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Extended abstract

Designing Digitally-Augmented Feedback for Physical Education

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1 Introduction

Active participation in physical activity (PA) is beneficial for teenagers' physical and mental development [1]. Moreover, it can also prevent childhood obesity and cardiovascular diseases [2]. However, extensive studies have shown that most adolescents (12-15 years) tend to drop out from regular PA [3,4], partly due to lack of interests [4].

Physical Education (PE) is an essential setting for adolescents to participate, learn skills [5], and develop interests towards PA [6]. Previous studies have suggested fun, enjoyment [7] and social relationship [8] as the primary motivational factors for teenagers' PA participation [9,10]. In PE, playfulness and social interaction are also seen as meaningful experiences [11] and thus become educational goals that go beyond teaching students' motor skills [12]. Thus, our research investigates the design of playful and social experiences in PE context to enhance the motivation of adolescents to be physically active.

In the field of human-computer interaction (HCI), many researchers have explored designing digitally augmented feedback (DAF) to promote adolescents' PA playfully and socially. For instance, Hitron et al. [13] developed tangible Scratch Nodes which provides a pair of players real-time LED light feedback during outdoor play. Delden et al. [14] augmented several virtual effects on a physical play space in the traditional group tag game. These researches have shown that using DAF could stimulate multisensory experiences and improving the performance of players. However, to our knowledge, few studies have explored the design approach and evaluated the effects of DAF on adolescents' PA in PE context.

In our research, we follow the approach of research-through-design [15] where the theoretical analyses, design practices, and evaluations are performed iteratively. Our research questions are: 1) How to design DAF to enrich and enhance adolescents' playful and social experiences in PE context? 2) To what extent could the playful and social experiences from DAF facilitate PE?

2 Previous Work and Findings

2.1 Explore the Effects of Audio-augmented Feedback

In our first explorative study, we designed and evaluated *Shuttlezap* [16,17], a cooperative tangible play object that provides real-time playful audio feedback based on user's performance and behaviors (see Figure 1). By following the research through design approach, the design of *Shuttlezap* was iterated with behavior pattern observation, video-based mock-up, and expert interviews. The final design was evaluated in a within-subject field study with 20 teenagers (Heerbeeck College, Best, the Netherlands) to investigate the effects of augmented audio feedback. Results showed the playful audio feedback could increase playfulness in terms of perceived *relaxation* and *expression*. We also summarized qualitative findings such as teenagers enjoying playful audio feedback because it is enjoyable and immersive; interactive and explorative. They felt more socially engaged due to it breaking the silence and providing a joyful atmosphere; stimulating interactions and promoting team climate. Their perceived competence is enhanced for it motivating active participation and competitiveness, providing guidance and feedback.

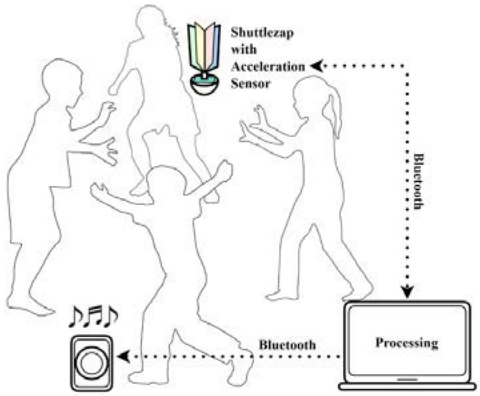

Figure 1. System structure of *Shuttlezap* [16].

2.2 Identify a Design Approach of DAF for Teenagers' PA

In the first explorative study, we saw the potential of audio-augmented feedback in enhancing teenagers' motivation for PA. To further explore the design approaches about DAF for teenagers' PA, we conducted a systematic literature review [18], which analyzed 25 studies about the design and evaluation of technology-supported interventions for promoting adolescents' PA. This review 1) illustrates a design diagram with four design phases to give an overview of the design knowledge through the process. 2) provides a theoretical framework with seven design requirements (see Figure 2) to inform future designs in the field. 3) makes recommendations that can support design decision making for future design research in the HCI domain.

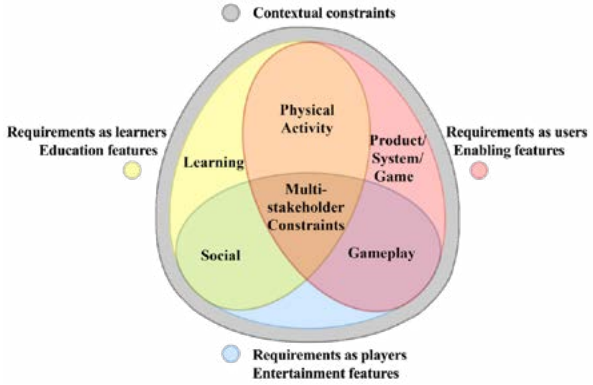

Figure 2. Framework of design requirements from adolescents' triple roles [18].

3 Current Status and Future Work

3.1 Understanding Users' Experiences and Identify the Design Opportunities for DAF

The framework from our review study suggests investigating design requirements from multiple perspectives and in a specific context. Therefore currently, we are carrying out one-on-one semi-structured interviews with 16 adolescents and 4 PE teachers (Heerbeeck College, Best, the Netherlands) in their real context of PE class. This user-context study is focused on 1) gaining a better understanding of adolescents' experiences, special needs, and PE teachers' requirements on giving and receiving feedback in PE context. 2) investigating users' acceptance of PA related technology. 3) identifying design opportunities and recommendations on introducing DAF into PE. Two coders are analyzing the qualitative data through a thematic analysis approach [19], and the results will be published later.

3.2 Future Work

In the future, we plan to organize three co-design workshops to generate, optimize, and refine a DAF design concept which focuses on the feedback of PA related physiology data in a PE context. The first workshop

focuses on eliciting adolescents' playful and social requirements on DAF and creating design concepts. In the second workshop, the designers will discuss the generated concepts with PE teachers and PE experts to position their educational requirements. The last workshop will focus on synthesizing and balancing stakeholders' requirements based on the previous requirements framework (see Figure 2). Designers from multidiscipline will be invited, such as backgrounds in child development, education, vitality, and data visualization.

The final concept from these co-design workshops will be developed and evaluated in two field studies. The first comparative study aims to examine the short-term effects of DAF on users' playful and social experiences. Moreover, the second longitudinal evaluation aims to investigate the long-term effect of DAF on users' motivation and engagement with PA.

4 Conclusions

This design research explores the design of DAF for motivating adolescents' PA participation in PE context through enriched and enhanced playful and social experiences. In the literature review, we investigated the design approach for DAF in teenagers' PA and provided theoretical knowledge on the design practice. Then we contextually interviewed adolescents, PE teachers, and PE experts to clarify design requirements and conducted three co-design workshops to generate the design concepts on the feedback of PA related physiology data. In future research, the co-created design concept will be developed and evaluated in the in-situ field study to investigate the short-term and long-term effects of DAF on user experiences and engagement with PE.

References

1. Humphrey, J.H. *Child development through sports*. The Haworth Press: New York, USA, 2003; pp. 65-72.
2. Strong, W.B.; Dishman, R.K.; Pivarnik, J.M. Evidence based physical activity for school-age youth, *J. Pediatr*. 2005**,** *vol. 146*, no. 6, pp. 732–737.
3. Sallis, J.F.; Prochaska, J.D.; Taylor, W.C. A review of correlates of physical activity of children and adolescents. *Med. Sci. Sport. Exerc.* 2000, *vol. 32,* no. 5, pp. 963–975.
4. Crane, J. and Temple, V. A systematic review of dropout from organized sport among children and youth, *Eur. Phys. Educ. Rev.* 2015, *vol. 21*, no. 1, pp. 114–131.
5. Hardman, K. Current situation and prospects for physical education in the European Union. European Parliament: Brussels, 2007; pp. 27-28.
6. Capel, S. *Learning to Teach Physical Education in the Secondary School: A Companion to School Experience,* 2nd ed.; RoutledgeFalmer: New York, USA, 2004; pp. 18-30.
7. Allender, S.; Cowburn, G.; Foster, C. Understanding participation in sport and physical activity among children and adults: A review of qualitative studies, *Health Educ. Res*. 2006, *vol. 21*, no. 6, pp. 826–835.
8. Macphail, A.; Gorely, T.; Kirk, D. Young people's socialisation into sport: A case study of an athletics club. *Sport. Educ. Soc.* 2003, *vol. 8*, no. 2, pp. 251–267.
9. Weiss, M.R. Back to the Future: Research Trends in Youth Motivation and Physical Activity. *Pediatr exerc sci.* 2013, vol, 25, no. 4, pp. 561–572.
10. Van Der Horst, K.; Paw, M. J. C. A.; Twisk, J. W. R.; Van Mechelen, W. A brief review on correlates of physical activity and sedentariness in youth, *Med. Sci. Sports Exerc.* 2007*, vol. 39, no. 8*, pp. 1241–1250.
11. Beni, S.; Fletcher, T.; Ní Chróinín, D. Meaningful Experiences in Physical Education and Youth Sport: A Review of the Literature. *Quest*. 2017, *vol. 69, no. 3,* pp. 291–312.
12. Borghouts, L. B.; Slingerland, M.; Haerens, L. Physical Education and Sport Pedagogy Assessment quality and practices in secondary PE in the Netherlands. *Phys. Educ. Sport Pedagog.* 2016, *vol. 22, no. 5*, pp. 1–18.
13. Hitron, T. et al. Digital Outdoor Play: Benefits and Risks from an Interaction Design Perspective. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems, April 21, pp. 1–13, 2018.
14. Van Delden, R.; Moreno, A.; Poppe, R.; Reidsma, D.; Heylen, D. A Thing of Beauty: Steering Behavior in an Interactive Playground. Proc. 2017 CHI Conf. Hum. Factors Comput. Syst.-CHI '17, pp. 2462–2472, 2017.
15. Zimmerman, J.; Forlizzi, J.; Evenson, S. Research through design as a method for interaction design research in HCI. Proc. SIGCHI Conf. Hum. factors Comput. Syst.- CHI '07, pp. 493, 2007.
16. Ma, Y.; Bekker, T.; Ren, X.; Hu, J. Vos, S. Effects of Playful Audio Augmentation on Teenagers' Motivations in Cooperative Physical Play, In Proceedings of the 17th ACM Conference on Interaction Design and Children. ACM 2018; pp. 43-54.
17. Ren, X.; Ma, Y.; Lu, Y.; Brombacher, A. ShuttleKicker +: Designing Gamified Sonification to Augment the Physical Leisure Activity. Extended abstracts publication of the annual symposium on computer-human interaction in play. ACM, 2017; pp. 471-478
18. Ma, Y.; Veldhuis, A.; Bekker, T.; Hu, J.; Vos, S. A Review of Design Interventions for Promoting Adolescents' Physical Activity, In Proceedings of the 18th ACM Conference on Interaction Design and Children. ACM 2019; pp. 161–172.
19. Braun, V. Clarke, V. Using thematic analysis in psychology. *Qual. Res. Psychol.* 2006, *vol. 3, no. 2*, pp. 77–101.