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Design Elements and Feasibility of an Organized Multiplayer Mobile Active Videogame for Primary School-Aged Children

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Abstract

Objective: This article describes the design, development, and implementation feasibility of a purpose-built mobile active videogame (M-AVG) named ''Pirate Adventure,'' which was designed for primary school-aged children to engage in physical activity (PA) and fundamental movement skills (FMS), such as hopping, sidestepping, jumping, or running, in an afterschool setting. The design of ''Pirate Adventure'' was the result of a collaboration between games designers and health researchers.

Subjects and Methods: ''Pirate Adventure'' was designed and developed using Android® (Google, Mountain View, CA) phone sensors to respond to player actions within a playground environment. Using an interactive game framework, players solve clues and complete PA and FMS challenges via sensing the physical world through marked-out key game locations. Fourteen primary school-aged children participated in the feasibility evaluation, which took place in four afternoon sessions. The game was evaluated using Android phone telemetry data and a post-gameplay survey for children on their opinions and enjoyment of the game.

Results: The ''Pirate Adventure'' game design facilitated an enjoyable treasure hunt game (average of 11 minutes of activity per game) with narrative elements supporting children's engagement with movement activities. The majority of children ($n = 9/13$) reported that they would like to play the game again.

Conclusions: Combining real world and virtual world content through ''Pirate Adventure'' was moderately successful, with multiple gameplay sessions occurring. Further implementation feasibility testing, under more controlled conditions, needs to be conducted to assert the benefits of using a M-AVG for children's PA and FMS.

Introduction

PROMOTING AN ACTIVE, HEALTHY lifestyle is an important societal initiative; however, the most recent figures for Australia show only 19 percent of Australian children met the physical activity (PA) guidelines,[1] which state that children should engage in 60 minutes or more of moderate-to vigorous-intensity PA every day. Furthermore, fundamental movement skills (FMS) (e.g., run, jump, catch, kick, hop) competency in both children and adolescents is low,[2–4] and this may be a contributing factor to low levels of PA.[5] High electronic media use by children may be a key factor in this scenario.[6] It is possible, however, that electronic pursuits played in an active manner may provide an innovative mechanism to achieve PA and FMS benefits for children.[2]

To date, active gaming interventions have often been trialed in home environments using a range of consoles.[7] However, organized settings such as schools also allow the opportunity for digital gameplay to take place in a controlled environment.[8] The afterschool environment in particular may have potential for increasing opportunities for active play because such settings are often the site of sedentary behavior.[9] Authors go on to suggest that active videogames (AVGs) may be one such mechanism that might achieve active play in this setting.[9]

AVG play can result in light-to-moderate-intensity PA.[10,11] AVG technology may also provide children with motivation to be more active through fun and enjoyment of game play.[12] Furthermore, AVGs may provide children the opportunity to practice FMS, with a recent study reporting that children who played more interactive console-based videogames had higher FMS.[7]

However, the constrained environment that consoles such as the Nintendo® (Kyoto, Japan) Wii™ and Xbox® Kinect®

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Table 1. Goals of a Videogame for Health (''Pirate Adventure'')

Game's design	→	*Change in player*	→	*Behavior*	→	*Health*
A competitive treasure hunt game, where specific items must be collected in a predetermined order. Movement activities are obstacles to or requirements for completion (finding the treasure).	→	Engage in walking and running behaviors (sensed by the mobile phone) during game play and practice FMS skills (e.g., jumping, hopping, leading, sidestep) during the game	→	Children engage in PA during afterschool care	→	The ultimate goal is to increase PA and FMS in the afterschool care setting to benefit children's health.

FMS, fundamental movement skills; PA, physical activity.

(Microsoft, Redmond, WA) operate may limit opportunities for active gameplay and energy expenditure. In contrast, mobile AVGs (M-AVGs) extend gameplay to occur outdoors or in unspecified locations. Because mobile devices (such as smartphones) are able to sense and respond to the physical environment using a range of in-built sensors (e.g., WiFi, Global Positioning System [GPS], microphone, camera) and interfaces (visual, audio, and tactile),[13–15] there is the opportunity to develop M-AVGs for use in settings, such as school playgrounds, that aim to encourage PA and FMS for young children.[13] This study took this novel opportunity to design, develop, and test the feasibility of a M-AVG that used mobile phone technology to promote PA and FMS play in an outdoor setting in afterschool care. The design was a collaborative effort between health researchers and games designers, which allowed beneficial health behaviors to be targeted.[16]

Subjects and Methods

Game design of an M-AVG: "Pirate Adventure"

Console-based AVG technologies sense PA using novel sensors such as accelerometer data or pressure-sensitive mats.[8,17] M-AVGs can overcome the restriction of a PA occurring within a fixed location by using the sensing capabilities of GPS built into mobile phones.[15,18] Existing M-AVG applications are often played over large distances (>1 km) and supported by the use of GPS. Using existing M-AVG applications was therefore not appropriate in this study as school playgrounds are smaller than this.

Current M-AVGs can encourage PA through purposeful game design.[18,19] In these designs, however, it is important to consider the correct assessment of exercise performance,[19,20] a variety of games to encourage motivation,[15] purposeful action in support of narrative and game mechanics,[21] and encouragement of thinking and problem-solving skills at the same time as PA.[22] With these considerations in mind, the investigators elected to create an original M-AVG called ''Pirate Adventure'' that facilitated ''treasure hunt'' gameplay and movement activities within a narrative context.

Goal of the game

The goal of M-AVG ''Pirate Adventure'' was to engage school-aged children in a movement treasure hunt game that incorporated clues within the physical environment to support gameplay. Players seek to find all the treasures on the map and achieve the highest score. Table 1 summarizes the design and health goals of the purposefully built M-AVG ''Pirate Adventure.'' Table 2 describes the characteristics of the M-AVG ''Pirate Adventure.''

Play form and actions

In the design of ''Pirate Adventure,'' the treasure hunt design was selected based on an assessment of age-appropriate games, as well as the potential for flexibility within an age-diverse context (primary school-aged children in the afterschool care setting range from 5 to 12 years) and for integration of PA with videogame elements. To support gameplay engagement, the narrative context of ''pirates'' supported and encouraged children to maintain participation. Unlike traditional pen-and-paper treasure hunt games, ''Pirate Adventure'' informed players about gameplay status, which allowed players to be aware of gameplay progress of all players, which maintained a competitive aspect.

The ''Pirate Adventure'' was designed so that it could be implemented in the outdoor playground in the afterschool setting in mind. Using the space available in a typical school playground environment (Fig. 1), the game can be mapped to existing conditions (e.g., taking into account playground markings, physical structures, green space) to produce a ''treasure hunt'' experience. The corresponding virtual map and game interface is shown in Figure 2.

To play the game, each player's phone received a copy of a map with a set of predefined clues and movement activities. Using the mobile phone camera, players interacted with gameplay by locating a treasure location in the real world (as indicated by the camera view of QR code scanning [top right corner of Fig. 2]).

Each treasure location was marked using a unique identifier (QR code) that was recognized by the phone and informed the player of his or her location on the game map. The QR code also prompted activities that needed to be completed at a location. Activities that were completed at each location include clue, movement, and path challenges.

An example of a clue from the game was ''Your next goal grows coconuts and provides shade,'' which was solved by finding the location containing the palm tree. Movement challenges used in the game design included both location- and path-based activities. A movement challenge associated

Table 2. Characteristics of a Videogame for Health ("Pirate Adventure")

Health topic(s)	*PA and FMS*
Targeted age group(s)	Primary school-aged children 5–12 years
Other targeted group characteristics	Afterschool care/non-classroom session
Short description of game idea	A mobile treasure hunt game that places clues within the augmented outdoor physical environment. Movement sensing and active game challenges encourage PA and FMS practice.
Target player(s)	☐ Individual ☐ Dyad ☐ Small group ☐ MMOG ☒ Other: Cooperative or collaborative small groups
Guiding knowledge or behavior change theory(ies), models, or conceptual framework(s)	The Youth Physical Activity Promotion Model (Welk[23]). Targeted enabling (e.g. skills, environment) and predisposing factors (enjoyment) to benefit PA
Intended health behavior changes	Increase PA and encourage FMS
Knowledge element(s) to be learned	Mapping of virtual world to physical world, strategically navigating maps with paths, solving puzzles
Behavior change procedure(s) (taken from Michie inventory) or therapeutic procedure(s) used	Nonspecific reward; behavioral/rehearsal practice; problem solving/coping planning; instruction on how to perform a behavior; prompts/cues
Clinical or parental support needed?	Parental or carer support required to run game session
Data shared with parent or clinician	☒ Yes ☐ No
Type of game	☒ Active ☐ Action ☒ Adventure ☐ Role-playing ☐ Simulation ☒ Strategy ☐ Sports ☒ Casual ☒ Educational ☐ Other: ___________________
Story	
Synopsis	The story behind the game revolves around being a pirate who has to locate treasure. A virtual map is provided in the game to assist with this.
How the story relates to targeted behavior change	NA
Game components	
Player's game goal/objective(s)	Find all the treasure via solving clues and completing movement activities.
Rules	Treasure locations must be visited in the order in which clues are provided. Players must follow paths laid out in game-level design. PA challenges incur a time penalty, which is reduced by performing the activity efficiently.
Game mechanic(s)	Scan locations in the physical world using a smartphone. Associate clues with location and complete movement activities to progress in finding the treasure.
Procedures to generalize or transfer what's learned in the game to outside the game	Children have the opportunity to learn about and practice different FMS, which is transferable to play settings beyond the game.
Virtual environment	
Setting (describe)	The game had a pirate theme and used audio and visual assets to represent the theme. Clues and movement activities were phrased to facilitate the theme.
Avatar	
Characteristics	Individual character names and voices were self-selected for each player. Player location was shown on the map via a colored icon.
Abilities	Location scanning, resolving clues, completing movement activities, and achieving a high score
Game platform(s) needed to play the game (check all that apply)	☒ Smartphone ☐ Tablet ☐ Kinect Xbox ☐ Wii ☐ PlayStation ☐ Computer ☐ Handheld device ☐ Other: _______________
Sensors used	WiFi, accelerometer, camera
Estimated play time	10–20 minutes

FMS, fundamental movement skills; MMOG, massively multiplayer online game; NA, not applicable; PA, physical activity.

FIG. 1. ''Pirate Adventure'' mapped out in the playground. Color images available online at www.liebertonline.com/g4h

with a location that was invoked randomly and involved performing a movement activity for a period of 10–20 seconds of time before the player was ''allowed'' to continue to the next location in the game. An example of a specific location FMS movement challenge from the game included ''A whale is spraying water at you, leap from side to side to avoid the spray.'' If a player failed to achieve the movement activity, his or her overall score was affected. An example of a path activity (using the FMS skill galloping) from the game included ''A giant Kraken [octopus] appeared, get from this location to the shore by galloping away on the giant sea horse's back.'' Path activities linked two ''destinations'' or locations (Fig. 1) in the game of ''Pirate Adventure.'' Players followed paths as shown on the virtual and physical map and could strategically plan their route in pursuit of the next treasure. During a game session all players must complete movement challenges in order to progress through the game.

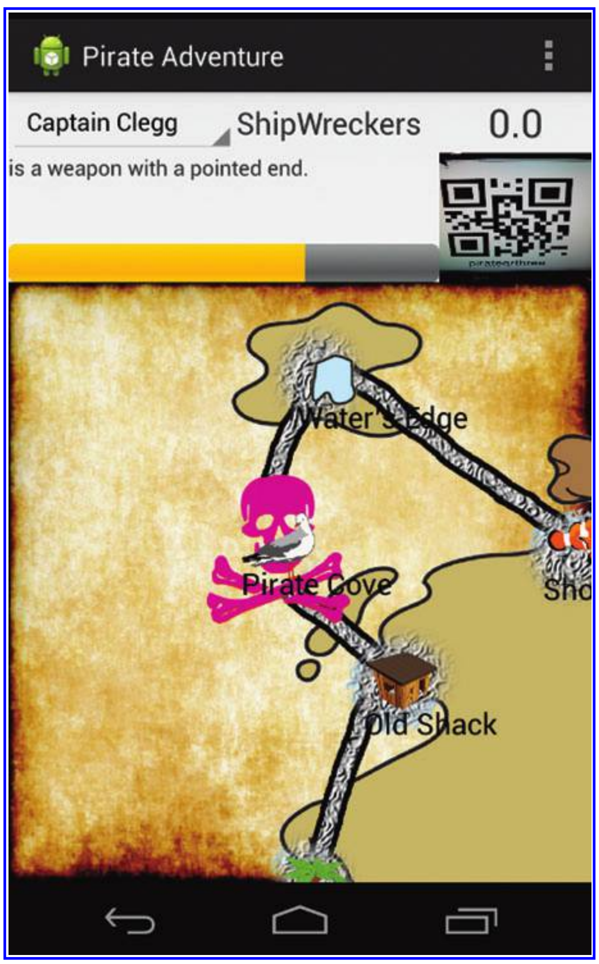

FIG. 2. Interface of the mobile active videogame ''Pirate Adventure.'' Color images available online at www.liebertonline.com/g4h

To achieve gameplay progression and to maximize children's engagement, each clue or movement activity of ''Pirate Adventure'' was designed to manage difficulty and duration. For example, clues were developed for younger children and older children. An additional gameplay element from completing clues and movement activities was a score achievement. High completion of clues movement activities, and the least path shortcuts, will result in a higher score. Achievement for completing the game the quickest was not a factor designed into the game; however, anecdotally players often measured their performance on who finished first.

When ''Pirate Adventure'' was being designed, variety and re-playability for players were key requirements. The game environment facilitates a different ''treasure map,'' both virtual and physical, to be distributed for each game of M-AVG ''Pirate Adventure.'' In this study the same physical treasure map was used (Fig. 1), with varying virtual maps distributed for variety. In addition, although the M-AVG ''Pirate Adventure'' can be played in either a cooperative or competitive formation, this feasibility focused on testing a competitive version. In a competitive game version, players were teamed up and competed against other teams to achieve the highest score in the fastest gameplay time.

In the M-AVG ''Pirate Adventure,'' success with the gameplay elements as described was detected by the Android phone technology. The following section describes the technology used to support gameplay.

Gameplay technology

The development of ''Pirate Adventure'' was achieved via the Android Development Kit under the Java Eclipse programming environment. The game was deployed for Google

Nexus 4™ smartphones and downloaded to each device. A single Android phone performed as the server during gameplay. The server provided the network access point to run the game, controlled gameplay settings such as the scenario to be used, number of clues, and path and movement activities, and facilitated the competitive gameplay.

Each Android phone used in the gameplay of ''Pirate Adventure'' employed the onboard sensors of camera, accelerometer activity monitoring, and WiFi networking in addition to logs of gameplay statistics. Using the camera sensor on each phone, players interacted with gameplay via scanning available ''treasure'' locations (the two-dimensional QR codes) mapped out in the physical environment. A player's movement activities were detected using the phone accelerometer. As it was difficult to distinguish between specific FMS and overall PA, the game only assessed detected activity against a threshold level of motion. Each activity defines a threshold duration, T, for the PA. The level of activity was sampled at regular intervals of $t = 0.1$ second to measure a weight, w_i, defined as the proportion of accelerometer variance relative to a maximum value. This maximum has been determined empirically to represent a minimal level of deliberate physical motion for the phones used. The activity is deemed complete when the weighted sum of activity intervals exceeds the threshold duration: $\sum w_i t > T$. The game deems the activity incomplete after time $4T$ without completion and allows play to proceed, effectively introducing a time penalty for incomplete activities. Movement detection measures sustained levels of PA over a set period. Although it is possible to cheat by just shaking the phone, the social nature of the game would discourage this. None of the subjects was observed deliberately bypassing the activity check.

When the gameplay sensed a challenge movement activity is to occur, the map interface was overlaid with an animation demonstrating the correct action (for example, an animation of a child hopping). At the same time, gameplay activities were reinforced by audio cues. For example, to prompt a movement activity the phone emitted an encouraging sound effect, which ascended in pitch until the movement activity was successfully completed.

The gameplay interface presented on the phone used multiple modalities of game feedback (audio, speech, visual, and haptic) to support the functioning of the game outdoors. Players did not need to select options on the phone screen to achieve gameplay, with interaction successfully achieved via pointing the camera device at the appropriate treasure and scanning. Audio cues were used to overcome difficulties with seeing the screen in bright daylight.

Evaluation of the M-AVG "Pirate Adventure"

The M-AVG ''Pirate Adventure'' was tested in an afterschool care program of an Australian primary school of convenience. After approval from the school and aftercare provider, all children who regularly attended afterschool care were invited to participate (*n* approximately 80) via a letter (including a plain language statement and consent form), which they took home for their parent/guardian to sign. Only children with active consent from a parent or guardian were eligible to participate. Ethics approval was provided by Deakin University and the Department of Early Education and Childhood Development.

Demographic information and child gaming experience

At the time of consent, parents completed a short survey reporting child information (child's age, sex) and their own demographic characteristics (country of birth, language spoken at home, education level, and employment status). Parents also reported on children's access to electronic entertainment devices in the home (options were listed for parents to tick [e.g., tablet, computer, Nintendo Wii, etc.]). Children's usual time (minutes per week and minutes per weekend day, from which a usual weekly estimate was calculated) spent in moving-around electronic games (defined as Nintendo Wii/Kinect/''EyeToy®'' [Sony] while *on feet*) and sitting-down electronic games (defined as PlayStation® [Sony], Xbox 360, Nintendo DS, computer games, Nintendo Wii/Kinect while *sitting*) was also proxy-reported by parents.

Process evaluation survey

Process evaluation data were collected from all children after their first attempt at playing the game. After completing the survey, the children were then encouraged to play the game again. Younger children were assisted with the completion of the survey by project staff, whereas older children completed the survey independently under the supervision of project staff.

To identify whether the game was considered to be fun, children completed a modified version of the Physical Activity Enjoyment Scale scale, originally used in adolescents[24] but also validated for children.[25] Some item wording was changed to simplify the responses for young children; these have been italicized. For example, ''Did playing frustrate you?'' was changed to ''Did playing frustrate (*or annoy*) you?'' The final items used were as follows: ''Did you enjoy it?,'' ''Did you feel bored?,'' ''Did you dislike it?,'' ''Did you think it gave you energy?,'' ''Did you think it gave you energy?,'' ''Did playing make you sad?,'' ''Did playing make your body feel good?,'' ''Did you get something out of it?,'' ''Did you think it was exciting?,'' ''Did playing frustrate (*or annoy*) you?,'' ''Did playing make you feel successful (*like a winner*)?,'' and ''Did it feel good to play?'' The original format for each item is scored on a 5-point Likert scale ranging from 1 (disagree a lot) to 5 (agree a lot), but as this feasibility study included children as young as 5 years, this was amended to a simple Agree (i.e., ''yes'') or Disagree (i.e., ''no'') for each item statement. To gain a further idea of enjoyment, children were qualitatively surveyed about the aspects of the game they enjoyed and disliked and whether they would like to play this sort of M-AVG game again.

Children were asked how easy they found the M-AVG game to play. They were also asked whether they felt tired after playing the game and whether they thought they did a lot of running and jumping around. To understand their perspective about playing the game in a group situation, children were asked whether they thought the other children enjoyed playing the game and whether they themselves liked playing this game with others. To gain an indication of game immersion, children were also asked whether they thought time went quickly when they played.

Gameplay data collection

During the testing sessions each mobile phone logged gameplay statistics and sensor information (QR code scanning).

The gameplay statistics captured information from each game session and included data that identified the length of the game, the number of treasure locations visited, the number of PA and FMS path activities, and the number of shortcuts taken by the children.

Results

Participants

Twenty children received parental consent to participate (25 percent response rate) in the study, with 14 children (nine boys and five girls) 5–10 years of age (mean = 6.8 years; standard deviation = 1.97 ± 2.0 years) participating in the game feasibility testing. Five children did not attend afterschool care on the days that the trial game was scheduled, and one child withdrew from the study. The child who withdrew was 5 years old, and her parent said she didn't want to play the game again but gave no specific reason.

Twelve of these children had parents born in Australia and English as a first language at home. Twelve parents had a university education, and two had technical or trade-level education. All parents were in paid full- or part-time employment. When asked to report on a usual week, 11 parents reported their child usually did ''sitting around electronic games'' (mean = 361 minutes; standard deviation = 261 minutes; range, 75–900 minutes). Six parents reported their child usually did ''moving around electronic games'' (mean = 258 minutes; standard deviation = 158 minutes; range, 90–420 minutes). Nearly all parents (n = 12) reported their child had access to a computer or a laptop. Ten parents reported access to a tablet, nine reported access to an iPod® (Apple, Cupertino, CA) Touch, nine reported smartphone access, six reported Nintendo Wii access, one parent reported access to an Xbox 360, and one reported access to a Sony PSP.

Number of sessions and games played

The M-AVG ''Pirate Adventure'' was played in a total of four afterschool sessions. During the sessions eight separate games were played by a total of 14 unique players: Five children played the game once, seven played twice, and two played three times. The number of games children played was a function of which consenting children were at the aftercare on the trial day. Because of the afterschool context in Australian schools, the number, age, and skills of participants varied.

Gameplay statistics

Based on the data from eight games of ''Pirate Adventure,'' the following gameplay statistics summarize some of the elements of play. On average, the duration of each gameplay session was 11 (± 5.9) minutes, and the mobile platform crashed (failed) once per gameplay session. In each gameplay session the number of treasure locations scanned and movement activities achieved varied because of the different game variables and map designs that were generated. On average, the number of locations visited per game was 31.5 (± 18.5). For all players the time taken to move between locations was 23 seconds on average. The gameplay logs show that players successfully completed PA/FMS tasks to the tolerance threshold required by the game. On average, the number of randomly specific movement activities completed per game was 3 (± 1.5).

The map layout was designed to constrain play to follow particular paths. Figure 3 outlines the directed path information taken by participants as captured during gameplay. It shows the extent to which the locations in the map are visited (accumulated over all players and excluding the tutorial period, which is played on a different map).

The patterned line indicates where the path followed by the player corresponds to a path as set by the game. The

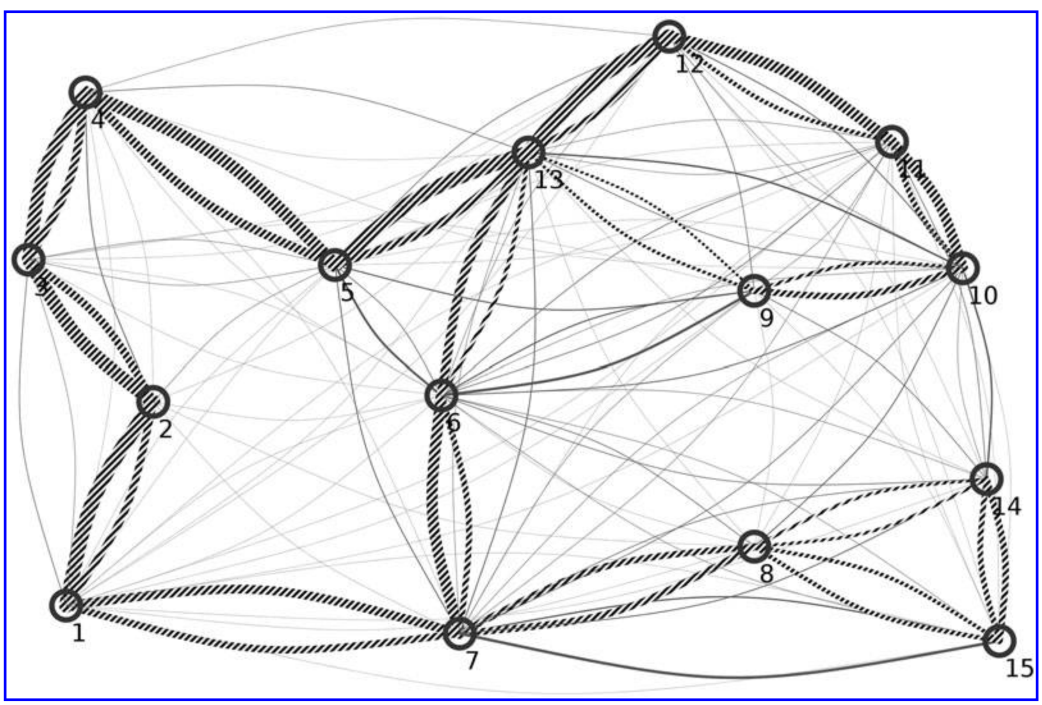

FIG. 3. Paths taken by participants during gameplay of the mobile active videogame ''Pirate Adventure.''

width of the lines represents the number of times each particular edge was used. The shortcuts are shown in thin light lines. Players tended to start the game from Location 1. There was some asymmetry in the traffic in opposite directions on many of the links, indicating that they were followed in a preferred direction. Many players followed one another when starting the game, which may introduce an inherent bias in the order in which loops are traversed. The average number of shortcuts was 4.8 (±2.3). Path completions averaged 3.1 (±2.1).

Process evaluation data

For 1 of the 14 children the postgame survey was not completed because of an early pick-up by the parent. For the other 13 children, nearly all (at least 11 children for each question) agreed the game was enjoyable, that they were not bored, it did not make them sad, their body felt good, it was exciting, and it was good to play. Around a quarter of children (three or four) reported they disliked it, it did not give them energy, they did not get something from it, it was frustrating, it did not make them feel successful, and they would rather do something else. To gain a further idea of enjoyment, children were also asked if they would like to play this sort of phone game again. Nine children reported they would like to play again, two were unsure, and two did not want to. Five children liked the process of finding and scanning the QR codes (e.g. ''The scanning bit, the mobile phone can actually find out what it is''), and three children liked the PA and FMS components (e.g., ''When you had to gallop across the sand''); however, one child did not (''When you had to jump from side to side away from the volcano because it was hard to do that''). Three children noted they felt achievement (''The sense of accomplishment when you find something,'' ''When I get points,'' ''Completing the missions''), and two children liked the clue process (e.g., ''Remembering where all the spots were'').

Four children commented that they didn't like being unsuccessful when playing the game (e.g., ''If you don't get it right you have to keep on going to find it'') and using the phone (e.g., ''I kept pressing the wrong button''). Two children didn't like the sounds used to assist with gameplay (e.g., ''It clicks at everything. I didn't like the noise. It annoys me,'' ''Bit tricky to find out what it meant and you can hear everyone's phones''). One child reported disliking when the game (phone) failed to work properly (''Sometimes scanning didn't work'').

Three children reported that they had played a similar type of game before. Three children thought the game was ''too easy,'' five children thought the level of difficulty was ''just right,'' three thought it was a ''bit tricky,'' and two thought it was ''too hard.'' The two children that thought the game was too hard were 6 and 7 years old. All 13 children thought they did a lot of running and jumping during the game, but only 5 considered themselves tired after playing. Nearly all children ($n=11$) thought the other children enjoyed the game, and all 13 children liked playing the game with other children. Nine children thought the game went quickly.

Discussion

This study reports the design elements and feasibility of a new M-AVG purposefully developed to promote PA and FMS in the afterschool care setting. The feasibility testing of the game demonstrated that the children participated in PA, with on average three deliberate PA or FMS activities completed per game (in addition to the movement between treasure locations along specified paths). The process evaluation demonstrated that those children involved in the whole enjoyed the game and felt tired after playing. As discussed by Baranowski et al.,[12] a key attractive feature of videogame play is the enjoyment derived from the act of play. Arguably, paper-and-pencil treasure hunt games could provide the same gameplay experience of ''Pirate Adventure''; however, it is the combination of interface, imagery, narrative, and environment sensing that authors believe provided an immersive context and player ''agency'' in achieving the games' objectives.[26] ''Pirate Adventure'' gameplay provided opportunities for players to surmount both narrative and movement-based challenges through active participation. Children noted that finding and scanning treasure locations was enjoyable and engaged with the movement activities such as ''galloping away on the giant sea horse's back,'' which may indicate they were immersed or transported into the game world.[8]

From a technological perspective the testing demonstrated issues with using a mobile phone as the sensing device to facilitate play. As noted by Benford et al.,[27] pervasive games, such as ''Pirate Adventure,'' have to negotiate uncertain sensing and often hybrid communication technologies to facilitate the play environment. The negotiation of input required between the virtual and physical world sometimes resulted in players inadvertently pressing phone buttons and interrupting gameplay, requiring gameplay to be restarted. The issue was unavoidable because of limits on the mobile platform that restricted phone functions that could be disabled. An important outcome from feasibility testing was that the mobile phone platform of ''Pirate Adventure'' provided a generally reliable platform with game state maintained, although the mobile platform did crash once per gameplay session.

Implementation feasibility

Delivering the program in the afterschool care setting presented some challenges. Although this setting provides opportunities for children to engage in different activities, other organized activities competed with the opportunity for children to play ''Pirate Adventure.'' Other issues include interrupted gameplay because of the weather or the child departing from the activity early because a parent or guardian arrived to pick him or her up. However, this real world approach has provided valuable information to other researchers and practitioners considering implementing M-AVGs into aftercare settings.

Conclusions and Future Directions

This study has detailed the design, development, and process evaluation of an implementation feasibility study of the M-AVG ''Pirate Adventure'' in a real world setting. The combination of real world and virtual world content, what Benford et al.[27] calls ''hefting domains,'' was moderately successful, with multiple gameplay sessions occurring and children enjoying their engagement with the game. The game design allowed PA and FMS to be included and was flexible to allow levels to be adapted based on the participant group and available context. The game design mechanism of a treasure hunt provided a suitable context to facilitate activity and is generic to allow new education and narrative content to be designed for the play situation. In addition, game design was successful within the confined space of a school playground, suggesting that M-AVGs can be useful in other organized indoor/outdoor play settings.[8]

Before this can occur, however, future studies are needed to examine the generalizability of the game with larger samples. For example, how does the game perform for younger versus older children, boys versus girls, and those with differing levels of AVG experience? Further research is also needed to test how the game performs when it is used cooperatively versus competitively and how it compares with a traditional non-AVG treasure hunt. Finally, future studies are needed to determine whether this type of game using a mobile phone platform can promote physical activity and improve FMS among primary school-aged children.

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Author Disclosure Statement

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