# Exploring the Application of Interactive Video Projection in Physical Education

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## Abstract
This paper describes explorations into related technology and research regarding the application of interactive video projection within physical education and the gym of the future. We discuss the application of exergaming in physical education, spatial augmented reality as a technology and participatory design with teachers and children as a design method to develop new concepts. Based on our initial findings we propose directions for further research. Further work includes developing new applications based on the wishes, needs and ideas of physical education teachers and children, incorporating opportunities provided by recent technological developments.

## Author Keywords
Physical Education, Spatial Augmented Reality, Exergames, Participatory Design, Interactive Video Projection

## ACM Classification Keywords
H.5.2 Information Interfaces and Presentation: User Interfaces—evaluation/methodology; interaction styles

H.5.1. Multimedia Information Systems: Artificial, augmented and virtual realities

## General Terms

Design, Human Factors

## Introduction

At primary schools in the Netherlands, physical education (PE) is used to encourage an active lifestyle by developing fundamental motor skills and practicing different sports. It improves the condition and health of children and enhances team building, cooperation, sportsmanship and fair play. Learning objectives transcend the motor skill level and also include improving attitudes, ethical and social norms and values of children. [11]

Even though interactive technologies have made their way into the physical space in recent years, within physical education the use of technology is still limited and the equipment that is being used in gyms has mainly been unchanged in recent decades.

Recently, video capturing and (projection) screens to provide feedback on previously performed exercises have been introduced to physical education, as well as exergames [3].

The implementation of interactive technologies could provide many opportunities for making physical education more efficient, more motivating and more targeted. More specific, the use of interactive video projection could enhance existing set-ups and provide opportunities for developing new exercises.

In this project we will look into the wishes and ideas of PE teachers, the perception and play of children and the opportunities offered by the space, equipment and technology.

## Target groups

Two target groups are important considering physical education: teachers and children. We want to involve both groups in multiple stages within this project to ensure that what we invent, design and develop fits the needs of our target group.

*Teachers*

Teachers have ample knowledge of didactics and motivational methods, existing exercises and games within physical education. Since teaching PE is their domain, it is important to involve them at moments in this project to gain a good understanding of PE, the problems they encounter and to validate our ideas.

It is important however to choose research methods wisely. Because teachers are experts on teaching PE, they might already have specific ideas on the application of new technologies. This might make it more difficult for them to think out of the box, something we consider important in finding new applications. We think it is important to choose methods that help them to broaden their view as much as possible.

*Children*

It is just as important to gain good understanding of how students experience PE and the gym as an environment and how we can design taking into account their perception. Children will be using the applications; therefore we need to know what their ideas and preferences are.

Children start physical education in kindergarten, aged 4 years and continue classes till high school, aged 16-18 years. Initially we will focus on physical education in

**Figure 1:** Equipment being used during a Physical Education class.

**Figure 2:** Examples of Projection Mapping.

elementary schools since that has so far been the main focus of our research group. Future research might involve adolescents or other target groups.

## Space & Sports Equipment

The gym as a space and the sports equipment bring many opportunities for interactive applications but also challenges/constraints that should be investigated.

The gym is an open, versatile space with numerous sports equipment that can be set up in unlimited configurations. An example is shown in figure 1.

## Related Technology

We are currently identifying potential technologies that could be applied in the gym of the future. In this chapter we describe technologies we have identified so far, and that we consider interesting to further study regarding their deployment within physical education.

*Spatial Augmented Reality*

Projection mapping, video mapping or spatial augmented reality (SAR) [13] is an interesting augmented reality technique for using video projection in physical spaces and creates a highly immersive experience [12]. An example can be seen in Figure 2.

A virtual three-dimensional image is projected upon a real three-dimensional surface, wrapping the image around the object [1]. This technique makes versatile, instantly altering appearances of existing surfaces possible [5].

Benefits of this technique are that any object or surface can be turned into anything, creating an augmented reality, adding movement and activity to stationary objects. [7]

There are several practical considerations using SAR. In bright environments, such as a gym, a video projector is needed with a high lumen count; otherwise the projected image will appear too light and unclear.

Another challenge is projecting on larges areas or avoiding shadows. Multiple projectors are required to solve this, causing projection overlap (a brighter area) that has to be eliminated by luminance compensation. [4,5,7]

Furthermore a robust construction is needed for mounting the projector, a slight bump might cause the projection to move or misalign. [4,5,7] We should look into using robust truss systems for mounting a video projector.

*Other Input and Output technologies*

Besides SAR, a wide range of technologies can be used for sensing objects and people, and for sensing and changing a physical environment [9]. Technologies we are considering are: Sound, Computer Vision, Microcontrollers, Sensors, and Actuators [9]

## Related Research

*Exergames*

Previous research on exergames in physical education is limited but shows physical, social and cognitive benefits [10]. Other benefits include weight loss and less obesity. [3]

Most exergames focus on the goal on getting children physically active, which they seem to do very well by

turning exercising into a game and making it more fun to do. [10].

Most research on exergaming focuses on health benefits. In our project it would be interesting to also consider the effects on motor skill development, interplay between children and progress in level of play.

Additionally exergames may offer the possibility that children can exercise much more independently and that PE teachers do not constantly have to monitor the entire class, but can focus on a specific task instead such as coaching individual students. Developing exergames that monitor play and skill levels, and adjust gameplay based on these factors can help doing this.

*Cooperative/Participatory Design*

Instead of designing applications for users it is interesting to design together with the users in this project. Previous research shows interesting and more versatile outcome when participating with users in creating concepts for technology.

When is comes to designing new technology for children we tend to forget that children are a very specific target group with their own perception. Instead of asking parents or teachers what children might like, we should involve children themselves [2] Children are very creative, intuitive, not limited by social conventions and great at thinking out of the box.

Various research describes methods for involving children in the design process in various roles [2,6]. Important factors to keep in mind are that children have a limited attention span [6], sessions have to be well prepared and participants have become used to their role [2].

Outcomes of design cooperation with children have to be translated into practical concepts, which require empathy and creativity of the researcher.

A familiar environment, preferably within the context of the design problem, works best for creating specific solutions [8]. For our project it might be a good idea to place design sessions with teachers in the gym. By using this location, participants can directly refer to the space and sports equipment.

In general, it might be wise to perform preliminary testing sessions to ensure that the chosen method works for gaining insights [6].

## Further Work

This project has started recently and therefore offers many opportunities for further work.

We have started gaining information by conducting informal interviews with PE teachers. We decided on this approach to get a general idea of the challenges and opportunities that were involved and to decide which further steps to take. First outcomes of these interviews are the need for assistive technology to provide support when teaching large groups of children.

Related research shows benefits of exergaming and our informal interviews suggest a need for applications that provide support when teaching. The characteristics of spatial augmented reality promise interesting applications within physical education. We therefore

think there is potential for the application of interactive video projection in physical education.

We will continue our research into related techniques and research to form a more solid foundation to build on in the next phases of our project. We will conduct qualitative and quantitative research using methods mentioned in the Related Research chapter involving both teachers and children. Our goal is to get a solid overview of the needs and ideas of both groups and technologies that could be used.

Once we have a clear picture of opportunities and challenges, we will continue with inventing, designing, developing and testing applications.

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