Designing for Bouldering: Supporting Kinesthetic Learning of Action Sport Enthusiasts

Hakan, Yılmazer
Koç University-Arçelik Research Center for Creative Industries, İstanbul, Turkey
hyilmazer18@ku.edu.tr

Florian, 'Floyd', Mueller
Exertion Games Lab, RMIT University, Melbourne, Australia
floyd@exertiongameslab.org

Aykut, Coşkun
Koç University-Arçelik Research Center for Creative Industries, İstanbul, Turkey
aykutcoskun@ku.edu.tr

ABSTRACT

In recent years, there have been increased attention from HCI research towards action sports. Results of these studies are mainly artifacts with a focused view on performance and technology. It is argued that an approach focusing on the unique interaction possibilities between users' physicality, users' cognitive processes and environment is still missing in the field. Whilst some previous work outlined these unique interaction possibilities, such as mental and emotional load from various action sports and how these translate to users' learning processes, dedicated works for understanding user needs and addressing them are lacking. During my PhD, I'm focus on bouldering, a branch of rock climbing. Using a RtD approach, I'll be looking into learning processes of novices. User insights and I aim to address cases of bodily learning in action sports, which is very important in terms of understanding the users and having long-term impact on their practices.

CCS CONCEPTS

• **Human-centered computing** → Interaction design; Interaction design process and methods; Interaction design; Interaction design process and methods; Interface design prototyping.

KEYWORDS

Bodily Interactions, Climbing, Co-design, Action Sports

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1 FRAME OF RESEARCH

Sports-HCI has been around a while, however, when it comes to action sports has been gathering research only very recently in the HCI community. Works, and outlining choices taken by users, on how and why they pursue these activities [30, 31], or unique interactions occurring around these activities [11] showed the potential broader impact of findings from action sports research on interaction design field. Focusing on bouldering sport, a branch of climbing, I've looked into how these mental and emotional impacts transform as a climber gains experience, and how they can be dynamically addressed by HCI artifacts.

These mental and emotional loads encompass a wide range, from perceived difficulty in learning processes, to user experience in success and failure scenarios. Problem that I aim to focus is, the mental and emotional impact of these sports on novice sportspeople, have been tied to various aspects influencing the sportspeople's performance, such as motivation, flow, and perceived difficulty [33]. The choice of novices as a user group is based on the variable magnitude of these mental and emotional aspects. As a person gets better at an action sport, importance, and impact of each one of these aspects fluctuate. For example, fear of falling from the top of a route can get lower as an experienced climber has many failures and falls under their belt, or a novice may disregard cool-off periods between each climb due to high flow "climb-fever", causing muscle strain that requires a few days rest period to heal, causing loss of motivation. Whilst some of these factors are well-known in climbing community, they aren't reflected in academia.

2 BACKGROUND AND RELATED WORK

In my PhD study, I've been reviewing works from Sports-HCI, with a focus on 2 of its branches; action sports, and learning in sports. Following their findings, we identified that the works aligned to physical performance provide important insights for tracking or interacting with users, yet broader impact of the solutions like how it affects the social or post-activity aspects of the sport were lacking.

2.1 General Frame of Works

Whilst how these "equipment enhancements" impact sports, in terms of entertainment, social acceptability and sports authorities' perspectives have been in the scope of HCI since early works in the field [1, 2, 4–6], more and more works outlined the limited frame taken to address these [25, 37, 38]. Following on studies showing importance of framing whole experience [16], for example how technological interventions for these activities affect sportspeople's daily lives [42] or how sportspeople take initiative in appropriating their wearables for individual needs [35], we can observe a research interest pointed at understanding sportspeople.

2.2 Learning and Guidance

Most of the artifacts in sports-HCI, aimed towards bridging this gap in learning processes [12, 14], focuses on using visual cues for physical aspect of the sport [20, 21, 36, 41]. These works can also be segmented under many fields, such as direct-visualizations [19],

post-action analysis systems [22] or in-situ guidance [17]. This is more of a blanket approach coming from interaction design literature, which is critiqued in other fields too [7], focusing on the advantages of graphical user interfaces in environmental settings. As a counter-point, internal influencers present a wider field of research to the intrinsic nature of them. In terms of learning processes of the action sports, the physical and mental strain can have detrimental effects on learning both during and after sport. Especially in the high-risk level sports, such as mountain climbing, weight of decisions with high-risk situations, can further increase this mental strain [8, 9]. To address this internal and more personal part of learning, there are many studies that illustrate the advantages and importance of other feedback modalities such as sound and touch [15, 27, 28, 34].

2.3 Climbing and Bouldering

Being an extremely physical and mental sport [23, 26, 29], each unique climb or each re-try on a route helps boulderers get more knowledge about themselves and environment. Looking at this process as a bodily learning, we can identify external and internal factors. For the external part, one of the important points in learning is the source of knowledge. This can be an individual tutoring the user from their personal experience, or a written source of knowledge. Whilst the range of these written knowledge sources is astonishing, they are critiqued by research to be lacking, as they couldn't encompass the full width of the personal and embodied learning experience in action sports [3].

Specific to climbing case, this approach mainly manifests as smart walls or projection systems. For the smart walls, examples include Digiwall [24], which enhance climbing holds on the walls to be both input and output systems. Using these holds, they explore the gamified aspects of climbing, from both motivation and performance aspects. Another branch in focusing on the interaction with the wall environment are the works that use projected systems. Examples of these, such as BouldAR [10], Betacube [41] and ClimbVis [21], use various tracking systems to get create visual representations on the walls. These visualizations range from projected climbs of previous climbers, preset climb animations of planned climb moves to games constructed on climbing wall.

Apart from the wall environment, researchers also focused on equipment used in climbing sport for analyzing climbers and giving feedback. These include embedded IMU sensors to the climbing harnesses Tonoli et al. [39] or in equipment used for safety Ivanova, et al. [18]. An extension to these is external devices specifically designed to track climbers. One of the early examples of such systems is ClimBSN [32], using a single IMU sensor to measure body movements of climbers and detect the performance of climbers. Similarly, ClimbAX [22], system was able to assess a climber's performance under 4 metrics: power, control, stability, and speed. Subsequently, Kosmalla et al. [20] designed and implemented ClimbSense, using the same wristworn logic of previous work, but focusing on climbs and routes. Their system also allowed climbers to compare their performance between other climbers and their previous climbs. ClimbingAssist [13] took this one step forward by using tactile feedback mechanisms on climber's shoes for providing feedback on climber's performance. Another unique work using wearable systems is the work of Mencarini et al. [26] focusing on communication between climbing partners. They explored importance of support and partnership in climbing and used co-design approach to gather insights from climbers and finding unique design opportunities is exemplar in terms of interaction design perspective.

2.4 Research Questions

In this Ph.D. study, my aim will be aiding learning processes in bouldering through designing and studying interactive artifacts. Following my main question; **How can we design for supporting kinesthetic learning of novice boulderers through interaction design?** I'll explore the embodied learning experience of climbers, to pinpoint hardships and opportunities for interaction design to create solutions for them. My sub questions in this study will be:

- What would the expectations of novice climbers be from technologies that support their learning needs?
- What are the design opportunities in bouldering sport for supporting climbers learning needs, from the scope of interaction design?
- How can we design support systems that focus on mental hardships arising from failure during learning in bouldering?
- How do our design concept(s) influence users' learning experience during mentally challenging scenarios?

3 RESEARCH GOALS AND PROPOSED METHODS

In the literature, there are many alternative solutions; using a variety of approaches to identify gaps and supporting experiences of action sports practitioners. These works set the base for expanding the design space by providing important user insights and considerations for future researchers. However, the technocentric and performance-based approach adopted by them is lacking to fully grasp sports people's needs. Even in the frame of wearable devices, investigation of preferences for real-time feedback of sportspeople, in terms of modality, usability and placement, comes secondary to addressing the quantitative metrics. It has been aptly expressed as the artifacts in HCI research has been investigated with premeditated intent to use [26].

Thus, we need to get a deeper understanding of users and their needs to create artifacts with lasting use and impact in their use. With these motivations that we stated above, my PhD study will explore the expectations of novice climbers from technologies that support their learning needs, and how design can support these needs from an interaction point of view. In my overall study, we'll be relying on participatory and design inquiry methods for our design research process. Following this purpose, I'll have 4 major steps in my PhD journey. Firstly, collection of user insights is my starting point to fulfill the gap on understanding sportspeople's needs. I've conducted co-design workshops with climbers and designers, using perspective taking and ideation. These workshops were aimed to get deep insights from novice climbers [40]. Putting designers in users' shoes and allowing them to experience users' sensations first-hand, was aimed to achieve empathic design, which emerges

when designers are able to grasp what is involved in the felt experience of user's lives and what is like to be in a situation from their perspective [1]. Our supportive methods like interviews, focus groups with novice climbers and designers aim at further defining the design space around the learning experiences in climbing and embodied learning.

In the 2nd and 3rd part I'll conduct design workshops and user experience studies based on my prototypes, aligned with the design inquiry approach. I'll be following up my controlled user studies within the wild studies of my concept to understand how well it can get integrated into the existing practices of climbers. Finally, I will explore how the knowledge collected from our workshops and design processes can support HCI practitioners and researchers when designing to support learning experiences in climbing sports, thus making the final step of my PhD journey.

4 RESEARCH SITUATION

I'm currently a 3rd year PhD candidate from Koç University, Turkey. Using my previous knowledge from Product Design, I've been working in this topic, designing for bouldering, for a year. Due to my product design background, I've been focusing on the user and design aspects of my field. Using design methodologies, such as co-design and journey maps, I've been making workshops and gathering insights on how we can address the needs of boulderers. My qualification exam was also focused on the insights I've gathered and design research directions I've identified to focus my future research. Currently, I'm in the progress of designing my initial research artefact, based on the insights I've gathered from my previous studies. Using that artefact as a base, I'll be further exploring how HCI research can support action sport enthusiasts, mainly boulderers, in their learning processes. Thus, I hope to get feedback on both my previous findings and my ideation results derived from them. This will help me refine my design artifact and continue up with my user experience studies.

So far, results of my initial user studies have been submitted as a full paper in DRS 2022. Findings outlined in that paper, on bodily awareness of climbers, community aspect of the sport and how failure impacts sportspeople, are being refined with supplementary workshops and have become the grounds of the design ideas I'm generating.

5 EXPECTED OUTCOMES

Expected outcomes of my Ph.D. process will be an accumulation of all the findings, to create a set of guidelines for helping HCI researchers for gathering insights and evaluating design research artifacts that support learning processes of sportspeople. They'll be formalized to be adjustable and applicable to other action sports for future implications. We are aiming to put these outcomes in 3 categories;

- A design framework, consisting of user insights and design opportunities, defining the design space for sports-HCI researchers working in learning processes in action sports.
- A design artifact for supporting novice climbers mentally and emotionally during their learning processes.
- Design considerations for designing support systems for learning in sports.

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A APPENDICES

A.1 Climbing Terms

Embodied learning - Embodied learning focuses on aspects of learning apart from the cognitive side. These are generally named as body and emotion behind learning. Especially for topics that are not simply mental concepts, like how to do a swim stroke in comparison to multiplication tables, it is crucial to have practice and application-based learning rather than theoretical. Thus, involvement of the person with their other bodily functions makes up embodied learning. This can be either the main aspect of learning a topic or a supportive element for cognitive learning.

Climbing holds - Any place to temporarily cling, pinch, grip, jam, press, or stand in the process of climbing. Holds are named after the moves or interactions with them and climbers' hands or feet.

Beta - The umbrella term used for information about a climb. It can range from a small hint about a difficult section to a step-by-step instruction of the entire climb. Step-by-step instructions that are made while a route is being made (for indoor climbing) are also called "intended beta" and can be documented as drawing or even video, in the form of a beta-map. E.g., A beta-video from International Federation of Sport Climbing route setters (Neumann, 2018)

IMU - Also known as inertial measurement unit, is a sensor that reports the forces acting upon a body by measuring acceleration and orientation. They are used in many fields for tracking changes in position of a body.

Belaying & Belayer - Belaying is the action of using safety devices to control descent, fall or intentionally going down, of a person. Belay devices can work in various ways, mostly being attached to a rope that is connected to the climber on one end, in a manner to suspend the climber in air in case of an unexpected fall. Belayer is the name given to the person operating the belay device, they can be an external person or the climber themselves.