Toward Exploratory Design with Stakeholders for Understanding Exergame Design

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Abstract
Prior work has explored improving the efficacy of exergames through participatory design with children. Children are not necessarily able to make informed decisions about their fitness, so their perspectives form only half 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 like similar game 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 in the formative design of exergames.

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

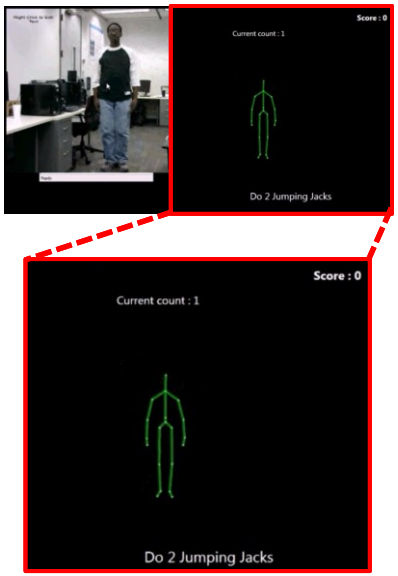

Figure 1: Basic Windows Kinect motion-tracking prototype, used as a design probe in our focus groups with children. The zoomed in view of the image on the right shows the key elements of the prototype: skeleton-tracked character, feedback, and score).

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 intensity physical activity levels, and in some cases, vigorous intensity levels [1,4,8,11,12,16]. For example, Al-Hrathi et al. [1] evaluated the use of ExerLearn Bike by eight children ages 7 to 13 years. The authors found a 60% increase in children's heart rates when playing the game, with most of the children achieving light to moderate intensity levels. Perron et al. [11] measured children's exertion levels with Wii Fit and EA Sports Active and found that both exergames achieved moderate intensity levels. Macvean and Robertson [8] evaluated their iFitQuest exergame in the classroom and found that children spent 56.8% of their time engaged in light intensity activity and 29.3% of their time in moderate to vigorous intensity levels. However, there are growing concerns about the efficacy of exergames in promoting sustained physical exertion [2,13]. Bidiss and Irwin [2] conducted a systematic review of the exergame literature and asserted that 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; after the initial excitement or interest fades, children's motivation to use these games is not sustained over time [13,14].

Researchers have explored improving the efficacy of exergames by using user-centered design approaches to get direct input from children [5,9,10]. For example, Madsen et al. [9] conducted phone interviews with children who played 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 able to make informed decisions about their fitness, so their perspectives form only half the picture. Adults who are invested in the problem of children's fitness (e.g., Physical Education (PE) teachers and sports coaches) are a valuable missing perspective. For example, 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 to both induce vigorous physical exertion and sustain children's motivation to exercise.

As a first step to understanding what we can learn from these stakeholders 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 [7] 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 liked game elements that facilitate **fun** (i.e., motivation to use exergames), such as reward systems, and elements that promote

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 encourage 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 progression. 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.

Method

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 [15] (Figure 1). We used a question guide to facilitate the sessions, to help us understand how children think about exergames (e.g., "How can we make you want to play exergames every day?" "What exercises do you 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 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), and 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 [7], 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 themes were overlapping, in which both the children and the PE teacher had similar reasonings behind why

Theme 3: Exertion
Both groups considered exertion as a form of evaluation and for promoting safety C8: "*After I run and [my heart is] beating slowly, that means I did not run as fast*." 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.*"
Theme 4: Reward Systems
Both groups wanted to positively reinforce exercise performance C8: "*When you complete … exercises, then you get a prize.*" 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*"

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

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 lunges 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*."

Summary. 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. This difference in how children versus the PE teacher motivated their reasonings for their design suggestions supports the notion that both perspectives are necessary to attain a better understanding of the design space of exergames that can induce vigorous physical exertion and sustain children's motivation to exercise.

Teacher-Only Themes

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.

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… if there is like another person playing, then afterwards they say … '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.

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.

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 are similar or different. This initial work-in-progress paves the way for future work in designing exergames for children that promote long-term motivation 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 [9,10]. A few games for children with motor disabilities [3,6] included physiotherapists in formative design to ensure therapeutic effectiveness was being met (e.g., Hanes and Hernandez [6] 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 the PE teacher provided a novel perspective that would not have otherwise 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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