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The impact of play on child development - a literature review

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ABSTRACT

Play is never absent in human life, especially for children. The act of playing requires a game. Games can be divided into digital games and non-digital games. Digital games are games that utilise computers, mobile or handheld devices, or gaming console as playing platform while non-digital games may require physical contact and/or equipment which are not digital devices. This review aims at investigating the impact of non-digital games in child development studies for children within the ages of 4 to 9 years old. 43 papers were identified based on the proposed classification approach and analysed from the perspective of year, age group, type of play, research method, and learning outcome. The findings imply that non-digital games can stimulate the cognitive development of preschool age children.

KEYWORDS

Child; cognitive;
development; game; play

Introduction

Play is never absent in human life, especially for children. A game is defined as an activity of playing, that is, an activity that one engages in for amusement or fun (Game, n.d.). A game can appear in various forms, such as virtual reality, augmented reality, the physical world, or even in man's own imagination.

Caillois and Barash (1961) and Huizinga (1971) defined a 'game' as an activity that is governed by rules. Crawford (1984) then classified a 'game' by the factors of representation, interaction, conflict, and safety. Most games, e.g. board games and sports games are designed with compliance to the aforementioned conditions. These games possess their own systems and rules; players react against the response or action given by another player. Additionally, games encourage competition between players, and the winner is rewarded at the end of the game. However, some games, notably imaginary ones, may not comprise rules or competition, and need no company to play. These kinds of game require only an object (toys) or particular skill (imaginative ability). Therefore, it is hard to give a universal definition to the term 'game'.

Recently, Granic, Lobel, and Engels (2014) defined 'game' as a kind of interactive play that can be completed cooperatively or competitively and may involve one (for physical games) to thousands of players (for online games). In this study, we defined 'game' as a human activity with numerous forms of existence; something humans attempt for the

purpose of pleasure which may benefit them mentally or physically; with no restrictions on the number of players, procedures or rules.

As games have a wide range of existing forms, there is a need to have a standard taxonomy to classify them. A proper scheme for classifying the games will help to understand the nature and usage of games. Games can be divided into those which are digital, and those which are non-digital. They can also be distinguished in several other aspects, namely playing platform, equipment/tools, involvement of players and game flow (Cojocariu and Boghian 2014). In this study, we focus only on non-digital games (NDG). Non-digital game studies (NDGS) are used to refer to research focusing on these types of games, or studies regarding children's play that may require physical contact and/or equipment other than digital devices.

Game genre is a suitable metric by which to classify digital games. A game's genre can be determined based on its design and gameplay (Apperley 2006; Gros 2007; Boyle et al. 2012). However, classifying by game genre does not work well for NDG. For example, pretend play could not fit neatly into any existing list of game genres. Therefore, Play Observation Scale (POS) was selected to categorise the NDG (Coplan, Rubin, and Findlay 2006; Fromberg and Bergen 2015). POS classified the NDG as the activity of functional, constructive, exploration, or dramatic play, or as a game-with-rules (Rubin 2001).

Children's interest in games changes from time to time due to developmental change and social needs (Vygotsky 1967). Nevertheless, existing literature reviews on games and learning seldom analysed the dimension of age, but instead often choose to focus on school levels such as elementary education, secondary education, and higher education (Hwang and Tsai 2011; Hwang and Wu 2012; Wouters and van Oostendorp 2013). Kovačević and Opić (2014) reported that NDG differ by age due to a child's psychophysical state. At a younger age, NDG may encourage the physical interaction and development of a child; while at an older age, they may foster the cognitive and social development of a child. The investigation of the impact of games on children's learning, studied through the dimension of age, is essential to understand their preferences and the potential outcomes for various areas of development.

This review aims at analysing the use and impact of NDG towards the child's development. The proposed classification of games offers detailed information, allowing the game to be matched with children's age, type of play, research method, and learning outcome. By understanding the preferences of games for children at different ages, educators and researchers may have sufficient information to choose a game for a particular age group of children, while avoiding the discrepancies in learning direction and planning.

Literature review

Existing review on participants' age

Existing reviews on using games for learning lack detailed analysis on the dimension of age. Boyle et al. (2016) and Connolly et al. (2012) reviewed game studies on various outcomes of learning, as well as the potential for promoting engagement and supporting learning. Although Connolly et al. (2012) did focus on participants over the age of 14 years, the details for particular age groups were neither analysed nor discussed. On the other hand, Powers et al. (2013) analysed and investigated the impact of games on

information processing skills for four general age categories, from young children to older adults. Nevertheless, the range of each age category was too large to represent a specific age group. Hwang and Tsai (2011) and Hwang and Wu (2012) analysed the learning outcomes based on school levels (e.g. elementary, secondary, and multi-level). Since each school level consisted of participants within a wide age-range, the interest in both games and the level of challenge might be different for each age. Although the above studies provide some useful information, educators and researchers may not have sufficient guidance on setting an educational plan and using games within teaching/learning strategies for a particular age group of children.

Game and its impact on learning

Playing games can not only fill up spare time, but can also lead to changes in knowledge, attitudes, behaviours, and skills (Ifenthaler, Eseryel, and Ge 2012). There exists various research today that discussed the impact of games on learning.

A classification scheme of learning outcomes that covered the aspects of cognitive, affective, and motor skills was proposed (Kraiger, Kevin Ford, and Salas 1993). As games develop at a fast pace, Wouters, van der Spek, and van Oostendorp (2009) suggested that collaboration and social skills should also be considered as learning outcomes of games. All of these learning outcomes can be further deconstructed into more specific skills. Thus, one of the interests of this study is to explore the subcategory of the learning outcomes (i.e. problem solving skills, behaviour changes, motor skills, social skills, etc.) to provide a clear, direct, and comprehensive view on the impact of games on learning. By understanding the potential of games in learning, educators, researchers, and game developers can make careful plans to utilise games for learning.

Game classification approach

Caillois (1955) categorised games based on Ludus and Paidea rules. Ludus games (i.e. board games and sport games) encourage competition among players, whereas Paidea games (i.e. block building and pretend play) emphasise the pleasure experienced by players. However, this classification is not suitable for learning games because of their complexity and heterogeneous features. Genre classification (i.e. role-playing and puzzle) is commonly used in many digital game studies (Lindley 2003; Whalen 2004; Apperley 2006; Elverdam and Aarseth 2007; Kim et al. 2010; Clearwater 2011) for discussion and comparison purposes. Nonetheless, some NDG, such as sand play and sticker games, are hardly able to be grouped using game genre. Play Observation Scale (POS) was selected to categorise NDG. In brief, POS consists of functional play, constructive play, exploration, dramatic play, and games-with-rules. This scale covers all levels of play, ranging from basic sensorimotor skill to the high level of cognitive skill involved in following rules and engaging in competition (Rubin 2001).

Method

The methodology used for this review is described in this section. The paper selection and filtering process began with a manual search via web-based electronic journal databases

using a set of search terms. The inclusion/exclusion criteria were used to define the boundary/scope for this review. A data extraction and coding method was developed to classify the related papers.

Data sources and search terms

The search was conducted via web-based electronic journal databases that were related to cognition, education, social science and information technology. The data sources used in this study were obtained from the American Physical Society (APS), BioMed Central, Education Resources Information Center (ERIC), IEEE Xplore, JSTOR Archive, ProQuest Education, PsycINFO, SAGE, Science Direct, Scopus, SpringerLink, Taylor & Francis Online and Wiley Online Library electronic journal databases.

The search terms used in database searches included terms that were related to play, games, and children learning. General terms such as 'traditional game' and 'learn through play' were used to achieve the goal of searching game related studies. More specific terms such as 'creativity' and 'literacy' were used to determine the scope of our definition of child development studies. Several keyword-searching criteria were applied to help in searching related publications such as;

- (1) 'Children', and/or 'game', 'play', 'intervention', 'training', 'learning', 'learn through play'.
- (2) 'Traditional game', and/or 'intervention', 'training', 'learning', 'learn through play'.
- (3) 'Fitness', 'cognitive', 'physical', 'mental', 'skill'.
- (4) 'Creativity', 'problem-solving', 'literacy', 'communication'.

Inclusion/exclusion criteria

Table 1 shows the inclusion and exclusion criteria used to filter the search results. All the papers obtained have to fit within the investigation time period to ensure a fair evaluation. The filtering criteria included that the participants must be children within the ages of four

Table 1. Inclusion and exclusion criteria for papers.

Inclusion	Exclusion
a) All or the majority of participants must be children between the ages of 4 and 9.	a) Studies focused on participants above 9 years old are excluded.
b) The paper is published between January 2004 and December 2013.	b) Papers published before 2004 or after 2013.
c) It must be journal paper.	c) Conference papers, book chapters, and game reports were excluded.
d) The study must related to: i. learn through play, ii. learning through game/with game element iii. intervention programme with game iv. children's cognitive, affective, psychomotor and/or communicative development	d) Studies that focused only on either one or a mixture of the following: i. Using digital games, ii. Theory or framework of games, iii. User satisfaction of games, iv. Comparison of most preferable games, v. Child's disease, impairment and rehabilitation/therapy
e) The paper must report findings/results/outcomes of the study.	e) No empirical evidence or details of the study were reported or explained.

to nine years old, and that the papers were related to the following fields: (i) learn through play, (ii) learning through game/with the game, (iii) intervention programme with games, and (iv) on children cognitive, affective, psychomotor and/or communicative development. Furthermore, the selected papers were also required to discuss the results of the study. Papers without findings which only focused on theory or game design framework, research on system performance and user preferences, simulation, and children's health issues were excluded. Two researchers worked independently to extract the relevant papers.

Data extraction and coding

After applying the inclusion/exclusion criteria in [Table 1](#), 43 papers were identified and accepted for this review. All of the collected studies were within the 2004–2013 date range. The studies are classified according to two age groups, namely 4–6 years old for early childhood studies and 7–9 years old for lower primary studies. For those studies that were comprised of participants with different ages, the respective papers were coded based on the age of the majority group or the mean age. If a study has a mean age (m) falling outside the range of the age group, (i.e. $m = 6.1$ to 6.9), it will be grouped with the nearest age group (i.e. age 4–6 because $m < 7$). The selected papers are named as NDGS and classified based on the proposed game classification scheme, learning outcome, and research method.

Categorisation of games

POS (Rubin 2001) was used to classify the NDGS, because this scale covers a wide range of NDG.

The characteristics of NDGS are as follows:

- (1) Activities: fitness, art, literacy, drama, and misc. activities (i.e. die throwing, building blocks, etc.).
- (2) Instruments used: Sport equipment, picture books (i.e. books and picture cards), toys, art materials and misc. instruments (i.e. dolls, marbles, play mats, etc.)
- (3) Presence of instructor: experimenters/teachers
- (4) Learning outcome: cognitive, affective, psychomotor, and communicative.
- (5) Form of participation: solitary (individual) or group.

The types of play used for NDGS are listed below:

- (1) Functional play refers to the repetition of motor movements such as jumping, running and dancing.
- (2) Constructive play is the manipulation of objects to create new substances such as Lego games and art works.
- (3) Dramatic play is similar to pretend play. The participant plays as a chosen character and reacts in turn.
- (4) Exploration is an act with the purpose of obtaining information through the process of examination, study and observation. Dominoes, storytelling, and experiments are all examples of exploration games.

- (5) Games-with-rules can be any games that are governed by procedures, rules, and regulations such as chess, basketball, and Monopoly.

Classification of learning outcomes

Based on the collected studies, the reported outcomes include cognitive, affective, psychomotor, and communicative changes. For cognitive development, the collected studies can be deconstructed into creativity, problem solving, and literacy skills within knowledge acquisition, whereas affective outcomes covered behaviour change, health awareness, personality and lifestyles, and emotion. The collected studies related to cognitive performance and motor skills were grouped under psychomotor outcomes whereas social skills were grouped under communicative outcomes.

A detailed description of each learning outcome is below:

- (1) Cognitive development studies:
 - Knowledge acquisition* – topics regarding learning new information or concepts.
 - Creativity* – studies on children's creativity or innovative skills in a specific domain, i.e. art.
 - Problem solving* – the strategy or solution used in solving a problem.
 - Literacy* – the development or training of language, writing, and/or reading.
- (2) Affective:
 - Behaviour change* – changes or improvements in attitude or habits.
 - Health awareness* – children's safety awareness.
 - Personality and lifestyle* – the child's character and personal choices on exercise.
 - Emotion* – topics that related to feelings, such as enjoyment.
- (3) Psychomotor development studies:
 - Cognitive performance* – refers to the improvement in attention and learning performance caused by performing fitness games or physical exercise.
 - Motor skill* – coordination and control skills needed for dancing.
- (4) Communicative:
 - Social skills* – communication and socialisation ability.

Classification of research methods

The collected studies were also coded into a number of methodological dimensions, including the research objective.

A detailed description of each dimension is below:

- (1) Objective – The aim of the study.
- (2) Research methodology – the reported methods included qualitative, correlation, quasi-experimental design, randomised control trial (RCT), and mixed method (which combines multiple methods into the study design).
- (3) Methods comparison – compares the proposed method with current teaching/learning strategies, such as classroom methods.
- (4) Results and conclusion – The findings or outcome of the study.

Reliability of data extraction and coding

Two coders worked separately to filter the papers based on the data extraction and coding scheme to ensure the reliability of the review. After comparing their work, the two coders analysed the disputed papers together to resolve the inconsistencies of data extraction and coding. All 43 papers complied with the inclusion criteria and were selected for this review.

Results

This section analyses the impact of games in child development studies over the last decade (2004–2013). A total of 1768 papers were identified based on the search terms mentioned in the previous method section. With the effort of the two experienced coders, 43 papers were selected by using the proposed data extraction and coding scheme. A descriptive statistic was used to provide a clear overview of the collected studies. Each study's year, type of play, age group, research method, and learning outcome was recorded.

Overview of collected game studies

This section gives an overview of the collected studies from the year 2004 to the year 2013. A further, more detailed analysis by age group, research method and learning outcome was inferred from the available data. The characteristics of the eligible NDGS were also further reviewed.

The collected NDGS were divided into two time frames, namely, between the years 2004 to 2008 and the years 2009 to 2013, for comparison purposes. The number of publications grew from 16 (first time frame) to 27 (second time frame), achieving approximately 68.8% of growth.

Figure 1 shows the number of collected NDGS for each type of play by time frame. The categories of constructive play, dramatic play, and games-with-rules showed positive growth during the second time frame.

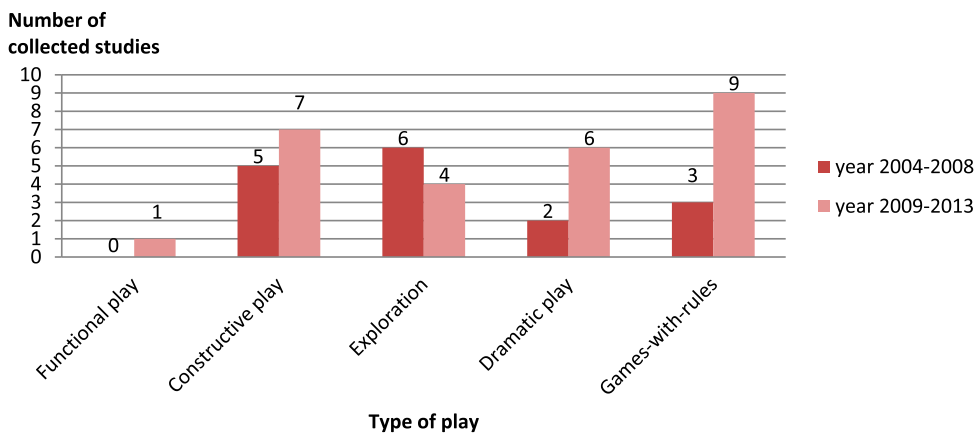


Figure 1. The number of collected NDGS for each type of play by time frame.

The collected NDGS can also be appraised into different age groups: 4 to 6 years old and 7 to 9 years old, respectively. 74.4% (32 papers) of the collected studies focused on subjects aged from 4 to 6 while the remaining 15.5% (11 papers) emphasised the older children. Clearly, most collected studies preferred focusing on early childhood.

Figure 2 shows the number of collected studies for each research method by time frame. Overall, all methods showed positive growth during the second time frame, except for the mixed method approach. The most commonly used method was the qualitative approach (34.9%), followed by the quasi-experimental approach (25.6%).

Evidently, there was positive growth for all types of learning outcomes, including cognitive, affective, psychomotor, and communicative (see Figure 3). Research on NDGS tended to focus on cognitive outcomes. Starting from 2009, the interest in studies associated with affective learning outcomes increased dramatically. However, very few studies

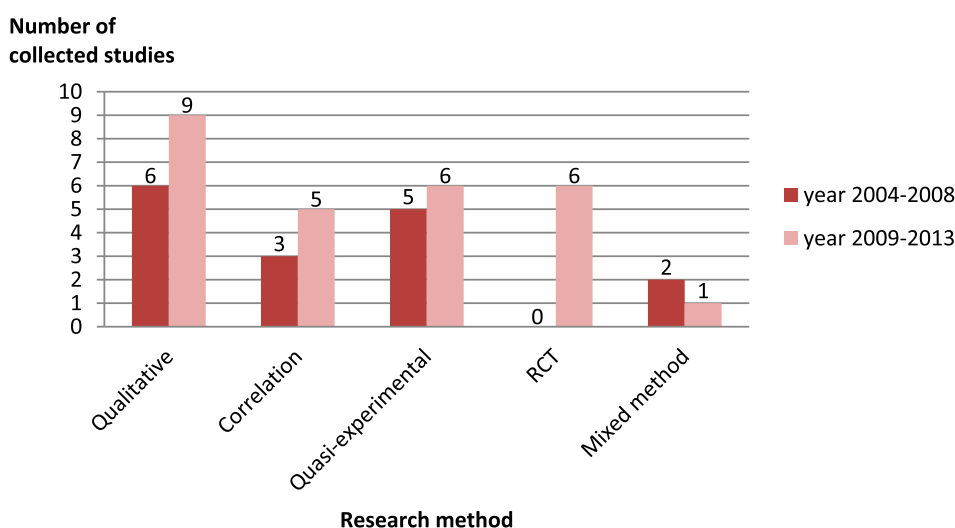


Figure 2. The number of collected NDGS for each research method by time frame.

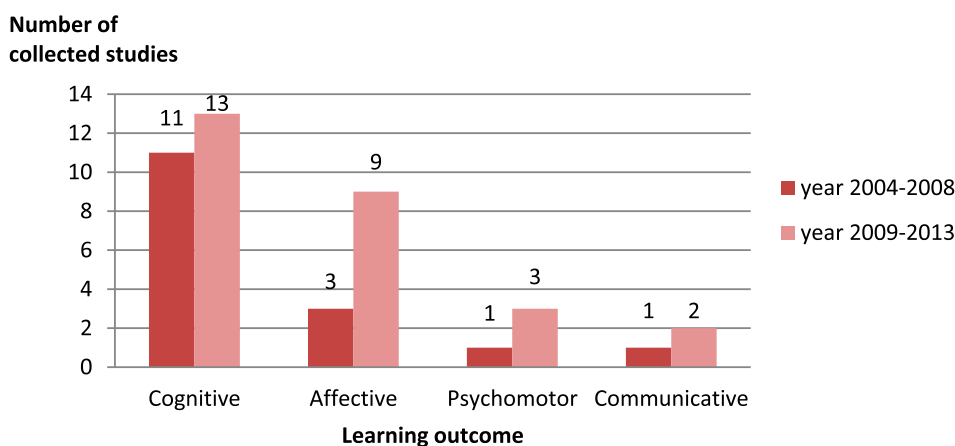


Figure 3. The number of collected NDGS for each learning outcome by time frame.

with psychomotor and communicative outcomes were found during for the entirety of the chosen time period.

Age group

Figure 4 shows the collected NDGS for each type of play by age group. In general, the collected NDGS included almost all the types of play, only functional play was found severely lacking while constructive play, exploration play, and games-with-rules seemed to be a favourite choice for pre-schoolers.

There were five common research methods used by the collected studies for the two age groups (see Figure 5). The qualitative approach (34.9%) was the most popular research

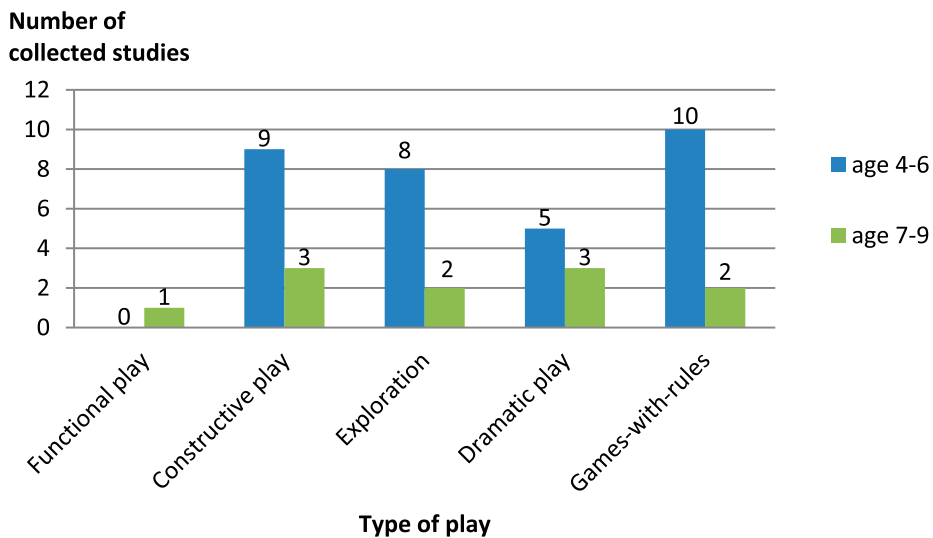


Figure 4. The number of collected NDGS for each type of play by age group.

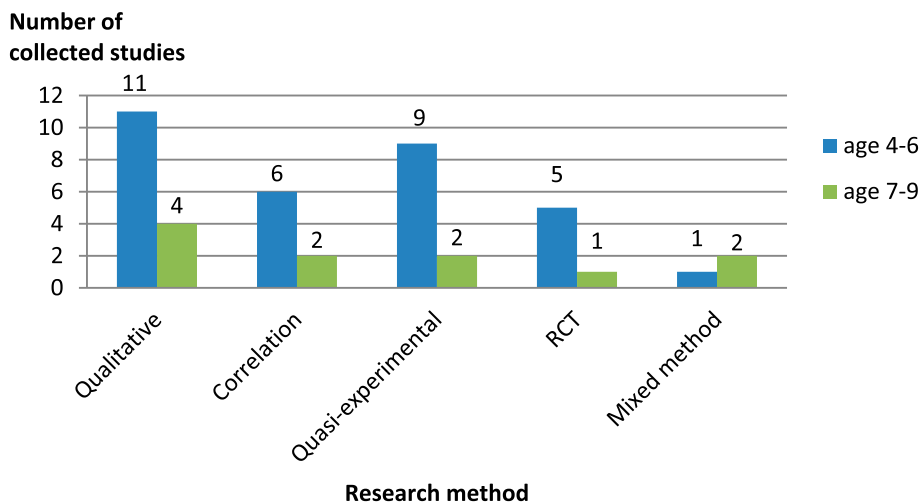


Figure 5. The number of collected NDGS for each research method by age group.

Number of collected studies

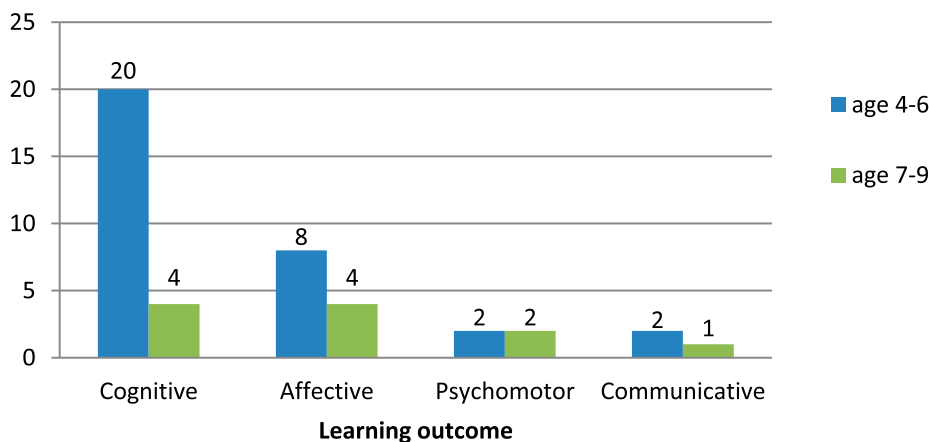


Figure 6. The number of collected NDGS for learning outcome by age group.

method for pre-schoolers and lower primary children, followed by the quasi-experimental approach (25.6%).

Figure 6 compares the reported learning outcomes of the collected studies by age group. 55.8% of the collected studies were associated with cognitive outcome, and primarily focused on pre-schoolers.

Research method

Figure 7 compares the reported outcomes of the collected NDGS by research method. In general, the qualitative approach was popular for studies with cognitive, affective, psychomotor, and communicative outcomes. On the other hand, studies with cognitive outcomes also tended to use the quasi-experimental approach, whereas studies with affective outcomes generally used the RCT approach.

Number of collected studies

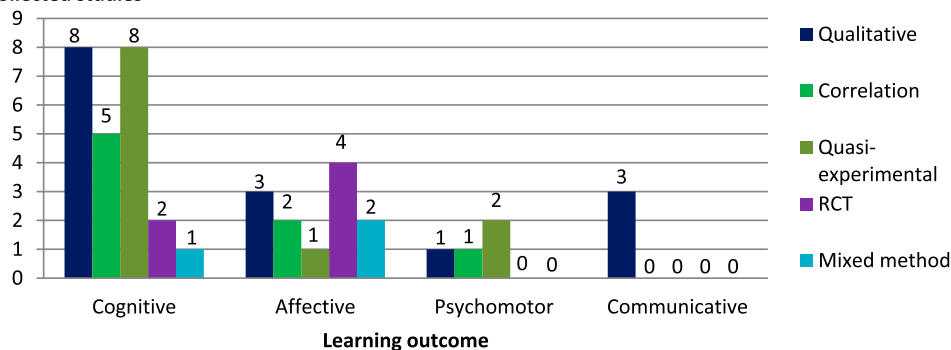


Figure 7. The number of collected NDGS for learning outcome by research method.

Learning outcome

Table 2 shows the subcategory of reported learning outcomes of the game studies as grouped by age group. The collected studies associated with cognitive development mainly targeted pre-schoolers. Attention was given to cognitive skills related to academic learning (i.e. knowledge acquisition and problem solving). The focus of studies related to affective outcomes was also on pre-schoolers, and mostly related to behaviour change. The studies associated with psychomotor outcomes were very scarce and covered cognitive performance and motor skills only. For communicative outcomes, the collected studies only reported social skills development.

Characteristics of game studies

Table 3 summarises the characteristics of NDGS. The reported activities for constructive play, exploration, and games-with-rules were mutually exclusive, and the instruments used also varied by activity. However, drama was the only activity used for dramatic play studies. As a side note, 93% of the collected studies required guidance from the instructor, and 69.8% were on group play.

Discussion

General findings

There was a significant growth in the number of NDGS publications since 2009. This growth suggests that games have an ineluctable role in the school curricula. It also suggests that games have the potential to promote learning among children. The analysis of collected studies by age group indicates that NDGS paid great attention to pre-schoolers (4–6 year olds).

Table 2. Learning outcomes as grouped by age group.

Learning outcome	Non-digital games studies		Total
	age 4–6	age 7–9	
<i>Cognitive</i>			
Knowledge acquisition	7	2	9
Creativity	4	0	4
Problem solving	5	0	5
Literacy	4	2	6
Total	20	4	24
<i>Affective</i>			
Behaviour change	7	1	8
Health awareness	0	1	1
Personality and lifestyle	1	1	2
Emotion	0	1	1
Total	8	4	12
<i>Psychomotor</i>			
Cognitive performance	1	2	3
Motor skill	1	0	1
Total	2	2	4
<i>Communicative</i>			
Social skills	2	1	3
Total	2	1	3

Table 3. The characteristics of NDGS as grouped by type of play.

Table 1. Frequency of play activities and instruments used by children in the sample												
Type of play	Activities					Presence of instructor					Form of participation	
	Arts	Drama	Fitness	Literacy	Misc.							
Functional play	0	0	1	0	0							
Constructive play	3	0	0	3	6							
Exploration	0	0	0	1	9							
Dramatic play	0	8	0	0	0							
Games-with-rules	1	0	2	0	9							
Total	4	8	3	4	24							
Type of play	Instruments used					Presence of instructor		Form of participation				
	Art materials	Picture book	Sport equipment	Toys	Misc.					Not stated		
Functional play	0	0	1	0	0	0	0	1	1	0		
Constructive play	2	2	0	2	6	0	12	0	1	11		
Exploration	1	1	0	2	6	0	9	1	5	5		
Dramatic play	0	0	0	2	4	2	7	1	4	4		
Games-with-rules	0	0	1	0	10	1	12	0	2	10		
Total	3	3	2	6	26	3	40	3	13	30		

Overall, the most frequently used research method for NDGS was the qualitative approach (34.9%), followed by the quasi-experimental approach (25.6%). The qualitative approach collects data via interviews and observations. As children may have difficulty in expressing their feelings and ideas through writing, interviews and observations can ease the process of data collection and ensure the accuracy of results. The quasi-experimental approach allows the children's performance to be compared before and after participation with game intervention, this is probably the reason why it is preferred by researchers.

Also worth noting, cognitive skill development was the main focus in child development studies, followed by the affective outcomes for the duration of 2004–2013. These two outcomes have strong relations with formal learning, and thus drew much attention from researchers. In contrast, studies that reported psychomotor and communicative outcomes were scarce. Incorporating NDG (i.e. functional play) into school physical education curricula can facilitate the psychomotor development of a child and promote an active lifestyle. Communication skills are an important twenty-first century ability and play an essential role in the new digital economy (Qian and Clark 2016). Therefore, future research should also pay attention to the children's social development.

Age group

Overall, the collected NDGS were not spread evenly across the types of play or the age groups. Although the studies for lower primary children covered all types of play, the number of studies was relatively low. One possible cause could be the poor understanding and interest in integrating NDG into the school curricula or learning activity for this age group. NDGS tended to focus on early childhood studies. It covered a wide range of play, except for functional play. Some functional play involved competitive sports and highly structured activities, and thus discouraged the participation of young children (Allender, Cowburn, and Foster 2006).

Qualitative and quasi-experimental approaches were preferred by NDGS for both age groups. Correlational research is not common for either age group. The difficulty in deciding the variables of the experiment explains why it was less popular. Reported studies with the RCT approach were scant, only 6 papers, possibly due to the difficulty in monitoring multiple experiment conditions. The use of the mixed method is also very limited. The combined use of research methods (mixed method) for data gathering might not be suitable for studies of children because expressing ideas and feedback through writing is a challenge for children, especially pre-schoolers.

The collected studies mainly focused on cognitive skill development for pre-schoolers. The studies on pre-schoolers and lower primary children pay more attention to cognitive outcomes may be due to the fact that early cognitive development may affect the later schooling performance and future achievement (Grantham-McGregor et al. 2007). Future research is encouraged to stimulate the development of children's psychomotor and social development, as the related studies found were scant.

Research method

In general, the qualitative approach was common for the collected studies as it can contribute reliable and precise, benchmark results with careful and in-depth question

design. The collected studies with cognitive outcomes preferred to use qualitative and quasi-experimental approaches. For example, Smogorzewska (2012) used interviews and observations (qualitative approach) to gather the data on students' progress, while Bulunuz (2013) used pre-test and post-test method (quasi-experimental approach) to compare the effectiveness of both the NDG and conventional classroom approaches in advancing the pre-schoolers' learning progress.

Relative, correlative, RCT, and mixed method research is not in common use in studies related to children. However, these three approaches represent different types of research design in meeting the objectives and requirements of research, and can be used as a reference when designing future game research.

Learning outcomes of games

Children always engage with games and playing is known to occupy large spans of children's spare time. Parents and practitioners were concerned about the impact of play towards the development of the children. The analysis on the outcome of children's play may encourage the use of games for learning.

Cognitive outcomes

The collected studies with cognitive outcomes pay more attention to both knowledge acquisition and problem solving skills, as these two skills have a strong relation with academic learning. Creativity allows people to solve a problem with an innovative solution (Orr and Kukner 2015). Most of the collected studies with creativity outcomes encourage playful learning. For literacy skill development, majority of the collected studies tended to use the traditional gaming approach, which allows face-to-face communication and hand writing exercises.

Affective outcomes

The majority of the collected studies which reported affective outcomes were related to behaviour change. Personality and lifestyle outcome studies included those studies which were related to personal perception (Lakes et al. 2013) and outcome-belief (Liao, Li, and Deák 2011). For emotion outcomes, Vass (2007) found that emotion-driven thinking encouraged children's creative writing. There was only one study which made a finding related to health awareness in the area of children's sexual abuse prevention (Weatherley et al. 2012). In the future, health awareness should also cover sexual health, as it is important to teach children about the basic knowledge of sexual development and prevention strategies for sexual crimes and diseases. Moreover, the awareness of the importance of healthy diets and behaviour, as well as of maintaining good physical activity (PA) levels, is also important, as it could help build a healthy lifestyle and prevent chronic diseases (Holzinger et al. 2010).

Psychomotor outcomes

Recent studies showed that sports games may also contribute to both physical fitness and cognitive performance (Jacobson and Matthaeus 2014; Moreau, Morrison, and Conway 2015). There are three studies that reported on the association between physical health and cognitive development. Ellemberg and St-Louis-Deschênes (2010) and Pirrie and

Lodewyk (2012) investigated the psychomotor effect on cognitive functions, while Lam-bourne et al. (2013) investigated its effect on academic achievement. As research on cognitive performance is limited, future research is encouraged to provide more scientific evidence on other areas of cognitive performance such as attention, problem solving, and analytical skills. In addition to that, Zachopoulou, Tsapakidou, and Derri (2004) conducted a study associated with motor skill development. The results showed that there was a significant improvement in jumping and dynamic balance (motor skill) for pre-schoolers. Children with better developed motor skills are more active and easier to engage in PA, resulting in better health (Williams et al. 2008).

Communicative outcomes

‘The ability to communicate effectively is a competence that may draw on an individual’s knowledge of language, practical information technology (IT) skills and attitudes towards those with whom he or she is communicating’ (Ananiadou and Claro 2009). The importance of communication skills has long been discussed and emphasised. However, research investigating the effect of games on communicative outcomes (i.e. social skills and collaboration skills) is limited (Wouters, van der Spek, and van Oostendorp 2009; Qian and Clark 2016). There were only three reported studies with communicative outcomes, and all reported positive results. Based on these findings, various game activities (i.e. sand play and language play) could be a complementary approach to promote and develop communication skills.

Characteristics of NDGS

A total of 43 NDGS were categorised based on the game activities, instruments used, presence of instructor and form of participation. NDGS activities were varied by type of play. Functional play and dramatic play studies involved only a single type of activity, which were fitness activities and drama activities respectively. The majority of the activities for constructive play, exploration, and games-with-rules were miscellaneous activities. Although the activities used were different among the studies, the outcomes of the games were of the utmost importance. The activities used by each type of play give insight to educators and researchers on matching the learning goal with an appropriately designed activity.

The reported instruments used by the collected NDGS were varied by study. The variety of instruments involved was probably because of the need to complete certain tasks within the activities. Beck et al. (2011) used a coloured dice (with two sides each of red, white, and green), a pom-pom, and three coloured doors (red, white, and green) to conduct their experiment on the reason that led young children to underestimate uncertainty. This experiment demonstrated how various objects can be used to trigger the interest of participants and encourage their exploration/engagement with the activity.

93% of NDGS required the presence of an instructor. Weisberg, Hirsh-Pasek, and Golinkoff (2013) claimed that, in certain learning circumstances, instructional guidance may trump free play and exploration in achieving the respective learning outcomes. Nonetheless, the presence of a teacher/instructor was compulsory to ensure safety and the completion of the task. Moreover, the support and feedback from the teacher can help the

children in developing their learning potential, and can also assist them to improve their existing knowledge and skills.

The majority of the collected studies favoured group play (69.8%). Group play promotes social and emotional competence among children and helps them to learn adaptive behaviours and effective communication skills (Chinekesh et al. 2014). It also encourages competition between peers (Andersen et al. 2013).

19 NDGS made comparisons either between experimental conditions and existing learning methods, or among the games used (see [Appendix A](#)). By comparing the findings in various experimental conditions, educators and researchers are offered insights into the respective areas. On the other hand, the comparison with existing learning methods, and amongst the games used, offers the educators a choice when selecting the right activity or game to enhance the children's learning.

Summary

In conclusion, a recommendation on game activities, instruments used, and form of participation based upon children's age, learning goals and expected learning outcomes, is suggested to enhance the proposed classification of NDG. The analysis on research methods used for specific types of play and learning outcomes could be used as a reference when designing research regarding children and their games, for data gathering and analysis. Careful planning on teaching and learning strategies can ensure a better learning experience and learning outcome.

Limitation

This review was limited by the search terms used, year of publication, journal databases and the inclusion and exclusion criteria. As the focus of this review was on the impact of NDG, those papers without empirical results and/or those where the participants' age was above nine were excluded. These exclusions were to ensure this review was supported by scientific evidence and focused on the impact of NDG on children's development. Additionally, this review only accepted NDGS, to further narrow the scope of the research.

Conclusion

In this review, a multi-dimension analysis scheme was proposed to offer a general view on children's development via NDG. Moreover, the comparisons among the inter-variables (type of play, age group, research method, and learning outcome) provide useful information for educators, game developers and researchers in understanding various type of play.

In summary, the collected studies were not split fairly across the age groups and type of play categories. The results imply that play can stimulate the cognitive development of pre-school age children. Further study on other areas of development such as psychomotor and communication skills is crucial for children in both age groups. For research methods, qualitative and quasi-experimental approaches were the most frequently used method for both age groups. Future studies should consider the use of correlation and

RCT approaches in providing more scientific evidence on the impact of NDG, allowing the recommendation of the most appropriate learning conditions with games.

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