# Evaluating technology that makes physical games for children more engaging.

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## ABSTRACT
Throwing is an important physical skill that lays the foundation for the ability to participate in many physical activities and sports experiences. We aim to support the development of physical skills through exertion game design; our focus here is on the design of an exertion based throwing game that aims to help children improve their ability to throw. We discuss the results of some initial play testing, and how these observations informed our game design.

## Categories and Subject Descriptors
H.5.2 [**User Interfaces**]: Information Interfaces & Presentation, Prototyping, User Centered Design.

## General Terms
Measurement, Design.

## Keywords
Exertion Interface, interaction design, kinesthetic literacy, learning, gaming, whole body interaction.

## 1. INTRODUCTION
The virtuosos in any professional sport are those who started playing the sport at an early age and had positive experiences. Young athletes who benefit from positive outcomes associated with sport will enjoy increased motivation to achieve and will continue sports participation [2]. Miracle and Reese [12] cite instances where negative youth sports experiences have inhibited character formation. In their opinion, such experiences can erode motivations for participation, produce excessive stress, and destroy feelings of self-worth. Physically ill-coordinated children, who often find it hard to catch, throw and dribble, are one demographic that is susceptible to such negative experiences. If this inability to catch and throw could be addressed at an early age, it would give them a better chance of picking up or learning a sport in the future and of benefitting from its positive outcomes.


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Given that today's average college student has spent over 10,000 hours playing video games [15], we propose to use this digital technology, coupled with exertion activities like throwing and catching, to encourage children to play more physical games, and gain kinesthetic literacy [22] in the process. Would pairing a traditional sports game with interactive digital technologies help make it more fun for children to play? Specifically, we would like to understand the opportunities and challenges involved in using technology to make exertion games for children more engaging. We hope that by making games more engaging, we can enhance opportunities for learning physical skills, and contribute to further participation in sports.

Sheridan & Mueller [22] suggest that kinesthetic literacy involves two major learning objectives, *learning to move* & *moving to learn. Learning to move* asks participants to focus on an understanding of the body in order to acquire the skills and techniques that are required to participate in physical activities. Doing so allows participants to take control of their body and to know its range and capacity for movement. Learning in this context often focuses on "fine-tuning" motor control [20][21] and fundamental aspects of movement such as hand-eye coordination, coping with space, speed and distance. In *moving to learn,* the physical activity is the context for a means of learning. For example, Sheridan *et al*. [20][21] have explored how a tangible, exertion interface can be used to learn about basic science concepts. Our game, in its current form, will explore the first of the two objectives, while subsequent versions might consider providing more of a contextual framework to the game, to be able to explore the second objective as well. We would like to present the game so it seems less about learning to throw, and more like a fun game that children would like to play repeatedly. Just getting kids to go through the action of throwing over and over to get better gets boring pretty quickly, especially if they are not really good at it and don't have the predisposition. But if the game is fun, exciting, challenging in terms of the game itself (content, mechanic, strategy, etc.) they will want to play it repeatedly. The idea is for the game to be the hook that will draw kids into throwing and get them working on it without even realizing it, because they are focusing on the game and not on the throwing itself. This way, we hope that children will not approach this like one of their curricular or extra curricular activities that are 'required' learning's, but as something that they would come back to repeatedly in their spare time. By abstracting the pedagogical aspect of the game and getting the children engaged in the act of throwing repeatedly through game play, we hope they will develop the kinesthetic literacy required to execute a throw and that this carries over to other outdoor sports as well.

## 2. CONTRIBUTION TO THEORY OF GAMIFICATION

'Gamification' is an emerging umbrella term for the use of video game elements in no-gaming interactive systems to engage users in (sometimes mundane) tasks, hence making the tasks more 'fun' in order to change people's activities for the better [4]. Our game system and its related studies are an attempt to identify exactly what it takes to make an exertion activity more fun and engaging for the players. We are most interested in the computing technology that goes behind such games.

## 3. DEFINING ENGAGEMENT

Research about engagement in classroom describes both psychological and behavioral characteristics [5, 10, 1]. Psychologically engaged learners are intrinsically motivated by curiosity, interest, and enjoyment, and are likely to want to achieve their own intellectual or personal goals. In addition, the engaged child demonstrates the behaviors of concentration, investment, enthusiasm, and effort [11]. This description can be extended to the field of games and sports as well, where engaged players are driven by the same characteristics, in a desire to finish on the winning side and/or achieve their personal goals. One recent study found, for example, that players of "Guitar Hero" are more likely to pick up a real guitar and learn how to play it [8]. We hope to be able to emulate this level of transfer with our game.

## 4. REVIEW OF EXISTING MATERIAL

An exertion interface is one that deliberately requires intense physical effort [9]. It has caught the attention of many researchers interested in bridging the digital and physical worlds of game play. One of the ideas explored in this context has been to combine regular outdoor sports with technology while retaining the key aspects of the underlying sport. Bringing technology into the sport helps add another dimension to the sport while also taking out certain risks that might have been a hindrance to playing the sport in the first place. A good example of this Remote Impact: Shadow Boxing over a Distance [13]. Here, two players separated over a distance box against each others shadows that are projected on a cushioned wall. The technology helps the two players box with each other, even though they are not in the same room while also eliminating the risk of being physically hit by the opponent.

Splashball [6] was a game developed at Philips Research Europe. This game used the impact of balls on the wall as a form of point and click interface and is for at least two players. Several games were developed for this platform, and could be adapted to the skill level of the players. For example, one game required the players to hit a mouse wearing a shirt of a particular color and running across the screen. The object of another game was to prevent an animated man from carrying a bucket of paint of a particular color across the screen by hitting him. Although simple, these games required the player to throw at the target accurately and consistently, which would be hard to do for children in our target demographic.

The Wii® game console comes with a controller that contains accelerometers to support physical activities in its games, and force-feedback is provided through subtle vibrations in the controller. Although such exertion games are achieving commercial success, they have been criticized for not being comparable to the sports activities they are simulating [7]. For example, Wii Tennis does not facilitate the same energy expenditure and therefore similar physical health benefits as a traditional game of tennis. We wanted the interaction of our game to mimic the real world throwing model as much as possible, so the transfer of skills from our game to other sports would be easier.

PingPongPlus [9] is a digitally enhanced ping-pong game using a "reactive table" that incorporates sensing, sound, and projection technologies. With PingPongPlus, users experience dynamic and athletic interactions using the full-body in motion, a paddle in hand, a flying ball, and a reactive table. In Pushing Pixels [22], kinesthetic literacy occurs as players are guided and build upon each other's movements while exploring their own bodily capabilities. A piece of exercise equipment (functions as a "pulley" for upper body exercises) is modified to capture real time data to be sent to a PC, that gives audio and visual feedback based on the received data. In both these examples, the underlying physical activity (playing Ping Pong or exercising with the equipment) was not modified. In fact, the developers of PingPongPlus anecdotally mention that one of the subjects used the game to train himself in PingPong [9]. We took inspiration from these games and tried to build a game that would retain the mechanics of throwing.

These examples show how technology has helped enhance an exertion activity, to make it more engaging. While Remote Impact helps players separated over a distance to play together, Splashball makes the task of throwing balls at a wall more interesting for players within the same room [6]. PingPongPlus and Pushing Pixels show that audio and visual feedback can spike the interest of players by getting them excited about the feedback and inciting them to play differently in order to be able to experience the feedback loop again and in different ways. Little work has focused on movement and action in learning contexts, and how design influences the kinds of learning opportunities engendered [18]. Wii Tennis or other Wii Sports games could be used for training, but since the physics is not like in the real world (e.g. no resistance of a physical racket hitting a physical ball) players don't see significant improvement in their tennis playing skills after using these consoles [3]. We attempt to explore this space by considering the design decisions that would encourage children to train themselves in the skill of throwing balls by playing the game repeatedly. This would require the game to be fun to play and it is our hope that the kinesthetic literacy children develop from playing our game will transfer to the field of traditional sport as well.

## 5. GAME

It is not clear whether more fun implies more learning, but something that's more fun to do is always more attractive to children and gets them engaged in the activity [17]. Having children engaged in the activity they are doing, increases the likelihood that they will take genuine interest in it and in turn, learning from it [17]. Our primary goal for this game is therefore to make it as much fun to play as possible.

The target audience for this game is children in the age group of 7-12 years, who may or may not be physically well coordinated or active in sports. The goal of the game is to create a digital collage of the physical soft toys a player has. Transfer of the soft toy from the physical to the digital world happens when the player throws the toy at a display screen. Once the toy hits the screen, an image of the toy is displayed at the location of the hit. After one minute of game play, the system makes a digital collage of all the soft toys displayed on its screen.

## 5.1 Design Decisions

We arrived at this iteration of the game by building a prototype and doing some initial play testing. The prototype was built with a baseball pitchback, a Wiimote and a projector. The game involved throwing a baseball at images that were projected on the pitchback. The Wiimote strapped onto the pitchback (see Figure 1) picked up the vibrations and sent them over Bluetooth to a computer, which changed the displayed picture and the audio feedback based on the amount of vibrations it received. Pictures included those of glass panes; the harder you threw at them the more they cracked, and those of the players' family members who shouted in pain when the ball hit them. The goal of the prototype was to ascertain what technological aspects of a throwing based exertion game children liked the most. Our observations from that play test have informed our design decisions and this section gives details of the game play and our reasons for choosing such a design.

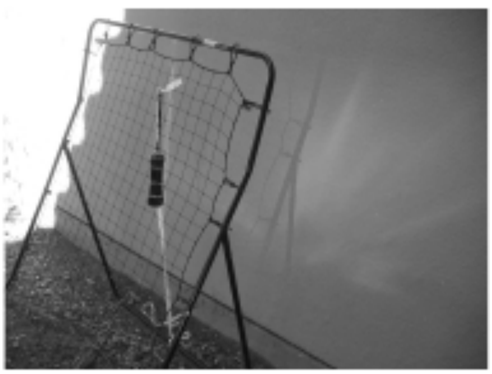

**Figure 1: Pitchback with Wiimote**

### *5.1.1 Real balls Vs virtual balls*

With the goal of keeping the exercise of throwing as true to other real world sports as possible, we opted to go with physical throwing objects instead of virtual ones (as in Microsoft Kinect games). Our play test showed us that the children approached the throw differently with a physical object in hand when compared to a virtual one. Having a physical object to throw, we hope, will help increase the probability of the children transferring their knowledge of throwing to other sports.

### *5.1.2 Bouncing balls*

Catching the ball bouncing off the board could be a hindrance to learning how to throw, especially for players who are new to the throwing exercise. The risk of being injured by a hard ball might also hinder game play, which was something we noticed in our play tests as well. Players sometimes didn't throw as hard or threw and moved out of the way of the bouncing ball to avoid injury. By using soft toys that generally do not bounce as much as balls, we try to eliminate the risk of injury and distraction from our goal, which is to learn how to throw.

### *5.1.3 Making the game more personal*

The children we tested with liked throwing the ball at images of people they knew. Having such personal connections [19] with the game made it more interesting and motivating to them. When activities involve objects and actions that are familiar, users can draw on previous knowledge, connecting new ideas to their pre-existing intuitions [19]. Incorporating soft toys that children have in their rooms and are already familiar with into our game, is one way of this fostering this familiarity.

### *5.1.4 Involve children of all skill levels*

Our game in its current form, does not reward accuracy, form or impact of a throw; nor does it have multiple levels that players need to overcome to reach the goal. We have intentionally kept the interaction simple, so players of all physical abilities can play and benefit from it. We would eventually like to provide some form of scaffolding, so players can benefit from the increasing level of challenges provided by the game. This scaffolding, we hope, will motivate children to play the game more and in the process, teach them the basics of throwing as well.

### *5.1.5 Type of feedback*

Reflecting on one's achievements is crucial in learning and motivation, and supports the formulation of new personal goals [23]. The kind of feedback we provide will enable the players to reflect on the kind of progress they are making. For the current version, we opted not to provide feedback about the quality of the throw, like it is done in the *VLM Pitchtracker* baseball training system. We believe that feedback about hand position, velocity of throw etc would make sense to players who are trying to fine tune their throwing skills, not for players who are trying to learn the basics. We would eventually like to compare our system with one of these professional training systems to validate our belief, but for now, the only visual feedback we provide is to mark the location of the hit with pictures of the soft toys. This will be accompanied with sound effects, that we hope will allow the player to involve himself in the fun aspects of the game rather than the training.

### *5.1.6 Multiple forms of self expression*

Educational designers cannot and should not control exactly what or when or how students will learn [24]. Our game has objects and actions that we believe will help children learn how to throw, but we are eager to study how they improvise and what forms of play lead to optimal learning. Soft toys come in a variety of shapes, sizes, form factors and weights. This variety makes throwing each of these at the screen a slightly different experience. Also, children can play the game by either throwing the soft toy at the screen or holding it in their hands and running up to the screen to make contact.

# 6. EVOLUTION AND FUTURE WORK

We incorporated the findings from the prototype into our current game design. The goal we have for the current version is to test it with children in our target age group to determine if our design decisions were right and if there is anything we need to change. Our study has been designed to measure mostly qualitative aspects of the game play so we can answer the questions about fun, engagement and how technology can be incorporated to improve these factors. Once we have empirical evidence about what it takes to engage children in such a game, we plan to conduct longer studies that will also measure learning and how much of it, if any, children can transfer to other sports.

# 7. CONCLUSION

We have presented here a game system that was designed based on an initial prototype and play testing that we did. We've described the game and also discussed the reasons for our design decisions and how they relate to the questions we are trying to answer. Through this game, we hope to learn more about what it takes to make an exertion activity like throwing more fun and engaging for children. The ultimate goal we have for our game is that it will make children better at throwing and encourage them to play sports that are based on the same physical activity.

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