objectivity evidence which can be determined by using the multi-raters kappa (Fleiss, 1971; O’Connor, Walliser, & Philips, 2010; Sawa & Morikawa, 2007) to determine the inter-rater agreement and Cronbach’s alpha (Cronbach, 1951) to measure the internal consistency.

Inter-rater reliability or inter-rater agreement is a measure of the degree of agreement among raters. It gives a score of the degree of consensus between the ratings given by raters. If rating scores differ greatly among raters based on the same video clip, it probably reflects either the scale/questionnaire is faulty or the raters need to be re-trained. Inter-rater reliability (video coding done by the different raters) was collected simultaneously while raters are rating PA game video recording for discriminant evidence. Some other common methods to determine inter-rater reliability are Fleiss kappa (1971), Scott’s Pi (Scott, 1955), and Cohen's kappa (Cohen, 1960).
One of the most important features of kappa statistics is that it is a measure agreement which naturally controls for chance \([Pr(e)]\). According to Fleiss (1981), there is a natural means of correcting for chance using indices of agreement and Kappa is based upon these indices. If there is a complete agreement, \(\kappa_f = 1\). If the observed agreement is greater than or equal to chance agreement, \(\kappa_f \geq 0\), if the observed agreement is less than or equal to chance agreement , \(\kappa_f \leq 0\).

In this study, Fleiss Kappa analysis was employed because it matches the data characteristics that will be collected (Likert-ordinal data and data will be rated by more than two raters). For example, Scott’s Pi is normally used for nominal data, whereas Cohen’s Kappa is used to assess the agreement between two raters (Gwet, 2010). Fleiss statistics was computed using an online Fleiss kappa calculator from StatTools.net designed by Emeritus Professor Allan Chang based upon three influential papers by Fleiss, Cohen, and Everitt (1969), Fleiss (1981) and Landis and Koch (1977), a simple explanation of the algorithm of the formula of multi-raters kappa (Galton, 1892) is described below

\[
\kappa_f = \frac{Pr(a) - Pr(e)}{1 - Pr(e)}
\]  

where \(Pr(a)\) is the relative observed agreement among raters, and \(Pr(e)\) is the hypothetical probability of chance agreement, using observed data to calculate the probabilities of each observer randomly in each categories. Simply put, if raters are in complete agreement the \(\kappa_f = 1\). If there is no agreement among the raters other than what would be expected by chance \([Pr(e)]\), \(\kappa_f = 0\). The philosophy of agreement is bound by three general operational requirements: (a) raters agree with the "official" rating of a performance, (b) raters agree with each other about the exact ratings score to be awarded, and (c) raters agree about which performance is better and
which is worse. Interpretation of Fleiss Kappa statistics (Landis & Koch, 1977) is presented on Table 13.

*Internal consistency* is generally used to measure correlations between different items or questions on the same test. Internal consistency measures whether a collection of items that was supposed to evaluate the same body of factor produce similar or almost similar scores. Internal consistency is typically measured with Cronbach’s alpha (Cronbach, 1951), a statistic calculated from the pair-wise correlations between items. The algorithm of the formula of Cronbach’s alpha (Cronbach, 1951) is described below:

$$
\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N - 1) \cdot \bar{c}}
$$

where, $N$ is equal to the number of items, $c$-bar is the average inter-item covariance among the items and $v$-bar equals the average variance. Hypothetically internal consistency (alpha) ranges from 0.0 to 1.0 but in practical alpha rarely alpha reaches both extreme.

George and Mallory (2003) proposed a simple guide to interpreting Cronbach’s alpha, as shown in Table 12, alpha of .60 - .79 indicate acceptable reliability, .80 -.94 indicate good reliability while .95 or higher is considered undesirable, as this might generally indicates that some items may be redundant or overlapping. In general, alpha of .70 and above is popularly accepted as Cronbach’s alpha cutoff (Nunnally, 1978; Morgan, Leech, Gloeckner & Barrett, 2007). However, some scholars claimed that determining a “one-size-fit-all” cutoff shows “short sightedness” (Schmitt, 1996) and is not always the best practice. When determining to delete or retain an item based on alpha values should take into account the purpose a scale is to be used (Hair, Black, Babin, Anderson, & Tatham, 2006) and content coverage (Schmitt, 1996). Schmitt (1996) also argued that “when alpha values are derived from meaningful content coverage of
certain domain and showed reasonable unidimensionality, low alpha value may not be a major obstruction, in reality may still be quite useful” (Schmitt, 1996, p. 351). Another popular argument is alpha level is affected by the length of the test. If the test length is too short, alpha value will be understandably reduced (Cortina, 1993; Schmitt, 1996; Streiner, 2003).

The goal in designing a reliable scale is to have items in a same factor or category to be related (interrelatedness) but at the same time slightly different therefore contributing some unique information towards understanding the factors or category. In order for Cronbach’s alpha to be correctly interpreted, a few assumptions must be fulfilled; normal data distribution; equal of variance, and unidimensionality (Beckman, Ghosh, Cook, Erwin, Jayawant & Mandrekar, 2004). In reality, alpha values can be very high due to a few reasons such as when measuring several unrelated latent factors and due to the length of the test (i.e., longer test) hence caution must be practiced (Revelle, 1979; Schmitt, 1996).

Table 12
Interpretation of Cronbach’s alpha

<table>
<thead>
<tr>
<th>Internal consistency</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; .50</td>
<td>Unacceptable</td>
</tr>
<tr>
<td>.50 -.59</td>
<td>Poor</td>
</tr>
<tr>
<td>.60-.69</td>
<td>Questionable</td>
</tr>
<tr>
<td>.70-.79</td>
<td>Acceptable</td>
</tr>
<tr>
<td>.80 -.89</td>
<td>Good</td>
</tr>
<tr>
<td>.90-.94</td>
<td>Excellent</td>
</tr>
<tr>
<td>≥ .95</td>
<td>Undesirable</td>
</tr>
</tbody>
</table>


**Analysis of discriminant evidence.** PAGPS-Raters (GRS) will be used by raters to score PA game providing discriminant or contrast evidence. Discriminant validity (evidence) is widely used in psychometrics testing. The rationale for analysis of discriminant evidence is to provide
support for construct validity. For example, to detect discriminant evidence between different PA games a total of ten games (10 videos of Grade 2 and 10 videos of Grade 5 playing) will be chosen with five PA games (easy level) specifically geared for Grade 2 and another five PA games geared to Grade 5 (moderately difficult level). The Grade 2 and Grade 5 students’ reactions during each game will be video-recorded. The recorded PA games’ videos will be uploaded to a secure website or Dropbox and later scored by raters.

<table>
<thead>
<tr>
<th>No.</th>
<th>Game</th>
<th>Grade 2</th>
<th>Grade 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>One-Leg</td>
<td>Moderately Hard</td>
<td>Moderately Hard</td>
</tr>
<tr>
<td>2</td>
<td>Kali-Tui</td>
<td>Moderately Hard</td>
<td>Moderately Hard</td>
</tr>
<tr>
<td>3</td>
<td>Blind man</td>
<td>Moderately Hard</td>
<td>Moderately Hard</td>
</tr>
<tr>
<td>4</td>
<td>Simon says</td>
<td>Easy</td>
<td>Easy</td>
</tr>
<tr>
<td>5</td>
<td>Eagle &amp; Hen</td>
<td>Easy</td>
<td>Easy</td>
</tr>
<tr>
<td>6</td>
<td>Hopscotch</td>
<td>Easy</td>
<td>Easy</td>
</tr>
<tr>
<td>7</td>
<td>Police &amp; Thieves</td>
<td>Moderately Hard</td>
<td>Moderately Hard</td>
</tr>
<tr>
<td>8</td>
<td>Duck Duck Goose</td>
<td>Easy</td>
<td>Easy</td>
</tr>
<tr>
<td>9</td>
<td>Monkey</td>
<td>Moderately Hard</td>
<td>Moderately Hard</td>
</tr>
<tr>
<td>10</td>
<td>Mr. Wolf</td>
<td>Easy</td>
<td>Easy</td>
</tr>
</tbody>
</table>

Figure 20. Game difficulty

The decision to determine whether a given game matched or mismatched a certain group can be statistically shown based on two approaches to achieve decision validity; empirical methods and judgmental-empirical methods (Safrit & Wood, 1995). Empirical method is used to select cutoff points for a criterion-referenced test while judgmental-empirical method requires judgment by the test administrator as well as a database. One type of judgmental-empirical method is known as the contrasting group method. According to Safrit and Wood (1995) in a physical education setting, this method can be applied provided a few conditions are fulfilled: (a)
two or more physical education teachers are knowledgeable about the physical abilities of the targeted student groups, (b) education objective has been set, (c) procedures for objective evaluation has been determined, and (d) no standard has been set-up. Physical education teacher(s) classifies each student group as either master or non-master based on his/her knowledge beside classifying the ten chosen games as easy or moderately hard (Figure 20).

Hypothetically, older students are classified as master, while younger students in the non-master group. Under common understanding, older students should possess higher physical ability compared to younger students. However, because individuals are born different, some students from the non-master group (younger) might be physically (stripes triangle) more advance than their peers, likewise some members of master group (older) might also be physically less advance than their peers (black triangle). These two groups of students (different from their peers) are considered misclassified as shown on Figure 21. A distribution scores is formed for students who are expected to master the given task (e.g., skill test) and one for those not expected to master the given task. The point that both distributions overlapped, is the best estimate of the cutoff score (Figure 21). However Safrit and Wood proposed an easier way to estimate test validity based on this approach that is to set up a contingency table (Figure 22).

In a hypothetical example, cross tabulation table will be used to produce 2 x 2 table (match/no match x. agree/disagree) contingency table. According to the game difficulty table

Note. From Introduction to measurement in physical education and exercise science by Safrit and Wood (1995).

Figure 21. Setting standards using the contrasting groups approach
(Figure 20) One-Leg is classified as a moderately hard game. Hence, when One-Leg is presented to Grade 5 group, it is a good match, hence all ratings from raters for Grade 5 group in this instance will be entered in Cross Tabulation Matched (row) on Figure 22, while when Grade 2 is presented with One-Leg it is classified as mismatch or unmatched hence all ratings are entered on the Unmatched row. The rating scales are coded as (1) for totally disagree, (2) for disagree, (3) for agree, and (4) for totally agree respectively. Data are later collapsed to form two column; agree (Agree + Totally Agree) and disagree (Totally Disagree + Disagree) shown on the far right smaller contingency tables. Item D1 states “This game is easy?” All scores from the smaller tables on the far right for item D1 are later summed to form a contingency table. The collapsed Figure 23 will provide information to compute Proportion of coefficient (P) and Kappa coefficient (κ) for Item D1.

Match* Game Item D1 Cross tabulation

<table>
<thead>
<tr>
<th>Rating</th>
<th>Game 1 Item D1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Match (Grade 5)</td>
<td>0</td>
</tr>
<tr>
<td>Unmatched (Grade 2)</td>
<td>0</td>
</tr>
</tbody>
</table>

Note. D1= This game is easy

Figure 22. Rating of Game 1 Item D1

<table>
<thead>
<tr>
<th></th>
<th>Easy</th>
<th>Not Easy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matched</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>0 (0.0)</td>
<td>10 (.50)</td>
</tr>
<tr>
<td>Unmatched</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>0 (0.0)</td>
<td>10 (.50)</td>
</tr>
</tbody>
</table>

Figure 23. Proportion P and K coefficient

\[
P_0 = \frac{A + D}{A + B + C + D} = \frac{10}{20} = .50
\]
When a moderately hard game (determined by judgmental empirical method) are matched to Grade 5 children, then the rating score would be placed in the upper-left cell (a) on the table. However, when Grade 2 students are presented with the same moderately hard game, rating scores would be tallied in the lower-left cell (c) because moderately hard game is a no match or mismatch for 2nd grader. When all scores have been tallied, the sum of the tallies in each cell is converted into a proportion (Figure 22). Each proportion is calculated by dividing the number of rating within a cell by N, the total number of rating. For example, in cell D, the proportion of rating is 10/20 or .50.

The validity proportion of agreement (P) or coefficient P is calculated by summing the proportion in the upper-left cell (A) and lower-right cell (D). In Figure 22 for Item D1, the whole numbers in the cell represent the number of ratings scores; the numbers in parentheses represent the proportion of ratings. Adding the proportion correctly match prescribed (A + D), the P agreement or P coefficient. In this case, \( P_0 \) is (.00 + .50) or .50.

However, \( P_0 \) agreement failed to account for categorization made due to chance. If we test the ratings by randomly and placing the rating scores into the four cells of contingency table, .25 of the ratings would be placed in each cell purely by chance. Therefore, a \( P_0 \) of .50 (cell A + D) could be obtained merely by chance. Swaminathan, Hambleton, and Algina (1974) suggested a way to correct for chance by applying kappa coefficient (\( \kappa \)). The formula of Kappa coefficient is presented below:

\[
\kappa = \frac{P_0 - P_c}{1 - P_c}
\]

(7)

where, \( P_0 \) is the proportion of agreement or \( P \) coefficient, \( P_c \) is proportion of agreement expected by chance. For example, \( P_c \) is derived by summing cell A + B (.00 + .50) = .50 to equal the
marginal proportion of the row while summing cell A + C (0.00 + 0.00) = 0.00 to equal the
marginal proportion of the column. Multiply the marginal proportion of the outmost row and
column of the table [(0.50)*0.00]. Repeat this process for the innermost row and column
[(1.0)*0.50] Figure 22. As a result, when element of chance is taken into account, the size of
proportion of agreement decrease. Kappa can be interpreted based upon Kappa coefficient table
shown on Table 13 (Landis & Koch, 1977) and Altman (1991).

\[
P_c = [(0.00 + 0.50)*(0.00 + 0.00)] + [(0.50 + 0.50)*(0.50 + 0.00)]
\]
\[
= [(0.00)] + [(0.50)]
\]
\[
= 0.50
\]

\[
\kappa = \frac{P_o - P_c}{1 - P_c}
\]
\[
= \frac{0.50 - 0.50}{1 - 0.50}
\]
\[
= 0.0
\]

Table 13

<table>
<thead>
<tr>
<th>Kappa</th>
<th>Agreement and interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.0</td>
<td>Less than chance agreement</td>
</tr>
<tr>
<td>0.01-0.20</td>
<td>Slight agreement (Slight)</td>
</tr>
<tr>
<td>0.21-0.40</td>
<td>Fair agreement (Fair)</td>
</tr>
<tr>
<td>0.41-0.60</td>
<td>Moderate agreement (Moderate)</td>
</tr>
<tr>
<td>0.61-0.80</td>
<td>Substantial agreement (Good)</td>
</tr>
<tr>
<td>0.81-0.99</td>
<td>Almost perfect agreement (Very good)</td>
</tr>
</tbody>
</table>

Note. From The measurement of observer agreement for categorical data by Landis and Koch (1977).

Descriptive statistics of games. Data collected from raters were further analyzed using
SPSS for different descriptive statistics. Frequency rating counts, percentage, median and inter-
quartile range (IQR) were derived for game-to-game comparison. Likert scale for each rating
choice (1-4) was summed by column to provide category total and overall game total score. Frequency rating counts is the sum of ratings on each category for example, Fun factor, how many times items in this factor were rated 1, 2, and so on, and percentage can be computed. Median is the middle value of a data distribution when the scores are arranged from lowest to highest. Median score divides the distribution in half with an equal number of cases above and below it. Inter quartile range is often used to show the variability of a data set. Inter quartile range is the distance between 25th and 75th percentile values.

In summary, two stages of development and validation process will be employed in this study. The developmental stage will focus on the development of PAGPS-PE Teachers while the validation stage will focus on the calibration and gathering validity and reliability evidences of PAGPS-Raters (GRS). The flow of this study is presented on Figure 24.
Development of PAGPS (Draft 1)

Round table panel expert discussion

Development of PAGPS (Draft 2)

Panel creates 5-7 items for each category

Panel self-evaluation Draft (2)

Final panel discussion

Development of PAGPS (Draft 3)

PAGPS (Draft 3) administer to PE teachers

PCA (Internal structure evidence)

Rasch Analysis (Internal structure evidence)

Cronbach Alpha (Internal consistency evidence)

PAPGPS (Draft 4) (Game Rating Scale [GRS])

P coefficient & K coefficient (Discriminant evidence)

Inter-rater reliability (Reliability evidence)

Descriptive Statistics (Validity evidence)

Validated PAGPS

School children participating in PA games

Video recording of PA games play

Figure 24. PAGPS developmental and validation flow chart
CHAPTER 4

RESULTS

This chapter contains the results of the statistical analyses based on the study specific aims. Results were consisted in three parts. Part One reported descriptive data of PE teachers and raters. Part Two data analysis consisted of PCA and Rasch modeling (WINSTEPS) data analysis for internal structure evidence. PCA and Rasch procedures addressed Aim One and Aim Two. Finally, Part Three consisted inter-rater reliability, kappa coefficient and game-to-game descriptive statistics are presented and explained in detailed answering Aim Three and thus validating PAGPS questionnaire.

Part One:

Participants’ Descriptive Characteristics

Two hundred physical education teachers (N=200) were recruited to rate the importance of each subscale and items in PAGPS-PE teachers (development stage) to determine which items should be included for the final PAGPS-Raters (Game Rating Scale or GRS). Mean age of PE teachers were 33.61 ± 6.7 years, ranging from 23 to 58 years old. Recruited PE teachers were fairly experienced with a reported mean teaching experience of 8.30 ± 5.63 years, ranging from 1 to 29 years (Table 14). Out of the 200 teachers, 145 (72.5%) were male. Most PE teachers taught at the high school level (n=152), follow by middle school (n=46), and kindergarten or elementary school (n=1). PE teachers were recruited from every state in Malaysia (Table 14) with majority PE teachers originating from Kuala Lumpur (68.5%) while the states that recorded the lowest number of participation are Kelantan (.5%) and Pahang (.5%) respectively.
Table 14

*Descriptive statistics of PE teachers and raters*

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent (%)</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
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<td><strong>PE Teachers</strong></td>
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</tr>
<tr>
<td>Master</td>
<td>4</td>
<td>40.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PhD</td>
<td>4</td>
<td>40.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Subsequently, a total of ten raters were also recruited for rating purposes (validating stage). Mean age of raters were 35.60±8.07 years, ranging from 25 to 46 years. Rating
experience ranges from $4.2 \pm 5.07$ years. Forty percent of the raters were female ($n=4$), while raters’ education background ranged from a bachelor degree to a doctoral degree.

**Part Two:**

Principal Component Analysis

Table 15

*KMO and Bartlett's test*

<table>
<thead>
<tr>
<th>KMO and Bartlett’s Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaiser-Meyer-Olkin Measure of Sampling Adequacy</td>
</tr>
<tr>
<td>Bartlett’s Test of Sphericity</td>
</tr>
<tr>
<td>Approx. Chi-Square</td>
</tr>
<tr>
<td>df</td>
</tr>
<tr>
<td>Sig.</td>
</tr>
</tbody>
</table>

PCA was administered to determine which factors or subscale to be maintained or deleted. Kaiser-Meyer-Olkin Measures, Communalities, Total Variance Explained, Scree Plot and Component Matrix tables were checked prior to further decision making.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) value ranged from 0 to 1 and the closer KMO value to 1 are regard as desirable. A KMO value of .6 is the minimum requirement for a satisfactory factor analysis to proceed. KMO analysis predicts whether enough items are predicted by each factor. Bartlett’s Test of Sphericity tests the null hypotheses that the correlation matrixes of the variables in the population correlation matrix are uncorrelated. A value of less than .05 is the accepted statistical significant value. This indicates that variables are correlated high enough to provide a basis to proceed with factor analysis. KMO analysis reported a value of 0.713, and Bartlett sphericity value observed significance level at .000 (Table 15), both provide positive indication to proceed with PCA.
Communalities table explained the proportion of variance explained by the principal components, whereby extraction column indicate the proportion of each variable’s variance that can be explained by principal components. A portion (10 out of 116 items) data analysis results are shown on Table 16. Communalities represent the relation between the variable and all other variables (i.e., the squared multiple correlation between the item and all other items). Extraction values ranges from 0 to 1.00. One (1.00) extraction value indicates that the factor successfully explained all the variance while zero (0) extraction values indicates that the common factor does not explained for any variance. For example, first round extraction for Item 1 (code F1): “Participants giggled/laughed” explained .751 of the variance, Item 2 (F2) Participants were excited (e.g., shouted “Yes”, “Yeah” etc.) explained .697 (Table 16), only a small portion of is presented. Overall high extraction values were reported ranging from .616 to .846.

Table 16

<table>
<thead>
<tr>
<th>Communalities</th>
<th>Extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants giggled/ laughed: Facial expression and verbal reaction: How important is the element of fun (facial expression) in game evaluation?</td>
<td>.751</td>
</tr>
<tr>
<td>Participants were excited (e.g., shouted ‘Yes’, ‘Yeah’, etc.): Facial expression and verbal reaction: How important is the element of fun (facial expression) in game evaluation?</td>
<td>.697</td>
</tr>
<tr>
<td>Participants were cheering for their partner, team mates or themselves: Facial expression and verbal reaction: How important is the element of fun (facial expression) in game evaluation?</td>
<td>.776</td>
</tr>
<tr>
<td>Participants were crying: Facial expression and verbal reaction: How important is the element of fun (facial expression) in game evaluation?</td>
<td>.736</td>
</tr>
<tr>
<td>Participants look excited: Facial Reaction and non-verbal reaction: How important is game fun (e.g., facial reaction, non-verbal) in game evaluation?</td>
<td>.828</td>
</tr>
<tr>
<td>Participants were smiling: Facial Reaction and non-verbal reaction: How important is game fun (facial reaction-non verbal) in game evaluation?</td>
<td>.752</td>
</tr>
</tbody>
</table>
Participants look enthusiastic: Facial Reaction and non-verbal reaction: How important is game fun (facial reaction-non-verbal) in game evaluation? .688

Participants look bored: Facial Reaction and non-verbal reaction: How important is game fun (facial reaction-non-verbal) in game evaluation? .799

Participants were frowning: Facial Reaction and non-verbal reaction: How important is game fun (facial reaction-non-verbal) in game evaluation? .721

Participants look confused: Facial Reaction and non-verbal reaction: How important is game fun (facial reaction-non-verbal) in game evaluation? .812

Participants look frustrated: Facial Reaction and non-verbal reaction: How important is game fun (facial reaction-non-verbal) in game evaluation? .749

Note. Selected first 10 results only

Next, in the “Total Variance Explained” table, component column explained how many components were extracted during principal component analysis. In our initial analysis, there are 116 items. However in Table 17, only 49 components/items were shown due to eigenvalues dropped below 1.00 and space constraint.

The cumulative column exhibited the cumulative percentage of variance accounted for by the current and all preceding principal components. Extraction Sums of Squared Loading reproduced the values given on the same row on the left side of the table (Initial Eigenvalues). The number of rows reproduced is determined by the number of components whose eigenvalues are 1 or greater (refer to Total in Table 17).

Factor One explained the most variance at 18.34%, Component 2 explained 4.93%, and so on. Extraction sum if squared loadings stopped at item 33 when eigenvalues dropped to less than 1.00. At this point cumulative percentage (Initial Eigenvalues) totaled 75.88%.
Table 17

Total variance explained (Round 1)

<table>
<thead>
<tr>
<th>Component</th>
<th>Initial Eigenvalues</th>
<th>Extraction Sums if Squared Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Variance Explained</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>% of Variance</td>
</tr>
<tr>
<td>2</td>
<td>5.722</td>
<td>4.933</td>
</tr>
<tr>
<td>3</td>
<td>4.928</td>
<td>4.248</td>
</tr>
<tr>
<td>5</td>
<td>3.643</td>
<td>3.141</td>
</tr>
<tr>
<td>6</td>
<td>3.023</td>
<td>2.606</td>
</tr>
<tr>
<td>7</td>
<td>2.808</td>
<td>2.421</td>
</tr>
<tr>
<td>8</td>
<td>2.616</td>
<td>2.255</td>
</tr>
<tr>
<td>9</td>
<td>2.433</td>
<td>2.097</td>
</tr>
<tr>
<td>10</td>
<td>2.373</td>
<td>2.045</td>
</tr>
<tr>
<td>11</td>
<td>2.219</td>
<td>1.913</td>
</tr>
<tr>
<td>12</td>
<td>2.034</td>
<td>1.754</td>
</tr>
<tr>
<td>13</td>
<td>2.029</td>
<td>1.749</td>
</tr>
<tr>
<td>14</td>
<td>1.922</td>
<td>1.657</td>
</tr>
<tr>
<td>15</td>
<td>1.880</td>
<td>1.620</td>
</tr>
<tr>
<td>16</td>
<td>1.844</td>
<td>1.589</td>
</tr>
<tr>
<td>17</td>
<td>1.738</td>
<td>1.498</td>
</tr>
<tr>
<td>18</td>
<td>1.656</td>
<td>1.428</td>
</tr>
<tr>
<td>19</td>
<td>1.638</td>
<td>1.412</td>
</tr>
<tr>
<td>20</td>
<td>1.597</td>
<td>1.376</td>
</tr>
<tr>
<td>21</td>
<td>1.497</td>
<td>1.291</td>
</tr>
<tr>
<td>22</td>
<td>1.445</td>
<td>1.246</td>
</tr>
<tr>
<td>23</td>
<td>1.419</td>
<td>1.223</td>
</tr>
<tr>
<td>24</td>
<td>1.356</td>
<td>1.169</td>
</tr>
<tr>
<td>25</td>
<td>1.328</td>
<td>1.145</td>
</tr>
<tr>
<td>26</td>
<td>1.293</td>
<td>1.115</td>
</tr>
<tr>
<td>27</td>
<td>1.228</td>
<td>1.058</td>
</tr>
<tr>
<td>28</td>
<td>1.194</td>
<td>1.029</td>
</tr>
<tr>
<td>29</td>
<td>1.174</td>
<td>1.012</td>
</tr>
<tr>
<td>30</td>
<td>1.109</td>
<td>.956</td>
</tr>
<tr>
<td>31</td>
<td>1.052</td>
<td>.907</td>
</tr>
<tr>
<td>32</td>
<td>1.047</td>
<td>.903</td>
</tr>
<tr>
<td>33</td>
<td>1.005</td>
<td>.867</td>
</tr>
<tr>
<td>34</td>
<td>.976</td>
<td>.841</td>
</tr>
<tr>
<td>35</td>
<td>.968</td>
<td>.834</td>
</tr>
<tr>
<td>36</td>
<td>.927</td>
<td>.799</td>
</tr>
<tr>
<td>37</td>
<td>.886</td>
<td>.763</td>
</tr>
<tr>
<td>38</td>
<td>.860</td>
<td>.741</td>
</tr>
<tr>
<td>39</td>
<td>.834</td>
<td>.719</td>
</tr>
<tr>
<td>40</td>
<td>.789</td>
<td>.680</td>
</tr>
<tr>
<td>41</td>
<td>.771</td>
<td>.665</td>
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<td>42</td>
<td>.750</td>
<td>.646</td>
</tr>
<tr>
<td>43</td>
<td>.743</td>
<td>.640</td>
</tr>
<tr>
<td>44</td>
<td>.727</td>
<td>.627</td>
</tr>
<tr>
<td>45</td>
<td>.697</td>
<td>.601</td>
</tr>
<tr>
<td>46</td>
<td>.683</td>
<td>.589</td>
</tr>
<tr>
<td>47</td>
<td>.645</td>
<td>.556</td>
</tr>
<tr>
<td>48</td>
<td>.635</td>
<td>.547</td>
</tr>
<tr>
<td>49</td>
<td>.598</td>
<td>.516</td>
</tr>
</tbody>
</table>

Extraction Method: Principal Component Analysis
Figure 25. Scree plot

The Cattell scree plot is a visual-graphical method that plotted the eigenvalues on the y-axis and the component number or factors on the x-axis (Cattell, 1966). The “elbow” is a point after which all the eigenvalues are aligned linearly. In Figure 25, approximately six or seven components onwards, the graph started to flatten.

The decision of the number of factors also takes into account recommendation that only components which possess eigenvalues greater than 1.0 should be retained (Kaiser, 1960). This is because components with an eigenvalues of less than 1.0 account for less variance than did the original variable (which had a variance of 1.0), hence are of little use (Leech et al., 2008). For the initial first round of PCA, six factors were extracted for analysis as shown on Component Matrix in Table 18.
Table 18  
**Component matrix (Round 1)**

<table>
<thead>
<tr>
<th>Component Matrix</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 38-Code P5: Participants exhibited hopping movement (starts on one foot and lands on the same foot): Loco motor Movement (one movement): How important is the element of physical abilities (loco motor movement) in game evaluation?</td>
<td>.632</td>
<td>.020</td>
<td>-.219</td>
<td>-.017</td>
<td>.016</td>
<td>-.047</td>
</tr>
<tr>
<td>Item 66-Code Sk5: Participants exhibited continuous skills (no obvious beginning or end. The end of one cycle of movements is the beginning of the next, and the skill is repeated like a cycle): Skills: How important is the element of skills in game evaluation?</td>
<td>.627</td>
<td>.081</td>
<td>-.229</td>
<td>-.015</td>
<td>-.034</td>
<td>-.127</td>
</tr>
<tr>
<td>Item 49-Code P16: Participants exhibited catching movement (e.g., catching thrown ball/object): Absorptive Movement: How important is the element of physical abilities (absorptive movement) in game evaluation?</td>
<td>.605</td>
<td>.260</td>
<td>.090</td>
<td>.073</td>
<td>-.018</td>
<td>.029</td>
</tr>
<tr>
<td>Item 51-Code P18: Participants exhibited passing movement (e.g., ball/object): Absorptive Movement: How important is the element of physical abilities (absorptive movement) in game evaluation?</td>
<td>.586</td>
<td>-.037</td>
<td>-.048</td>
<td>-.118</td>
<td>.077</td>
<td>-.096</td>
</tr>
<tr>
<td>Item 43-Code P10: Participants exhibited ball rolling movement (i.e., ball/object): Manipulative Movement: How important is the element of physical abilities (manipulative movement) in game evaluation?</td>
<td>.585</td>
<td>-.010</td>
<td>.297</td>
<td>-.226</td>
<td>.010</td>
<td>.075</td>
</tr>
<tr>
<td>Item 5-Code F5: Participants look excited: Facial Reaction and non-verbal reaction: How important is game fun (facial reaction-non-verbal) in game evaluation?</td>
<td>.397</td>
<td>.306</td>
<td>.288</td>
<td>-.261</td>
<td>-.040</td>
<td>-.054</td>
</tr>
<tr>
<td>Item 91-Code E6: Game is affected by weather (sun/cloudy/rain, etc.): Environment and Equipment: How important are the elements of environment and equipment(s) in game evaluation?</td>
<td>.340</td>
<td>-.330</td>
<td>-.229</td>
<td>.041</td>
<td>.064</td>
<td>.301</td>
</tr>
</tbody>
</table>

*Note.* Selected result only. Extraction Method: Principal Component Analysis. 6 components extracted.

Component Matrix table indicates how each item in the analysis correlates with each of the retained factors. Negative and positive correlations carry the same weight. Three selected items from the Component Matrix table are shown in Table 18. If there are more than one high value(s) and both loaded strongly, that particular item has to be removed because it failed to
indicate which component it belong. For example, Item 38, 43, 49, 51, 66 loaded nicely on Factor 1. However, Item 5 (F5) “Participants look excited” cross loaded on Factor 1 (.397) and Factor 2 (.306) at the same time. Item 5 failed to clearly indicate which factor it belongs to, hence this item was deleted. Another example Item 91 (E6): “Game is affected by weather (sun/cloudy/rain, etc.)” cross loaded three factors: Factor 1 (.340), Factor 2 (-.330), and Factor 6 (.301) respectively. One of the values is negative, as explained earlier, positive and negative values carry the same weight. As a result, this item was also deleted.

A second round of PCA were run to determine which item would remain. A total of 12 items were deleted in Round One. Six component/factors were selected in the varimax rotation. The selected results are presented on Table 19 for Communalities and Table 20 Rotated Matrix Analysis respectively.

Table 19

Communalities table (Round 2)

<table>
<thead>
<tr>
<th></th>
<th>Extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants giggled/ laughed:</td>
<td>.346</td>
</tr>
<tr>
<td>Facial expression and verbal</td>
<td></td>
</tr>
<tr>
<td>reaction: How important is the</td>
<td></td>
</tr>
<tr>
<td>element of fun (facial</td>
<td></td>
</tr>
<tr>
<td>expression) in game evaluation?</td>
<td></td>
</tr>
<tr>
<td>Participants were excited (e.g.,</td>
<td>.360</td>
</tr>
<tr>
<td>shouted 'Yes', 'Yeah', etc.):</td>
<td></td>
</tr>
<tr>
<td>Facial expression and verbal</td>
<td></td>
</tr>
<tr>
<td>reaction: How important is the</td>
<td></td>
</tr>
<tr>
<td>element of fun (facial</td>
<td></td>
</tr>
<tr>
<td>expression) in game evaluation?</td>
<td></td>
</tr>
<tr>
<td>Participants were cheering for</td>
<td>.290</td>
</tr>
<tr>
<td>their partner, team mates or</td>
<td></td>
</tr>
<tr>
<td>themselves: Facial expression</td>
<td></td>
</tr>
<tr>
<td>and verbal reaction: How</td>
<td></td>
</tr>
<tr>
<td>important is the element of fun</td>
<td></td>
</tr>
<tr>
<td>(facial expression) in game</td>
<td></td>
</tr>
<tr>
<td>evaluation?</td>
<td></td>
</tr>
<tr>
<td>Participants were crying:</td>
<td>.300</td>
</tr>
<tr>
<td>Facial expression and verbal</td>
<td></td>
</tr>
<tr>
<td>reaction: How important is the</td>
<td></td>
</tr>
<tr>
<td>element of fun (facial</td>
<td></td>
</tr>
<tr>
<td>expression) in game evaluation?</td>
<td></td>
</tr>
<tr>
<td>Participants look excited:</td>
<td>.406</td>
</tr>
<tr>
<td>Facial Reaction and non- verbal</td>
<td></td>
</tr>
<tr>
<td>reaction: How important is the</td>
<td></td>
</tr>
<tr>
<td>game fun (facial reaction-non-</td>
<td></td>
</tr>
<tr>
<td>verbal) in game evaluation?</td>
<td></td>
</tr>
<tr>
<td>Participants were smiling:</td>
<td>.224</td>
</tr>
<tr>
<td>Facial Reaction and non-verbal</td>
<td></td>
</tr>
<tr>
<td>reaction: How important is the</td>
<td></td>
</tr>
<tr>
<td>game fun (facial reaction-non-</td>
<td></td>
</tr>
<tr>
<td>verbal) in game evaluation?</td>
<td></td>
</tr>
</tbody>
</table>

Note. Selected result only.
Table 20

**Rotated component matrix**

<table>
<thead>
<tr>
<th>Component Matrix</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants experienced the value of teamwork and cooperation: Social: How</td>
<td>.593</td>
<td>.273</td>
<td>.055</td>
<td>.216</td>
<td>-.050</td>
<td>-.028</td>
</tr>
<tr>
<td>important is the element of social aspect in game evaluation?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For more than 6 participants: Number of participants: How important is participants'</td>
<td>.567</td>
<td>.217</td>
<td>.056</td>
<td>-.094</td>
<td>-.032</td>
<td>.055</td>
</tr>
<tr>
<td>characteristics (number of participants) in game evaluation?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participants learned orienteering skills: Cognitive: How important is the element</td>
<td>.536</td>
<td>-.033</td>
<td>.249</td>
<td>.109</td>
<td>.017</td>
<td>-.184</td>
</tr>
<tr>
<td>of cognitive ability in game evaluation?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Required the availability of special environment/facility (e.g., gym, field,</td>
<td>.515</td>
<td>.103</td>
<td>-.003</td>
<td>-.101</td>
<td>.054</td>
<td>.059</td>
</tr>
<tr>
<td>court, swimming pool): Environment and Equipment: How important are the elements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of environment and equipment(s) in game evaluation?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For 3-6 participants: Number of participants: How important is participants'</td>
<td>.507</td>
<td>.250</td>
<td>-.011</td>
<td>.041</td>
<td>.224</td>
<td>-.002</td>
</tr>
<tr>
<td>characteristics (number of participants) in game evaluation?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Game is played outdoor environment: Environment and Equipment: How important is</td>
<td>.500</td>
<td>-.112</td>
<td>.200</td>
<td>.024</td>
<td>.100</td>
<td>-.080</td>
</tr>
<tr>
<td>the elements of environment and equipment(s) in game evaluation?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participants exhibited leaping movement (starts on one foot and lands on the</td>
<td>.475</td>
<td>.308</td>
<td>.311</td>
<td>.037</td>
<td>-.012</td>
<td>-.075</td>
</tr>
<tr>
<td>other foot): Loco motor Movement (one movement): How important is the element of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>physical abilities (loco motor movement) in game evaluation?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>This game combined chance, physical skills and strategy (in any order or</td>
<td>.472</td>
<td>.022</td>
<td>.288</td>
<td>.078</td>
<td>-.118</td>
<td>.017</td>
</tr>
<tr>
<td>combination): Game structure: How important is the element of game structure(s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in game evaluation?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Game is played in an open environment (e.g., field or school playground whereby</td>
<td>.470</td>
<td>.129</td>
<td>.171</td>
<td>.137</td>
<td>.143</td>
<td>.161</td>
</tr>
<tr>
<td>game-play depends on weather and exposed to other uncontrollable factors): Game</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>structure: How important is the element of game structure(s) in game evaluation?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


In PCA analysis, decisions to delete item are based upon component matrix. The unsuitable or deleted items (indicated with an “x”) in each round of PCA analysis are summarized in Table 21. For example, under Player Characteristic factor, Item 77 (Gs6):

“Predetermined time frame” was deleted in First Round because loading were shown on three
factors (Factor 1, 3 and 4). In Round One, 13 items was deleted, seven more items were deleted in Round Two (Table 21). Although PCA proposed to delete Item 93, based on content consideration (Granger, 2008; Lopez, 1996), it was retained. Specifically Item 93 was retained so that raters in the later stage of data collection can determine if a game is “easy” or moderately hard."

Table 21

Summary of PCA deleted items

<table>
<thead>
<tr>
<th>Round 1</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
<th>Factor 5</th>
<th>Factor 6</th>
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</thead>
<tbody>
<tr>
<td>Fun</td>
<td></td>
<td>x</td>
<td>x</td>
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<tr>
<td>Item 2: F2 Excited</td>
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<tr>
<td>Item 5: F5 Excited (non-verbal)</td>
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<tr>
<td>Item 16: F16 Refused to stop playing</td>
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<td></td>
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<td>x</td>
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<tr>
<td>Social</td>
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<tr>
<td>Item 24: S4 Exposed to social tension</td>
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<td>x</td>
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<tr>
<td>Games Structure</td>
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<tr>
<td>Item 73: Gs2 Rules quite structured</td>
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<tr>
<td>Item 77: Gs6 Predetermined time frame</td>
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<td>x</td>
<td>x</td>
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<td>Environment</td>
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<tr>
<td>Item 89: E4 Game is played in indoor environment</td>
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<tr>
<td>Item 91: E6 Affected by weather</td>
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<tr>
<td>Player’s Characteristics</td>
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<tr>
<td>Item 100: PC4 Need 1-2 players</td>
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<tr>
<td>Item 103: PC7 Need high skills</td>
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<td>Item 104: PC8 Need moderate skills</td>
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<td>Item 107: PC11 Age related cognitive readiness</td>
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<tr>
<td>Round 2</td>
<td>Factor 1</td>
<td>Factor 2</td>
<td>Factor 3</td>
<td>Factor 4</td>
<td>Factor 5</td>
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<td>Item 7: F7 Enthusiastic</td>
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<tr>
<td>Item 72: Gs1 Rules loose/simple</td>
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<td>Games Difficulty</td>
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<td>Item 93: GD1 Easy**</td>
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<td>Item 95: GD3 Moderate difficult</td>
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<td>Item 96: GD4 Difficult</td>
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<td>Player’s Characteristics</td>
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<tr>
<td>Item 97: PC1 Suitable for children without special needs</td>
<td>x</td>
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</tr>
</tbody>
</table>

Note. X indicates loading as shown on component matrix.
**Item 93 was retained due to content relevance and balance reason.

Rasch Analysis

Rasch analysis was used to check for goodness-of-fit of model and data. Goodness-of-fit statistics are checked using Infit and Outfit mean square statistics indexes. This study followed the recommendation of .5 to 1.5, a more relax criterion (Winsteps & Rasch Measurement
Software, 2010) hence any item with outfit or infit values less than .5 or more than 1.5 were deleted.

Table 22

**Summary of Rasch analysis**

<table>
<thead>
<tr>
<th>Category</th>
<th>Items (99 items)</th>
<th>Calibration (Logits)</th>
<th>SE Logits</th>
<th>Infit (MnSq)</th>
<th>Outfit (MnSq)</th>
<th>Numbers of item in short version</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>Giggled/ laughed</td>
<td>0.05</td>
<td>0.09</td>
<td>0.9</td>
<td>1.0</td>
<td>X X X X</td>
</tr>
<tr>
<td>F3</td>
<td>Cheering</td>
<td>-0.21</td>
<td>0.09</td>
<td>0.9</td>
<td>0.9</td>
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<tr>
<td>F4</td>
<td>Crying</td>
<td>0.76</td>
<td>0.08</td>
<td>1.4</td>
<td>1.5</td>
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</tr>
<tr>
<td>F6</td>
<td>Smiling</td>
<td>-0.38</td>
<td>0.10</td>
<td>1.0</td>
<td>1.1</td>
<td>X X X X</td>
</tr>
<tr>
<td>F8</td>
<td>Look bored</td>
<td>0.57</td>
<td>0.08</td>
<td>1.3</td>
<td>1.6</td>
<td>X X X X</td>
</tr>
<tr>
<td>F9</td>
<td>Frowning</td>
<td>0.52</td>
<td>0.08</td>
<td>1.0</td>
<td>1.1</td>
<td>X X X</td>
</tr>
<tr>
<td>F10</td>
<td>Confused</td>
<td>0.62</td>
<td>0.08</td>
<td>1.2</td>
<td>1.3</td>
<td>X X X X</td>
</tr>
<tr>
<td>F11</td>
<td>Frustrated</td>
<td>0.46</td>
<td>0.08</td>
<td>1.3</td>
<td>1.4</td>
<td>X X X X</td>
</tr>
<tr>
<td>F13</td>
<td>Look disinterested</td>
<td>0.38</td>
<td>0.09</td>
<td>1.3</td>
<td>1.5</td>
<td>X X X</td>
</tr>
<tr>
<td>F14</td>
<td>Curled up in a corner</td>
<td>0.47</td>
<td>0.08</td>
<td>1.6</td>
<td>1.8</td>
<td>X X X X</td>
</tr>
<tr>
<td>F15</td>
<td>Paying attention</td>
<td>-1.53</td>
<td>0.14</td>
<td>1.5</td>
<td>2.0</td>
<td>X X X</td>
</tr>
<tr>
<td>F17</td>
<td>Engaged actively</td>
<td>-1.09</td>
<td>0.12</td>
<td>1.3</td>
<td>1.5</td>
<td>X X</td>
</tr>
<tr>
<td>F18</td>
<td>Requested to play again</td>
<td>-1.09</td>
<td>0.12</td>
<td>1.4</td>
<td>1.5</td>
<td>X X X X</td>
</tr>
<tr>
<td>F19</td>
<td>Clapping their hands in excitement</td>
<td>-1.48</td>
<td>0.13</td>
<td>1.4</td>
<td>1.7</td>
<td>X X X X</td>
</tr>
<tr>
<td>F20</td>
<td>Look withdrawn, shy, or intimidate</td>
<td>-0.72</td>
<td>0.11</td>
<td>1.3</td>
<td>1.5</td>
<td>X X X X</td>
</tr>
<tr>
<td>S1</td>
<td>Encouraged to interact</td>
<td>-0.12</td>
<td>0.09</td>
<td>0.9</td>
<td>0.9</td>
<td>X X X</td>
</tr>
<tr>
<td>S2</td>
<td>Encouraged to integrate, &amp; united</td>
<td>-0.25</td>
<td>0.09</td>
<td>0.9</td>
<td>0.9</td>
<td>X</td>
</tr>
<tr>
<td>S3</td>
<td>Encouraged respect</td>
<td>-0.47</td>
<td>0.10</td>
<td>1.0</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>S5</td>
<td>Experienced teamwork</td>
<td>-0.35</td>
<td>0.10</td>
<td>1.0</td>
<td>0.9</td>
<td>X X</td>
</tr>
<tr>
<td>S6</td>
<td>Exposed to racial tolerance</td>
<td>-0.07</td>
<td>0.09</td>
<td>1.1</td>
<td>1.1</td>
<td>X X X</td>
</tr>
<tr>
<td>S7</td>
<td>Exposed to aggression &amp; hostility</td>
<td>0.33</td>
<td>0.09</td>
<td>1.2</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>Learned strategic planning</td>
<td>-0.01</td>
<td>0.09</td>
<td>1.1</td>
<td>1.1</td>
<td>X X</td>
</tr>
<tr>
<td>C2</td>
<td>Practiced basic mathematics</td>
<td>0.21</td>
<td>0.09</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>Learned creative thinking</td>
<td>-0.22</td>
<td>0.09</td>
<td>1.1</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>C4</td>
<td>Learned orienteering skills</td>
<td>0.22</td>
<td>0.09</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>C5</td>
<td>Learned to follow basic instruction</td>
<td>-0.13</td>
<td>0.09</td>
<td>1.1</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>C6</td>
<td>Encourage to use their memory</td>
<td>-0.06</td>
<td>0.09</td>
<td>1.1</td>
<td>1.1</td>
<td>X X X</td>
</tr>
<tr>
<td>Category</td>
<td>Items (99 items)</td>
<td>Calibration (Logits)</td>
<td>SE (Logits)</td>
<td>Infit (MnSq)</td>
<td>Outfit (MnSq)</td>
<td>Numbers of items in short version</td>
</tr>
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<td>------------</td>
<td>-------------</td>
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</tr>
<tr>
<td>P1</td>
<td>Exhibited walking movement</td>
<td>-0.22</td>
<td>0.09</td>
<td>0.9</td>
<td>0.8</td>
<td>X X X X</td>
</tr>
<tr>
<td>P2</td>
<td>Running movement</td>
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<td>0.10</td>
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<tr>
<td>P3</td>
<td>Jumping movement</td>
<td>-0.20</td>
<td>0.09</td>
<td>0.8</td>
<td>0.7</td>
<td>X X X X</td>
</tr>
<tr>
<td>P4</td>
<td>Leaping movement</td>
<td>0.05</td>
<td>0.09</td>
<td>0.9</td>
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<td>X X X X</td>
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<tr>
<td>P5</td>
<td>Hopping movement</td>
<td>0.19</td>
<td>0.09</td>
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<td>X X X X</td>
</tr>
<tr>
<td>P6</td>
<td>Galloping movement</td>
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<td>0.09</td>
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<td>0.8</td>
<td>X X X X</td>
</tr>
<tr>
<td>P7</td>
<td>Sliding movement</td>
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<td>X X X X</td>
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<tr>
<td>P8</td>
<td>Skipping movement</td>
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<td>0.09</td>
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<td>0.7</td>
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<tr>
<td>P9</td>
<td>Climbing movement</td>
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<tr>
<td>P10</td>
<td>Ball rolling movement</td>
<td>0.05</td>
<td>0.09</td>
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<td>Throwing movement</td>
<td>-0.17</td>
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<td>P12</td>
<td>Kicking movement</td>
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<td>0.09</td>
<td>0.9</td>
<td>0.8</td>
<td>X X</td>
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<tr>
<td>P13</td>
<td>Striking/ tagging movement</td>
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<td>Volleying movement</td>
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<td>0.09</td>
<td>0.8</td>
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<tr>
<td>P15</td>
<td>Bouncing movement</td>
<td>0.16</td>
<td>0.09</td>
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<td>0.9</td>
<td>X X X X</td>
</tr>
<tr>
<td>P16</td>
<td>Catching movement</td>
<td>-0.08</td>
<td>0.09</td>
<td>0.9</td>
<td>0.8</td>
<td>X X X X</td>
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<tr>
<td>P17</td>
<td>Trapping movement</td>
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<td>0.09</td>
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<tr>
<td>P18</td>
<td>Passing movement</td>
<td>-0.07</td>
<td>0.09</td>
<td>0.7</td>
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<tr>
<td>P19</td>
<td>Shooting movement</td>
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<td>0.09</td>
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<tr>
<td>P20</td>
<td>Dribbling movement</td>
<td>0.15</td>
<td>0.09</td>
<td>1.0</td>
<td>0.9</td>
<td>X X X X</td>
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<tr>
<td>P21</td>
<td>Bending movement</td>
<td>-0.23</td>
<td>0.09</td>
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<td>0.8</td>
<td>X X X X</td>
</tr>
<tr>
<td>P22</td>
<td>Stretching movement</td>
<td>-0.18</td>
<td>0.09</td>
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<td>0.8</td>
<td>X X X X</td>
</tr>
<tr>
<td>P23</td>
<td>Twisting movement</td>
<td>-0.07</td>
<td>0.09</td>
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<td>0.8</td>
<td>X X X X</td>
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<td>Body rolling movement</td>
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<td>X X X X</td>
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<td>P25</td>
<td>Balancing movement</td>
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<td>0.09</td>
<td>1.0</td>
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<td>Dodging movement</td>
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<td>P27</td>
<td>Turning movement</td>
<td>-0.04</td>
<td>0.09</td>
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<td>Swinging movement</td>
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</tr>
<tr>
<td>SK1</td>
<td>Gross motor skills</td>
<td>-0.25</td>
<td>0.09</td>
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<tr>
<td>SK2</td>
<td>Fine motor skills</td>
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<tr>
<td>SK3</td>
<td>Discrete skills</td>
<td>-0.14</td>
<td>0.09</td>
<td>0.8</td>
<td>0.7</td>
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</tr>
<tr>
<td>SK4</td>
<td>Serial skills</td>
<td>0.10</td>
<td>0.09</td>
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<td>X X X X</td>
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<tr>
<td>SK5</td>
<td>Continues skills</td>
<td>0.17</td>
<td>0.09</td>
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<td>X X X X</td>
</tr>
<tr>
<td>SK6</td>
<td>Open skills</td>
<td>-0.05</td>
<td>0.09</td>
<td>1.0</td>
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<tr>
<td>SK7</td>
<td>Closed skills</td>
<td>-0.07</td>
<td>0.09</td>
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</table>
Table 22 (cont.)

<table>
<thead>
<tr>
<th>Category</th>
<th>Item (99 items)</th>
<th>Calibration (Logits)</th>
<th>SE (Logits)</th>
<th>Infit (MnSq)</th>
<th>Outfit (MnSq)</th>
<th>Numbers of items in short version</th>
</tr>
</thead>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>53 36 28 20</td>
</tr>
<tr>
<td>SK8</td>
<td>Single task skill</td>
<td>0.02</td>
<td>0.09</td>
<td>0.8</td>
<td>0.7</td>
<td>X</td>
</tr>
<tr>
<td>SK9</td>
<td>Dual-tasks skills</td>
<td>0.09</td>
<td>0.09</td>
<td>0.7</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>SK10</td>
<td>Multi-tasks skills</td>
<td>0.03</td>
<td>0.09</td>
<td>0.8</td>
<td>0.8</td>
<td>X X X X</td>
</tr>
<tr>
<td>G3</td>
<td>Very structured (complex or tight)</td>
<td>0.24</td>
<td>0.09</td>
<td>1.1</td>
<td>1.2</td>
<td>X X X X</td>
</tr>
<tr>
<td>G4</td>
<td>Control environment</td>
<td>0.22</td>
<td>0.09</td>
<td>0.9</td>
<td>0.9</td>
<td>X X X X</td>
</tr>
<tr>
<td>G5</td>
<td>Open environment</td>
<td>0.00</td>
<td>0.09</td>
<td>1.1</td>
<td>1.0</td>
<td>X X X X</td>
</tr>
<tr>
<td>G7</td>
<td>No predetermined time frame</td>
<td>0.34</td>
<td>0.09</td>
<td>1.1</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>G8</td>
<td>Based upon chance</td>
<td>0.31</td>
<td>0.09</td>
<td>0.9</td>
<td>0.9</td>
<td>X X X X</td>
</tr>
<tr>
<td>G9</td>
<td>Based upon physical prowess</td>
<td>0.09</td>
<td>0.09</td>
<td>0.8</td>
<td>0.8</td>
<td>X</td>
</tr>
<tr>
<td>G10</td>
<td>Based upon strategy</td>
<td>0.03</td>
<td>0.09</td>
<td>1.0</td>
<td>1.0</td>
<td>X X</td>
</tr>
<tr>
<td>G11</td>
<td>Chance, physical skills &amp; strategy</td>
<td>-0.28</td>
<td>0.09</td>
<td>1.2</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>L1</td>
<td>Instruction is clear</td>
<td>-0.28</td>
<td>0.09</td>
<td>1.1</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>L2</td>
<td>Instruction comprehensive &amp; correct</td>
<td>-0.23</td>
<td>0.09</td>
<td>0.9</td>
<td>0.8</td>
<td>X</td>
</tr>
<tr>
<td>L3</td>
<td>Certain language barriers</td>
<td>-0.05</td>
<td>0.09</td>
<td>1.3</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>E1</td>
<td>Small playing area (≤ 100 ft)</td>
<td>0.47</td>
<td>0.08</td>
<td>1.2</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>E2</td>
<td>Medium playing area (≥ 100-399 ft)</td>
<td>0.28</td>
<td>0.09</td>
<td>0.8</td>
<td>0.8</td>
<td>X X</td>
</tr>
<tr>
<td>E3</td>
<td>Large playing area (≥ 400 ft)</td>
<td>0.19</td>
<td>0.09</td>
<td>1.0</td>
<td>1.1</td>
<td>X X X X</td>
</tr>
<tr>
<td>E4</td>
<td>Game is play indoor environment</td>
<td>0.38</td>
<td>0.09</td>
<td>1.0</td>
<td>1.0</td>
<td>X X X X</td>
</tr>
<tr>
<td>E5</td>
<td>Game is play outdoor environment</td>
<td>0.17</td>
<td>0.09</td>
<td>1.1</td>
<td>1.1</td>
<td>X</td>
</tr>
<tr>
<td>E7</td>
<td>Required availability of special environ</td>
<td>0.11</td>
<td>0.09</td>
<td>1.3</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>GD1</td>
<td>Easy (not challenging, feel bored)</td>
<td>0.07</td>
<td>0.09</td>
<td>1.3</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>GD2</td>
<td>Moderate (not too easy nor difficult)</td>
<td>-0.14</td>
<td>0.09</td>
<td>0.8</td>
<td>0.8</td>
<td>X</td>
</tr>
<tr>
<td>PC2</td>
<td>Suitable for children with special needs</td>
<td>-0.17</td>
<td>0.09</td>
<td>0.9</td>
<td>1.1</td>
<td>X X X X</td>
</tr>
<tr>
<td>PC3</td>
<td>Suitable for everyone</td>
<td>-0.29</td>
<td>0.09</td>
<td>1.2</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>PC5</td>
<td>3-6 participants</td>
<td>0.16</td>
<td>0.09</td>
<td>0.9</td>
<td>0.9</td>
<td>X</td>
</tr>
<tr>
<td>PC6</td>
<td>More than 6 participants</td>
<td>-0.06</td>
<td>0.09</td>
<td>1.1</td>
<td>1.1</td>
<td>X X X X</td>
</tr>
<tr>
<td>PC9</td>
<td>Minimum skills</td>
<td>0.09</td>
<td>0.09</td>
<td>1.1</td>
<td>1.1</td>
<td>X X</td>
</tr>
<tr>
<td>PC10</td>
<td>No prior skill, exp. or ability needed</td>
<td>0.25</td>
<td>0.09</td>
<td>1.1</td>
<td>1.2</td>
<td>X X X X</td>
</tr>
<tr>
<td>PC12</td>
<td>Age related physical-readiness</td>
<td>0.05</td>
<td>0.09</td>
<td>0.8</td>
<td>0.8</td>
<td>X X X X</td>
</tr>
<tr>
<td>PC13</td>
<td>Age related emotion &amp; social readiness</td>
<td>0.13</td>
<td>0.09</td>
<td>1.1</td>
<td>1.0</td>
<td>X X X X</td>
</tr>
<tr>
<td>PC14</td>
<td>Exposed to racial tension</td>
<td>0.34</td>
<td>0.09</td>
<td>1.3</td>
<td>1.4</td>
<td>X X X X</td>
</tr>
<tr>
<td>PC15</td>
<td>Encouraged to practice racial tolerance</td>
<td>-0.10</td>
<td>0.09</td>
<td>1.2</td>
<td>1.2</td>
<td>X X X X</td>
</tr>
<tr>
<td>PC16</td>
<td>Taught to be more culturally accepting</td>
<td>-0.08</td>
<td>0.09</td>
<td>1.2</td>
<td>1.1</td>
<td>X X X X</td>
</tr>
<tr>
<td>PC17</td>
<td>Exposed to gender discrimination</td>
<td>0.33</td>
<td>0.09</td>
<td>1.1</td>
<td>1.3</td>
<td>X X X X</td>
</tr>
<tr>
<td>PC18</td>
<td>Not exposed to gender discrimination</td>
<td>0.23</td>
<td>0.09</td>
<td>0.9</td>
<td>0.9</td>
<td>X X X X</td>
</tr>
<tr>
<td>PC19</td>
<td>Exposed to body contact activity</td>
<td>0.27</td>
<td>0.09</td>
<td>1.0</td>
<td>1.1</td>
<td>X X X X</td>
</tr>
<tr>
<td>PC20</td>
<td>Not exposed to body contact</td>
<td>0.49</td>
<td>0.08</td>
<td>1.2</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total items deleted</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>46 17 8 8</td>
</tr>
</tbody>
</table>

Note. X indicates item deleted based on Goodness-of-Fit, logits and content relevance. F= Fun, S= Social, C=Cognitive, P=Physical, SK=Skill, G=Game Structure, L=Language, E=Environment, GD=Games Difficulty, PC=Player’s Characteristics.
After various PCA deletion rounds, 99 items were loaded on WINSTEPS software to perform Rasch analysis. Item deletion and data fit are based on goodness-of-fit statistics, item difficulty (logits) and content relevance was further taken into consideration. In the initial Rasch analysis 53 items were retained (46 items deleted), in subsequent rounds 36 items were retained (17 items deleted), then 28 items were retained (8 items deleted) and finally 20 items were retained (8 items deleted) Table 22. However, later two more items were systematically removed after some counter checking based on data fit hence new PAGPS (Game Rating Scale [GRS]) retained only 51-item.

Table 23

**Paired samples correlations**

<table>
<thead>
<tr>
<th>Pairing</th>
<th>N</th>
<th>Correlation</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item_99 &amp; Item_51</td>
<td>200</td>
<td>.980</td>
<td>.000</td>
</tr>
<tr>
<td>Item_99 &amp; Item_36</td>
<td>200</td>
<td>.956</td>
<td>.000</td>
</tr>
<tr>
<td>Item_99 &amp; Item_28</td>
<td>200</td>
<td>.935</td>
<td>.000</td>
</tr>
<tr>
<td>Item_99 &amp; Item_20</td>
<td>200</td>
<td>.919</td>
<td>.000</td>
</tr>
</tbody>
</table>

Table 24

**Paired samples t-test**

<table>
<thead>
<tr>
<th>Pairing</th>
<th>Mean</th>
<th>Std Deviation</th>
<th>Std. Error</th>
<th>95% Confidence Interval of the Difference</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item_99 &amp; Item_51</td>
<td>.02715</td>
<td>.14034</td>
<td>.00992</td>
<td>-.04672 - .00758</td>
<td>-2.736</td>
<td>199</td>
<td>.007</td>
</tr>
<tr>
<td>Item_99 &amp; Item_36</td>
<td>.04940</td>
<td>.23506</td>
<td>.01662</td>
<td>-.08218 - -.01662</td>
<td>-2.972</td>
<td>199</td>
<td>.003</td>
</tr>
<tr>
<td>Item_99 &amp; Item_28</td>
<td>.07615</td>
<td>.30248</td>
<td>.02139</td>
<td>-.11833 - -.03397</td>
<td>-3.560</td>
<td>199</td>
<td>.000</td>
</tr>
<tr>
<td>Item_99 &amp; Item_20</td>
<td>-.13615</td>
<td>.36026</td>
<td>.02547</td>
<td>-.18638 - -.08592</td>
<td>-5.345</td>
<td>199</td>
<td>.000</td>
</tr>
</tbody>
</table>

Subsequently correlations values between the 99-item and other shorter version (51, 36, 28, and 20 items) were computed using PE Teachers ability measures logits and high correlations of .919-.980 were reported in Table 23 respectively. Finally paired samples t-test was computed
to determine which PAGPS versions to be used for PAGPS rating (Validation Stage). Table 24 reported that all pairs are statistically significantly different .000 to .007 which was likely due to influence of large sample size. The final decision to pick Item-51 version over other shorter version was based upon two considerations: It has the highest correlation with the 99-item version and it covered more valuable content information.

**Cronbach Alpha**

Cronbach’s alpha was run to further check for internal consistency. Results of Cronbach’s alpha are shown in Table 25. Internal consistency refers to relatedness of a set of items (Schmitt, 1996). In general, alpha must be positive and .70 and above to provide sufficient support for internal consistency (Morgan, Leech, Gloeckner, & Barrett, 2007; Nunnally, 1978).

<table>
<thead>
<tr>
<th>Factor/Category</th>
<th># of items</th>
<th>Cronbach’s Alpha (α)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fun and social</td>
<td>12</td>
<td>.72</td>
</tr>
<tr>
<td>Cognitive</td>
<td>6</td>
<td>.77</td>
</tr>
<tr>
<td>Physical and skill</td>
<td>12</td>
<td>.83</td>
</tr>
<tr>
<td>Game Structure and environment</td>
<td>12</td>
<td>.75</td>
</tr>
<tr>
<td>Game difficulty</td>
<td>2</td>
<td>.60</td>
</tr>
<tr>
<td>Player’s Characteristics and language</td>
<td>7</td>
<td>.69</td>
</tr>
</tbody>
</table>

The Cronbach alpha item deletion process took into account suggestions by Schmitt, (1996) on meaningful content coverage, reasonable unidimensionality, and criterion set by George and Mallory (2003) of .70, only two factors were affected. Based on sufficient content coverage and unidimensionality proven by Rasch and PCA analyses, respectively and to avoid
future model identification issues, at least three to four items must be retained in each sub-
category (Hair et al., 2006); therefore, no items were removed.

Part Three: Other Reliability and Validity Evidence

Inter-rater reliability

Data were collected using 51-item PAGPS-Rater (GRS) developed from the earlier version of PAGPS-PE Teachers. However, later 2 items were systematically removed after some counter checking based on data fit; hence new PAGPS-Rater (GRS) maintained 51-
item. The PAGPS-Raters (GRS) were coded using Likert scale of 1 (Strongly Disagree) to 4 (Strongly Agree) by ten raters. Fleiss Kappa analysis was performed to check for inter-rater reliability. Data from PAGPS-Raters (GRS) were transposed using Excel software and fed into online kappa calculator and it was found on average good inter-rater reliabilities with Fleiss Kappa ranging from .700 to .910 (Table 26).

Table 26

Summary of inter-rater reliability

<table>
<thead>
<tr>
<th></th>
<th>Game 1</th>
<th>Game 2</th>
<th>Game 3</th>
<th>Game 4</th>
<th>Game 5</th>
<th>Game 6</th>
<th>Game 7</th>
<th>Game 8</th>
<th>Game 9</th>
<th>Game 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kappa</td>
<td>.737</td>
<td>.879</td>
<td>.829</td>
<td>.792</td>
<td>.843</td>
<td>.910</td>
<td>.827</td>
<td>.849</td>
<td>.829</td>
<td>.805</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>.0135</td>
<td>.0132</td>
<td>.0138</td>
<td>.0137</td>
<td>.0138</td>
<td>.0146</td>
<td>.0125</td>
<td>.0135</td>
<td>.0139</td>
<td>.0146</td>
</tr>
<tr>
<td>95% CI</td>
<td>.71-.76</td>
<td>.85-.90</td>
<td>.80-.86</td>
<td>.77-.82</td>
<td>.82-.87</td>
<td>.88-.94</td>
<td>.79-.84</td>
<td>.82-.88</td>
<td>.80-.86</td>
<td>.78-.83</td>
</tr>
<tr>
<td>Grade 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kappa</td>
<td>.700</td>
<td>.741</td>
<td>.703</td>
<td>.725</td>
<td>.749</td>
<td>.802</td>
<td>.756</td>
<td>.805</td>
<td>.721</td>
<td>.785</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>.0133</td>
<td>.0128</td>
<td>.0141</td>
<td>.0146</td>
<td>.0133</td>
<td>.143</td>
<td>.0128</td>
<td>.0142</td>
<td>.0140</td>
<td>.0135</td>
</tr>
<tr>
<td>95% CI</td>
<td>.67-.73</td>
<td>.72-.77</td>
<td>.68-.73</td>
<td>.69-.75</td>
<td>.72-.78</td>
<td>.77-.83</td>
<td>.73-.78</td>
<td>.78-.83</td>
<td>.69-.75</td>
<td>.76-.81</td>
</tr>
</tbody>
</table>

Note. Std. Dev. = Standard deviation; CI= Confidence interval

P coefficient and Kappa (K) coefficient

Beside inter-rater reliability, discriminant evidences are also established based on P coefficient and Kappa coefficient. A full detailed computation for both P coefficient and Kappa were presented in Chapter 3. Cross tabulation analyses were computed in SPSS using two items from Game Difficulty factor; Item D1 (This game is easy) and D2 (This game is moderate).
Ratings from D1 “This game is easy” in Figure 26 was summarized into smaller table on the far right and later formed Figure 27. The same procedure applied to Ratings for D2 “This game is moderately hard” in Figure 28 and later formed Figure 29.

Match* Game Item D1 Cross tabulation

<table>
<thead>
<tr>
<th>Rating</th>
<th>Game 1 Item D1</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Match (Grade 5)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Unmatched (Grade 2)</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>3</td>
</tr>
</tbody>
</table>

Note. D1= This game is easy

Figure 26. Rating of Game 1 Item D1

<table>
<thead>
<tr>
<th></th>
<th>Easy</th>
<th>Not Easy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matched</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>(0.0)</td>
<td>10 (.50)</td>
</tr>
<tr>
<td>Unmatched</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>(0.0)</td>
<td>10 (.50)</td>
</tr>
</tbody>
</table>

Figure 27. Proportion P and K coefficient for Item D1

\[ P_o = A + D \]
\[ = 10/20 \]
\[ = .50 \]

\[ P_c = [(0.00 + .50)*(0.00 + .00)] + [(0.50 + 0.50)*(0.50 + 0.00)] \]
\[ = [(0.00)] + [(0.50)] \]
\[ = .50 \]

\[ \kappa = \frac{P_o - P_c}{1.0 - P_c} \]
\[ = \frac{.50 - .50}{1.0 - .50} \]
\[ = .00 \]
Match* Game1 Item D2 Cross tabulation

<table>
<thead>
<tr>
<th>Rating</th>
<th>Game 1 Item D2</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Match (Grade 5)</td>
<td>2</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Unmatched (Grade 2)</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

Note. D2= This game is moderately hard

Figure 28. Rating of Game 1 Item D2

<table>
<thead>
<tr>
<th>Matched</th>
<th>Not Moderately</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Moderately</td>
<td>Hard</td>
<td>Not</td>
<td>Moderately</td>
</tr>
<tr>
<td>A</td>
<td>10</td>
<td>(.50)</td>
<td>B</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>0</td>
<td>(.00)</td>
<td>D</td>
<td>10</td>
</tr>
</tbody>
</table>

Figure 29. Proportion P and K coefficient for Item D2

\[ P_o = A + D \]
\[ = 20/20 \]
\[ = 1.0 \]

\[ P_c = \left[ (.00 + .50)(.50 + .00) \right] + \left[ (.00 + .50)(.50 + .00) \right] \]
\[ = \left[ (.50)(.50) \right] + \left[ (.50)(.50) \right] \]
\[ = .25 + .25 = .50 \]

\[ \kappa = P_o - P_c \]
\[ = 1.0 - .50 \]
\[ = 1.0 - .50 \]
\[ = 1.0 \]

The whole numbers in the cell represent the number of ratings scores; the numbers in parentheses represent the proportion of ratings. \( P \) coefficient and \( K \) coefficient were computed for all ten games and summarized in Table 27.
A summary of $P$ coefficient (agreement) and $K$ coefficient for all ten games are presented on Table 27. Since Kappa coefficient is a chance corrected measure of agreement, it sometimes can be negative. A negative Kappa indicates that there is less agreement than would be expected by chance given the marginal distributions of ratings.

**Frequency and descriptive of PAGPS-Raters (GRS)**

Although the sample of games are small ($N=10$), this study expected to unearth some unique features from these ten chosen games using PAGPS (GRS). A corresponding descriptive statistics analysis was computed using SPSS (version 20). All games played by Grade 2 and Grade 5 were analyzed; descriptive statistics were later summarized by frequency, percentage, median and inter-quartile range (IQR). Median and IQR were computed instead of mean because the data was slightly skewed. This study proposed five easier games to be suitable for Grade 2 students while another five moderately hard games would appeal more to Grade 5 students. Game Rating Scale was able to detect some unique characteristic or motor skills that matched the information mentioned in literature review (see Chapter 3). For each item, 20 ratings were

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provided by raters (10 ratings for Grade 2 and 10 ratings for Grade 5). Full table of Game 1, One-Leg is presented in Table 28 (results of nine other games are enclosed in Appendix B).

Table 28

*Frequency (F) and descriptive statistics for Game 1 (One-Leg)*

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Note. F= Frequency; Rating (1 = Strongly Disagree, 2= Disagree, 3= Agree, 4 = Strongly Agree); G2=Grade 2, G5=Grade 5

Game One: One-Leg is a leaping and balancing game whereby IT (One-Leg) had to leap and balance in order to tag other player (run). These unique features required to play One-Leg were observed by raters. Item from Physical factors (P4) Leaping was scored “agree” 11 times
(55%) and “strongly agree” nine times (45%). This skill is considered unique because not only
the One-Leg (IT) had to leap, it is a dynamic leap (leaping and chasing a target) to tag other
players which is an uncommonly complex but unique among PA games. Another item from
Physical factor (P2) Running was scored “agree” one time (5%) and “totally agree” 19 times
(95%), other players were seen running away from IT. Based on the result, Fun factor item (F3)
Cheering was scored “disagree” six times (30%), “agree” 13 times (65%) and “totally agree” one
time (5%); item (F15) Paying attention was scored “disagree” one time (5%), “agree” 16 times
(80%) and “totally agree” three times (15%); and item (F17) Engaged actively was scored
“agree” 18 times (90%) and “totally agree” two times (10%) respectively. One-Leg was
classified as moderately hard by PE teachers (Figure 20). Based on Game Difficulty factor item
(D1) “This game is easy” raters scored “strongly disagree” 13 times (65%) and “disagree” seven
times (35%) that One-Leg is an easy game. Raters’ ratings confirmed the game classification
made by PE teachers. However, two minor skills balancing and tagging were not evaluated.

Game Two: Kali-Tui a team game of strategy (cognitive), teamwork, and running. The
uniqueness of this game is in the combination of both physical prowess (i.e., running) and
cognitive ability (strategy) resulting in good teamwork. All three unique abilities were
prominently scored in this game (see Appendix B for full report). Item from Physical factor (P2)
Running was scored “agree” three times (15%) and “strongly agree” 17 times (85%). Item from
Cognitive factor (C1) Strategic planning was scored “agree” three times (15%) and “strongly
agree” 17 times (85%), while item from Social factor (S5) Teamwork was scored “totally agree”
20 times (100%) by raters. Besides, the combination unique element of chance, physical and
strategy on item Game structure factor (G11) was also scored “agree” 19 times (95%) and
“strongly agree” one time (5%), however the element of chance was not represented in Kali-Tui.
Based on the result, Fun factor item (F3) Cheering was scored “agree” 19 times (95%) and “totally agree” one time (5%); item (F15) Paying attention was scored “agree” 17 times (85%) and “totally agree” three times (15%); and item (F17) Engaged actively was scored “agree” 16 times (80%) and “totally agree” four times (20%) respectively. This game was classified moderately hard because it involves a combination of few unique skills and depended highly on organization/cognitive skills. Based on Game Difficulty factor item (D1) “This game is easy?” was scored “strongly disagree” one time (5%) and “disagree” 19 times (95%) that this game is easy to play. Raters’ ratings confirmed the game classification made by PE teachers. However one minor skill that was not evaluated was tagging.

Game 3: Blind man is a game of blindfolding, orienteering, tagging, dodging, and running. The uniqueness of this game is the skill of orienteering (sense of direction while blindfolded) beside it also tests blind man’s (IT) sense of hearing in locating other players. Physical factor item (P2) Running and Cognitive item (C4) Orienteering received the same scored “agree” 18 times (90%) and “strongly agree” two times (10%) respectively (see Appendix B for full report). Based on the result, Fun factor item (F3) Cheering was scored “agree” 18 times (90%) and “totally agree” two times (10%); item (F15) Paying attention was scored “agree” 19 times (95%) and “totally agree” one time (5%); and item (F17) Engaged actively was scored “disagree” one time (5%), “agree” 17 times (85%) and “totally agree” two times (10%) respectively. Blind man was classified moderately hard by PE teachers (Figure 20). Based on Game Difficulty factor item (D1) “This game is easy?” raters scored “strongly disagree” nine times (45%) and “disagree” 11 times (55%) that this game is easy. Raters’ ratings confirmed the game classification made by PE teachers. However two minor skills that were not evaluated were dodging and tagging.
Game 4: Simon says is a game of giving, understanding, and responding to instructions. The uniqueness of this game is the ability to accurately understand instruction and responder o correct/valid instruction. Cognitive item (C5) “Required to follow basic instruction” was rated “agree” 16 times (80%) and “strongly agree” four times (20%) respectively (see Appendix B, for full report). Item from Language factor (L1) “Instructions are clear” was scored “agree” 17 time (85%) and “strongly agree” three times (15%); item (L2), “In this game instructions is comprehensive and correct speed/pace?” was scored “agree” 19 times (95%); and “strongly agree” one time (5%) and finally item (L3) “There are some language barriers” was scored “totally disagree” one time (5%) and “disagree” 19 times (95%). Based on the result, Fun factor item (F3) Cheering was scored disagree 1 time (5%), agree 17 times (85%), and “totally agree” two times (10%); item (F15) Paying attention was scored “agree” 20 times (100%); and item (F17) Engaged actively was scored “disagree” two times (10%) and “agree” 18 times (90%) respectively. Simon say was classified as easy by PE teachers (Figure 20). Based on Game Difficulty factor item (D1) “This game is easy” raters scored “disagree” three times (15%) and “agree” 17 times (85%) that this game is easy. Majority of raters’ ratings (85%) agreed with the game classification made by PE teachers.

Game 5: Eagle and chicken is a game of mimicry (animals), strategy (IT), and teamwork. Basically eagle (IT) tries to capture chicken while hen (mother) tries to protect chicken (children). The uniqueness of this game is mimicry of animals (eagle, hen, and chicken) and strategy (IT). Item from Game Structure factor (G10) Strategy was scored “agree” nine times (45%) and “strongly agree” 11 times (55%) respectively (see Appendix B for full report). Eagle had to strategize to overcome the hen (mother) to capture chicken. Item from Social factor (S2) teamwork was scored “agree” 20 times (100%). Children (chicken) required some form of teamwork
in terms as not breaking the “human chain” (players holding onto shirt or body of players in front), once broken, mother/hen can’t shield them from being captured (see Chapter 3). Based on the result, Fun factor item (F3) Cheering was scored “disagree” three times (15%), “agree” 17 times (85%); item (F15) Paying attention was scored “agree” 10 times (50%); and “totally agree” 10 times (10%); and item (F17) Engaged actively was scored “agree” 19 times (95%) and “totally agree” one time (5%) respectively. Eagle and chicken was classified as easy by PE teachers (Figure 20). Based on Game Difficulty factor item (D1) “This game is easy” raters scored “agree” 18 times (90%) and “totally agree” two times (10%) that this game is easy. Raters’ ratings in unison confirmed the game classification made by PE teachers.

Game 6: Hopscotch is a game of leaping, balancing, and some basic arithmetic (counting). Basically player hops from one square to another according to numbers printed on the squares. Item from Physical factor (P5) Hopping was scored “agree” 19 times (95%) and “strongly agree” one time (5%) respectively (see Appendix B for full report). Cognitive factor item (C2) Basic mathematics was scored “agree” 10 times (50%) and “strongly agree” 10 times (50%).

Hopscotch was classified as easy by PE teachers (Figure 20). Based on the result, Fun factor item (F3) Cheering was scored “agree” 19 times (95%) and “totally agree” one time (5%); item (F15) Paying attention was scored “agree” 20 times (100%); and item (F17) Engaged actively was scored “agree” 19 times (95%) and “totally agree” one time (5%) respectively. Based on Game Difficulty factor item (D1) “This game is easy” raters scored “agree” 17 times (85%) and “strongly agree” three times (15%) that this game is easy. raters’ ratings confirmed the game classification made by PE teachers.

Game 7: Police and thieves is a game of teamwork, strategy, running, and tagging. Basically, team police tried to capture every member of “team thief” while team thief tried to
escape. The unique characteristics of Police and thieves can be traced to the combination of team cohesion/teamwork (social), extensive use of cognitive (strategy planning), and physical (running) skills all at once. Item from Social factor (S5) Teamwork was scored “agree” 19 times (95%) and “totally agree” one time (5%) respectively (see Appendix B for full report). Item from Cognitive factor (C1) Strategic planning was scored “agree” 11 times (55%) and “totally agree” nine times (45%); and finally item from Physical factor (P2) Running was scored “agree” four times (20%) and “totally agree” 16 times (80%). Based on the result, Fun factor item (F3) Cheering was scored “disagree” 10 times (50%) and “agree” 10 times (50%); item (F15) Paying attention was scored “agree” 19 times (95%) and “totally agree” one time (5%); and item (F17) Engaged actively was scored agree 17 times (85%) and “totally agree” three times (15%) respectively. Police and thieves game was classified as moderately hard by PE teachers (Figure 20). Based on Game Difficulty factor item (D1) “This game is easy” raters scored “totally disagree” 18 times (90%) and “disagree” two times (10%) that this game is easy. Majority of ratings (90%) confirmed the game classification made by PE teachers (see Appendix B for full report). However one minor skill that was not evaluated is tagging.

Game 8: Duck Duck Goose is a game of running in a circle trying to tag the goose before s/he sits down. Basically Duck Duck goose involved just two simple skills; running and tagging. This game is unique due to its simplicity. “If you can run, you can play.” Item from Physical factor (P2) Running was scored “agree” 11 times (55%) and “totally agree” nine times (45%) respectively (see Appendix B for full report). Based on the result, Fun factor item (F3) Cheering was scored “agree” 19 times (95%) and “totally agree” one time (5%); item (F15) Paying attention was scored “agree” 20 times (100%); and item (F17) Engaged actively was scored “disagree” one (5%), “agree” 18 times (90%) and “totally agree” one time (5%) respectively.
Duck Duck Goose was classified as easy by PE teachers (Figure 20). Based on Game Difficulty factor item (D1) “This game is easy” raters scored “agree” 19 times (95%) and “totally agree” one time (5%) that this game is easy. Majority of ratings (95%) confirmed the game classification made by PE teachers (see Appendix B for full report). However one minor skill that was not evaluated is tagging.

Game 9: Monkey in the middle is a game of throwing, catching, and in some cases leaping/jumping (Monkey). Basically, players try to pass the ball to his/her friends by either throwing, bouncing, or passing whereas the Monkey tries to intercept the ball, hence the “holder” of the ball needs to discard the ball before Monkey gets hold of it. The uniqueness of this game is the excitement never stops, wherever the ball goes, it creates excitement and adrenaline rush. Item from the Physical factor (P11) Throwing was scored “agree” nine times (45%) and “totally agree” 11 times (55%) respectively (see Appendix B for full report). Another item from Physical factor (P4) Leaping was scored “agree” 10 times (50%) and “disagree” 10 times (50%). Based on the results, Fun factor item (F3) Cheering was scored “disagree” two times (10%) and “agree” 18 times (90%); item (F15) Paying attention was scored “agree” 11 times (55%) and “totally agree” nine times (45%); and item (F17) Engaged actively was scored “agree” 10 times (50%) and totally agree 10 times (50%) respectively. This game was classified as moderately hard by PE teachers. Based on Game Difficulty factor item (D1) “This game is easy” raters scored “agree” seven times (35%) and “disagree” 13 times (65%) that this game is easy. Majority of ratings (65%) confirmed the game classification made by PE teachers.

Game 10: Mr. Wolf is a game of understanding basic instruction, responding to instruction, and running. Basically, players need to listen to command given by Mr. Wolf, counting how many steps to take (time given by Mr. Wolf) and prepare to run when the word
“Lunch, dinner or supper” is uttered. The uniqueness of this game is it is a combination of cognitive, language skills and basic loco motor skill (running) all in one. Item from Physical factor (P2) Running was scored “agree” 18 times (90%) and “totally agree” two times (10%) (see Appendix B for full report). Item from Cognitive factor (C5) Follow basic instruction was scored “agree” one time (5%) and “totally agree” 19 times (95%). Item under Language factor (L1) “In this game, instructions are clear” was scored agree 20 times (100%); Item (L2), “In this game instructions is comprehensive and correct speed/pace?” was scored “agree” 20 times (100%); and finally item (L3) “There are some language barriers” was scored “totally disagree” two times (10%) and “disagree” 18 times (90%). Based on the results, Fun factor item (F3) Cheering was scored “agree” 18 times (90%) and “totally agree” two times (10%); item (F15) Paying attention was scored “disagree” 10 times (50%) and “agree” 10 times (50%); and item (F17) Engaged actively was scored “disagree” one time (5%), “agree” 18 times (90%) and “totally agree” one time (5%) respectively. Mr. Wolf was classified as easy by PE teachers (Figure 20). Based on Game Difficulty factor item (D1) “This game is easy” raters scored “agree” 12 times (60%) and “strongly agree” three times (15%) and “disagree” five times (25%) that this game is easy. Majority of ratings (75%) confirmed the game classification made by PE teachers.

The summary of median ($M$) and inter-quartile ranges (IQR) were presented in Table 29. For Factor one (Fun and social), Kali-Tui was rated the highest at $M=60$, IQR=$5.25$ while Hopscotch and Mr. Wolf rated the lowest at $M=50$, IQR=$.00$ and $M=50$, IQR=$2.00$ respectively. For Factor two (Cognitive) Blind man’s bluff was rated the highest at $M=32$, IQR=$1.00$ while Duck duck goose and Monkey in the middle were rated the lowest at $M=19$, IQR=$.00$ and $M=19$, IQR=$1.25$ respectively. For Factor three (Physical and Skills), One-Leg and Hopscotch were rated the highest at $M=48$, IQR=$2.50$ and $M=48$, IQR=$.75$ respectively, both are hopping games.
For Factor four (Game structure and environment) Kali-Tui was rated the highest at $M=68$, IQR=.25 while Mr. Wolf was rated the lowest at $M=53$, IQR=2.00. For Factor five (Games difficulty) Mr. Wolf was rated the highest at $M=12.5$, IQR=3.00 while Blind man’s bluff and Simon says were rated the lowest at $M=7$, IQR=1.25 and $M=7$, IQR=.50 respectively. For Factor six (Player’s characteristics and language) Eagle and Hen was rated the highest at $M=38$, IQR=.25 while Monkey in the middle was rated the lowest at $M=29$, IQR=.50. Overall Kali-Tui has the highest total scores while Mr. Wolf accumulated the lowest total scores of all ten games.

Table 29

Summary of median and inter-quartile range of PA games

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<td>50</td>
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<td>58</td>
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<td>8. Duck duck goose</td>
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<td>9. Monkey in middle</td>
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<tr>
<td>10. Mr. Wolf</td>
<td>Median</td>
<td>50</td>
<td>25</td>
<td>38</td>
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CHAPTER 5
DISCUSSION

With combination of extensive literature reviews, content experts’ advice, physical educators’ feedback, and advanced statistical methods, this study was able to scientifically narrow down important game factors, leading to the development of Physical Activity Games Playability Scale (PAGPS) or Game Rating Scale (GRS) which was later validated with inputs by the raters. This chapter interprets and discusses the results reported in Chapter 4. Specifically data analyses during the development stage based upon Principal Component Analysis (PCA), Rasch and Cronbach’s alpha analyses addressing Aim 1 and Aim 2 are discussed. Data analysis during validation stage based upon inter-rater reliability, discriminant evidence, and descriptive analyses (logical evidence) are also interpreted to address Aim 3. This chapter also highlights study limitations and explores directions of plausible future research. Finally, conclusions based upon this study are presented.

Construct and Scale Development

Extensive literature reviews and panel content experts suggested ten factors that could generally represent the construct of PA games. These factors are fun (Caillois, 1961; Morris & Stiehl, 1999; Verenikina et al., 2003), social (Gulick, 1903; Morris & Stiehl, 1999; Vygotsky, 1978), cognitive (Bancroft, 1949; Garvey, 1990; Piaget, 1962), physical (Gallahue & Cleland-Donnelly, 2003; Morris & Stiehl, 1999), skills (Bancroft, 1949; Gallahue & Cleland-Donnelly, 2003), game structure (maroney, 2001; Morris & Stiehl, 1999; Robert, Arth, & Bush, 1959), language (Gallahue & Cleland, 2003), environment and equipment (Gallahue & Cleland-Donnelly, 2003; Ridell, 1975), game difficulty, and players’ characteristics (Bancroft, 1949; Ridell, 1975). The literature guided the conception of PA game heuristics and a panel of experts
to develop, select, review, and evaluate relevant PA games items to be used in the earlier PAGPS draft. One hundred and sixteen items (draft) were suggested to be administered to PE teachers. Based on the feedback (data) from 200 PE teachers, the total numbers of items were reduced to 99-item using PCA. Rather than the original 10-factor construct, PCA illustrated a 6-factor: fun and social, cognitive, physical and skills, game structure and environment, game difficulty, and players’ characteristics and language. The 6-factor were used for the rest of the study based on the statistical evidence provided by PCA (i.e., scree plot and rotated component matrix). In short, PCA revealed factorial data structure, eliminate cross loaded items and showed evidence of unidimensionality (assumption for the Rasch analysis).

**Item Reduction**

According to Zhu and Cole (1996) and Zhu, Ennis, and Chen (1998), many test and measures in physical activity domain are calibrated using subject-centered approach based on classical test theories (CTT). CTT based measures inherits several limitations as discussed in Chapter 3 (i.e., sample-dependent or test item-dependent; parameters set on different scales; ordinal score used as interval/scale score, total score computed inappropriately). Rasch analysis a response-centered approach can circumvent all these disadvantages (Zhu, & Cole, 1996).

Rasch model, a one-parameter logistic model (1-PLM), is preferred over CTT approach based on three unique advantages; invariance, ability to locate all facets on a common scale and additive (see Chapter 3) specifically. However, advantages of Rasch analysis can only hold true if certain assumptions are met: unidimensionality and “local independence.”

Unidimensionality refers to the items within a scale all measure a single latent trait or factor (Erhart et al., 2009). Reckase (1979) and (Hambleton et al., 1991) suggested two ways to assume unidimensionality: (a) the dominant factor explaining around 20% or more variance and
(b) the ratio eigenvalues of the first dominating factor and second factor needs to be at least two times or more than the subsequent factor. In this study, the eigenvalues over 1 explained 75.876% of the total variance, around the first dominant factor explained 18.342% of the variance. The first factor satisfied condition around 20%. Secondly, eigenvalues ratio requirement between two main factors was also met One: Factor Two \((21.28: 5.722 = 3.72)\).

Local independence refers to the control of all the abilities so that responses to items could be independent of one another (Hambleton, Swaminathan & Rogers, 1991). Since the criterion of unidimensionality was achieved by forming a single factor underlying trait, it was assumed that local independence was also met (Edelen, & Reeve, 2007; Georgiev, 2008).

However, in reality, the assumption of unidimensionality is not always perfectly met for example in personality factors (Hambleton & Jones, 1993) and gross skills are known to be inherent multi-dimensions (Zhu & Cole, 1996). A way for assumptions check is determined by goodness-of-fit statistics produced through data calibration or scaling. In our study, misfits items were eliminated through four rounds of data deletion based on .50 to 1.50 data fit criterion (Winsteps & Rasch Measurement, 2010).

In this study, misfit items were deleted in each round based upon three criteria; goodness-of-fit statistics, measure logits and content balance were further used for item reduction, specifically to form different versions of PAGPS-Raters (Game Rating Scale). Four short versions of PAGPS (GRS) consisting of 51-item (46 items deleted), 36-item (17 items deleted), 28-item (8 items deleted) and 20-item (8 items deleted) were created. The invariance features of Rasch model was clearly demonstrated by these short versions even when items were reduced to about 20% of the original length (20/99 items), still high correlation (.92) was found between 20-
item version and 99-item version. The 51-item version was finally selected because it has high correlation with the 99-item version and it has better content coverage.

The unique features and advantages of Rasch model however does not warranty that PAGPS (GRS) will automatically become a better rating scale. To achieve this, other psychometrics evidence, such as validity and reliability evidence of the PAGPS (GRS) scale must be ensured.

**Validation of PAGPS**

The current accepted validation practices are based upon the definition and understanding of major measurement and testing concepts suggested by American Psychological Association (APA), American Educational Research Association (AERA) and national Council on Measurement in Education (NCME) in 1999. In the book review for *Measurement in Physical Education and Exercise Science*, Zhu (2001) discussed the changes made in the 1999 editions of *Standards for Education and Psychological Testing (Standards)*. Validation process related to three major changes (i.e., validity, reliability and recent practices in educational and psychological testing) in Standards in relation to current PAGPS (GRS) study were discussed.

**Validity.** In the 1999 edition of *Standards*, three major types of validity evidences were redefined, including construct-, content-, and criterion-related validity. Other types of validity evidences such as validity generalization and differential prediction were also included as parts of validity evidence. As a result, the current validity evidence consists of the evidence based on response processes, internal structure, relation to other variables (including convergent and discriminant evidence, test-criterion relations, and validity generalization), and consequences of testing.
“Test validity is thus considered as a unitary concept that integrates all of the accumulated evidence and information relevant to the technical quality of a test system (Zhu, 2001, p. 253).” The relevant information refers to test construction, reliability, appropriate test administration and scoring, accurate score scaling, equating, standard setting, test fairness, and so on. Finally, test validation is considered a joint responsibility of the test developer and the test user. Test developer is responsible for providing relevant evidences and rationale in support of the proposed test use while the test user is responsible for evaluating the evidence in the particular setting in which the test is used. In this study, the joint validation was established whereby author provided relevant test evidences (content validity evidence, discriminant evidence and games’ descriptive evidence) while PE teachers (test users) evaluated the PAGPS-PE draft based on PE settings.

**Reliability:** The second major change is that the description of the reliability of a test is now based on the testing theories used to construct a test. If a test is constructed using the classic testing theory, traditional reliability coefficients (e.g., test-retest or stability coefficients) or generalizability coefficients then the generalizability theory, should be used. However, if a test is constructed based on the item response theory, an index called test information (logits) that summarizes how well the test discriminates among individuals at various levels of the ability then IRT theory should be used. Besides “conditional standard errors,” which provides precision information at various score level is recommended over interpretation of individual scores (i.e., traditional index, standard error of measurement).

**Development in education and psychological testing.** The third major change is that many recent developments in educational and psychological testing, adopted the combination of both theory and practice approaches recommended and described in the *Standards*. Item
response theory, alternative assessment (e.g., performance assessment, portfolio, and scoring rubrics), and differential item function are just a few examples (Zhu, 2001).

Measurement specialist from exercise science had since adopted these concepts suggested in Standards psychometrics literature. Validation process in exercise sciences concentrated more on the intended use and interpretation of test score rather than validity as a test property echoing the view of Benson (1998) and current psychometrics understanding. The data reports and data interpretation were presented and interpreted according to current Standards conceptual understandings in establishing validation evidences. In this study, validity evidences were presented based on a collection of evidences; content validity, construct validity (discriminant evidence) and descriptive statistics (logical). Reliability evidences were presented based on collection of evidences; internal consistency reliability (Cronbach’s alpha) and inter rater reliability (Fleiss Kappa).

Validity Evidences

*Content validity evidence*. Content validity refers to “the degree to which the content of the items reflects the content domain of interest (AERA, APA, & NCME, 1985, p. 9).” Content validity evidence during development stage in this study was established based on the approach, which include item development and selection, comprehensive reviews, expert judgment and logical arguments by panel experts that resulted in the development of Draft 3 (10 factors and 116 items). This draft was later narrowed down to 10 factors and 51-item (PAGPS Draft 4 or Game Rating Scale) using advanced statistical software(s) as shown on Figure 24 and in the process establishing content validity evidence.

*Discriminant evidence*. P coefficient and K coefficient evidence were collected to evaluate the ability of the PAGPS (GRS) by discriminating between easy and moderately hard
games. \( P \) coefficient (\( P_0 \)) or \( P \) agreement is compute by summing two proportions (A + D) on a given contingency (see Table 30). However, when \( P_0 = .50 \), this imply that the classification is no better than chance this is due to every square in the 2 x 2 contingency table has a .25 proportion \((.25 + .25 = .50)\). In fact, when \( P_0 = .50 \), the validity coefficient can be interpreted as zero (Safrit & Wood, 1989), therefore meaningful interpretable range of \( P \) coefficient values ranged from .50 to 1.00. Safrit and Wood (1995) suggested validity coefficient of .80 as being desirable. The results on Table 30 showed that \( P \) coefficient (\( P_0 \)) ranges from .15 to 1.00 with eight out of ten games achieving meaningful \( P \) coefficient values (more than chance) but fell short of the high “suggested” value.

Since \( P \) coefficient does not discriminate for chance, \( K \) coefficients were calculated to correct for chance. According to Safrit and Wood (1995), \( K \) coefficient values can range from -1.00 to +1.00, but in reality meaningful interpretable values range from 0.00 to 1.00. Table 31, showed results of \( K \) coefficient values range from -.70 to 1.00. The analyses of \( K \) coefficient showed that eight out of ten games are within meaning interpretable range, while two games (Game 9 and Game 10) showed negative \( K \) values which basically have no meaning.

**Descriptive statistics for games.** Validity can also be considered as indicating poor agreement between game selected and raters’ observation. Evidence refers to “scientifically sound argument to support the intended interpretation of test scores and their relevance to the proposed use (AERA, APA & NCME, 1985, p. 9).” In this study, descriptive statistics (i.e., frequency, percentage) of test/rating scores from each game served as another support for validity evidence for PAGPS (GRS). The ability of PAGPS (GRS) to consistently single out information (i.e., uniqueness of game, game difficulty, unique skills needed) exhibits substantial degrees of discriminating abilities and validity evidences. From exercise science point of view,
Safrit (1981) termed it as “logical validity” for motor skill or physical activity related test where expert judgments (raters) are used.

For example, based on game literature, Game 6 (Hopscotch) required leaping and basic counting skills (i.e., count the numbers on the square). The Game Rating Scale provides these checklist options while raters observed and scored these skills accordingly for example Item (P4) leaping was agreed 19 times (95% agreement) and strongly agreed one time (5% agreement) while “basic mathematics” was agreed 10 times (50% agreement) and strongly agreed (10 times or 50% agreement). Besides, Hopscotch is classified as easy game by PE teachers (Figure 20) and later raters confirmed the initial classification by rating “agree” 17 times (85% agreement) and “strongly agree” three times (15% agreement) based on Item (D1) “This is an easy game.” PAGPS (GRS) was able to consistently use to evaluate ten games.

The uniqueness characteristic of most games were consistently picked up using PAGPS (GRS), e.g., leaping (Game 1), strategic planning and teamwork (Game 2), orienteering (Game 3), follow basic instruction and language ability (Game 4), leaping and mathematic (Game 6), strategic planning and teamwork (Game 7), throwing (Game 9), and follow basic instruction and mathematic (Game 10). However, not all unique skills or items were “identified” because some items were not included in PAGPS (GRS) such as balancing, dodging, and tagging (deleted during item reduction process) while some features are just too “distinct” or limited to only one games to be included for example blindfolding (i.e., Blind man) or animal mimicry (i.e., Eagle and hen).

These inadequacies were found after data analyses, and will be addressed under the study limitation section. Suggestions were also made on how to rectify this inadequacy under Future direction section. Overall the Game Rating Scale shows good content/item representation,
demonstrating sufficient validity evidence (i.e., measure what it was supposed to measure), logical evidence and consistency evidence (i.e., evaluate ten PA children game-consistently). In summary, good “validation process is continuous and context specific comprises of many different types of evidence and it is iterative” (Rowe & Mahar, 2006). As in any new test, measure or scale development, validation process is an ongoing process until “perfection” is achieved.

**Reliability Evidences**

*Internal consistency reliability.* During PAGPS developmental stage, internal consistency reliability was checked and confirmed based on Cronbach’s alpha values. Overall, alpha value for PAGPS 51-item (Game Rating Scale) showed high alpha value at .914 while the values of each factors demonstrated fair to average internal consistency ranging from .42 to .77 with eight out of ten factors showed more than .60 (alpha) hence conforming to acceptable alpha .60 to .79 (George & Mallery, 2003). However, Fun and Player’s Characteristics factors did not sufficiently meet the criterion, but no items were removed based on content balance purposes (Rasch analysis) and proof of unidimensionality (PCA analysis). In fact, these decisions are justifiable based on suggestions by measurement and psychometrics expert (e.g., Nunnally, 1978) that "the satisfactory level of reliability also depends on how a measure is being used,” while Hair and colleagues (2006) also suggested that alpha values near to .60 can be accepted if a factor have only few items and in order to avoid future model identification issues, at least three to four items must be retained in each category or factor (Hair et al., 2006).

Schmitt (1996, p. 351) also argued using a particular alpha level (i.e., .70) without further consideration of its unidimensionality or construct validity is “shortsighted.” This is because when alpha is derived from data set that covers majority of the measured factor and showed
reasonable unidimensionality, low alpha value may not be a major issue, and in fact may still be quite useful (Schmitt, 1996). Schmitt quoted the classical reliability theory saying that the square root of the reliability of the criterion is that of the upper limit of validity (the relationship between predictor and criterion), e.g., an alpha of .49 has an upper limit of .70 (square root of .49). Schmitt also believed, that the “true correlations between a predictor and unreliable outcome variable are sometimes underestimated (i.e., attenuated) due to inadequate criterion reliability rather than lack of real relationship (Schmitt, 1996, p. 351).” Cortina (1993) and Streiner (2003) also stressed that alpha level is affected by the length of the test and number of items, hence when a test is short (less items), alpha values will be compromised. Items in PAGPS (GRS) factors ranged from two-six items hence Cronbach alpha values could be possibly affected.

**Inter rater reliability.** According to Foster, Bell-Dolan, and Burge (1988) direct observation of behavior has long been the foundation of behavioral studies. One of the most commonly used technique to evaluate reliability and validity of observational data is through inter-observer agreement or inter-rater agreement (Cone, 1977; Foster et al., 1988; Suen, 1988). Inter rater reliability refers to the degree of agreement between raters. Inter rater reliability is calculated using Fleiss kappa because there are more than two raters. Overall, the results of inter rater analyses revealed good kappa reliability ranging from .70 to .91 (Table 27).

However, it was observed that inter rater reliability statistics are slightly lower for Grade 5, whose data were collected later during this study (i.e., after Malaysian school holidays). According to Keyton, King, Mabachi, Manning, Leonard, and Schill (2004) few reasons might contributed to lower inter rater reliability; when raters are fatigue due to coding large sets of information (e.g., rating mistakes might occur), or when rating process is bound by tight deadline
Due to time limitation, PE teachers (raters) that just returned from a one week school holiday were requested to rate 10 videos (Grade 5). The hectic schedule at the beginning of semester and a tight deadline might have contributed to the slight difference in inter rater reliability nevertheless the Fleiss kappa values of .70-.81 (Grade 5 only) which still met the criterion for good agreement well within the suggested range of .61-.80 (Landis & Koch, 1977).

**Expected and Unexpected**

During the entire course of this study, there are some expectations or results that turn out as planned while other results were unexpected. As expected, PAGPS development stage was tedious and thorough but content validity was successfully established with combined effort of content expert, PE teachers and advanced statistical programs. Secondly, inter rater reliability (Fleiss coefficient) and Cronbach’s alpha values as expected showed sufficient reliability evidence. Discriminant validity evidence revealed meaningful discriminant abilities by differentiating between easy and moderately hard games. If developed well, Game Rating Scale is expected to be able to pick up important or unique characteristic(s) of games this was evident and proven with results from the collection of reliability and validity evidence that were presented earlier.

However, not everything went as planned. This study experienced some unexpected “revelations.” For example, first factor variance in PCA was supposed to explain huge variance but only revealed 18.52% just about enough to justify unidimensionality, one of the pre-assumption to run Rasch analysis. In addition, item reduction process through PCA and Rasch analysis could be “overkill” sometimes. As an example, a few deleted items (e.g., Physical factor-Item [P13] tagging, Item [P17] trapping/catching and Item [P25] balance; game difficulty factor i.e., Item [GD4] “This game is hard”) should be retained due to their potential usages in
game evaluation. This confirms that item reduction should be conducted with a balance between statistical methods employed and the content representations.

Finally, another surprising finding is that students seem to be having fun and enjoying all the PA games that were introduced, and their reaction (i.e., cheering, participating actively, and enthusiasm) showed there might be realistic hope of using PA games to promote healthier lifestyle among children. Overall, expected results and evidence outweigh unexpected results.

**Limitations**

Like any other investigation, this study identified several limitations. First, only ten games were tested in this study due to sampling, time, financial and human constraints (two videos are needed for each game). Each game needs at least 15-20 minutes of preparation including set-up, briefing and students administration while students’ available time is limited to daily PE time slot. In addition not many schools were willing to participate because headmasters were afraid of rescheduling or disruption of classes. Payment to participants e.g., PE teachers, raters, and video recording are costly too. Rating a group of active children is not an easy task (especially when children are actively running and jumping around). Game videos had to be replayed multiple times to rate and provide consistent ratings. Besides, since raters had to rate a total of 20 videos (second rating sessions) that might possibly lead to raters’ fatigue and might affect the quality of game ratings.

Another concern was some relevant items (i.e., balancing, tagging) and game difficulty (i.e., hard, and very hard) items were deleted during item reduction process due to item misfit. This limitation might have an effect on the validity evidence. In future these few items can be reviewed individually and if needed will be added to the existing PAGPS (GRS) items.
Current children that voluntarily participated in this study were in Grade 2 and Grade 5; hence results cannot be generalized to other age groups. Malaysian children were seen to be enjoying the game; however this result might not be representative of children with other backgrounds, ethnicities, SES, or in other countries. To reconfirm generalizability of these findings, more testing, games (sample), and more analyses in different countries are warranted.

Lastly, there are no academic articles, studies and books on traditional Malaysian PA games for references. This is a clear indication of a dire need to conduct more research in the area of Malaysian PA games.

Future Direction

The results from this study represent only an early step in the use of Rasch analysis approach, an advanced measurement and statistical method to develop a questionnaire and scale in exercise science.

In the future, when more data (i.e., games) is more readily available, multi-dimensional IRT analysis can be executed, since the domain of games playability could possibly be multi-dimensional in nature like what was found in other area of studies, for example personality factors (Hambleton & Jones, 1993) and gross skills (Rowe & Maher, 2006; Zhu & Cole, 1996).

Secondly, data from previous studies (based on inappropriate summation of ordinal total scores) can be potentially reanalyzed using Rasch analysis (Zhu, 1996). This is due to the ability of Rasch analysis to calibrate ordinal data to ratio-scale in the form of “logits.” Logits is a form of probability Z-score, which inherits equal interval values allowing total scores to be added (additive) to reveal more meaningful and valid interpretation, contributing to the existing literature (Brodgen, 1977; Luce & Tukey, 1964; Perline, Wright, & Wainer, 1979).
With the development and validation of the PAGPS (GRS) tool, PA games “advocates” around the world can rate their local PA games and upload rated game data onto a PAGPS game bank (Wright & Bell, 1984; Wood & Zhu, 2006). The concept of a game bank is similar to a test item bank which are widely used in education measurement and testing (Choppin, 1976; Roid, 1989). An item bank is a collection of items or questions organized and cataloged to take into account the content of each item, as well as other measurement characteristics (Umar, 1997). Uploaded data will be analyzed, calibrated, and archived to provide game information in terms of item difficulty and other useful game information (e.g., fun score for each game). Future PA game user (e.g., PE teachers or policy makers) can use the game bank website to retrieve game information by typing a chosen keywords e.g., high “fun” level or low games difficulty. A game bank will respond by suggesting a group of games that matched the keywords.

Finally, the application of Rasch analysis in education, and psychology has long been recognized (AERA, 1999; Perline, Wright, & Wainer, 1979; Wright & Master, 1982). This study and a few other earlier studies (Safrit, Cohen, & Costa, 1989; Zhu & Cole, 1996; Zhu, 1996; Zhu & Safrit, 1993) presented many advantages of Rasch analyses in PA research. Therefore there is a clear potential and need to introduce more PA researchers to Rasch modeling and make Rasch analysis a common statistical method in PA questionnaire construction and development.

Conclusion

Based on the findings, the following are the study’s conclusion:

1. Using advance statistical methods (i.e., PCA and Rasch), this study identified six factors that represent the construct of PA games (i.e., playability).

2. The advantages of Item Response Theory (IRT), Rasch analysis, can be applied to
develop a PA questionnaire at the same time it can eliminate weakness normally associated with the traditional classical test theory approach as shown in this study.

3. There is a need to promote more advanced statistical analysis such as IRT approach and making Rasch analysis as a conventional practice in PA questionnaire or scale development to PA researchers, so as to reaffirm Spray’s (1990) call to “become familiar with … advances and techniques in psychometric theories (p. 230).”

4. Due to limited information on PA games, there is a need for a PA game bank to support PE teachers’ learning and teaching strategies (i.e., providing game information and choices of games) in promoting physical activities to the younger generations.
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APPENDIX A: Physical Activity Games Playability Scale (PAGPS [GRS])

Invitation
You are invited to participate as rater because you indicated your interest in our previous online survey titled "Development and Validation of a Physical Activity Games Playability Scale" (PAGPS). The purpose of this assignment is to rate the playability of each game and not the ability of the participants. You are responsible to rate 10 physical activity games based upon pre-recorded videos using PAGPS. Each game rating assignment will take approximately 8-12 minutes. A gift card of RM50 will be awarded upon completion of all 20 rating assignments.

Consent
Your decision to participate or decline participation in these rating assignments is completely voluntary and you have the right to opt out this rating assignment at any time without penalty. Your decision to participate, decline, or withdraw from this rating assignment will have no effect on your current status or future relations with the Ministry Education of Malaysia, State Education Department or University of Illinois, Urbana-Champaign, United States of America. If you do not wish to complete this rating assignment, just close your browser. Your participation in this rating assignment will be completely confidential and data will be averaged and report in aggregate. Possible outlets of dissemination may be through publication of papers in academics journals, dissertation and conference presentations. Although your participation may not benefit you directly, it will help us improve the validity and reliability of PAGPS instrument. Information and conclusions drawn from this study will help us understand the importance of each game feature to be included in PAGPS instrument which in turn should help PE teachers and policy makers choose and implement more attractive game activities in our school system during PE classes. There are no significant physical, mental, emotional, or legal risks for individuals participating in this rating assignment beyond those that exist in daily life. A secret ID/code will be used during the entire rating assignment to protect your identity.

For further information regarding these rating assignments, please contact either:
Weimo Zhu (Ph.D.)
University of Illinois at Urbana-Champaign
weimozhu@illinois.edu
001-(217) 333-7503 (USA)

or

Eng Wah Teo
University of Illinois at Urbana-Champaign
vteo2@illinois.edu
001-(217) 419-3187 (USA)

Your contribution is very valuable to us. We hope you will consider being a part of this important study.

Please indicate whether you agree or disagree to continue with these rating assignments:

☐ Yes
☐ No
Identification Code/Secret ID: 

Age (years) 

Gender 
- Male 
- Female 
- Don't know 

Highest level of education 
- High School 
- Diploma 
- Bachelor Degree 
- Master 
- PhD 
- Other professional certificate 

Rating experience related to physical activities or physical education (years) 

### Elements/sub-scale of games evaluation

<table>
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</tr>
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<tr>
<td>In this game, are participants having fun?</td>
<td>Strongly agree</td>
</tr>
<tr>
<td>Verbal reaction</td>
<td></td>
</tr>
<tr>
<td>In this game participants can be heard cheering either for their partner, team mate or themselves.</td>
<td>In this game, some participants cried.</td>
</tr>
<tr>
<td>Non-Verbal/Facial Reaction</td>
<td></td>
</tr>
<tr>
<td>In this game participants are frowned.</td>
<td></td>
</tr>
<tr>
<td>Postural Reaction</td>
<td></td>
</tr>
<tr>
<td>In this game, participants look disinterested (e.g., refuse to participate, talking or doing something else other than playing.</td>
<td></td>
</tr>
<tr>
<td>Behavioral Reaction</td>
<td></td>
</tr>
<tr>
<td>In this game, participants paid attention.</td>
<td>In this game, participants engaged actively.</td>
</tr>
<tr>
<td>2. Social</td>
<td></td>
</tr>
<tr>
<td>In this game, are participants socially engaged?</td>
<td></td>
</tr>
<tr>
<td>This game encouraged interaction.</td>
<td></td>
</tr>
<tr>
<td>This game encouraged integration and unity.</td>
<td></td>
</tr>
<tr>
<td>This game encouraged respect for one another and respect of multi-cultures.</td>
<td></td>
</tr>
<tr>
<td>This game encouraged teamwork and cooperation.</td>
<td></td>
</tr>
<tr>
<td>This game encouraged racial tolerance.</td>
<td></td>
</tr>
<tr>
<td>This game exposed participants to game aggression or hostility.</td>
<td></td>
</tr>
<tr>
<td>3. Cognitive</td>
<td></td>
</tr>
<tr>
<td>In this game, are participants challenged cognitively?</td>
<td></td>
</tr>
<tr>
<td>This game required strategic planning.</td>
<td></td>
</tr>
<tr>
<td>This game required basic mathematics.</td>
<td></td>
</tr>
<tr>
<td>This game required participants to be creative.</td>
<td></td>
</tr>
<tr>
<td>This game required orienteering skills.</td>
<td></td>
</tr>
<tr>
<td>This game required participants to follow basic instructions</td>
<td></td>
</tr>
<tr>
<td>This game required participants to use their memory.</td>
<td></td>
</tr>
<tr>
<td>4. Physical</td>
<td></td>
</tr>
<tr>
<td>In this game, are participants physically challenged?</td>
<td></td>
</tr>
<tr>
<td>Loco motor movement</td>
<td></td>
</tr>
<tr>
<td>This game required running movement.</td>
<td></td>
</tr>
<tr>
<td>This game required leaping movement (starts on one foot and lands on the other foot).</td>
<td></td>
</tr>
<tr>
<td>Combination loco motor movement</td>
<td></td>
</tr>
<tr>
<td>This game required climbing movement.</td>
<td></td>
</tr>
<tr>
<td>Manipulative skills</td>
<td></td>
</tr>
<tr>
<td>This game required throwing movement (e.g., ball/object).</td>
<td></td>
</tr>
<tr>
<td>This game required kicking movement (e.g., ball/object).</td>
<td></td>
</tr>
<tr>
<td>This game required volleying movement (e.g., ball).</td>
<td></td>
</tr>
<tr>
<td>5. Type of skills</td>
<td></td>
</tr>
<tr>
<td>In this game, what type of skills are participants experiencing?</td>
<td></td>
</tr>
<tr>
<td>This game required fine skills (involved smaller muscle groups to perform tasks that involved motor control, precision, and accuracy of movement).</td>
<td></td>
</tr>
<tr>
<td>This game required discrete skill (involved brief, well-defined actions that have a clear beginning and end).</td>
<td></td>
</tr>
<tr>
<td>This game required continuous skill (no obvious beginning or end)</td>
<td></td>
</tr>
<tr>
<td>This game required closed skill masterly (take place in a stable, predictable environment and the performer knows exactly what to do and when).</td>
<td></td>
</tr>
<tr>
<td>This game required single tasking (perform one task at a time).</td>
<td></td>
</tr>
<tr>
<td>This game required dual tasking (perform two tasks at a time).</td>
<td></td>
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Name of the game:
<table>
<thead>
<tr>
<th>Elements/sub-scale of games evaluation</th>
<th>Raters</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Strongly agree</td>
</tr>
<tr>
<td>6. Structure of the game</td>
<td>In this game, what type of game structure are participants exposed to?</td>
</tr>
<tr>
<td></td>
<td>SA</td>
</tr>
<tr>
<td>In this game rules are very structured (complex or tight).</td>
<td></td>
</tr>
<tr>
<td>This game has no predetermined time frame.</td>
<td></td>
</tr>
<tr>
<td>This is a game of chance (e.g., poker, dice).</td>
<td></td>
</tr>
<tr>
<td>This is a game of physical skill (e.g., running, jumping).</td>
<td></td>
</tr>
<tr>
<td>This is a game of strategy (e.g., chess, combat).</td>
<td></td>
</tr>
<tr>
<td>This is a combination of chance, physical skill and strategy game (in any order or combination).</td>
<td></td>
</tr>
<tr>
<td>7. Language</td>
<td>In this game which language and instruction elements are relevant?</td>
</tr>
<tr>
<td>In this game, instructions are clear (direct and easy to understand).</td>
<td></td>
</tr>
<tr>
<td>In this game, instructions at the beginning of the game is comprehensible and at the correct speed/pace (easy to follow).</td>
<td></td>
</tr>
<tr>
<td>In this game, there are some language barriers (e.g. language other than what is spoken daily or at their level of understanding).</td>
<td></td>
</tr>
<tr>
<td>8. Environment and equipment</td>
<td>In this game which environment and equipment elements are relevant?</td>
</tr>
<tr>
<td>This game required small playing area (&lt; 100 ft²).</td>
<td></td>
</tr>
<tr>
<td>This game required medium playing area (100-399 ft²).</td>
<td></td>
</tr>
<tr>
<td>This game required large playing area (&gt; 400 ft²).</td>
<td></td>
</tr>
<tr>
<td>This game is suitable for indoor environment.</td>
<td></td>
</tr>
<tr>
<td>This game is suitable for outdoor environment.</td>
<td></td>
</tr>
<tr>
<td>This game required the availability of special environment/facility (e.g., gym, field, court, swimming pool).</td>
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</tr>
<tr>
<td>9. Difficulty Level (games)</td>
<td>In this game which level of difficulty is relevant?</td>
</tr>
<tr>
<td>This game is easy (not challenging, most participants feel bored).</td>
<td></td>
</tr>
<tr>
<td>This game is moderate (not too easy or difficult).</td>
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</tr>
<tr>
<td>10. Players</td>
<td>In this game which players' characteristic (mobility ability) are relevant?</td>
</tr>
<tr>
<td>Health Status</td>
<td></td>
</tr>
<tr>
<td>This game is suitable for children with special needs.</td>
<td></td>
</tr>
<tr>
<td>Number of participants</td>
<td>In this game which players' characteristic (number of participants) are relevant?</td>
</tr>
<tr>
<td>This game is for 3-6 participants.</td>
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</tr>
<tr>
<td>Ability level (participants)</td>
<td>In this game which players' characteristic (ability) are relevant?</td>
</tr>
<tr>
<td>This game required participants to possess minimum skill (below the level of ability attainable at their age group).</td>
<td></td>
</tr>
<tr>
<td>Ethnicity and culture</td>
<td>In this game which players' characteristic (ethnicity and culture) are relevant?</td>
</tr>
<tr>
<td>In this game, participants were taught to be to be more culturally accepting.</td>
<td></td>
</tr>
<tr>
<td>Gender and body contact</td>
<td>In this game which players' characteristic (gender and body contact) are relevant?</td>
</tr>
<tr>
<td>In this game, participants were exposed to gender discrimination.</td>
<td></td>
</tr>
<tr>
<td>In this game, participants were exposed to some body contact (bias towards female participants).</td>
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APPENDIX B: Descriptive Statistics of Ten PA Games

Frequency (F) and Descriptive Statistics for Game 1 (One-Leg)

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<th>Item</th>
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<th>IQR</th>
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<td>F</td>
<td>F</td>
<td>F</td>
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<td>Fun and Social</td>
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<td>Look disinterested</td>
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<td>Encouraged to interact</td>
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<td>Encouraged to integrate, &amp; united</td>
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<td>Encouraged respect</td>
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<td>Exposed to racial tolerance</td>
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<td>Exposed to aggression &amp; hostility</td>
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154
### Game 1 (cont.)

<table>
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<tr>
<th>Physical and Skills</th>
<th>G2</th>
<th>(15%)</th>
<th>G5</th>
<th>(66.67%)</th>
<th>G2</th>
<th>(16.67%)</th>
<th>G5</th>
<th>(1.67%)</th>
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<td>Very structured (complex or tight)</td>
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<tr>
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<td>Based upon physical skill</td>
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<td>Small playing area (≤ 100 ft²)</td>
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<tr>
<td>Medium playing area (100-399 ft²)</td>
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155
### Game 1 (cont.)

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<td>G5</td>
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<td><strong>Game is suitable for outdoor environment</strong></td>
<td>0</td>
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<td>G2</td>
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<td>G5</td>
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<tr>
<td><strong>Required availability of special environment</strong></td>
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**Category Total**: 240 (22.50%)

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<th><strong>Game is moderate</strong></th>
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**Category Total**: 40 (37.5%)

<table>
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<tr>
<th><strong>Player’s Characteristics and Language</strong></th>
<th><strong>For 3-6 participants</strong></th>
<th><strong>Required minimum skills</strong></th>
<th><strong>Taught to be more culturally accepting</strong></th>
<th><strong>Exposed to gender discrimination</strong></th>
<th><strong>Instructions are clear</strong></th>
<th><strong>Instruction comprehensive &amp; correct speed</strong></th>
<th><strong>Some language barriers</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>G2</td>
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<td>2</td>
<td>8</td>
<td>0</td>
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**Category Total**: 140 (11.76%)

**Grand Total**: 1020 (19.71%)

**Note.** F= Frequency; Rating (1 = Strongly Disagree, 2= Disagree, 3= Agree, 4 = Strongly Agree)
### Frequency and descriptive statistics for Game 2 (Kali-Tui)

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**Category Total**

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<td>Cognitive</td>
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<td>Physical and skills</td>
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**Physical and skills**

| Running movement       | G2     | 0     | 0     | 1     | 9 | 4 | 0   |
|                       | G5     | 0     | 0     | 2     | 8 | 4 | .25 |

**Category Total**

<table>
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Game 2 (cont.)

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<th>G2</th>
<th>G1</th>
<th>G0</th>
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<th>G1</th>
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<td>Based upon chance</td>
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<td>Based upon physical skill</td>
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<td>Small playing area (≤ 100 ft²)</td>
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<td>Medium playing area (100-399 ft²)</td>
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<td>Large playing area (≥ 400 ft²)</td>
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<td>Game is suitable for indoor environment</td>
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### Game 2 (cont.)

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<td>Required availability of special environment</td>
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<td>G5: 0</td>
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<th>Rating (F)</th>
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<td>Total: 1</td>
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<tr>
<td>Game is easy (not challenging, feel bored)</td>
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Note.  F= Frequency; Rating (1 = Strongly Disagree, 2= Disagree, 3= Agree, 4 = Strongly Agree)
Frequency and descriptive statistics for Game 3 (Blind man’s bluff)

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Frequency and descriptive statistics for Game 4 (Simon says)

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Note. F= Frequency; Rating (1 = Strongly Disagree, 2= Disagree, 3= Agree, 4 = Strongly Agree)
Frequency and descriptive statistics for Game 5 (Eagle & Hen)

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**Note.** F= Frequency; Rating (1 = Strongly Disagree, 2= Disagree, 3= Agree, 4 = Strongly Agree)
Frequency and descriptive statistics for Game 6 (Hopscotch)

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**Note.** F= Frequency; Rating (1 = Strongly Disagree, 2= Disagree, 3= Agree, 4 = Strongly Agree)
## Frequency and descriptive statistics for Game 8 (Duck Duck Goose)

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### Subcategories:

- **Fun and Social**
  - Cheering
  - Crying
  - Frowning
  - Look disinterested
  - Paying attention
  - Engaged actively
  - Encouraged to interact
  - Encouraged to integrate, & united
  - Encouraged respect
  - Experienced teamwork
  - Exposed to racial tolerance
  - Exposed to aggression & hostility

- **Physical**
  - Running movement

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- **Cognitive**
  - Required strategic planning
  - Practiced basic mathematics
  - Required creative thinking
  - Required orienteering skills
  - Required to follow basic instructions
  - Encouraged to use their memory

- **Physical**
  - Running movement
**Game 8 (cont.)**

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**Note.** F = Frequency; Rating (1 = Strongly Disagree, 2= Disagree, 3= Agree, 4 = Strongly Agree)
### Frequency and Descriptive Statistics for Game 9 (Monkey in the Middle)

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| Game structure and Environment | 20 | 72 | 100 | 57 | 11 | 47 | 4.75 |
| Very structured (complex or tight) | 0 | 0 | 10 | 0 | 3 | 0 |
|               | G5 | 0 | 1 | 9 | 0 | 3 | 0 |
|               | Total | 0 | 1 | 19 | 0 | 6 | 0 |
| No predetermined time frame | G2 | 0 | 0 | 10 | 0 | 3 | 0 |
|               | G5 | 0 | 2 | 8 | 0 | 3 | .25 |
|               | Total | 0 | 2 | 18 | 0 | 6 | .25 |
| Based upon chance | G2 | 1 | 9 | 0 | 0 | 2 | 0 |
|               | G5 | 0 | 11 | 0 | 0 | 2 | 0 |
|               | Total | 1 | 19 | 0 | 0 | 4 | 0 |
| Based upon physical skill | G2 | 0 | 0 | 10 | 0 | 3 | 0 |
|               | G5 | 0 | 0 | 9 | 1 | 3 | 0 |
|               | Total | 0 | 0 | 19 | 1 | 6 | 0 |
| Based upon strategy | G2 | 0 | 0 | 10 | 0 | 3 | 0 |
|               | G5 | 0 | 1 | 9 | 0 | 3 | 0 |
|               | Total | 0 | 1 | 19 | 0 | 6 | 0 |
| Chance, physical skills & strategy | G2 | 0 | 0 | 10 | 0 | 3 | 0 |
|               | G5 | 0 | 0 | 10 | 0 | 3 | 0 |
|               | Total | 0 | 0 | 20 | 0 | 6 | 0 |
| Small playing area (≤ 100 ft²) | G2 | 10 | 0 | 0 | 0 | 1 | 0 |
|               | G5 | 8 | 2 | 0 | 0 | 1 | .25 |
|               | Total | 18 | 2 | 0 | 0 | 2 | .25 |
| Medium playing area (100-399 ft²) | G2 | 0 | 0 | 10 | 0 | 3 | 0 |
|               | G5 | 0 | 1 | 9 | 0 | 3 | 0 |
|               | Total | 0 | 1 | 19 | 0 | 6 | 0 |
| Large playing area (≥ 400 ft²) | G2 | 0 | 0 | 10 | 0 | 2 | 0 |
|               | G5 | 1 | 9 | 0 | 0 | 2 | 0 |
|               | Total | 1 | 19 | 0 | 0 | 4 | 0 |
| Game is suitable for indoor environment | G2 | 0 | 0 | 10 | 0 | 3 | 0 |
|               | G5 | 0 | 0 | 9 | 1 | 3 | 0 |
### Game 9 (cont.)

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| Category Total                          | 240    | 39 | 46 | 152 | 3  | 60 | .50|

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| Category Total                          | 140    | 46 | 33 | 59  | 2  | 29 | .50|

| Grand Total                             | 1020   | 239| 284| 420 | 77 | 223| 13.25|

Note. F= Frequency; Rating (1 = Strongly Disagree, 2= Disagree, 3= Agree, 4 = Strongly Agree)
Frequency and descriptive statistics for Game 10 (Mr. Wolf)

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*Note. F= Frequency; Rating (1 = Strongly Disagree, 2= Disagree, 3= Agree, 4 = Strongly Agree)*