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Miller, Andrew. "Games centered approaches in teaching children & adolescents: systematic review of associated student outcomes" Published in *Journal of Teaching in Physical Education*, Vol. 34, Issue 1, Pages 36-58, (2015).

Available from: <http://dx.doi.org/10.1123/jtpe.2013-0155>

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Games Centered Approaches in Teaching Children & Adolescents: Systematic Review of
Associated Student Outcomes

Abstract

The purpose of this systematic review was to investigate the weight of scientific evidence regarding student outcomes (physical, cognitive and affective) of a Game Centered Approach (GCA) when the quality of a study was taken into account in the interpretation of collective findings. A systematic search of five electronic databases (Sports Discuss, ERIC, A+ Education, PsychInfo and PROQUEST Education) was conducted from their year of inception to 30 January 2014. Included studies were longitudinal or experimental / quasi-experimental studies involving children or adolescents that quantitatively assessed (using repeat measures and / or comparison to a control group) the effects upon student outcomes when an intervention involved the use of a GCA. The search identified 15 articles examining the effects of GCA on student outcomes that met the criteria for inclusion. The weight of evidence provided by the included studies identified an association between a GCA and the outcomes of declarative knowledge, support during game play and affective outcomes of perceived competence, interest/enjoyment and effort/importance. Development of technical skill, procedural knowledge and game play skills of decision making and skill execution are not supported by the level of evidence currently provided. Intervention volume appears to have a large effect on the development of game based decision making and skill execution, with a positive association between these outcomes and use of GCA interventions greater than eight hours in volume. More longitudinal and intervention research examining the use of a GCA and potential psychological, physiological and behavioral outcomes in children and adolescents is recommended.

Keywords: game centered, student, outcomes, quantitative, physical education

Games Centered Approaches in Teaching Children & Adolescents: Review of Associated Student Outcomes

Children enjoy playing games, and they demonstrate positive changes in attitude and physical self-perception when given the opportunity to engage in game play in a supportive environment (Chen & Light, 2006; Fry, Tan, McNeill, & Wright, 2010). A Games Centered Approach (GCA) “advocates learners playing the game as the central organizational feature of a lesson” (Oslin & Mitchell, 2006, p. 630) and includes such approaches as Teaching Games for Understanding (Bunker & Thorpe, 1982), Play Practice (Lauder & Piltz, 2006), Game Sense (Light, 2006) and Tactical games (Griffin & Sheehy, 2004), to name just a few. This pedagogical method was born out of a desire for physical education students to not only learn the skills required to play a particular game, but to have the ability to understand the constructs of the game (Bunker & Thorpe, 1982). In essence, the goal of using a GCA in teaching and coaching is to better connect the learners and their skills (both technical and cognitive) to the demands of the game via a process that recognizes the inherent connection between cognition and physical performance (Kirk & MacPhail, 2002).

A GCA lies in contrast to what is seen as a ‘traditional’ direct instruction approach, where a student’s technical skills are seen as central, and without the development of technical skills, involvement in game play is limited (Rink, French, & Tjeerdsma, 1996). Technical skills learnt (normally first in controlled learning environments) are placed in increasingly dynamic and competitive learning environments in which the learner is presented with the opportunity to combine technical and cognitive skills into more dynamic forms (Rink et al., 1996). This learning process highlights the traditional divide in physical education between cognition

(performance of game skills. eg., communication, positioning, support) and technical skill performance (Kirk & MacPhail, 2002).

The GCA has been criticized as lacking a sufficient and unified theoretical perspective to investigate the mechanisms underlying the pedagogical model and the achievement of perceptual-motor-learning (Chow et al., 2007; McMorris, 1998). Theoretical frameworks presented thus far include: (a) achievement goal theory (Xiang, McBride, & Solmon, 2003), (b) constructivism (French & McPherson, 2004; Light, 2008; Turner & Martinek, 1999), (c) a situated learning perspective (Kirk & MacPhail, 2002; Lave & Wenger, 1991), and more recently (d) a constraints led framework (Chow et al., 2007) as placed within the dynamical systems theory of motor-learning (Davids, Button, & Bennett, 2007; Handford, Davids, Bennett, & Button, 1997).

Empirical evidence is required for the development and testing of a theoretical framework that seeks to connect the pedagogical principles of a GCA (coupling of movement technique to game context) with the process of motor learning. Investigation of student variables (technical skill, knowledge, game performance, and affective outcomes) using a GCA has for the most part compared the two pedagogical approaches (GCA and direct instruction), matching them off to see which one achieved greater results in a grab for legitimacy within the tested domain. This research path is considered limited in the testing of theoretical perspectives, as it moves away from testing the elements of a theoretical construct and how these elements provided greater access to learning within a physical domain, overlooking this information in favor of the greatest effect size. In most cases this approach has provided argument for opponents of a GCA due to the mix of experimental designs and narrowed terms of reference (Kirk & MacPhail, 2002).

Kirk (2005) presents a move away from a comparative research model towards a ‘practice referenced’ approach. In this approach a teaching experiment takes place in which an intervention is put in place to work towards set outcomes for the group involved, and student changes in relation to these outcomes measured, irrespective of an alternate approach. This review takes on this perspective, only analyzing the repeat-measures outcomes of GCA interventions, not GCA significance in relation to an alternate approach.

The purpose of this systematic review is to investigate the weight of scientific evidence regarding student outcomes (technical skill, knowledge, game performance, and affective outcomes) of a GCA when the quality of a study is taken into account in the interpretation of collective findings. This process lies in contrast to narrative review of GCA literature (Harvey & Jarrett, 2013; Oslin & Mitchell, 2006; Stolz & Pill, 2014), which whilst giving summary of collective research findings, often provide limited reference (and critique) to the quality of study design when presenting findings. To date, the weight of scientific evidence approach is lacking in reviews of sport pedagogy, however is in line with the method presented in physical activity research in schools (Dudley, Okely, Pearson, & Cotton, 2011), and the health effects of fundamental movement skill improvement in children (Lubans, Morgan, Cliff, Barnett, & Okely, 2010). A theoretical framework is not presented; rather the intention of this analysis is to provide (a) a systematic perspective of the way quantitative evidence has been collected since the inception of GCA research, and (b) what evidence of GCA effectiveness the science currently provides, irrespective of comparative findings. This review is written with the view to improving future quantitative GCA research for greater application and/or empirical testing of theoretical perspectives.

The weight of evidence approach was chosen for this review as a starting point for the investigation of commonalities within empirical findings. In a review of the weight of evidence approach within a risk assessment domain, Weed (2005) recommends a) the weight of evidence concept and its methods be fully described when used, and b) the goal of this approach is to work toward a consensus on the meaning and methods of weight of evidence. With the application of many and varying “weights” against research findings, consistency and applicability of purpose are fundamental to the use of this approach in driving research forward. To this end, an approach previously used in the physical activity research domain has been modified to investigate the findings in a social sciences domain, with the purpose of driving GCA research forward through greater empirical focus and hopefully effect. The methods used have been fully described and future discussion should surround what is important within quantitative GCA research and thus the way evidence is weighted in the future.

Methods

The Quality of Reporting of Meta-analyses (QUOROM) statement (Moher et al., 1999) was consulted and provided the structure for this review. The checklist provided within the QUORUM statement describes the preferred way to present the abstract, introduction, methods, results, and discussion sections of a report of a meta-analysis within clinical research, and as such was considered applicable to provide a standardized and rigorous approach for this review of quantitative research findings. It must be noted that this review is not a meta-analysis, rather an investigation of the common evidence currently provided by GCA research. A systematic search of five electronic databases (SPORTDiscuss, ERIC, A+ Education, PsychInfo and PROQUEST Education) was conducted from their year of inception to 30 January 2014. Individualized search strategies for the different databases included combinations of the

following keywords: ‘Teaching games for understanding’, ‘TGfU’, ‘Play Practice’, ‘Play philosophy’, ‘GCA’, ‘Games Sense’, ‘Games instruction’, ‘Playsport’, ‘tactical learning’, or ‘tactical approach’. Only articles published in refereed journals were considered for review. Dissertations were excluded, and due to the limited methodological and statistical data available, conference proceedings, grant reports and abstracts were not included. In the first stage of the research, titles and abstracts of identified articles were checked for relevance. In the second stage, full text articles were retrieved and considered for inclusion. In the final stage, the reference lists of retrieved full text articles were searched and additional articles were assessed for possible inclusion.

Criteria for Inclusion / Exclusion

Studies were assessed for inclusion according to the following criteria: (a) participants were aged 3–18 years, (b) the investigation included a group undertaking a period of activity based on any of the pedagogical practices in the database search terms, (c) quantitative assessment of physical education outcomes (i.e. technical skill, knowledge, game performance or affective), (d) longitudinal or experimental / quasi-experimental study design, (e) physical education outcomes assessed using pre-to-post intervention repeated measures and / or comparison to a control group; and (f) published in English. As this review focused on the potential benefits of a GCA on developmental learners and on the effectiveness of modifying pedagogical methods, studies containing university populations and descriptive studies respectively were excluded.

The decision to include research from across 25 years, despite the changes in focus across this period, was made due to the continued inclusion of findings from earlier research reports in

empirical justification and in development of GCA theoretical frameworks (Chow et al., 2007; Kirk & MacPhail, 2002; Méndez Giménez, Valero Valenzuela, & Casey, 2010).

Criteria for Assessment of Study Quality

The criteria for assessing the quality of included studies were adapted from the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement (Vandenbroucke et al., 2007) and the Consolidated Standards of Reporting Trials (CONSORT) statement (Moher, Schulz, & Altman, 2001). A formal quality score for each study was completed by assigning a value of 0 (absent or inadequately described) or 1 (explicitly described and present) to each of the following seven criterion questions: (a) Did the study report a sample size calculation? (b) Were the participants randomly allocated? (c) Did the study report the sources and details of outcome assessment? (d) Did outcome assessment instruments have acceptable reliability for the specific age group? (e) Did the study report the precise details of the interventions intended for each group and how and when they were actually administered? (f) Did the study report the fidelity of the intervention that was delivered to participants and was the delivered content in the true nature of the intended intervention? (g) Did the study report the effect size of primary and secondary outcome investigation? Studies that scored 0 – 1 were regarded as ‘very low’ quality studies, studies that scored 2 – 3 were classified as ‘low’ quality studies, studies that scored 4 – 5 were classified as ‘moderate’ quality studies, and those that scored 6 – 7 were classified as ‘high’ quality investigations.

Categorization of Outcome Variables and Level of Evidence

Outcomes were categorized as follows: technical skill (e.g. process outcome such as fundamental movement skill assessment, or product outcome such as accuracy of kicking at a target), knowledge (e.g. declarative and procedural), game performance (e.g. on-ball decision

making and performance, and off-ball support), or affective (e.g. enjoyment and perceived competence). The relationship between GCA pedagogy and each outcome category (the level of evidence provided) was determined by examining the percentage of studies that reported a statistically significant relationship within an outcome category. Consistent with criteria first described by Sallis et al (2000) and more recently modified by Lubans et al (2010), if < 33% of the included studies reported a relationship between a GCA and the outcome, the result was categorized as no association (0). If 33 – 59% of the studies reported statistically significant relationships between a GCA and the outcome, the result was categorized as inconsistent or uncertain (?). If 60 – 100% of studies reported a positive relationship between a GCA and the outcome, the result was coded as a positive association (+). Finally, if 60 – 100% of high quality studies (≥ 3 high quality studies) found a positive relationship between a GCA and the outcome, the result was coded as having strong evidence for a positive association (++).

Results

Overview of Studies

The flow of studies through the review process and the reasons for exclusion are reported in Figure 1. A total of 942 potentially relevant articles were identified using database searches, and a total of 15 articles satisfied the inclusion criteria and were included in the review (Table 1). Of the included articles, the majority involved the investigation of invasion games (12 / 15), middle school (defined as age 10 – 14 years) students (10 / 15), the use of research developed curriculum (13 / 15), and interventions were mostly delivered by physical education specialists (7 / 15) or members of the research team (6 / 15). The number of study participants ranged from 24 (Nevett, Rovegno, & Babiarz, 2001) to 108 (Nathan & Haynes, 2013), and the intervention exposure was between five (Gray & Sproule, 2011) and 22.5 (French, Werner, Hussey, Taylor,

& Jones, 1996; Tjeerdsma, Rink, & Graham, 1996) hours. With regard to the assessment of physical education outcomes, technical skills outcomes were assessed in five studies, knowledge outcomes in seven studies, game performance in ten studies, and affective outcomes were measured in five studies.

Overview of Study Quality

Results from the study quality assessment are reported in Table 2. One study was identified as high quality using the selected criteria (French et al., 1996), ten studies were rated as moderate in quality, with three studies in the low and one in the very low quality categories. The majority of the studies (12 / 15) used valid and reliable outcome measures, less than half (6 / 15) reported the fidelity of interventions or effect size calculations (7 / 15) for hypothesized relationships; and none of the studies reported sample size calculations.

Technical skill outcomes

Four of the five investigations displayed improvements in technical skill execution, with improvement reported in net / wall (French et al., 1996; Lawton, 1989), and invasion game (Nathan & Haynes, 2013; Turner, 1996; Turner & Martinek, 1992) contexts. Investigations involving hockey (Nathan & Haynes, 2013; Turner, 1996; Turner & Martinek, 1992) used the Henry Freidel Field Hockey Test as the skill outcome measure. All studies reported improvement in the speed component of the skill test, however only Nathan and Haynes (2013) reported an effect in the accuracy component. Of the investigations involving badminton (French et al., 1996; Lawton, 1989), only French et al (1996) reported skill improvements, however it must be noted that this study had an older participant group, and was four times longer than the Lawton (1989) investigation. Participant numbers ranged from 13 to 108, and only two of the investigations of technical skill included use of a control group (French et al., 1996; Lawton,

1989). A GCA had a positive association with 56% of tested technical skill variables (Table 3). The outcome association with a GCA given the level of evidence provided by the reported research was considered uncertain for the outcome of technical skill.

Knowledge outcomes

Seven studies investigated knowledge outcomes (declarative and / or procedural) associated with GCA pedagogy. Five studies investigated declarative knowledge (French et al., 1996; Nathan & Haynes, 2013; Nevett, Rovegno, & Babiarz, 2001; Turner, 1996; Turner & Martinek, 1992), with all but the study by Turner and Martinek (1992) finding improvements in declarative knowledge. Two of the investigations that reported a positive effect used a combined declarative / procedural test (French et al., 1996; Nevett, Rovegno, & Babiarz, 2001) however, given there was no reporting of the effect on the individual domains of knowledge, it was difficult to ascertain if declarative, procedural or both domains were affected by the intervention. This lack of reporting was also the case for procedural knowledge, where the two investigations listed above were included among the four studies (French et al., 1996; Nathan & Haynes, 2013; Nevett, Rovegno, & Babiarz, 2001; Tallir, Musch, Valcke, & Lenoir, 2005) that reported a GCA as having a positive effect on procedural knowledge.

For the collective findings within the knowledge outcome (with the two investigations using the combined procedural / declarative knowledge test assumed as contributing positively to each knowledge domain), a GCA had a positive association on 80% of tested declarative knowledge variables and 57% of procedural knowledge outcomes (Table 3). The outcome association with a GCA given the level of evidence provided by the reported research was considered positive for declarative knowledge and uncertain for procedural knowledge outcomes (Table 3).

Game performance outcomes

Game performance was the most commonly assessed student outcome for association with a GCA, being included in ten studies (Table 1). All studies of the association of game performance with a GCA used some form of the Game Performance Assessment Instrument (GPAI) to analyze game play performance variables. Game performance was investigated in invasion (9 / 10) and net / wall (1 / 10) contexts, with the majority of invasion game studies focusing on attack (7 / 9), with only two involving defense (Harvey, Cushion, Wegis, & Massa-Gonzalez, 2010; Mesquita, Farias, & Hastie, 2012). The majority of investigations (6 / 10) reported and analyzed appropriate actions (decisions, skills, support) relative to the total number of actions (indices), two investigations (Gray & Sproule, 2011; Harvey et al., 2010) reported the volume of appropriate and inappropriate decisions made, and two investigations (Mesquita et al., 2012; Nathan & Haynes, 2013) did not detail the calculation process of game play variables.

Decision making was measured in ten investigations, with the majority measuring decision making within an invasion game context (9 / 10). Of the invasion game studies, intervention volume appeared to have an effect on the development of decision making, with the three lowest volume interventions (Gray & Sproule, 2011; Harvey et al., 2010; Turner & Martinek, 1992) not supporting the use of a GCA in an invasion game setting.

Skill execution was investigated in nine studies, and involved the greatest number of variables within the game performance category (26 variables). Skill execution findings were inconsistent within the majority of studies, with all but two (Nathan & Haynes, 2013; Tallir, Lenoir, Valcke, & Musch, 2007) of the eight investigations using multiple skill variables finding both for and against the use of a GCA for improvement of these variables. As was the case with decision making, intervention volume appeared to affect game skill performance. Indeed, the

three investigations wholly supporting (all skill variables improved) the use of a GCA were the three largest volume interventions among the invasion game investigations (Chatzopoulos, Drakou, Kotzamanidou, & Tsorbatzoudis, 2006; Nathan & Haynes, 2013; Tallir et al., 2007).

Support play was the least measured of the game performance outcomes, included in only three (Chatzopoulos et al., 2006; Gray & Sproule, 2011; Harvey et al., 2010) of the eight investigations. Unlike the other game performance outcomes, there was no intervention exposure trend, with one of the highest (Chatzopoulos et al., 2006), and the two lowest (Gray & Sproule, 2011; Harvey et al., 2010) volume interventions reporting a positive association with support during game play.

For the collective findings within the game performance outcome, a GCA had a positive association with 58% of tested decision making variables, 59% of skill execution variables, and 93% of the investigated support variables (Table 3). The outcome association with a GCA given the level of evidence provided by the reported research was considered inconsistent / uncertain for decision making and skill execution outcomes during game performance and positive for the support during game performance outcome (Table 3).

Affective outcomes

While an affective outcome measure (perceived competence, interest-enjoyment, effort-importance, tension-pressure, perceived choice or value/usefulness) was included in eight studies, only four investigations (Chatzopoulos et al., 2006; Gray & Sproule, 2011; Jones, Marshall, & Peters, 2010; Tjeerdsma et al., 1996) reported quantitative analysis of an affective outcome. Perceived competence was measured in all four studies, with only one (Jones et al., 2010) not reporting a positive association with a GCA. Interest-enjoyment and effort-importance were reported in three investigations (Chatzopoulos et al., 2006; Jones et al., 2010; Tjeerdsma et

al., 1996), with a positive association reported for both outcomes. A GCA was reported as having no effect on tension/pressure, perceived choice and value/usefulness. In summary, the outcome association with a GCA given the level of evidence provided by the reported research was considered inconsistent / uncertain for the affective outcomes of tension/pressure, perceived choice and value/usefulness, whereas outcome association for perceived competence, interest-enjoyment and effort-importance was considered positive (Table 3).

Discussion

The purpose of this systematic review was to investigate the weight of scientific evidence regarding student outcomes (physical, cognitive and affective) of a GCA when the quality of a study was taken into account in the interpretation of collective findings. Fifteen articles were identified assessing 12 potential benefits within the four categories: 1- technical skills, 2- knowledge (declarative, procedural), 3- game performance (decision making, skill execution, support), and 4- affective (perceived competence, interest-enjoyment, effort-importance, tension-pressure, perceived choice and value/usefulness). Of the investigated outcomes, none displayed strong evidence for a positive association with the use of a GCA (++ association) due to the lack of high quality studies contributing to the collective findings. A GCA displayed a positive association with outcomes within the knowledge, game performance and affective outcomes categories, with the level of reported evidence supporting outcomes of declarative knowledge, support during game play, perceived competence, interest-enjoyment and effort-importance as positively associated with the use of a GCA.

Technical skill outcomes

A GCA recognizes the inherent connection between cognition and physical performance (Kirk & MacPhail, 2002), with the overarching goal to develop both requirements of successful

game play. This interdependence between cognition and physical performance stems from models such as the information processing model (Abernethy, 1996), where perception, decision making and movement performance occur during dynamic game play; and the situated learning (Kirk & MacPhail, 2002) model, in which learners interact and respond to the demands of the environment they are placed in. The GCA investigations of technical skill development all used assessment methods that isolated a skill or set of skill components, measuring the outcome of movement performance. Separation of movement performance from the perception and decision-making phases of information processing, or taking away the environment in which students must react lacks true representation to the game/sport being assessed, and thus lacks ecological validity. In isolated forms, technical skill development using a GCA was considered inconsistent / uncertain in this review.

Previous reviews (Harvey & Jarrett, 2013; Stolz & Pill, 2014) support this finding; however previous review findings are based on there being no significant difference between pedagogical approaches for improvement of technical skills. The current review only analyses the effects from repeat measures of GCA interventions, not comparison of effects, with uncertainty still evident among findings. It must be noted that the design of the GCA interventions used appear to avoid development of the technical skills and movement patterns specific to the chosen assessment outcome in favor of tactical and game skill development.

If the point to be made was that isolated skill development can still be obtained within a GCA, then interventions needed to involve greater development of the tested skills through modification of the game environment and rules to promote exaggeration of specific skills (Holt, Streat, & Bengoechea, 2002), or measures focused more towards a process outcome designed to identify a GCA effect on advancement towards more complex/mature versions of a technical

skill (skill performance component checklist) rather than the isolated product outcomes measured. Assessment of product based outcomes, with the exception of one recent investigation (Nathan & Haynes, 2013), did not move past the 1990s, and assessment moved toward situated environments that better represented the activities being taught (see game performance outcomes).

Measurement of technical skill, particularly process based outcomes, should not be discounted in the context of GCA research. Just as the transfer of tactical awareness across similar game categories has been demonstrated (Memmert & Harvey, 2010), technical skill movement patterns are often common to multiple physical domains, and are proposed as the foundations of an active lifestyle (Gallahue & Ozmun, 2006; Stodden et al., 2008). The development of more mature movement patterns is an important outcome of a GCA, as tactical and technical skills are both addressed in a game-centred learning context (Stolz & Pill, 2014, p. 57). Regardless of personal opinion towards Fundamental Movement Skills (FMS), there is strong evidence of association between higher FMS levels and greater physical activity levels in children and adolescents (Lubans, Morgan, Cliff, et al., 2010). The process based FMS are not measured within active game play (currently), however the ability of a GCA in developing process based technical skill outcomes should be explored, especially when considered in conjunction with the affective outcomes discussed in a subsequent section, and the call for GCA research to explore potential physical activity benefits (Harvey & Jarrett, 2013).

Knowledge outcomes

Results from the knowledge domain highlight the complexity of developing effective game players, and reiterates the earlier statements regarding the relevance of individual assessment of what are interdependent participant characteristics (Kirk & MacPhail, 2002).

Rules are concrete concepts that games operate within, they give a game shape, constrain time and space, and dictate the range of skills required to play (Holt et al., 2002). Decision making in a game environment however is not concrete, with the ability to analyze the dynamic environment of the game and recognize cues and opportunities within this environment required (Holt et al., 2002). Rules are generally re-enforced each time they are broken, thus participants learn very quickly what they can and cannot do within the game. Unlike the reinforcement of rules when one is broken, the game generally does not stop each time a poor decision is made (except for the occasional teachable moment). By consequence, the reinforcement process surrounding decision making is generally going to be slower.

In the timeline of learning using a GCA, declarative knowledge (rules) is addressed early in the game appreciation phase, with procedural knowledge (decision making) addressed latter in a phase of cue perception and decision making (Kirk & MacPhail, 2002). The process of development of these knowledge concepts is highlighted by the results observed in the knowledge domain, with development of declarative knowledge (rules) supported, and procedural knowledge (decision making) not supported by the evidence provided in the reviewed investigations.

These findings highlight the importance of time in the development of higher order procedural knowledge (decision making). Given that intervention length displayed a relationship with the development of decision making when assessed within games, and the two longest interventions in the procedural knowledge outcome domain displayed full support (all measured variables improved), this review supports the call from a previous review (Harvey & Jarrett, 2013) for greater intervention volumes.

Comparative research designs promote GCA interventions as focusing on the development of declarative, procedural and strategic knowledge and a skill-based approach concerned with movement pattern development (Kirk & MacPhail, 2002). The process of assessing knowledge as an independent domain is a way of focusing on the perceived strengths of a GCA in this circumstance. Nevertheless, this approach is questionable, particularly within a theoretic context outside that of actual game play, as it adds little to the question of how to produce more physically capable students and athletes.

Game performance outcomes

Good sports performance requires strong cognitive and decision making skills (Nevett, Rovegno, & Babiarz, 2001), with expert performers developing a deeper knowledge base, more effective recognition and response to game situations, and a greater ability to apply appropriate strategies to game situations (Janelle & Hillman, 2003). All of the investigations of game performance outcomes used a form of GPAI. The GPAI was designed to assess game performance behaviors that demonstrate tactical understanding, decision making and the application and performance of appropriate skills (Oslin, Mitchell, & Griffin, 1998). This assessment process allows for the measurement of game play variables in isolation; however as opposed to the measurement of a skill or level of knowledge in an isolated manner, a participant is measured within an ecologically valid environment. Thus decisions made and skills performed are within the description of a true information processing sequence involving perception, decision making and movement performance (Abernethy, 1996).

When all of the available studies are included in the synthesis of findings, the level of evidence provided does not support the development of decision making or skill execution during game play. This finding is surprising given a GCA revolves around students acquiring

game knowledge (declarative and procedural) and physical skills through game play challenges (Holt et al., 2002). Intervention volume appears to have a large effect on the development of decision making and skill execution within a GCA. If the level of evidence is calculated excluding investigations with eight hours or less of intervention volume (Gray & Sproule, 2011; Harvey et al., 2010; Turner & Martinek, 1992), the percentage of positive game performance decision making and skill execution outcomes is 73% and 74% respectively, inferring a positive association between these outcomes and use of a GCA.

This finding, and the positive association evident between a GCA and development of the off-ball game performance outcome of support, regardless of intervention volume, highlights the increased physical and cognitive demands of the on-ball outcomes and the difficulty of developing these on-ball skills across the time frames used in the reviewed research.

Development of off-ball skills, particularly that of finding or creating space, is addressed within the tactical awareness phase of a GCA (Holt et al., 2002). This phase lies post learning of rules within the game appreciation phase, and prior to decision making and skill execution phases of development, with the concept of space critical in the development of effective game play (Holt et al., 2002).

The data presented in this review supports this development process. Investigations involving greater volume interventions displayed higher levels of support for decision making and skill execution outcomes, with no such trend observed among the off-ball outcomes (high and low volume interventions displayed support). An intervention volume of greater than eight hours, or ten sessions appears to be a common cut point for greater positive support for the use of a GCA in the development of decision making and skill execution variables. Future interventions involving the use of a GCA should take intervention volume into account during planning and

interpretation of results, with intervention volumes of less than 8 hours undertaken with caution when in game decision making and skill execution are measured via use of a GPAI.

Affective outcomes

Given that a GCA revolves around student centered pedagogy and is said to create an enjoyable learning environment (Griffin, Oslin, & Mitchell, 1995; Lawton, 1989), the lack of investigation around the affective outcome of student enjoyment was surprising. Previous qualitative work displays a link between GCAs and student enjoyment (Chen & Light, 2006; Fry et al., 2010; Light, 2003), however quantitative evidence of GCA efficacy is required to complement qualitative data and inform future translational efforts. The lack of evidence may rest with the difficulties associated with the measurement of what is termed “enjoyment”, with this term having mixed connotations, often associated with constructs such as fun, interest and intrinsic motivation (Dudley et al., 2011).

The positive association of a GCA with perceived competence and motivation (interest-enjoyment and effort-importance) should be considered a strength of the GCA. It is reported that improved long term physical activity outcomes in children and adolescents are mediated by higher levels of perceived sports competence (L M Barnett, Morgan, Van Beurden, Ball, & Lubans, 2011; Lisa M Barnett, Morgan, van Beurden, & Beard, 2008; Clark, 2005; Lubans, Morgan, Cliff, et al., 2010), and intrinsic motivation (Ntoumanis, 2001) among young people.

There is limited previous review of self-perception and motivation literature due to the limited amount available, and much of the affective research surrounds teachers’ and learners’ attitudes/perceptions of a GCA (Harvey & Jarrett, 2013). Improvement of self-perception towards physical skills works towards the concept of the whole child presented by Holt, et al (2002), in which physical education is not only focused solely on the development of physical

skills, but on cognitive abilities and student affective characteristics. With actual competence said to precede perceived competence (Harter, 1978; White, 1959), Holt's (2002) assertions that mastery of less complex versions of adult games using a GCA may provide positive affective experiences in addition to feelings of competence are relevant and should be investigated further in future GCA research.

Professional Development

A common component of the majority of interventions used in the reviewed investigations is the use of a set curriculum, designed by the research team involved. A lack research into professional learning for in-service teachers has been previously identified (Harvey & Jarrett, 2013), and is supported within the current review, with only one of the investigations reporting the use of professional learning for the development and delivery of intervention curriculum (Gray & Sproule, 2011).

The design of stage appropriate experiences using a GCA is not easy, and as demonstrated through this review, effective learning of higher order thinking and performance concepts within game play takes considerable time. The maintenance of effective teaching to promote learning in dynamic environments is going to be critical across the time frames required to promote this learning. As Metzler (2011) states, "teachers must have a strong expertise in games taught with the tactical model", and that "familiarity goes well beyond game rules and basic strategies". This lack of ease in design and implementation of GCA principles, and the confusing competing nuanced interpretations of essentially the same pedagogical emphasis (Stolz & Pill, 2014) assist in the maintenance of the segmented instructional model within physical education.

Strong professional development programs are common to successful interventions targeting physical activity and movement skills (Dudley et al., 2011). Themes in successful professional development include: the involvement of and access to external experts; engagement of teachers to deepen their knowledge and extend skills in ways that improve student outcomes, and challenging of teachers' prevailing discourse, as well as conceptions about learning (Timperley, Wilson, Barrar, & Fung, 2007). The facilitation of these concepts is just the beginning of effective professional learning. The environment teachers learn in is important, and just as learning is situated within game play for students, professional learning should be situated within the context of the teacher's class/es (Lave & Wenger, 1991). The use of communities of practice to provide teachers and coaches with the longer term support required to maintain learning within a GCA is suggested by Harvey and Jarrett (2013), and supported by evidence in this review of the need for expanded time frames for complex learning.

Professional development involving academic partnering for assisting and mentoring effective curriculum design and delivery using a GCA in an authentic setting is of great interest in the investigation of the longer term effects of GCAs on student physical education and physical activity outcomes, particularly in non-specialist physical education teachers.

Strengths and Limitations

There are five major strengths to this review. First, it provides a current snapshot of the quality of study design and the level of evidence provided by existing GCA investigations for a range of student outcomes, a process that is yet to be undertaken in reviews of sport / physical education pedagogy. Second, it is not a comparison of pedagogical models. This independent assessment of GCA interventions is important in identifying the areas in which GCA interventions and investigations (ie. Intervention volume) can be improved in the future. Third,

to allow comparison between studies, detailed information was drawn from each investigation, and this information has been analyzed using the CONSORT and STROBE statements. Fourth, studies were retrieved across a 25 year period. Fifth, inclusion criteria provided a focus on school based learners and allowed for a variety methodological designs.

Limitations are also recognized. Only studies published in English that provided repeated measures analysis of a GCA were included. Although the non-comparative design (of pedagogical approaches) of this review is one of its strengths, loss of data due to these criteria must be acknowledged. Between-group comparison provided a positive picture for the use of a GCA, however the focus of this review process was to investigate the effects on student outcomes when a GCA was involved, which was not provided by studies that did not report repeat-measures results. Further to this, this review only compares investigations against a set of quality criteria as it was considered outside the scope of this review to provide direct comparison of repeat measures data via meta-analysis.

Whilst not recognized as a limitation to this review, it must be acknowledged that much work has been published surrounding the positive effects of a GCA using qualitative research methodologies, with much of this work synthesized by recent narrative reviews (Harvey & Jarrett, 2013; Stolz & Pill, 2014). Qualitative investigations excluded from this systematic review provide a broader picture of the effectiveness of GCA use than provided by the quantitative data addressed in this manuscript. In particular, the all-important affective domain, which is displaying more relevance in positive longer term health and wellness outcomes, and is often difficult to measure using quantitative methodologies, is addressed in the qualitative domain.

Design of future interventions

The absence of GCA use among research dedicated to increasing physical fitness (Harvey & Jarrett, 2013), physical activity participation (Dudley et al., 2011; Harvey & Jarrett, 2013), and movement skill proficiency (Dudley et al., 2011) has been noted previously and requires attention from advocates of a GCA. Given the positive effect upon perceived competence, student motivation, and the potential to increase game play decision making and skill performance (given the right amount of intervention time) displayed in the synthesis of evidence presented in this review; it is proposed that future quantitative GCA research investigate the relationships between GCA use and potential health outcomes (improved fitness levels and increased physical activity behaviors) in children and adolescents.

In order to facilitate effective investigation of these outcomes the intervention, outcome assessment and efficacy assessment components of study design need to be considered. Study design recommendations shadow those of previous reviews (Harvey & Jarrett, 2013; Oslin & Mitchell, 2006) that studies should be ecologically robust. With regard to interventions, longer term interventions (greater than 8 hours) should be integrated into the current teaching or coaching environment that children/adolescents are exposed to, with development of professional learning that is situated within the facilitator's (teacher or coach) existing program (Lave & Wenger, 1991) suggested in order to achieve this. The use of communities of practice previously suggested by Harvey and Jarrett (2013) are also of interest in initial professional learning, and during the maintenance of GCA facilitation across longitudinal time frames post professional learning.

Outcome assessment should also be ecologically valid, with the use of game performance assessment instruments supported for assessment of game performance variables, as demonstrated by Harvey et al (2010) and Gray and Sproule (2011). In a school setting,

assessment of movement skill proficiency (FMS) developed via a GCA, as suggested by Dudley et al (2011) is encouraged in light of the relationship between movement proficiency, perceived competence and physical activity levels. Despite the lack of ecological validity of process based FMS outcomes (although advanced movement patterns could be measured in game play) for movement skill assessment, these skills are used across a variety of movement domains, and are in line with current physical activity literature (Lubans, Morgan, Cliff, et al., 2010).

The assessment of intervention effects has moved more towards the practiced referenced, repeat measures design suggested by Kirk (2005). Whilst this is positive for assessment of GCA effects, and has demonstrated a greater volume of positive effects for the approach, scientific rigor should be considered. The use of a control group for evaluation against normal treatment is important in investigating rates of change when an intervention is in place. Interventions can still be tailored to be more ecologically sound (as discussed above), however with the use of clustered design studies, variation between classes or groups involved can be accounted for in repeated-measures statistical models. A clustered design allows for greater generalizability of results of interventions involving GCA use, rather than single group “teaching experiments” which lack statistical power. Both methods (practice referenced & randomized-control-trial) have a place in the investigation and dissemination of GCA based outcomes.

As per the analysis of study quality, only one of the 15 investigations (French et al., 1996) scored a level of “high” on the quality criteria checklist. Regardless of the design used to assess intervention effects, quality needs to be addressed. High quality studies in the physical activity domain provide a model for design and reporting of intervention effects (Lubans, Morgan, Dewar, et al., 2010; Salmon, Ball, Hume, Booth, & Crawford, 2008). Of issue in the present review were sample and effect size calculation and the reporting of intervention fidelity.

Prevention of type two errors (mistakenly finding no effect) is paramount in providing consistent evidence of the benefits of GCA use, and calculation of large enough samples to detect an effect should be considered for future investigations. Fidelity measures ensure an intervention is undertaken in the true nature in which it was designed, and should be undertaken to ensure the quality of intervention is suitable to produce an effect. Harvey and Jarrett (2013) argue that greater reporting of intervention procedures and fidelity would expand the context of interventions and may help expand acceptance of a GCA.

Finally, the call for further investigation of philosophical understandings of GCAs by Harvey and Jarrett (2013) is shadowed here. Cluster design randomized control trials should not be singled out as quantitative only in nature, and investigation of the way in which teachers and learners connect to the methods employed during an intervention should be undertaken. Likewise, theoretical frameworks should be incorporated into the design of quality empirical investigations.

Conclusion

Evidence collected within this review demonstrated that the quality of quantitative research undertaken to evaluate the efficacy of a GCA could be improved in order to strengthen the empirical basis of the pedagogical approach. A greater focus on the design quality of investigations can only strengthen the collective findings of GCA use for improvement of student outcomes, which at the moment should be interpreted with caution. In studies investigating skill development outcomes, pedagogical focus towards the improvement of the skill measures being used appears lacking during GCA interventions. Collective findings displayed no association between the use of a GCA and improvement in product based skill outcomes.

Intervention volume appears to be a very important factor for the achievement of outcomes using GCA pedagogy. Among knowledge outcomes, a GCA displayed positive association with the outcome of declarative knowledge (rules), but not procedural knowledge (decision making), highlighting greater time frames may be required to develop complex decision making skills in game play environments. Greater intervention volume was supported among game performance investigations evaluating game based decision making and skill execution, with both of these outcomes positively associated with use of a GCA when intervention volume was above eight hours.

GCA use was positively associated with the affective outcome of perceived competence and motivation (interest-enjoyment and effort-importance). Given the importance of improved physical self-perception and intrinsic motivation in the improvement of long term physical activity outcomes for children and adolescents, this outcome is considered of great interest in future GCA based investigations for promotion of physical education and physical activity outcomes through the development of actual and perceived physical competence for improved physical self-perception.

598 Table 1. Summary of included studies

Study	Outcomes			
	Technical	Knowledge	Game	Affective
Lawton (1989)	X	X		
Turner & Martinek (1992)	X	X	X	
Turner (1996)	X	X	X	
French, Werner, Hussey, Taylor, & Jones (1996)	X	X	X	
Tjeerdsma, Rink, & Graham (1996)				X
Nevett, Rovegno, Babiarz, & McCaughtry (2001)			X	
Nevett, Rovegno, & Babiarz (2001)		X		
Tallir, Musch, Valcke, & Lenoir (2005)		X		
Chatzopoulos, Drakou, Kotzamanidou, & Tsorbatzoudis. (2006)			X	X
Tallir, Lenoir, Valcke, & Musch (2007)			X	
Harvey, Cushion, Wegis, & Massa-Gonzalez (2010)			X	
Gray & Sproule (2011)			X	X
Jones, Marshall, & Peters (2010)				X
Mesquita, Farias, & Hastie (2012)			X	
Nathan & Haynes (2013)	X	X	X	

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Table 2. GCA study quality checklist with quality scores assigned

Study	Did the study report a sample size calculation?	Were the participants randomly allocated? ^a	Did the study report the sources and details of outcome assessment?	Did outcome assessment instruments have acceptable reliability for the specific age group?	Did the study report the precise details of the interventions intended for each group and how and when they were actually administered?	Did the study report the fidelity of the intervention that was delivered to participants and was the delivered content in the true nature of the intended intervention?	Did the study report the effect size of primary and secondary outcome investigation?	Quality score total/7	Quality rating 0 – 1 = Very low 2 – 3 = Low 4 – 5 = Moderate 6 – 7 = High
Lawton (1989)	0	0	0	0	0	0	0	0	Very low
Nevett, Rovegno, & Babiarz, (2001)	0	0	1	1	1	0	0	3	Low
Mesquita, Farias, & Hastie (2012)	0	0	1	1	1	0	0	3	Low
Nathan & Haynes (2013)	0	0	1	1	1	0	0	3	Low
Turner (1996)	0	1	1	1	1	0	0	4	Moderate
Tjeerdsma, Rink, & Graham . (1996)	0	1	1	0	1	1	0	4	Moderate
Nevett, Rovegno, Babiarz, & McCaughtry. (2001)	0	0	1	1	1	0	1	4	Moderate
Chatzopoulos, Drakou, Kotzamanidou, & Tsorbatzoudis (2006)	0	1	1	1	1	0	0	4	Moderate
Jones, Marshall, & Peters (2010)	0	1	1	1	0	0	1	4	Moderate
Turner and Martinek (1992)	0	1	1	1	1	1	0	5	Moderate
Tallir, Musch, Valcke, & Lenoir (2005)	0	1	1	0	1	1	1	5	Moderate
Tallir, Lenoir, Valcke, & Musch (2007)	0	1	1	1	1	0	1	5	Moderate
Harvey, Cushion, Wegis, & Massa-Gonzalez (2010)	0	0	1	1	1	1	1	5	Moderate
Gray and Sproule (2011)	0	0	1	1	1	1	1	5	Moderate
French, Werner, Hussey, Taylor, & Jones (1996)	0	1	1	1	1	1	1	6	High

Note a. Were participants randomly allocated and was the process of randomization clearly described and adequately carried out?

Table 3. Summary of GCA investigations and associated benefits

Student outcome	Positive association of student outcome with GCA (reference)	No association of student outcome with GCA (reference)	n/N (%) of studies supporting outcome	Association (+/-)
Technical skill	French et al (1996): 3/4 measures Turner & Martinek (1992): 1/2 measures Turner, A (1996): 1/2 measures Nathan & Haynes (2013)	French et al (1996): 1/4 measures Turner & Martinek (1992): 1/2 measures Turner, A (1996): 1/2 measures Lawton (1989)	2.8/5 (56)	?
Knowledge (Declarative)	Turner, A (1996) French et al (1996) Nevett, Rovengo & Babiarz (2001) Nathan & Haynes (2013)	Turner & Martinek (1992)	4/5 (80)	+
Knowledge (Procedural)	French et al (1996) Nevett, Rovengo & Babiarz (2001) Tallir, Musch, Valcke, & Lenoir (2005) Nathan & Haynes (2013)	Lawton (1989) Turner & Martinek (1992) Turner, A (1996)	4/7 (57)	?
Game performance (Decision making)	French et al (1996): 2/3 measures Mesquita, Farias, & Hastie (2012): 1/6 measures Turner, A (1996) Nevett, Rovengo, Babiarz & McCaughtry (2001) Chatzopoulos, Drakou, Kotzamanidou, & Tsorbatzoudis (2006) Tallir, Lenoir, Valcke, & Musch (2007) Nathan & Haynes (2013)	French et al (1996): 1/3 measures Mesquita, Farias, & Hastie (2012): 5/6 measures Turner & Martinek (1992) Harvey, Cushion, Wegis, & Massa-Gonzalez (2010) Gray & Sproule (2011)	5.8/10 (58)	?
Game performance (Skill execution)*	Harvey, Cushion, Wegis, & Massa-Gonzalez (2010): 1/2 measures Turner & Martinek (1992): 2/5 measures French et al (1996): 3/5 measures Turner, A (1996): 1/2 measures Nevett, Rovengo, Babiarz & McCaughtry (2001): 3/5 measures Mesquita, Farias, & Hastie (2012): 1/4 measures Chatzopoulos, Drakou, Kotzamanidou, & Tsorbatzoudis (2006) Tallir, Lenoir, Valcke, & Musch (2007) Nathan & Haynes (2013)	Harvey, Cushion, Wegis, & Massa-Gonzalez (2010): 1/2 measures Turner & Martinek (1992): 3/5 measures French et al (1996): 2/5 measures Turner, A (1996): 1/2 measures Nevett, Rovengo, Babiarz & McCaughtry (2001): 2/5 measures Mesquita, Farias, & Hastie (2012): 3/4 measures Gray & Sproule (2011)	5.9/10 (59)	?
Game performance (Support)	Harvey, Cushion, Wegis, & Massa-Gonzalez (2010): 3/4 measures Chatzopoulos, Drakou, Kotzamanidou, & Tsorbatzoudis (2006) Gray & Sproule (2011)	Harvey, Cushion, Wegis, & Massa-Gonzalez (2010): 1/4 measures	2.8/3 (93)	+
Affective (Perceived competence)	Tjeerdsma, Rink, & Graham (1996) Chatzopoulos, Drakou, Kotzamanidou, & Tsorbatzoudis (2006) Gray & Sproule (2011)	Jones, Marshall, & Peters (2010)	3/4 (75)	+
Affective (Interest-	Chatzopoulos, Drakou, Kotzamanidou, & Tsorbatzoudis (2006)	Tjeerdsma, Rink, & Graham (1996)	2/3 (67)	+

enjoyment)	Jones, Marshall, & Peters (2010)			
Affective (Effort- importance)	Chatzopoulos, Drakou, Kotzamanidou, & Tsorbatzoudis (2006) Jones, Marshall, & Peters (2010)	Tjeerdsma, Rink, & Graham (1996)	2/3 (67)	+
Affective (Tension- pressure)		Chatzopoulos, Drakou, Kotzamanidou, & Tsorbatzoudis (2006) Jones, Marshall, & Peters (2010)	0/2 (0)	0
Affective (Perceived choice)		Jones, Marshall, & Peters (2010)	0/1 (0)	0
Affective (Value/useful ness)		Jones, Marshall, & Peters (2010)	0/1 (0)	0

*object control variables have been included in skill execution category

Figure 1. Study flow

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