
Toward Exploratory Design with Stakeholders for Understanding Exergame Design

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Abstract

Prior work has explored improving the efficacy of exergames but they typically work with children. Children are not necessarily well suited for making informed decisions about their fitness, so their perspectives only form half of the picture. Adults who are invested in the problem of children's fitness (e.g., PE teachers) are a valuable missing perspective. As a first step to understanding what we can learn from these stakeholders to aid the design of exergames, we conducted one in-depth interview with a PE teacher and several focus groups with children. Our findings showed that although both children and the PE teacher consider similar elements, children viewed the elements through the lens of **fun** while the PE teacher viewed the elements through the lens of **effectiveness**. Our preliminary findings establish the importance of including such stakeholders who can make informed decisions about children's fitness in the formative design of exergames.

Author Keywords

Exergames; design space; children; physical education teachers; PE; exertion games; exercise games.

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CSS Concepts

- Human-centered computing~User centered design
- Applied computing~Computer games
- Social and professional topics~Children

Introduction

Exertion games (exergames) have been recommended as a potential solution for promoting physical activity in children. Exergames are effective for inducing light to moderate physical intensity levels, and in some cases, vigorous intensity levels [9]. For example, Al-Hrathi et al. [1] evaluated the physical intensity of ExerLearn Bike during usage by 8 children ages 7 to 13 years. Children's heart rate measured during rest and while using ExerLearn Bike showed an average increase of 60% with most of the children achieving light to moderate intensity levels. Perron et al. [9] also measured children's exertion levels during their interaction with two exergames (Wii Fit and EA Sports Active) and found that both games achieved moderate intensity levels. However, there are growing concerns about the long-term efficacy of exergames in promoting physical exertion in children [2,10]. Bidiss and Irwin [2] conducted a systematic review of the exergame literature and asserted that although exergames can promote light to moderate physical intensity levels, there is no evidence supporting the efficacy of these games in promoting long-term adherence to exercise. Researchers have also found that exergames are susceptible to novelty effects; children's motivation to use these games is not sustained over time [10,11].

Researchers have explored improving the efficacy of exergames by using user-centered design approaches to get direct input from children [4,7,8]. For example, Madsen et al. [7] conducted phone interviews with

children after usage of Dance Dance Revolution (DDR) over a 6-month period and noted that concepts such as *competition* and *group participation* helped to sustain children's long-term interest. However, children are not necessarily well suited for making informed decisions about their fitness, so their perspectives only form half of the picture. Adults who are invested in the problem of children's fitness (e.g., PE teachers, sports coaches, and parents) are a valuable missing perspective. For example, physical education (PE) teachers design exercise experiences to motivate children over the course of a school year. By soliciting the perspective of both groups of stakeholders (teachers and children), we believe we can attain a better understanding of the design space of exergames that can induce long-term physical exertion and sustain children's motivation to exercise.

As a first step to understanding what we can learn from involving stakeholders who can make informed decisions about children's fitness in the formative stages of design, we conducted one qualitative in-depth interview with a PE teacher and three focus group sessions with 15 different children. The goal of these sessions was to identify the elements that children and PE teachers consider important for the design of exergames. We analyzed the data collected from these focus group sessions using affinity diagramming [6] to generate themes. We compared the themes we obtained from the children and teacher to identify overlaps and non-overlaps between both perspectives.

Our findings indicate that both the children and PE teacher we spoke to considered elements that facilitate **fun** (i.e., motivation to use exergames), such as reward systems, and elements that promote

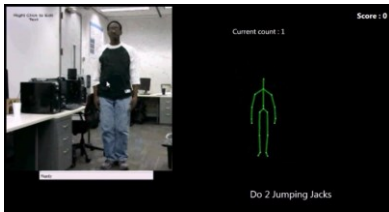


Figure 1: Basic Windows Kinect motion-tracking prototype, used as a design probe in our focus groups with children.

Theme 1: Progression

Both groups wanted to advance the intensity of the exercises as levels increased in the exergame

C8: "There should be different levels like beginner, middle, ... and then in beginner you can have easier exercises, and then middle has harder exercises..."

T1: "Have options for 'do you consider yourself beginner, moderate, ...' and beginner would work within range of 60 to 70 percent and moderate would be 70 to 80..."

Theme 2: Multiplayer

Both groups wanted to include multiplayer scenarios that encourages competition

C6: "I like to race with my friends"

T1: "If they have ... something that they have to reach in order to get a certain status, ...that's the first thing that they'll brag about. And then that's the healthy competition. [Kids] will say, 'What did you end up at? I got the silver. Oh well, I'm going to get gold next time.'..."

effectiveness (i.e., induce exertion at targeted intensity levels), such as exertion. More interestingly, we found that even though children and the PE teacher mentioned similar game elements, the lens through which they viewed such elements differed. Children emphasized the **fun** aspect while the PE teacher emphasized the **effectiveness** aspect. For example, both children and PE teachers considered feedback an essential element to include in exergames. However, children viewed feedback through the lens of **fun** by emphasizing visual feedback using animations, while PE teachers viewed feedback through the lens of **effectiveness** by emphasizing expert feedback through guidance and instruction. Our preliminary findings establish the importance of including such stakeholders (e.g., sports coaches) who can make informed decisions about children's fitness in the formative design of exergames.

Methodology

We conducted three focus group sessions with 15 different children ages 6 to 10 ($M = 7.8$ years, $SD = 1.2$); parents identified six as girls and nine as boys. Each session lasted around 30 minutes and was video recorded. Each session began with a video recording of a basic prototype of a Kinect-based exercise "game" as a design probe [12] (Figure 1). We used a question guide to facilitate the sessions. The guide included questions to help us understand how children think about exergames (e.g., "What is your motivation behind exercising or being physically active? What kind of exercises do you just not like to do?")

We also conducted an in-depth qualitative interview with one PE teacher who had certificate training in physical health education and over ten years of

experience teaching elementary physical education (children ages 5 through 10) at a local K-12 school. The interview lasted 45 minutes and was audio recorded. We had modified the design probe from the children's session in the ways the children described to make it more game-like (e.g., using a 3D character model instead of a Kinect skeleton). We presented the design probe briefly prior to the start of the interview. The goal of the semi-structured interview was to elicit design ideas from the PE teacher regarding how she thought a digital version of a game to motivate children to exercise and induce exertion should work. We provided sketching materials (large sheets of paper and markers) for the teacher to illustrate her design ideas.

Analysis

We transcribed statements from the video recordings and audio recordings of the children's and PE teacher's sessions, respectively. We analyzed these transcriptions using affinity diagramming [6], a technique for organizing large amounts of unstructured qualitative data. We wrote each individual statement on a post-it note and grouped the notes inductively to capture emergent themes. A post-it note could belong to multiple themes if its statement expressed multiple ideas. These themes capture the main elements that the children and PE teacher we spoke to thought important for exergames, from their own perspectives. We compared the themes that emerged to identify overlaps and non-overlaps between both perspectives on what should be included within exergames.

Findings

We identified eight themes from the children's sessions and 11 themes from the PE teacher's interview. Comparing both sets of themes revealed that four

<p>Theme 3: Exertion</p> <p>Both groups considered exertion as a form of evaluation and for promoting safety.</p> <p>C8: "After I run and [my heart is] beating slowly, that means I did not run as fast."</p> <p>T1: "... if there was a heart rate check because at the beginning of the game if you were able to... have their training heart rate range, so once you got that, that would be assuring you that they are within the safe zone."</p>
<p>Theme 4: Reward Systems</p> <p>Both groups wanted to positively reinforce exercise performance</p> <p>C8: "When you complete ... exercises, then you get a prize."</p> <p>T1: "If they improve, they start seeing something fill up in different colors, that might just motivate them to achieving because they can see that visual thing as opposed to a number"</p>

Table 1. Elements that both children and PE teachers considered necessary to include in exergames for similar reasons.

themes were overlapping, in which both the children and the PE teacher had similar reasonings behind why they should be included in exergames; seven other themes were non-overlapping, in which the groups' reasonings differed. Since our goal is to understand what we can learn from PE teachers, we provide a summary of the overlapping themes in Table 1 and focus on the non-overlapping themes in this paper.

Common Themes from Different Perspectives

We discuss elements that both the children and PE teacher we spoke to found essential to include in exergames, and describe the differences in both groups' reasonings (e.g., **fun** vs **effectiveness**).

Variations of Exercise. Children suggested exercises to include in exergames based on their perceived difficulty (e.g., dancing and yoga), exercises they found interesting (e.g., push-ups and burpees), and exercises they had prior experience with (e.g., sprinker lunge from sports camps). Children thought including different exercise types would make exergames **fun**:

C1: "You should update [the exercise] so you're not just standing around." C2 (continuing): "You don't want kids saying, 'oh man, this is boring, I quit'."

Although the PE teacher considered perceived difficulty and children's interest towards the exercise, the teacher was more concerned with including exercises that benefit children's physical skill development, thus contributing more to the **effectiveness** of exergames:

T1: "With your type of game, its probably going to be more stationary type of movements. I would try to encompass... those types of movements [that] are actually very beneficial to their balance..."

Goals. Children wanted specific goals to be included in exergames such as time limits and obstacles to increase difficulty: "Animated cake and pudding falls down and you have to get out of the way" [C5], and, "And if it is lettuce, you want to touch it." [C4]. Children considered these types of challenges as a way to make exergames **fun**. In contrast, the PE teacher considered setting goals as a way to improve the **effectiveness** of exergames. In her classes, the PE teacher uses goals to track and measure children's progress and increase the time children spend active:

T1: "I say okay, first goal is to do the plank for as long as you can. Some kids might do 2 or 3 seconds. And then eventually then I'll say let's work up to 10 seconds. So when they work up to that point and they get to that time, they get really excited...."

Feedback. Children thought exergames would be more **fun** by providing reactions to their actions using visual feedback (e.g., through animations): "If you complete the level, [your character will] get buff." [C1]. On the other hand, the PE teacher mentioned that exergames should provide expert feedback since children may not perform exercises at expected exertion levels, thus reducing the **effectiveness** of exergames:

T1: "Some kids will self-limit, where some will do high knees really high and others will be [lower]. You could have a voice on there that says, 'get those knees up' or like what coaches do, that would be nice to have background prompts."

Negative Outcomes. Children suggested that penalties should be given when exercises are not performed correctly or fast enough, which they saw as a means to compete with themselves or their peers and make the exergame more **fun**: "If you do the motion

wrong like three times, then it can say game over." [C3]. The PE teacher, in contrast, thought that exergames should only penalize children to show the importance of specific processes that can negatively impact the **effectiveness** of exergames if neglected:

T1: *"You need to do your cooldown activity, this is what is recommended... it is highly suggested... And if they opt to not do the cool down, maybe they get deducted points, get penalized."*

Teacher-Only Themes

The themes described above showed that children viewed elements to include in exergames from a lens of **fun**, while the PE teacher viewed similar elements from a lens of **effectiveness**. Children were more concerned about the satisfaction they can derive during interaction with exergames. In contrast, the PE teacher was more concerned about the health benefits that exergames can provide to children, which likely stems from a perspective that exergames are created for a purpose of fitness and activity levels, as opposed to just for fun as the children would be thinking of. The trend in the themes of how children motivated their reasoning for design suggestions supports our belief that both perspectives are necessary to attain a better understanding of the design space of exergames that can induce long-term physical exertion and sustain children's motivation to exercise. In this section, we present themes that only emerged from the PE teacher's input. These themes further emphasize the PE teacher's focus on **effectiveness** when thinking about elements to include in exergames.

Accessibility. The PE teacher wanted exergames to include exercises that are accessible to everyone irrespective of constraints impeding their athletic

abilities (e.g., disabilities or injury). The PE teacher also felt that such exercises could even be beneficial in helping to treat injuries:

T1: *"You do have some individuals that are sometimes in a wheel-chair... So, if there is a part of the game that would be just upper body where they would be seated... There is a lot of research that shows that, when you engage the upper body, even when you have a leg injury, if you just move one leg, the healthy leg, then the leg that's getting treatment at the time [also] gets benefits."*

The PE teacher thought that including exercises that are accessible to everyone would ensure that the **effectiveness** of the exergame is maintained regardless of a child's athletic abilities. Children did not mention this concept during our session with them.

Cross-curricular Skills. The PE teachers wanted the exergame to also teach children about soft skills not specific to exercise, such as compassion. They mentioned that they teach children such skills in their classes to aid children's development as individuals:

T1: *"With different types of units that I have for teaching different types of compassion...and different social stuff... if there is like another person playing, then afterwards they say 'okayyy highfive' or 'fistbump to your partner and tell them good job'. So that could [be] something good for them to learn, like win or lose you shake hands with your friends."*

The teacher thought that practicing these skills would help children become well-rounded both in and out of physical activity settings; children did not share this motivational lens when thinking about exergames.

Form. The PE teacher also wanted exergames to ensure that children use proper technique when

performing exercises. She emphasized that learning technique reduces the possibility of forming bad habits:

T1: *"If they are doing mountain climbers, keep that back straight, can you hold a glass of water on your back? Keep the knees behind the toes when doing squats..."*

The PE teacher thought that using the right form would ensure exercises are performed correctly to achieve targeted exertion levels, thus improving the **effectiveness** of exergames. Children did not mention this concept during our sessions with them.

Conclusions and Future Work

Our preliminary findings from our focus groups with children and our semi-structured interview with a PE teacher show the ways in which the two groups' perspectives on exergame design were similar or different. This initial work-in-progress paves the way for future work in designing exergames for children that promote long-term efficacy to exercise.

Our findings showed many overlaps between themes that emerged from the children's and PE teacher's suggestions. However, even when children were proposing the same game features as teachers, their perspectives differed. Children placed more importance on **fun** (i.e., motivating elements) in their comments. For example, children wanted to incorporate fun within exergames by increasing game difficulty using time limits and obstacles, and including exercises they perceive as difficult. On the other hand, the PE teacher placed more importance on **effectiveness** (i.e., inducing exertion). For example, the PE teacher wanted the game to prevent children from setting goals that were too easy, and to include exercises that target and work different muscle groups. This difference in

perspective could be informative to the design of exergames that are more effective in the long term.

The idea of eliciting formative input from stakeholders like PE teachers in the design of exergames is supported by our findings as well. However, most prior work in exergames has focused on getting direct formative input from children only [7,8]. A few games for children with motor disabilities [3,5] included physiotherapists in formative design to ensure therapeutic effectiveness was being met (e.g., Hanes and Hernandez [5] in designing an exergame for children with cerebral palsy). Even in a non-therapeutic context, such a perspective can be valuable. The PE teacher we spoke to focused on the lens of ensuring correct performance of exercises and advancing child development. For example, when varying exercises in her class, the PE teacher includes exercises that target balance and varied muscle groups (**effectiveness**), as well as exercises that are of interest to children (**fun**). Children did not mention these same ideas, thus providing a novel perspective that would otherwise not have emerged. Therefore, it is clear that the perspectives of these stakeholders will be informative in the design of exergames in general. A focus of our continuing work will be to conduct further research with such stakeholders (e.g., PE teachers, parents, sports coaches) to understand what we can learn from them to aid in the design of exergames for children.

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