Bringing intuitions of natural and virtual interactions into conflict: the POLYMECHANON experience

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Abstract. This paper focuses on the ways that physical and virtual places may relate to each other and the type of design decisions that an interaction designer need to focus on. In particular, we investigate situations where physical and virtual interactions come into conflict so that the user can have fun. The interactive means are gestures and other body interactions and we explore if such interactions can also facilitate meaningful interactions that employ body and mind. We aim to study the physical exploration of concepts and systems by moving within and acting upon an environment.

Keywords: gestures, full- body interaction, embodied cognition

1 Introduction

This paper focuses on the ways that physical and virtual places may relate to each other and the type of design decisions that an interaction designer need to focus on. In particular, we investigate situations where physical and virtual interactions come into conflict so that the user can have fun. The interactive means are gestures and other body interactions and we explore if such interactions can also facilitate meaningful interactions that employ body and mind. We aim to study the physical exploration of concepts and systems by moving within and acting upon an environment. The testbed for such explorations is Polymechanon (http://polymechanon.gr), an interactive educational gaming centre where visitors can have full-body collaborative experiences during their visit. Visitors interact with virtual and real objects (e.g. joysticks and push buttons) through which they need to accomplish specific goals to win a game [1].

When full body interactions are employed, learners construct strong relations between physical movement and visual representations. Gestures and other body interactions with visual representations, enabled by interactive technologies, can, under specific circumstances, encourage rhythmic cycles of engagement and reflection [2]. The question that guides this research is to specify the circumstances by which visitors of the gaming centre not only have fun but also enjoy the educational benefits of gestures and other body interactions, as the means to turn action into meaning.

During the design of a virtual environment, designers make implicit or explicit choices regarding the coupling between the physical world and the virtual. When designing a ball-based video game, for example, they may decide for the ball to move like real, depending on the speed that the user comes into contact with it, keeping

friction constant. On the other hand, the designer may decide the ball to move unlike the real world, e.g. to move without friction. Therefore, among the multiple decisions in the design process, there is the degree that affordances of the physical world will be transferred to the virtual.

Such interactions are explored within the team as opportunities to provide alternative experiences in learning about concepts in science and mathematics. These experiences are 'alternative' in the sense that students' or system's actions and reactions are not necessarily anticipated by the players. Instead, they are sometimes against the indication of common sense, e.g. you can 'kick' a virtual ball with any part of your body. While playing the game, players seem to generate a theory on how the system perceives their actions and adjust their behaviour accordingly. In this sense, they are acting according to their intuitions of the system as specified by Fischbein [3].

We explore whether such counterintuitive experiences can offer a set of possibilities for learners to interact with objects and to get an 'insider's' feeling of scientific concepts. For example, players can physically interact with virtual objects to explore the phenomenon of friction as well as physics laws, e.g. 3rd Newton's law (action-reaction). The question lies into finding the ways that the players could take advantage of existing understanding of those concepts to explore it further without missing the fun experience. How could experiences be related to science concepts through physical exploration of representations and how can the fun aspect of the experience be maintained?

1.1 The game

To explore such conflicts, we focus on a specific interactive game, called "air-hockey". To play air-hockey, the players need to interact with a projection of a puck which can move depending on their shadows' position and velocity. The virtual objects projected on the floor are the puck along with the elements of a hockey field. The aim is to score as many goals as possible by placing the puck at one of the two goalposts. The challenge of the game is for the players to realize what the sensors read and how exactly the puck is moving. Through 'trial and error' they can realize that the sensors read not only the movement of the foot but also the movement of the whole body. Therefore, they can hit the ball with their hand or shoulder as long as the sensor reads their shadow. The puck's reaction depends on the velocity and the angle that the shadow hits the virtual object (puck). We have observed some students of various ages to interact with the game and it was revealed that they created ad-hoc strategies to play the game mostly depending on the instructions given by the facilitators [4].

During the game, players have to collaborate rapidly to fill in the gaps of the hockey field. The players act like air-hockey mallets and the movement of each player affects the condition of the puck. They need to find how they can score as well as how to avoid a goal.

As the player advances in the game, the experience becomes more complicated with the addition of extra balls. The players in this situation have to increase the speed of decision making in the angle, and velocity of their actions as well as change their strategies of attack and defense.

Fig, 1 The air-hockey game

2 Method

Following a design-based paradigm we explore how such experiences need to be framed so that players can extract the max of their educational potential. We employ research of embodied cognition which regard bodily activity as being essential to understanding human cognition [5]. These theories have important implications for designing interactive systems [6]. Therefore we aim to explore the connection between thinking and doing adopting a synthesis of educational, gestural and cognitive perspective.

We also aim to study how players can act as participants in the design process by helping us to understand and explain how it works by constructing, elaborating and modifying the representations of the game [7]. We also utilise ill-defined games and malleable educational material that learners are requested to question during their experience [8].

Procedure. We will present how players experienced the game through an iteration of 2 phases: a. initial trial and error, and b. reflective gaming.

The first phase consists of an initial exploration of the system where the player tries to identify the important elements of the interaction. It should be short and unprompted.

During the second phase, the player identifies the elements that influence interaction through a prompt-based discussion with the researcher that also expands on how such elements could be further explored or supported.

Data collection. We carried out 15 student interviews (aged 12-15) in of the first phase and 3 of the second.

Data analysis. a theme-based analysis of the interviews was carried out, where we identified:

a intuitive-counterintuitive divide: this unique experience was either questioned by the players or students looked for resemblances with everyday world. The former was expressed through a. blaming the sensor for false operation, b. blaming the puck for crazy behavior and c. characterizing the shadow as 'confused'. The latter was achieved by relating to similar experiences like an Air-hockey table and an uncontrollable car. Such divide suggest that innovative experiences may result in lack of trust to the interaction features that may deteriorate the students' experience. It also point to the need for further support to understand the game, either through interacting with facilitator or with information posters or packs.

a focus on changing the layout of the game: When the students were asked to identified what they'd like to change, the majority suggested changing the layout of the

game (e.g. size of court, color of puck or of the shadows) rather than changing the variables of the games (e.g. degree of friction). This suggests that students would need further support to understand the flexibility of the game and how they could utilize it for their own benefit.

3 Conclusions

This paper dealt with design decisions around the degree of resemblance of real to virtual world. We explored theoretically situations where virtual interactions do not resemble the real world and discussed how educational benefits may be encountered. Finally we described the first steps of analyzing students' interviews where such thoughts can be empirically tested. We identified the need for extra support of the user experience through facilitators and/or information posters or packs. Our ambition is to map interactive features to the understanding of specific science concepts for the educational benefit of the player.

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