

# New Directions in Designing Exergames for the Whole Family

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## ABSTRACT

Exergames, i.e. games that combine play with physical activity, rarely recognize the whole family as a user group in its own right. We organized a design workshop to explore new direction for those types of exergames. We argue that recognizing the whole family as a target group implicitly improves game enjoyment due to its friendly social context, provides an excellent opportunity to improve social relatedness experiences through family bonding and intergenerational interactions, and contributes to individuals' wellbeing in terms of both physical thriving and social relatedness. Three design concepts were proposed using cooperative and/or competitive game modes. We propose considering family members with limited gaming experience as audience players and recognising their autonomy in the exergame design. We believe that through an enhanced understanding of family exergames, designers and developers can build new experiences that accommodate various capabilities and social dynamics of the family.

## CCS CONCEPTS

• **Human-centered computing** → **Interaction design** → **Interaction design process and method**; User centered design; • **Interaction paradigms** → Virtual reality; Collaborative interaction

## KEYWORDS

Exergames, Social Relatedness, Physical Activity

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## 1 INTRODUCTION

Physical inactivity is the largest cause of obesity and increases the risk for several other chronic diseases (e.g. heart disease,

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diabetes). Recent studies estimate that physical inactivity causes 5.3 million deaths per year worldwide [11] and creates an economic burden of \$67.5 billion in health-care expenditure [2].

With the recent proliferation of sensor technology, literature in exercise games (herein referred to as exergames) has also seen a growth in the last few years. Exergames are videogames that combine physical activity with play [1] in a single or multiplayer platform. Exergames have the potential to engage and motivate individuals in more physical activity as they offer an enjoyable experience that bridges exercise and the entertainment.. Larsen, Schou, Lund, & Langberg [9] listed Wii Fit, Wii Sports, Kinect games, Sony's EyeToy, Dance Dance Revolution as well-known exergames in academic literature. These games are particularly designed to motivate healthy young adults to engage in physical activity. The use of some of those exergames in the context of physical rehabilitation for older adults have also been investigated. For instance, Verdecchia et al. [3] used five Nintendo Wii platforms, including Wii Fit Plus, Wii Sport and Wii Play, to reduce the dizziness and perception of handicap in older adults diagnosed with chronic unilateral vestibular hypofunction. Others suggested that dance games are well received and are popular amongst older adults [13, 14]. Most of these exergaming setups are repurposed to accommodate a program for older adults but are not designed initially for older users.

### 1.1 Aim

In this paper, we report on work towards designing multiplayer exergames that motivate physical activity and support social relatedness within the context of a family. In such conditions, people's natural competencies flourish [16]. We recognize research in wellbeing psychology, and its increasing impact on the research in HCI often called Positive Computing [15]. We also acknowledge the frameworks provided in gaming literature in terms of context relevant and feasible design strategies. Some of these are discussed next and used later in a design workshop presented in this paper. Our aim with the workshop was to examine whether some of the suggestions in the literature can be used as a basis for conceptualising exergames specifically designed to be played by the whole family. In doing so, we follow a multi-disciplinary approach and bring in experts in fields of design, Human-Computer Interaction (HCI) and psychology, to create the link between the above-mentioned

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frameworks. To improve communications in such multi-disciplinary setting, we use design thinking techniques for brainstorming, prioritising ideas and ideations.

## 1.2 Diversity in Roles Amongst Game Players

To date, only a few number of exergames directly support inter-generational social relatedness in play environment. One example is *Age-Invaders* [4], where grandparents can play a computer game together with their grandchildren using a floor display platform. The game allows adjustment of game parameters such as response time and speed based on player's age. Various levels and types of social relatedness experience through game has been discussed in the literature before [6], that observed participation (described as physical and social interaction) in social videogaming between friends and family. Downs and colleagues identified three types of participation namely *player* (person actively interacting with the game), *audience* (person(s) in the vicinity of the player who watches or indirectly participates in the game) and *bystanders* (persons present in the vicinity of the player who do not engage in the game). They argue that acknowledging those roles are important considerations for game design, often ignored. Following the suggestion of Downs et al. [6], we recognise audience participants an important consideration for the new design directions for exergames.

## 1.3 Multiplayer Games

The gaming literature has highlighted the importance of multiplayer game modes. For instance, competitive exergames can enhance cognitive outcomes for adolescents [1]. Schmierbach et al. [12] showed through experimental evidence, that playing with (*cooperative*) or against (*competitive*) game partners enhances game enjoyment compared to playing alone. They linked the said enjoyment to providing a social context, amongst other reasons. Even more importantly, they suggested that an important condition for enjoying multiplayer game, especially in competitive settings, is pairing with a friendly partner towards whom the player has a positive attitude. It is reasonable to deduct then that playing an exergame would be enjoyable within the social context of a family. We consider this another important consideration in the new design directions for exergames discussed in the workshop presented in this paper.

## 1.4 Social Relatedness and Wellbeing

Research in psychology and wellbeing suggests that individuals greatly benefit from social interactions in their everyday life. Self-Determination Theory (SDT), for instance, describes wellbeing as a function of the extent to which three basic human needs are satisfied [16]. Those are autonomy (a sense of volition), competence (experience mastery), and social relatedness (connecting with others). In the context of everyday activities, Reis et al. [5] showed that fluctuations in day to day wellbeing is determined by the degree of basic needs' satisfaction. Therefore, it is naturally concluded that creating opportunities to foster social relatedness, as one of the three basic human needs, greatly contributes to wellbeing and quality of life in general. This is also an important consideration for the new design directions discussed in our workshop.

The above three considerations, i.e. recognising the role diversity particularly between the audience and the player(s), accommodating multiplayer game platforms, and enhancing social relatedness in the context of game, were then used in a design workshop reported next in this paper.

## 2 DESIGN WORKSHOP ON WELLBEING

We conducted a workshop on design for wellbeing. Within the workshop, a team of participants discussed ideas around exergames that support physical thriving in the context of family. The challenge was helping individuals in the family to engage in the game play as a socially dynamic group whilst recognising their sense of autonomy and volition as individuals. The results indicated several future design directions. Those initial design directions were further conceptualised into several design concepts for family oriented exergames. Note those are presented as examples of the new design directions. We do not aim to validate those concepts in this short paper nor do we believe the concepts are the only possible design outcomes. While testing the implications of previously discussed literature for design of exergames, we pursue to examine how a multi-disciplinary team of experts in the fields of HCI, design and psychology can work together to envision the future of exergames for families. To that end, the team used design thinking techniques for discussion and ideation.

### 2.2 The Workshop Setting

Researchers from two Australian universities participated in a day long workshop on design for wellbeing. The overall aim of the workshop was to promote an understanding of Human-Centred Design (HCD) methods in relation to research on technology strategy and discuss future directions for design for wellbeing. Through a series of presentations and group discussions, the workshop first created a shared understanding of HCD, design thinking techniques and design for wellbeing. A few design examples were discussed, then participants were assigned to teams and tasked with several challenges on design for physical thriving, indigenous thriving and education. In this paper, we report on the activities and design outcomes of the team that focused on enabling active lifestyle for individuals within a family.

### 2.3 The Workshop Activities

The team included one interaction designer, two HCI researchers and one psychologist. First, the participants shared their existing knowledge on determinants of motivation for physical activity and its benefits for social relatedness. Second, the team brainstormed on the following topic: '*exploring new directions for exergames for the whole family*'. Opportunities for using exergames to support physical activities in the family context, while writing down ideas on small notes. The group refrained from discussions during this part of the activity. The notes were then sorted and grouped together based on similarities in topics. Following a brief discussion, an affinity diagram was created with five directions for new exergame designs, as shown in Fig. 1.

Finally, the team used the affinity diagram as basis for ideating new design concepts, using the group passing technique. This involved each member taking the role of a designer and

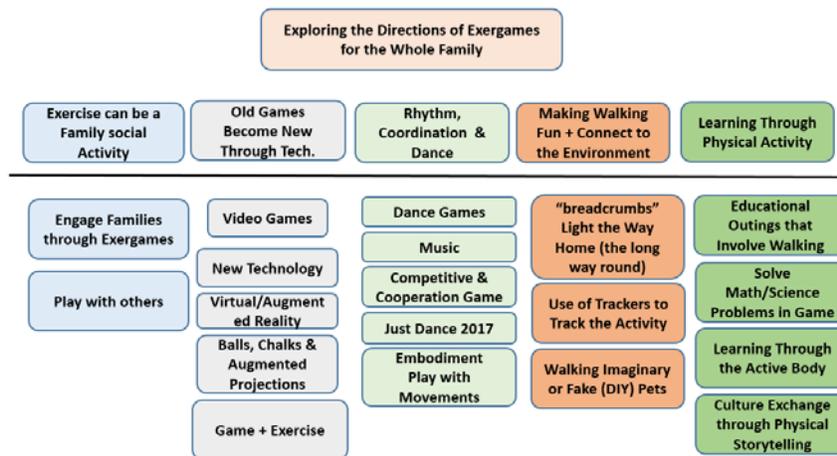


Figure 1. Affinity Diagram – Exploring the Exergames Design Directions

conceptualising a design solution using one or more of the five design directions. The technique required everyone annotating their idea through writing or sketching on a piece of paper, then passing it to the next person who would contribute to the existing idea by adding more details (e.g. features) to it. Once all papers were circulated, the team discussed the merits of each idea and merged those that were similar, resulting in three distinct design concepts.

In the next section, we describe the initial five design directions and the three exergames concepts that emerged to specifically target the family as a user group. As mentioned before, the concepts should be viewed as examples of future design directions rather than complete design outcomes.

### 3 NEW DESIGN DIRECTIONS

The affinity diagram highlighted five clusters as new design directions for exergames for families. Those are exercise as a family social activity (e.g. engage the family as a whole to complete activities together), re-purposing the old but familiar games through technology (e.g. using existing video games), rhythm and dance coordination (e.g. embodied play with movements), making walking fun through connecting to the environment (e.g. using activity trackers), and learning through physical activity (e.g. solving puzzles through active body).

#### 3.1 Design Concept 1: Mapping the Neighbourhood Trails

This idea is formed around making walking fun, exercise as a family social activity and using old and familiar game scenarios. The gamers are required to go outdoors and map an area such as the neighbourhood trails (Fig. 2 depicts a sketch from the workshop). The initial idea is similar to a treasure hunt game. Each evening, the family goes out for a walk to find the trail markers put down in a previous outing. The family is split into two teams to cooperate through specific tasks/roles:

- *Markers* (mark spots with special symbols with associated meanings)
- *Finders* (Take photos, geo-tag or clear the marks)

While navigating the trails, the *markers* and *finders* are expected to engage in physical activities such as walking, push ups or star jumps. Over time, the geo-tagging process will generate digital maps of the neighbourhood tagged with the trail markers, and which grows with each walk. Other potential features for improving player motivation include adding rewards/bonuses for doing extra physical activities during mapping. In addition, the ability to share the maps and activity scores with family and friends on social media might generate ripple effect to encourage others to join the game. This design encourages the whole family to be physically active together, be connected and collaborative. The design combines traditional games such as treasure hunt with technology. Finally, the mapping activity implicitly enables inter-generational interaction in the context of family.

#### 3.2 Design Concept 2: A Virtual Reality Dance and Music Exergame

Entertainment and fun are central to this exergame design concept, which aims to engage the individuals in a family, in coordinated movements. The concept employs Virtual Reality (VR) technology in a multi-player game with two modes as follows:

- *Competitive Mode*: engaging younger individuals to play against the senior members of the family.
- *Cooperative Mode*: engaging two mixed group (parent and children) in the game context.

Both modes of the game use music and dance for coordinated rhythmic movements. For young players, the game offers a higher level of physical challenge similar to Just Dance 2017 [18]. In comparison, senior members of the family (parent, grandparents) can participate in the play session that matches their physical and technical capabilities. The players use musical instruments similar to Happy Drummer VR [10] and Drummer Talent VR [17]. Other potential features include gauging intensity and challenge levels in the game. For instance, the VR-display can present snake-like rhythms and depending on the intensity, various muscles are engaged in the movement. Challenge levels may be incorporated into different game stages whereby game bonuses unlock music instruments. The design emphasises competition, cooperation and relatedness among the

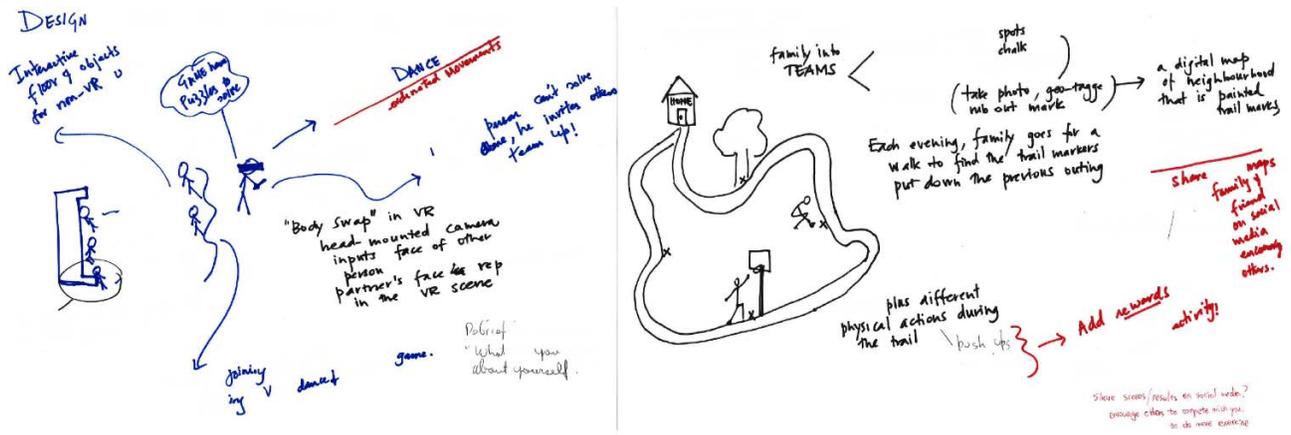


Figure 2. A Pictorial View of Design Concepts I (right) and III (left)

players, building up on family bonds and intergenerational relationships.

**3.3 Design Concept 3: A Game for Family in Lounge**

This design combines interactive floor and VR technology, offering an entertaining exergaming experience to everyone in the family and providing learning through physical activity. Two types of players are involved in this game: the *VR-player*, plays in an immersive VR mode wearing a headset, while receiving help and/or encouragement from *non-VR players*. Fig. 2 depicts a sketch of the game from the design workshop. The VR Player is tasked with solving a puzzle to unlock game challenges. If they fail, they can then invite non-VR player(s) to assist with the puzzle. The non-VR player is considered an audience player and can choose if/when they want to join the VR-player. Upon unlocking the puzzles, music is played to encourage non-VR players to dance on the interactive floor. Overall, the VR- and non-VR players cooperate in both solving the puzzle and dancing with music to enhance social interactions. Other potential features of the game may involve non-VR players judging the game, narrating the activity for VR players or performing a *Body Swap* during dance. This design is particularly encouraging of individuals who do not consider themselves *gamers* or have not played video games before.

**4 DESCUSSION AND CONCLUSION**

**4.1 Lessons Learned for Future Work**

Several lessons were learned from the design workshop presented in this paper. First, we found great advantage in organising a multi-disciplinary design workshop, where researchers from different backgrounds were brought together, to explore the new directions in designing exergames for the whole family. Through workshop activities, the participants shared knowledge about physical activity, wellbeing and exergame design which resulted in producing a much-needed link between fields of psychology, design and HCI. Second, the design thinking techniques employed in the workshop helped us establish clear goals for several new design directions and subsequently ideating design concepts. We found Design Thinking techniques such as creating an affinity diagram and

group passing technique for brainstorming particularly helpful in facilitating communication within a multi-disciplinary group of participants with different expertise. Finally, we found the theories and models in wellbeing psychology provide further directions for some of the frameworks currently available in the game literature. The later are more situated in HCI while the former describe the impact and effects of interventions such as exergames on social dynamics and individual behaviour. We draw from our experience in immersive exergames [7,8] that such multi-disciplinary design efforts are critical to successful adoption of exergame technology for wellbeing and behaviour change.

**Table 1: Summary of Co-Play Mode of the Design Concepts**

Exergame Design Concept	Competitive	Cooperative	Age Diversity
1		X	X
2	X	X	X
3		X	X

**4.2 Design Implications**

To test the design implications of the findings in this paper, we particularly consider prototyping and evaluating the effectiveness of the proposed concepts. Follow up evaluations with families would reveal the potential impact of these concepts on social relatedness (e.g. bridging intergenerational gaps) and physical activity. As shown in Table 1, all three design concepts aim to engage a diversely aged group of users, treating the whole family as the target user group. All three design concepts include cooperative multiplayer mode and one includes a competitive mode in addition.

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