Complicated, by Design: The Dynamic Use of a User-Centred Design Process

by

Ioana Visescu

Dissertation submitted to the School of Computer Science
at Reykjavík University in partial fulfillment
of the requirements for the degree of

Doctor of Philosophy

7th of March, 2025

Supervisors:	Marta Kristín Lárusdóttir, Professor, Reykjavik University
	Anna Sigríður Islind, Associate Professor, Reykjavík University
Examining Board:	Janet Read, Professor, University of Central Lancashire
	Sofia Ouhbi, Associate professor, Uppsala University
	Stefán Ólafsson, Assistant Professor, Reykjavik University
Examiner:	Torkil Clemmensen, Professor, Copenhagen Business School

ISBN 978-9935-539-68-7 Print version
ISBN 978-9935-539-69-4 Electronic version
ORCID 0000-0002-5304-9006

Complicated, by Design: The Dynamic Use of a User-Centred Design Process

Ioana Visescu

March 7th, 2025

Abstract

Software design, as a dynamic and context-dependent practice, plays a crucial role in addressing the evolving challenges of software development. It requires continuous adaptation to technological advancements and changing user expectations, making ideation and problem-framing vital for successful outcomes. User-Centred Design (UCD) is a foundational methodology prioritising user needs and iterative feedback, recognised as a potential avenue to achieving human-centred software solutions. However, the practical implementation of UCD faces challenges, particularly in educational settings where guidance for students is often insufficient, and the need for structure and scaffolding is dire. This discrepancy is compounded by the diverse needs of practitioners and the constraints of real-world environments, such as time, resources, and organisational goals, which can hinder the application of structured UCD processes. As software design challenges become more complex, the need for flexible, yet structured software design processes that balance detailed guidance with adaptability becomes more pronounced.

This thesis explores the application of a structured UCD process called the UCD Sprint, that aims to support the needs of both students and practitioners in navigating these complexities effectively while maintaining alignment with user needs. Through five key papers, the research explores how the UCD Sprint can address the challenges faced by practitioners and students. Key findings include identifying limitations in current UCD practices, such as time constraints, insufficient managerial support, and conflicting stakeholder priorities, highlighting the flexibility required for practitioners to adapt UCD processes to unique project needs while ensuring that these processes remain efficient and scalable across various contexts.

A significant focus of the thesis is on students, while learning to conduct UCD activities in the early stages of software development. The findings show that the structure offered through the UCD Sprint proves effective in addressing the needs of students learning UCD. The UCD Sprint provides essential scaffolding, aiding students in developing critical skills like problem framing and avoiding premature fixation on solutions. Feedback from classroom integration of the UCD Sprint shows positive outcomes, including improved comfort with core UCD activities. The structured process can bring value through bridging the gap between theoretical knowledge and practical application, thus demonstrating the importance of scaffolding in supporting students.

The theoretical and practical implications of this thesis emphasise the need for adaptability, and context-sensitivity when aiming to cater to the specific needs of practitioners, and the role of UCD processes in this environment. Furthermore, the findings show the importance of breaking down complex projects into manageable components and exposing students to a variety of UCD activities to ensure a comprehensive understanding of the process. Ultimately, this thesis contributes to the knowledge of the needs of practitioners and students, but also to the knowledge of the development of UCD processes.
Keywords: User-Centred Design, Design Process, Design Practice, Higher Education

Acknowledgements

To the village I left behind, and the village that pushed me forward. The village that supports me and makes me who I am. Because I carry within me a piece of every village I have ever been part of - with pride, with love, and with so much gratitude. To the village I grew up in, the village that raised me, and the home I built in every one of you who found place for me.

Și mamei mele, care nu a ridicat niciodată garduri inaintea educației copiilor ei.

This PhD project was partly supported by the AFA, research grant number 180250.

Publications List

Publications Included in the Thesis

Publication I

I. Visescu, M. Lárusdóttir, and W. Choi, "Exploration of UCD Practice Limitations," Interacting with Computers, Oct. 2024, doi: https://doi.org/10.1093/iwc/iwae046

Publication II

M. K. Larusdottir, R. Lanzilotti, A. Piccinno, **I. Visescu**, and M. F. Costabile, "UCD Sprint: A Fast Process to Involve Users in the Design Practices of Software Companies" International Journal of Human-Computer Interaction, pp. 1–18, Nov. 2023, doi: https://doi.org/10.1080/10447318.2023.2279816

Publication III

I. Visescu, M. Larusdottir, and A. S. Islind, "Supporting Active Learning in STEM Higher Education Through the User-Centred Design Sprint," in 2023 IEEE Frontiers in Education Conference (FIE), IEEE, Oct. 2023, pp. 1–10. doi: https://doi.org/10.1109/fie58773.2023.10342978

Publication IV

I. Visescu, M. Lárusdóttir , and A. S. Islind, "Exposure to User-Centred Design Activities: Experiences in Higher Education", *Paper accepted for publication at* IEEE Global Engineering Education Conference (EDUCON), IEEE, Apr. 2025

Publication V

G. C. Natucci*, **I. Visescu*** [1], M. K. Larusdottir, M. A. F. Borges, and A. S. Islind, "Experience-Driven Game Design: A Process for Game Design Focused on Affective Outcomes", *Submitted to* Proceedings of ACM on Human Computer Interaction (HCI) (CHI PLAY '25), *(Under Review)*

Other Publications by Author

I. Visescu, L. Johannsdottir, and A. S. Islind, "Whistling in the Dark: Inability to Recognise Dark Patterns and Lack of Concern Amongst Teenagers", in Proceedings of the Italian Chapter of AIS (Association for Information Systems), AISel, 2024

C. Carpinelli, **I. Visescu**, A. S. Islind, et al., "Digital Nudging Towards Sustainability: Exploring Strategies to Encourage Greener Choices Among Adolescent Girls", in Proceedings of the Italian Chapter of AIS (Association for Information Systems), 2024

Courses, Workshops, Demos, and Extended Abstracts

M. K. Larusdottir, V. Roto, and **I. Visescu**, "Kokemux: Step- by-Step UX Design Process", in NordiCHI '24 Adjunct: Adjunct Proceedings of the 2024 Nordic Conference on Human-Computer Interaction, Sep. 2024, pp. 1–2. doi: https://doi.org/10.1145/3677045.3685448.

[1]*These authors contributed equally to this work

I. Visescu, M. Larusdottir, and A. S. Islind, “User-Centred Design: Experiences from Toolbox-Based Learning”, in HCSE 2024: Lecture Notes in Computer Science, Springer Science+Business Media, Jun. 2024, pp. 233–240. doi: https://doi.org/10.1007/978-3-031-64576-1_14

M. Larusdottir, V. Roto, R. Lanzilotti, **I. Visescu**, “The UCD Sprint: Bringing Users Along to Sprint”, in INTERACT 2023: Lecture Notes in Computer Science, Springer Science+Business Media, Jan. 2023, pp. 259–263. doi: https://doi.org/10.1007/978-3-031- 42293-5_19

M. Larusdottir, V. Roto, R. Lanzilotti, **I. Visescu**, “The UCD Sprint: A Process for User-Centered Innovation”, in Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems, Apr. 2023. doi: https://doi.org/10.1145/3544549.3574176

M. K. Larusdottir, V. Roto, R. Lanzilotti, **I. Visescu**, “Tutorial on UCD Sprint: Inclusive Process for Concept Design”, in Adjunct Proceed- ings of the 2022 Nordic Human-Computer Interaction Conference, Oct. 2022. doi: https://doi.org/10.1145/3547522.3558901

I. Visescu, A. Blindu, U. Radhakrishnan, et al., “Teaching Project Management in a Virtual Environment: The Virtual Scrum Simulator (ScrumSim)”, in NordiCHI ’22 Adjunct: Adjunct Proceedings of the 2022 Nordic Human-Computer Interaction Conference, Oct. 2022. doi: https://doi.org/10.1145/3547522.3547717

List of Tables

List of Figures

Contents

Chapter 1

Introduction

Software design is cultural and context-dependent [1]–[3], it influences the world, and the world influences it back. Fundamentally, it is a way of thinking and problem-solving that has increasingly become recognised as crucial for innovation and addressing the world's challenges [4].

Software design has evolved to focus on how software systems can enhance human lives and abilities [5], influencing lives for better [6] or for worse [7]. This further positions software design as a complex problem-solving practice. To navigate this complexity, ideation and problem framing become crucial [8], [9].

Many approaches and processes have evolved for conducting software design. In their research, Sanders and Stappers [11] present a two-dimensional matrix to outline the map of design practice and research, providing a framework that encapsulates some of the varied approaches and perspectives present, further discussed by Sanders [10], and illustrated in Figure 1.1. The matrix maps design research across two dimensions: approach (Research-Led vs. Design-Led) and mindset (Expert Mindset vs. Participatory Mindset).

This thesis explores a software design process from User-Centred Design (UCD) [12]. UCD positions itself predominantly at the intersection of Research-Led and Expert-Mindset. As shown on the map, UCD serves as an umbrella term encompassing various methods and approaches, leading to variations in its definition [10]. At its core, UCD is a foundational design approach, that prioritises user needs, goals, and behaviours. Initially conceptu-

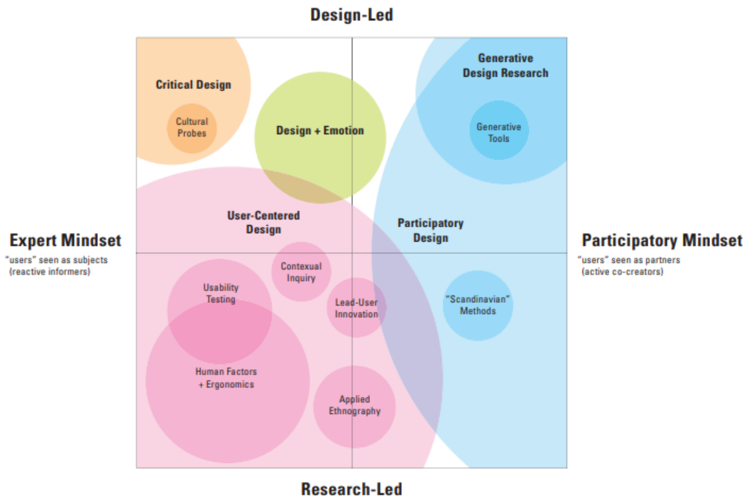

Figure 1.1: Map of Design Practice and Design Research, Source [10]

alised in the 1970s, it gained prominence from the second half of the 1980s, through work by Donald Norman and Stephen Draper [12]. UCD was formalised in the ISO standards such as ISO 13407 [13] and ISO 9241-210 [14], and it provides a framework that centres the software design activities around user tasks, contexts, and feedback, promoting iteration in order to meet user needs [14].

UCD has evolved and matured alongside new challenges. The existing principles for UCD, notably those outlined in the ISO 9241-210 [14] emphasise iteration and continuous user feedback. However, while UCD is conceptually appealing, implementing it as a practical, adaptable, and consistent methodology across various contexts and project scopes presents significant challenges, revealing gaps between UCD theory and its practical application [15]–[17]. This is partially due to the wide variety of activities performed [17].

To address some of these challenges, UCD processes can be essential, creating systems that respond effectively to complex, dynamic user requirements. Processes can offer structure and flexibility, linking together series of activities. The 2010 ISO

9241-210 [18] suggests a UCD process must be abstract and iterative. It should encompass stages known under a variety of names, from divergence, transformation, convergence [19], to discover, define, develop, deliver [20], offering guidance through exploration, ideation, and refinement. These stages and the activities within them are integral to understanding user needs, generating innovative solutions, and evaluating design outcomes.

UCD processes may further facilitate collaboration and maintain consistency, especially in multidisciplinary teams where stakeholders may have varying priorities or communication issues, as processes can offer a shared language and set of practices. This can enhance communication and streamline decision-making, enabling teams to address complex user needs efficiently [21].

As UCD is complex and dynamic, it has to be learned and practised, thus the level of competencies can vary from being a student to having a professional skillset. In this work, *practitioners* are defined as professionals focused on designing software solutions, having a professional skillset to do so. While their scope and experience levels might vary, they are employed in a role that requires skills and knowledge in the field of software design. Throughout the literature, these individuals are categorised under a variety of job titles, including but not limited to human factor specialist or user interface designer [22], Human-Centred Design or UCD or User Experience (UX) practitioner/professional [23], thus this thesis uses the term *practitioner* as an umbrella term. In a similar manner, in this work, *students* are defined as individuals who are currently undergoing formal training in UCD, and do not have practical experience. In the context of the publications included in this thesis, this refers specifically to bachelor students in Computer Science and Software Engineering.

Practitioners demonstrate rather different problem-solving abilities and approach UCD differently than students, although they might use the same UCD activities. For example, as UCD is complex and iterative, it relies heavily on problem framing to define and structure problems and ill-defined challenges. Early problem framing is particularly critical when engaging in ideation or exploration, as it is the step clarifying boundaries and setting the potential directions for the project [24], [25]. However, iteration through framing and reframing is a highly complex task [26] and, as problems and solutions co-evolve, problems require continuous re-evaluation throughout [27], [28]. While practitioners can leverage their experience and domain knowledge to frame complexity effectively, students often lack these skills and tend to fixate prematurely on solutions [25].

Research further shows practitioners leverage prior experience to generate and evaluate solutions early, which leads to efficient prediction and refinement of outcomes [29]. Those lacking experience and practice, on the other hand, tend to adopt a trial-and-error approach [30], [31]. Additionally, Deininger et al. [32] found that while students engaged in various prototyping activities, they often lacked strategic intent, relying on trial-and-error. Based on this, Deininger et al. [32] underscore the importance of reflective practice, and targeted training for better outcomes, as well as by encouraging iterative prototyping activities.

From the increasing complexity of UCD challenges, we see not only a difference in approach to UCD activities, but also a discrepancy in needs emerge. Limited time, resources, managerial support, and alignment with rapid iteration cycles often constrain UCD practitioners [15], [17], [33], [34]. While adopted in practice, rapid iteration cycles can restrict comprehensive user research and testing, and insufficient managerial support may deprioritise comprehensive user research, limiting the depth of user insights gathered, in favour of business objectives [33]–[35]. On the student side, a reoccurring issue is that many of the existing UCD principles are primarily addressed to practitioners already familiar with UCD activities. This leaves unaddressed the need for structured guidance that supports the needs of students in understanding *how* to apply said UCD activities.

Students also benefit from a clear roadmap to develop foundational skills. A UCD process can offer them a scaffolded approach, as introduced by Wood et al., [36], offering temporary support and gradually decreasing assistance as competence grows. This can balance the need for detailed guidance with room for creative exploration [15], [37]. A UCD process can also allow students to dedicate themselves to the project without feeling overburdened [38]. By providing a framework and boundaries, UCD processes can allow students to build comfort and confidence with user-centred activities, before starting to adapt these approaches based on project demands. In this way, UCD processes can aim to prepare students for professional environments.

To summarise, practitioners often encounter resource constraints, tight deadlines, and competing stakeholder interests. The use of a UCD process in practitioner contexts can offer a foundation that supports consistency and adaptability, ensuring that each design decision aligns with user needs while accommodating resource and time constraints [33]. In educational contexts, a UCD process can represent a manner of integrating a wide variety of UCD activities in a constricted time period, in order to maximise productivity while keeping track of goals and restrictions such as budget, time, or team availability [15].

With the aim to introduce UCD into an iterative, fast-paced process, the UCD Sprint was created. The UCD Sprint evolved through iterations based on extensive feedback, leading to a refined structure that emphasises user research. Designed by Human-Computer Interaction researchers from the Nordics, as a step-by-step process, it aims to aid software teams in idea generation while maintaining a strong user focus [39]. It consists of three phases, Discovery, Design, and Reality Check, each with six activities. In these phases, the UCD Sprint aims to guide teams through a series of UCD activities such as user interviews, low- and high-fidelity prototype evaluations, and iterative redesign, emphasising understanding user needs early and consistently incorporating user feedback. This makes it particularly useful for exploring innovative software ideas. Its structure aims to accommodate both students and practitioner contexts, providing clear guidance for students, while addressing limitations faced by practitioners.

1.1 Research Questions

This thesis aims to investigate how the UCD Sprint can address the specific needs of both practitioners and students. The research questions focus on key aspects of UCD practice and educational contexts. This is done through the following research questions:

RQ1: Practitioner Needs and Results
How can the introduction of the UCD Sprint process address the key limitations in the current ways of working of UCD practitioners?

RQ2: Student Needs and Results
How can the introduction of the UCD Sprint process address the needs of students learning UCD?

1.2 Outline and Publications

The work towards answering the research questions is comprised of five papers, included in the current thesis, as shown in Figure 1.2. It aims to answer these research questions in the context of the UCD Sprint process, applied across various contexts to understand how it is perceived by practitioners and students alike.

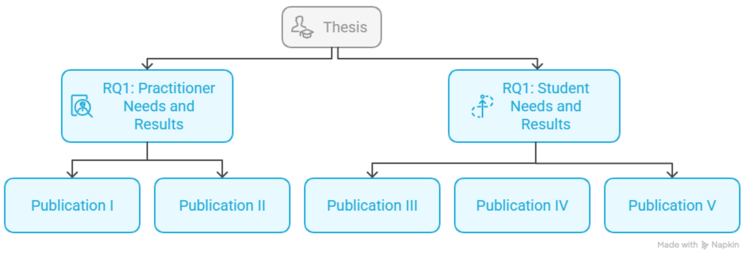

Figure 1.2: Publication Overview

The UCD Sprint as a process is new, and its adaptability in meeting both practitioner and student needs has not been extensively studied, and there is limited empirical evidence regarding its suitability as a UCD process across different contexts. By studying the UCD Sprint from the perspectives of practitioners, both within a structured course setting and through initial impressions, and in student contexts with bachelor students at different stages in their education, and in its application to a specific environment in the context of game design, this research aims to identify whether the UCD Sprint, as a UCD process, can be consistently applied across these diverse settings. Further, the thesis aims to explore if, and how, the needs of these two demographics - practitioners and students, can be met.

1.3 The UCD Sprint Digital Aid

The UCD Sprint digital aid is part of the contribution of the current thesis. The process of designing the educational digital aid [1] used across all publications focusing on students, followed a structured and iterative approach based on the UCD Sprint process.

[1] https://ucdsprint.com/

The aid was envisioned as a comprehensive resource hub containing instructions, templates, and examples to support educators and students in engaging with the UCD Sprint process.

To ensure the creation of a relevant and useful platform, I conducted interviews with students to understand their needs, expectations, and potential challenges. I systematically analysed the data gathered from these interviews to identify key features and functionalities that the Digital Aid should prioritise. Based on these findings, I created a series of prototypes, iteratively refined them, and performed a series of tests to assess how well the digital aid meets the needs of its target users. The development process was supported by collaboration with a team containing a professor and two practitioners. The professor contributed insights into academic requirements and student needs, while the practitioners provided technical guidance and the final development effort. The digital aid serves as an accessible tool for the educational community and a practical application of the UCD Sprint process, aligning with the goals of the thesis.

The digital aid was formally validated in Publication III, was presented in courses and presentations at a range of universities and conferences, and is currently in use in courses at Reykjavik University, and open to the larger public.

1.4 Thesis Contributions

The contributions of this thesis span theoretical and practical domains. The theoretical contribution lies in the outlining of findings and presentation in the context of core, contextual, and peripheral UCD activities, which aims to offer a nuanced perspective that can be used when using or teaching UCD processes. The thesis brings together insights from multiple publications, analysing the UCD Sprint process in both student and practitioner environments, findings of which can be transferred on a practical level on potential approaches to UCD in educational environments. The work towards this thesis further contributes through the development of the UCD Sprint website, an accessible digital aid that supports the teaching and learning of the UCD Sprint. This website serves as a structured resource, offering guided steps to navigate the UCD Sprint process. Last but not least, the thesis provides a series of recommendations based on the findings, on how to approach UCD processes as a concept, and their potential role in practitioner and student contexts.

1.5 Thesis Journey

The development of this thesis was shaped by an iterative process informed by multiple stages of feedback and reflection, beginning with the initial thesis proposal. In 2022, during the first year of the PhD studies, the proposal was formally presented to the thesis committee and peer researchers in an open presentation. This session provided a platform for detailed critique and constructive feedback. The feedback from this presentation prompted significant revisions, including the enhancement of the theoretical framework and the study design to ensure its alignment with the broader objectives of the thesis.

The iterative nature of the thesis was further reinforced through participation in academic consortia. In 2023, the thesis was presented at the doctoral consortium of the INTERACT conference, which provided an opportunity to engage with an international community of researchers and practitioners, in a context focusing specifically on the thesis and its direction. The feedback from this consortium highlighted the importance of contextualising the UCD Sprint within a broader design landscape and addressing emerging challenges in its application. Building on this, another round of feedback was received at the HCSE 2024 doctoral consortium [40], which called attention to the need to narrow down to very specifics in order to provide a comprehensive analysis of the UCD Sprint process, that can then be used as a building platform for future, more high-level research endeavours.

Each of these engagements prompted adjustments to the thesis, ranging from minor refinements in writing and framing to substantial revisions in the methodological approach and analysis strategies. Collectively, the feedback from these stages strengthened the thesis coherence but also underscored the dynamic, evolving nature of the research process itself. This iterative engagement with expert feedback appeals to the core principle of adaptive refinement, which is central to the field of design and reflective of the methodological framework of this thesis.

Chapter 2

Related Work

This chapter discusses the application and challenges of UCD in both professional settings and educational environments. It highlights key UCD activities, while also identifying the challenges professionals face, such as resource constraints and the lack of structure. In student contexts, it emphasises the importance of teaching design processes. Lastly, it underscores the need for adaptable approaches to effectively prepare student for real-world software design challenges, and presents the UCD Sprint, which is researched as a potential solution to address these challenges.

2.1 UCD and Software Design Processes in Practice

A systematic literature review by Bano and Zowghi [41] confirms the positive impact of user involvement on system success but highlights that this relationship is complex, multifaceted, and influenced by various factors. Effective user involvement requires addressing multiple perspectives and levels of engagement from the side of users to maximise benefits. Key recommendations include identifying the right user categories and tailoring their level of participation based on their roles and system impact. Participation should align with psychological, managerial, methodological, political, and cultural perspectives to address challenges and benefits effectively. Additionally, the degree and level of user participation must be carefully planned to balance resources and desired outcomes, ensuring an appropriate involvement at each stage of the process [41].

UCD activities commonly utilised by practitioners, such as prototyping and iterative usability testing with substantial user input, are integral to creating user-friendly designs [16]. Informal approaches, such as user blogs and casual feedback on prototypes from peers, have also been utilised [42], although research on the usefulness of various UCD activities indicates that formal user testing is highly valued by practitioners, ranking as the most useful UCD activity [43]. While there is a consensus on the significance of involving users, practitioners often employ a diverse range of activities and tools to do this, frequently adapting existing approaches or developing their own [44], [45], which underscores the importance of flexibility in practice and reflects the absence of a single dominant software design approach [46].

Furthermore, real-world implementation of UCD faces numerous challenges, including constraints related to time, resources, and organisational support [17], [34], [47], [48]. Further barriers include weak stakeholder communication, conflicting priorities, and insufficient user involvement driven by resource and cost limitations [35]. Research also highlights a consistent gap between the theoretical ideals of UCD and their practical application, as practitioners often revert to familiar activities to navigate project limitations, due to a lack of structure and the barriers encountered when trying to learn and apply new approaches [17]. This to say, while there is a wide variety of activities out there, practitioners highlight it as difficult to learn and use them, and there is a call for developing new ways to support the learning and usage of these activities, primarily in the context of collaborative work [17].

The integration of UCD activities into software development circles prioritising feedback and improvement through continuous iteration has been explored extensively since the 2000s, highlighting shared aspects like user involvement, iterative design, continuous testing, and prototyping [49], [50]. However, challenges persist, particularly in communication, tensions forming between the prioritisation of software architecture over user requirements [51].

UCD is supported by several established processes, each offering unique approaches to creating systems that align with user needs. The ISO process for Human-Centered Design [14] provides a systematic, iterative framework that emphasises understanding users and their contexts, defining requirements, generating design solutions, and evaluating outcomes. This standardised structured approach enables software designs to meet usability standards and addresses potential issues early. However, it can be resource-intensive, and due to its formality, it is generally utilised as a guide rather than a process in itself.

For teams seeking rapid results, the Design Sprint offers a streamlined alternative [52]. Condensed into five days, it facilitates problem-solving through focused collaboration, rapid prototyping, and user feedback. Its speed and cross-functional teamwork make it ideal for environments where quick validation of ideas is critical. Yet, its rigid timeline can limit the exploration of complex problems, and its intensity can lead to fatigue, especially when repeated or extended. Furthermore, although condensed to only 5 days, iterations of the Design Sprint have emerged condensing it even further [53], which deepens the issue of exploration limitations and fatigue. However, the Design Sprint is heavily supported resource-wise, benefiting from a book [52], courses [53] a guide created by Google [54] and plenty of anecdotal evidence of its use, with many and frequent changes to suit the people using it, some better documented than others [15], [55].

Approaches to UCD share common strengths, including their usefulness in ideation and iterative nature, reliance on collaboration, and structured frameworks, but their ease of application often hinges on adaptability. Experienced practitioners tailor these approaches to fit specific project needs, balancing user requirements with practical constraints such as timelines and budgets [15].

In conclusion, UCD practices can have a beneficial effect on software success [41], with formal user testing being the most valued activity among practitioners [43]. However, real-world UCD implementation faces challenges such as time and resource constraints, weak stakeholder communication, and lack of managerial support, leading to the use of diverse and often adapted activities, at times isolated to only parts of the development process [56], [57]. The integration of UCD in these software development processes is partially built on common principles [49], [50], but issues persist, especially in balancing user requirements with software architecture priorities [51]. Practitioners seem to frequently face challenges in learning and implementing these UCD activities, especially in collaborative environments [17]. Despite the abundance of UCD activities, a significant gap persists in the literature regarding their successful application in a structured manner. While numerous papers explore approaches for the integration of UCD in rapid iteration software development, they are insufficiently described [58], or their evidence is anecdotal, lacking validation in controlled experiments, which highlights the need for more empirical research [21].

2.2 UCD and Software Design Processes in Student contexts

Defining and framing problems is a critical step in the software design process, yet its non-linear nature poses challenges, particularly for students [8], [9], [59]. Framing establishes boundaries and provides the structure for addressing problems effectively, but it requires experience, as practitioners spend more time on framing and information gathering compared to novices such as students [25], [27]. Despite the iterative nature of software design, problem framing typically occurs early, though reframing is often necessary as understanding evolves [24], [60]. This complexity makes framing a daunting but essential skill for students transitioning from structured to open-ended problem-solving scenarios. While both practitioners and students engage in problem structuring throughout the design, practitioners are better at doing it coherently and generally at strategic prioritisation, which is a hallmark of successful design behaviour [61], [62]. A study by Chen et al. [63] analysed these differences in a design task and found that while both practitioners and students followed a similar sequence of software design phases, with significant time spent in discovery, key behavioural distinctions emerged: practitioners conducted early, thorough problem analysis and persistently transitioned between phases, while students struggled with problem scoping, leading to less effective final performances. A study by Deininger et al. [32] further revealed that students initially defined prototypes narrowly but used them broadly during projects for communication, testing, and iterative refinement. This may suggest that students would benefit from more educational initiatives or opportunities to gain experience through simulated projects, allowing them to build skills in controlled environments that can be effectively applied in practice.

Introducing students to UCD activities within cyclical processes involving multiple stakeholders, can enhance the ability of students to address complex problems [59], [64], [65]. UCD further supports the development of empathy, problem-framing, and socially responsive skills, which are vital for tackling these complex problems [66], [67]. As the industry increasingly adopts UCD, there is growing momentum to integrate these practices into educational settings [68], [69].

However, in practice, more often than not informal activities are used for UCD [17], [70], and this lack of formality and structure can make it difficult to translate them into educational initiatives. In order to guide students through the best combination of activities when approaching UCD, educators are encouraged to anticipate potential hurdles and offer a core set of activities to rely on, to foster and cultivate skill development [71]. For this, some parallels have been drawn between UCD and active learning, encouraging learner-centric approaches that follow similar principles to UCD [72].

In their work, Pontis and Van Der Waarde [73] argue for a comprehensive pedagogical model to address nine interrelated changes in software design practice, education, and pedagogy driven by global transformations, introducing a student-focused, research-led approach demonstrated through two courses while highlighting challenges and providing step-by-step recommendations for adapting software design education. Amongst these recommendations, they highlight creating a deeper understanding, focusing on problem definition, and including user-centred research throughout the software design process.

As maybe one of the most popular processes, the Design Sprint process was included in a university course [38], showing benefits related to the process structure, such as increased satisfaction and grade improvement. The authors implemented the process in a first-year course, and along with improved grades, they found that the sprint structure offered greater simplicity and improved time management, with one of the highlighted benefits being the software design activities being pre-planned. Similarly, Ferreira and Canedo [74] implemented an adapted Design Sprint in an undergraduate class, results highlighting the importance of time, highlighting the timeframe of the adapted Design Sprint as not feasible. Both studies [38], [74] researched adapted Design Sprints, and both aimed for findings related to the structure and the skills developed through it. However, neither assessed the activities within the Design Sprint, or the participant perceptions of process usefulness.

Despite the demonstrated benefits of integrating structured processes into educational settings, existing studies often focus on outcomes such as grades and time management, overlooking critical aspects such as the evaluation of specific activities within the process and participant perceptions of their usefulness. Although challenges exist, such as the lack of structured practices and the complexity of translating industry practices into educational materials, a strategic, structured approach can foster skill development for students. This gap highlights the need for further research into how a structured, user-centred process can be presented in educational contexts to prepare students for real-world challenges.

2.3 Prior Research on the UCD Sprint

The beginning of the UCD Sprint is tied to the search for a UCD process that could appeal to students, and provide the desired structure while maintaining a user focus. This search took place within the boundaries of a series of three courses, through the NordPlus [75] project. In the first iteration of the course, Contextual Design [76] was used as a process, receiving mixed reviews. This course was documented in Larusdottir et al. [77].

A different format was introduced in the second iteration of the course, in 2018 [78], drawing on constructivist learning theories, and expanding the Design Sprint [52]. The UCD Sprint was created in response to a key limitation observed in the Design Sprint: a lack of systematic focus on user needs and feedback at crucial points. The traditional Design Sprint, as outlined by [52], emphasises rapid ideation and prototyping but does not incorporate comprehensive user input throughout the process. Recognising this gap, researchers from several institutions in the Nordics sought to merge more UCD activites with the Design Sprint framework to better capture user needs. This resulted in the development of the UCD Sprint.

The course where it was first introduced was structured over two weeks, and aimed to emphasise hands-on practice with the

Design Sprint activities in the first week, adhering closely to the checklists and guidelines by the book. Each activity was introduced through a brief lecture, followed by supervised practical sessions. In the second week, the focus was on UCD, with added emphasis on redesigning and evaluating prototypes to enhance user experience. This phase combined lectures and applied practice in UCD techniques. By the end of the course, participants were expected to understand the complete design cycle.

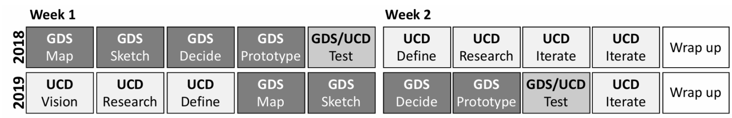

Figure 2.1: Overview of the UCD Sprint Process - 2018 and 2019 Iterations, Source [39]

In this 2018 course, the course structure focused heavily on completing the Design Sprint "by the book" over the first week, followed by UCD activities to refine the prototype in the second week. However, this sequence presented challenges: participants found it difficult to switch from the fast-paced Design Sprint activities to the user-focused UCD ones, and after a weekend break, fatigue set in, leading to diminished energy by the time the UCD actually started.

To address these issues, a new iteration of the process emerged, taught during the third occasion of the course, in 2019 [39]. This iterated process prioritised introducing UCD activities before the Design Sprint to establish a stronger understanding of user needs and contextualise the design challenge. This adjustment resulted from feedback indicating participants needed more context to the problem before diving into a solution-driven mindset for the Sprint. In the new format, participants began with three days dedicated to UCD tasks, such as defining user groups, conducting user interviews, analysing needs, and setting UX goals. This allowed participants to create a design brief and clearly establish the challenge before starting the Design Sprint activities.

The subsequent Design Sprint process then ran from the fourth day of the first week to the middle of the second week, allowing participants to use the foundational UCD insights to inform their design decisions within the Design Sprint. The final days of the course were devoted to UCD evaluations, including testing and iterating prototypes based on user feedback. This restructured approach helped maintain momentum throughout the course and created a balanced workflow, aligning creative ideation with real user insights for a more comprehensive and engaging learning experience.

The UCD Sprint process officially received its name in the INTERACT 2021 conference paper titled "Focus, Structure, Reflection! Integrating User-Centered Design and Design Sprint" [39], when the 2019 results were published.

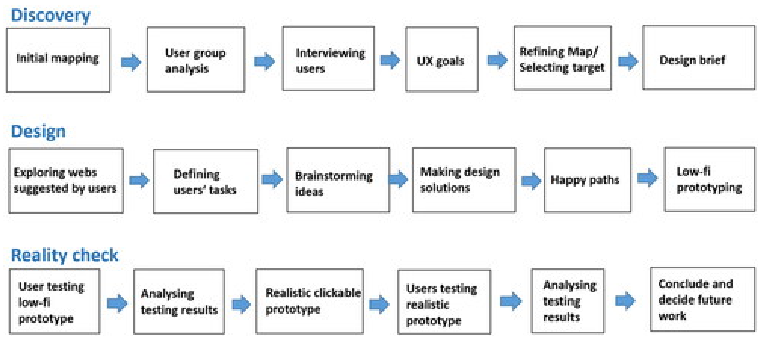

Figure 2.2: Overview of the UCD Sprint Process - Current Version, Source [33]

The latest version of the UCD Sprint introduces three phases: Discovery, Design, and Reality Check, each containing six steps, as seen in Figure 2.2. Unlike the earlier time-bound structure, this version offers more flexibility by not being linked to specific days of the week. This new structure was first published as part of the current PhD research, in the Larusdottir et al. [33] publication.

The UCD Sprint as a process aiming to meet both practitioner and student needs has not been extensively studied, with limited empirical evidence on its suitability across professional and educational contexts. This thesis addresses this gap by examining the UCD Sprint in diverse settings, aiming to identify how the process, but also the individual activities it includes are perceived, and whether it can meet the distinct needs of practitioners and students.

Chapter 3

Research Approach

This chapter outlines the methodological foundation of the thesis, detailing how the research was designed, conducted, and analysed. It introduces the empirical context in which the study takes place and describes the overall research strategy, including philosophical underpinnings, participant demographics, data collection techniques, and methods of analysis. The chapter highlights how the research was structured to explore the dynamic nature of the UCD Sprint process across different settings.

3.1 Empirical Context

This thesis addresses the dynamic nature of the UCD Sprint process through a series of contexts and environments. By examining the UCD Sprint across different environments and contexts, this thesis aims to understand how it can be presented and adapted to meet the diverse needs of practitioners and students. The research is structured as a 3-year multiple-case study, including four cases, where data is collected and analysed in iterative cycles allowing for research optimisation over time. Each paper is structured to stand alone while contributing to the overarching aim of analysing the UCD Sprint within various contexts, as seen in Figure 3.1.

Multiple-case studies are particularly suitable when the research question focuses on process questions. Yin [79] highlights a series of criteria which would make a multiple-case study the right approach, and the alignment between these criteria and the research design and objectives of this study drives the decision

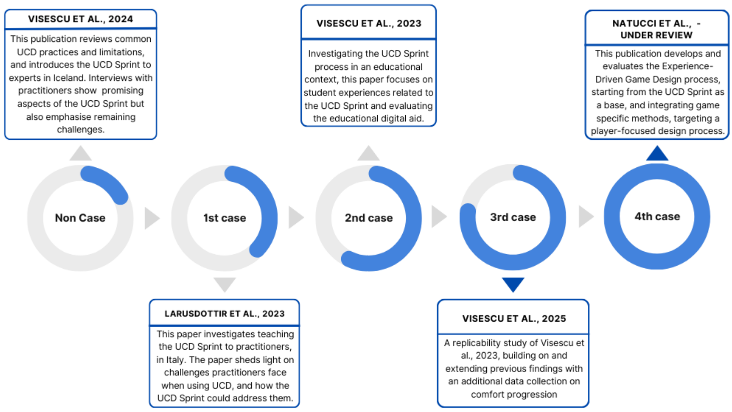

Figure 3.1: Case Overview

to adopt a multiple-case study methodology. In this thesis, the research questions examine *how* the UCD Sprint is seen, learnt, and applied to achieve specific goals across diverse settings. This inherently process-oriented inquiry makes the multiple-case study approach an ideal fit. This research examines the UCD Sprint as it is implemented and refined, in a context-dependent manner. This enables iterative adjustments to data collection and analysis as new insights emerge from each case. Furthermore, a hallmark of the multiple-case study methodology is the integration of diverse data sources, which aligns with the mixed-methods approach employed in this thesis. Each case involves collecting and analysing multiple types of data, adapted to fit both the UCD Sprint and the context in which it is applied.

An initial paper builds the foundation for the case studies, evaluating the broader implications of the UCD Sprint applicability and adaptability. This is done through synthesising findings from literature and practitioners (Publication I). The research is further structured around four core case studies, each representing a distinct context: a professional training program for practitioners (Publication II), two university courses in a first-semester Computer Science bachelor's programme (Publications III and IV), and a game design course (Publication V). These cases were purposefully selected to explore the dynamic interplay between process design and contextual needs. In each case, data are collected from multiple sources, adhering to Yin's principles of using diverse evidence [79]. This methodological approach ensures that findings are comprehensive and reflect the complex realities of learning and applying a design process.

The iterative nature of the research process mirrors the cyclical refinement of the design process itself, with each case study building upon the insights of the previous one. By structuring the research around the UCD Sprint, this thesis is able to explore its immediate applications and the dynamic nature of how it is learned, modified, and used across varying levels of expertise and environments.

3.2 Research Philosophy

This research adopts a pragmatism paradigm [80] to understand the dynamic nature of a UCD process, the learning behind using said process, and the adaptation and application needed for a successful approach, through objective and subjective experiences of participants engaging with it. The pragmatism paradigm was chosen for its bringing together of the positivistic and interpretivistic beliefs, and providing a middle way that allows for a flexible and problem-solving approach that integrates both qualitative and quantitative methods. Given the diverse nature of the data collected and the varying analytical approaches required, pragmatism provides the best fit by valuing both overall findings and individual experiences, ensuring a comprehensive understanding.

Throughout this thesis, the pragmatism stance highlights the prioritisation of the study context and the unique needs that go with it in order to analyse the UCD Sprint process. The thesis adopts a contextual and iterative methodology. While consistent for the sake of comparison, data collection is designed to be dynamic and responsive to emerging insights, reflecting the belief that understanding evolves through interaction and iterative exploration. This approach allows for the adaptation of tools and methods to better suit analysing participant experiences as they unfold, ensuring that the study remains grounded in their lived realities. For instance, qualitative methods such as interviews and reflective surveys are tailored to explore the subjective interpretations of the design processes participants hold, and quantitative data complements these insights, offering additional dimensions of analysis.

By adopting a pragmatic approach [81], this thesis embraces the diversity of experiences across participants and settings, recognising that the meaning and usefulness of design processes cannot be universally defined, and the data gathering and analysis move beyond a more constrictive paradigm, into adapting to the needs of the specific study at hand. Through this lens, the research not only examines the practical application of UCD activities individually, but also provides insights into the dynamic nature of learning and applying a UCD process as a whole, in real-world contexts.

3.3 Participants

The participants in the publications presented include industry practitioners and students - undergraduate students from computer science and software design-related courses, to capture both real-world and educational perspectives on the UCD Sprint process. The students were drawn from various academic levels, ranging from first-year undergraduates to those nearing graduation, offering a view across different stages of academic development.

The research spans multiple international contexts, with Reykjavik University (Iceland) serving as the site for two student cases, complemented by a student case from the University of Campinas (Brazil). Additionally, practitioners from Italy and Iceland contribute practitioner insights, aiming for a balanced understanding of how the process is perceived, adapted, and applied in both academic and professional environments. An overview of the participants can be seen in Figure 3.2.

3.4 Data Collection

The data collection process for this study is quantitative, qualitative, and iterative. A mixed-methods approach is employed to collect data, combining both qualitative and quantitative measures to gain a comprehensive understanding of participant ex-

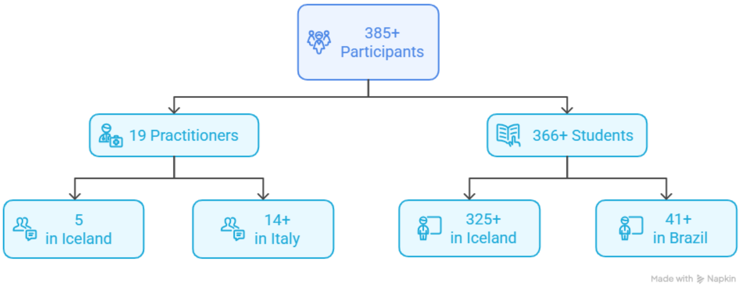

Figure 3.2: Overview of Participants

periences, and to facilitate triangulation. This also facilitates a nuanced understanding of how participants engage with the UCD Sprint. Within courses, data are collected at different stages, aiming for a thorough analysis of participant engagement.

As this thesis is comprised of 5 publications, each representing a separate study, the methodology for data collection and analysis is kept consistent to a degree that would allow inter-study comparison, but also allow for modifications to fit the study context and participants, as seen in Figure 3.3.

Publication	Description	Data Collection Methods		
Publication I - Exploration of UCD Practice Limitations	This non-case publication examines the role of the UCD Sprint in addressing common UCD challenges, highlighting strengths in streamlining practices and fostering user involvement while emphasising the need for adaptability.	Semi-Structured Interviews		
Publication II - UCD Sprint: A Fast Process to Involve Users in the Design Practices of Software Companies	This first case explores the impact of the UCD Sprint on UCD practictioners, highlighting its potential to address design challenges and foster teamwork while emphasising its dual role as a practical tool and educational framework.	Semi-Structured Interviews	Process Evaluation (Qual)	Activity Evaluation (Quant)
Publication III - Supporting Active Learning in STEM Higher Education through the UCD Sprint	This second case evaluates the UCD Sprint and its digital aid as educational tools for 1st year Computer Science students, highlighting practical application while identifying areas for improvement.	Digital Aid Evaluation (Quant)	Process Evaluation (Qual)	Activity Evaluation (Quant)
Publication IV - Exposure to UCD activities: Experiences in Higher Education	This third case explores the integration of the UCD Sprint in a 1st year Computer Science course, showing improvement in comfort with UCD activities, fostering practical skills, and providing structured learning.	Comfort Levels (Quant)	Process Evaluation (Qual)	Activity Evaluation (Quant)
Publication V - Experience-Driven Game Design: A Process for Game Design Focused on Affective Outcomes	This fourth case examines the Experience-Driven Game Design process, an adaptation of the UCD Sprint for game design, highlighting its effectiveness in fostering player-focused design through hands-on activities.	Experiential Evaluation (Qual+Quant)	Remembrance Evaluation (Qual+Quant)	

Figure 3.3: Overview of Data Collection

Surveys were administered in the courses of publications II to V, to gather insights into the participant perspective of the process and the course context. As part of the Activity Evaluation, participants evaluated the activities within the UCD Sprint, focusing on their thought-provoking nature, usefulness in the course, and potential future use in professional or academic settings, on a 7-point Likert scale. This measurement was kept from [78]. These evaluations offered insights into the relative strengths and areas for improvement of different activities, and their perceived usefulness in real-world applications. Comfort Levels used self-evaluation, present in one publication, to further extend the quantitative exploration, allowing participants to assess their comfort with core UCD activities at the beginning and end of the course. This enabled the track of changes in comfort over time.

In the Process Evaluation, the qualitative dimension of the research encouraged participants to reflect on their experiences with the UCD Sprint through the Retrospective Hand Technique [82]. While in Publication II the method was used in its entirety for Process Evaluation, meaning inquiring about the five dimensions as following: 1) This was good; 2) I want to point this out; 3) This was not as good; 4) I will take this home; and 5) I would have liked more of this, in Publication III, IV, and V, a variation of this method was used, asking the participants about positives, negatives, and areas of potential improvement. This was done as the usage of all five dimensions led to overlapping or confusing comments, the nature of which had to be determined during the analysis. In the practitioner studies, the qualitative findings were enriched through semi-structured interviews. These interviews detailed personal experiences with UCD activities, challenges faced, and the broader implications for their problem-solving skills and professional development. The flexibility of the semi-structured format meant focusing on in-depth, structured data collection, with room for adaptation for new insights that might emerge [83]. These reflective exercises encouraged deeper engagement with participants and their beliefs, and provided a platform for them to critically assess their interactions with the UCD Sprint.

Publication V splits the evaluation in Experiential and Remembrance Evaluation [84]. The Experiential Evaluation uses the UMUX-Lite [85] seeking to evaluate the usability of certain activities or provided material. Additionally, the full Retrospective Hand Technique [82] was used to assess the process phases

(Discovery, Design, and Reality Check). For the Remembrance Evaluation, the Activity Evaluation is used, together with the Process Evaluation.

Overall, the studies in this thesis adopted an iterative approach to data collection, allowing the process to evolve in response to emerging findings. Refinements to tools such as the Retrospective Hand Technique [82] and the semi-structured interviews ensured that the research remained responsive to the complexities and diversity of participant experiences. This adaptability was central to the dynamic and context-dependent nature of UCD. Details on the methods used in each of the papers composing this thesis can be found in section 4, as well as in the papers themselves.

3.5 Data Analysis

Throughout this thesis, data analysis integrates both quantitative and qualitative methods to provide a comprehensive understanding of participant opinions, experiences, and the effectiveness of the UCD Sprint process. Quantitative data is analysed through descriptive and inferential statistics to evaluate participant perceptions. Descriptive and inferential statistics were used for comparative analysis to examine perceived usefulness, and thought-provoking nature across different activities and dimensions of the UCD Sprint process, while the comfort levels allow for a pre-post analysis. This numerical approach identifies patterns, highlights significant differences, and underscores the effectiveness of specific UCD activities, to offer insights into their educational and professional applicability, while also highlighting the areas that would require improvement.

In parallel, qualitative data analysis focuses on participant narratives to uncover more nuanced insights. Techniques such as thematic analysis enable the identification of recurring themes and subthemes, reflecting participant expressions and contextual dynamics. The themes created are cross-referenced between publications and adapted to the specific context of research. Publication IV uses broad themes, while Publications III, and V use more detailed themes, building on the ones previously used for assessing the UCD Sprint [39]. Publication II uses both broad themes - in the semi-structured interview analysis, and more detailed themes building on previously existing ones [39] for the analysis in Process Evaluation. This flexible approach was chosen in order to ensure the themes represent the participant message, without restricting it.

3.6 Researcher's role

As per Reykjavik University guidelines, a declaration of authorship is submitted to the Research Group on Constitutional Studies in the Computer Science Department, outlining my contributions to each stage of the research and publication process for the papers in this thesis. Specific contributions are outlined in the Appendix A, and Table 3.1.

Paper name	**Idea**	**Related work & literature**	**Data gathering**	**Research design**	**Artifact design**	**Analysis & synthesis**	**Draft**	**Administration**
Exploration of UCD Practice Limitations	EE	ME	EE	EE	EE	EE	EE	EE
UCD Sprint: A Fast Process to Involve Users in the Design Practices of Software Companies	LE	CE	LE	LE	CE	CE	CE	LE
Supporting Active Learning in STEM Higher Education through the User-Centred Design Sprint	EE	ME	ME	EE	EE	ME	ME	ME
Exposure to User- Centred Design Activities: Experiences in Higher Education	EE	ME	ME	EE	EE	ME	ME	ME
xperience-Driven Game Design: A Process for Game Design Focused on Affective Outcomes	EE	EE	EE	EE	EE	EE	EE	ME

Table 3.1: Declaration of authorship contribution.
ME = Main effort, includes the main effort in the indicated column. EE = Equal efforts, includes that there was a shared equal effort between at least one other author of the paper. CE = Contributing effort, entails important effort, but there is someone else in the author list that delivered the main effort. LE = Learning effort, includes an effort of a learning character, for instance, by assisting with the data collection or the analysis.

Chapter 4

Results

The work towards answering the research questions is comprised of five publications, included in the current thesis. An overview of methods and findings, contextualized in relation to the research questions, is provided below. The structure is deliberately chosen to easier build towards a cohesive Discussion section.

4.1 Publication I: Exploration of UCD Practice Limitations

Full reference:
I. Visescu, M. Lárusdóttir, and W. Choi, "Exploration of UCD Practice Limitations," Interacting with Computers, Oct. 2024, doi: https://doi.org/10.1093/iwc/iwae046

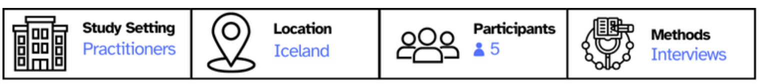

Figure 4.1: Publication I Overview

Overview

This non-case publication explores the UCD Sprint in the context of UCD practices, by synthesising prior research findings and conducting semi-structured interviews with five Icelandic practitioners. The participants included four women and one man, each with varied academic backgrounds ranging from business and computer science to psychology and HCI. Their professional experience in UCD spanned from UX consultancy and product management to project leadership in diverse sectors such as healthcare, emergency services, climate change, and e-commerce, offering a rich and diverse view of UCD practices in the Icelandic tech industry. The semi-structured interviews, each lasting approximately one hour, focused on three key areas: participant professional background and current UCD practices, the challenges and limitations they encounter, and their perceptions of the UCD Sprint after reviewing its structure and contents through a one-page overview. This methodology allowed tailored follow-up questions to capture the different perspectives and more nuanced insights. This publication was chosen as the first publication in the thesis as it presents practitioner experiences - the five interviewed practitioners with extensive experience across a variety of UCD projects, contextualised within the findings from the literature regarding UCD practices and limitations.

The findings in relation to the literature highlight that the UCD Sprint could address common UCD challenges such as time constraints, insufficient management support, prioritisation conflicts among stakeholders, and communication breakdowns within organisations, streamlining UCD activities, fostering user involvement, and reducing inefficiencies, such as post-implementation changes.

Participants mentioned some activities they commonly use, like interviews, brainstorming design ideas, and high-fidelity prototyping, which are included in the UCD Sprint and were highly rated for their practicality and relevance. However, other activities, such as personas and client/stakeholder interviews, were mentioned by practitioners as commonly used but are not part of the UCD Sprint. Integrating these methods could enhance the UCD Sprint, either by replacing less favoured activities or providing them as supplementary activities to strengthen user and stakeholder insights.

Despite the strengths and commonalities seen between the UCD Sprint and their current practices, participants stressed the need for adaptability to specific project contexts, as rigid adherence to any process may limit its effectiveness. They described the ideal usage of the UCD Sprint as what can be a dynamic toolbox that allows selective adoption of its activities to suit evolving work environments. This need for flexibility aligns with the broader trend amongst practitioners of adapting and personalising all processes and activities used to fit the context and stakeholders they are addressing. Practitioners further highlighted the potential of the UCD Sprint as an educational tool for teaching UCD activities to students. Its structured, guided approach provides a solid foundation for learning and applying UCD activities.

Overall, the UCD Sprint was praised for its clarity, structure, and ability to enhance UCD practices, though practitioners emphasised the importance of further refining its adaptability to diverse contexts.

4.2 Publication II: UCD Sprint: A Fast Process to Involve Users in the Design Practices of Software Companies

Full reference:
M. K. Larusdottir, R. Lanzilotti, A. Piccinno, **I. Visescu**, and M. F. Costabile, "UCD Sprint: A Fast Process to Involve Users in the Design Practices of Software Companies" International Journal of Human-Computer Interaction, pp. 1–18, Nov. 2023, doi: https://doi.org/10.1080/10447318.2023.2279816

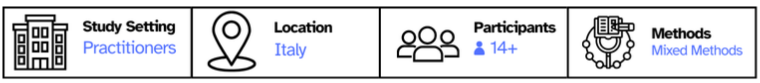

Figure 4.2: Publication II Overview

Overview

This first case publication investigates the impact of the UCD Sprint on design practices among practitioners in Italy, combining semi-structured interviews, a practitioner-focused course, and follow-up interviews to assess its utility and adoption. Seven practitioners in Italy were initially interviewed to identify current UCD practices and challenges, followed by a course on the UCD Sprint with 14 participants, whose feedback was collected through a comprehensive questionnaire containing mixed methods. Seven weeks later, follow-up interviews with eight participants explored if and how they integrated the UCD Sprint into their ongoing projects.

In the initial interviews, seven participants were selected through convenience sampling, representing various roles including development managers, UI/UX managers, a developer, and professional service managers. They worked at four companies of varying sizes and domains, ranging from a small 16-employee software company to a large international business consultancy with over 2000 employees. This sample offered a diverse range of organisational contexts and professional perspectives relevant to UCD practices. In the practitioner-focused course, 14 participants (4 females, 10 males), aged between 24 and 42 were included. Participants were selected to ensure availability and competence, and they came from mixed educational and professional backgrounds. The group included full-time designers/developers at IT companies, part-time designers/developers pursuing industrial PhDs in Computer Science, freelancers with experience in graphic design, and individuals with a strong interest in UCD. Finally, in the follow-up interviews, eight of the 14 course participants were included. Among them, four were full-time employees at IT companies working as designers/developers, three were part-time designers/developers concurrently pursuing industrial PhDs, and one was a freelancer studying Computer Science with a strong UCD interest.

This publication presents findings from practitioners with a varying level of experience - from part-time and freelancers, to full-time designers. The seven practitioners initially interviewed had extensive experience in user-related activities, from requirement gathering to UCD. The 14 course participants had varying backgrounds and professions, and while they were all employed or freelance working with UCD activities, their experience level differed.

The findings of the initial interviews show significant limitations in current UCD practices, such as neglecting end users during requirement gathering, over-reliance on customers as user proxies, and insufficient systematic user feedback during design and development. Participants also underlined the undervaluation of their roles, which are often conflated with graphic design, and resource and time constraints, as well as management support were highlighted as barriers that hinder effective UCD implementation. Findings from the course showed the UCD Sprint was perceived as a way to partly address these challenges through activities such as iterative user testing, prototyping at various fidelity levels, and collaborative decision-making, offering a structured, systematic approach to integrating user insights.

Results on the UCD Sprint and on the course itself from both the Process and the Activity Evaluations show that some activities stood out, either positively or negatively. The most highly rated activities were user testing of high-fidelity prototypes and the subsequent analysis of test results. These steps were seen as thought-provoking and highly useful for both the course and future applications. Participants appreciated the hands-on approach of testing prototypes with external users, finding it beneficial for understanding user needs and refining their designs. Discussing results post-user-testing in a visual manner, where key takeaways from user testing were documented using post-it notes on a blackboard, was an engaging and effective way to synthesise insights. Low- and high-fidelity prototyping were well-received, reinforcing the importance of iterative design and user testing. Some activities were less positively received, particularly refining the map and selecting a target, as well as examining user-suggested webs. These steps were perceived as less thought-provoking and less useful for both the course and future work. One reason for this could be that participants had already engaged in initial mapping early in the process, making the revisiting of the map feel repetitive or redundant. Additionally, the time constraints meant that activities like examining user-suggested webs were deprioritised, leading to lower perceived usefulness. Many participants felt constrained by the time allocated to the course, wishing for an extra day to develop prototypes more thoroughly and to receive more guidance on prototyping tools. However, the overall feedback was positive, with many participants valuing the practical, interactive nature of the course and recognising its potential application in professional settings.

Post-course interviews underscored the potential of the UCD Sprint to involve stakeholders, foster teamwork, and create resource-efficient, user-focused designs. While six of the eight interviewees had not yet applied UCD Sprint activities due to ongoing advanced projects, all participants expressed strong interest in adopting the process in future work. Participants praised the course for fostering teamwork, practical learning, and iterative design, and particularly its emphasis on user engagement and soft skills. However, time constraints and limited opportunities to explore prototyping tools were noted as drawbacks, with recommendations to extend the course duration for deeper exploration.

The results echo the findings from Publication I, highlighting the dual role of the UCD Sprint as a potential practical solution to industry challenges and a potentially effective educational tool. Its structured approach can serve as an up-skilling process to equip practitioners to address resource limitations and enhance user engagement, while its emphasis on theory and hands-on practice provides a robust foundation for fostering collaboration and creative exploration. This being said, the feasibility of the UCD Sprint as an educational tool in practitioner contexts is tightly tied to the time frame of the course. Due to the limited time practitioners have available, a course on the UCD Sprint must be adapted to their schedule. The 4-day approach presented in this publication was perceived by participants as too short. A longer course might prove ill-fitting due to the long hours required, proof of that being that time availability was one of the dictating factors during participant recruitment.

4.3 Publication III: Supporting Active Learning in STEM Higher Education Through the User-Centred Design Sprint

Full reference:
I. Visescu, M. Larusdottir, and A. S. Islind, "Supporting Active Learning in STEM Higher Education Through the User-Centred Design Sprint," in 2023 IEEE Frontiers in Education Conference (FIE), IEEE, Oct. 2023, pp. 1–10. doi: https://doi.org/10.1109/fie58773.2023.10342978

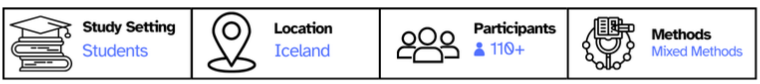

Figure 4.3: Publication III Overview

Overview

As highlighted in the first two publications as a process to be used as an educational tool, this second case evaluates the implementation of the UCD Sprint and its associated digital aid as educational tools for students - first-semester undergraduate Computer Science students at Reykjavik University. Over the span of seven weeks, participants were introduced to 14 UCD activities through a combination of lectures and on-site problem-solving sessions. They further had access to a digital aid designed to support their learning of the UCD Sprint. Feedback on the learning of the UCD Sprint process was collected through in-person surveys with 70 respondents, and qualitative digital aid evaluations through student reporting from 110 respondents.

The study employed a mixed-method approach through the Process and Activity Evaluations. Insights were gathered using the Retrospective Hand Technique [82] to assess course strengths, weaknesses, and improvement areas, alongside a 7 point Likert-scale evaluation of 14 UCD Sprint activities based on their usefulness, thought-provoking nature, and potential future application. Out of the 103 students present in person during the class in which the questionnaire was handed out, 68% handed in their responses, with some filling only parts of it in. The respondents were relatively evenly distributed in terms of age: 33% were between 17–20 years old, 45% were 21–25, and 22% were over 26. Regarding gender, 17% identified as female and 83% as male. Some of the participants reported having a previous degree or work experience, which may have included some exposure to UCD concepts, although this was not specifically quantified in the questionnaire.

Additionally, participant engagement with the UCD Sprint website was analysed in the Digital Aid Evaluation, focusing on its frequency of use, perceived functionality, and interface. In the penultimate week of the course, participants conducted peer interviews to discuss their experiences with the digital aid, providing anonymised reports that identified strengths and areas for improvement of the digital aid. This part of the study involved 110 students, whose feedback was collected through peer interviews. No demographic data (such as age or gender) was collected for this section, and the responses were anonymous. However, since the participants were drawn from the same cohort as in the Process and Activity Evaluations, it is reasonable to assume a similar demographic profile. Regarding experience, their feedback focused on using the UCD Sprint website, providing qualitative insight into their hands-on learning experience with UCD concepts during the course.

The findings indicate that the participants found activities involving direct user interaction, such as interviews and prototype testing, to be particularly valuable. These activities were praised for their practicality and ability to align design efforts with user needs. Hands-on elements like high-fidelity prototyping and user testing were especially appreciated for their relevance to real-world design applications and their potential utility in future work/study activities. Conversely, activities aimed at refining initial ideas were rated lower, as participants found these activities less directly connected to immediate practical outcomes. Although participants provided some criticism regarding the course structure, workload, and the alignment of materials with assignments, they recognised the UCD Sprint as a process able to improve collaborative efforts, and enhance practical design skills, as well as improve their UCD skills. The multidisciplinary and interactive nature of the course was seen as particularly beneficial, reinforcing its applicability to real-world challenges. While some participants initially struggled with understanding the UCD Sprint process, their comprehension grew as the course progressed.

Feedback on the digital aid was generally positive. Participants valued the clear instructions for implementing the UCD Sprint activities but noted areas for improvement, particularly in its intuitiveness and alignment with other course materials. The digital aid was often used in conjunction with additional resources, including slides, textbooks, and online tools, reflecting the importance of providing diverse and complementary learning materials.

This study shows how the UCD Sprint is perceived when used in an educational context by combining structured UCD activities, active learning, and digital support to prepare students to address UCD challenges.

4.4 Publication IV: Exposure to User-Centred Design Activities: Experiences in Higher Education

Full reference:
I. Visescu, M. Lárusdóttir , and A. S. Islind, “Exposure to User-

Centred Design Activities: Experiences in Higher Education", *Paper accepted for publication at* IEEE Global Engineering Education Conference (EDUCON), IEEE, Apr. 2025

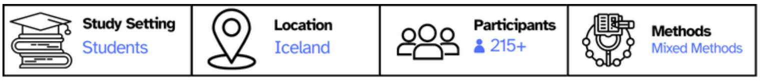

Figure 4.4: Publication IV Overview

Overview

This third case builds on Publication III, acting as a replication of it. However, this case no longer collects data on the digital aid, but instead adds an additional layer on the assessment of the effects of the UCD Sprint - the Comfort Level evaluation. The publication investigates the integration of the UCD Sprint process in a first-semester undergraduate Computer Science course at Reykjavik University, aiming to expose students to a variety of UCD activities in a structured manner, and enhance their comfort with UCD activities. The participants in this study were students enrolled in a university-level course, with the majority being Icelandic. The age distribution was relatively balanced: 38% were aged 17–20, 28% were aged 21–24, 13% were aged 25–28, and 22% were over 28 years old. In terms of gender, 25% identified as female, 73% as male, and 1% as non-binary (rounded values). While specific prior experience in UCD was not formally measured in this study, the participants belong to a similar cohort to the one described in Publication III, thus it can be assumed some of the participants had a previous degree or work experience, which may have included some exposure to UCD concepts, although most likely limited. Over seven weeks in a 12-week course, participants engaged with the UCD Sprint through lectures, hands-on problem-solving sessions, and comprehensive templates.

Two questionnaires were used for data collection. The background questionnaire, distributed at the start of the course, gathered demographic information and assessed the initial comfort levels of participants with UCD activities like user interviews, prototyping, and user testing, from 215 respondents. Near the end of the course, the Activity Evaluation gathered detailed feedback from 57 respondents on the UCD Sprint process, asking participants to rate individual UCD activities on in-course usefulness, their thought-provoking nature, and perceived future applicability. Open-ended questions in the Process Evaluation allowed participants to reflect on positive aspects and suggest improvements, while quantitative ratings in the Comfort Levels evaluation provided a before-and-after comparison of their comfort with UCD activities.

The feedback on the UCD Sprint process shows that it was largely appreciated for its structured approach, engaging activities, and learning value. However, there were several suggestions for improvement related to the course materials and the complexity of the process itself. Participants highlighted the UCD Sprint process clarity, usefulness, and the step-by-step structure, which they found easy to follow, and many appreciated the learning curve it provided, especially in cultivating design skills. On the other hand, the improvement suggestions were largely directed at the course and learning materials, participants suggesting more examples, particularly those that showcase the transferability of the UCD activities to different contexts. Furthermore, participants noted that assignment instructions should be more concise, clear, and consistent. The remaining improvement suggestions regarding the UCD Sprint process itself centred around simplifying the structure, with participants proposing that some steps be combined or skipped. Some found the process overwhelming, confusing, or time-consuming, and expressed discomfort with certain soft skills activities, such as interviewing users.

In terms of specific activities, in spite of the discomfort they created in some participants, interviews received high ratings for being thought-provoking, useful in the course, and likely to be used in the future. Together with Hi-Fi prototyping, these activities scored particularly well, standing out as highly relevant. Lo-Fi prototyping, while valued for its course relevance, was rated lower for future usefulness, suggesting that participants didn't see it as valuable in the long term. Process-related activities, such as refining the map, and selecting a target garnered lower ratings for future use, reflecting a potential preference for activities with more immediate user interaction.

While the Process and Activity Evaluations reinforced findings from Publication II, showing that the UCD Sprint is a structured process perceived as useful and its activities enabled students to learn about UCD skills through practice, assessing the progression in participant comfort with UCD activities was a new addition compared to Publication III. It aimed to assess whether exposure to UCD activities impacts the comfort level of students. The results on comfort highlighted statistically significant improvements in their comfort levels across all UCD activities. By enabling participants to self-assess their comfort levels with various UCD activities, the study uncovered a significant progression across all dimensions measured by the end of the course. This progress is a promising indicator that exposure to a comprehensive range of activities within the full design process can equip students with not only the skills, but the assurance needed for future professional applications.

This case reaffirms findings from earlier research in Publication III, both cases highlighting the UCD Sprint process as an effective manner of scaffolding learning by providing a clear, structured, and step-by-step framework that students can follow. This approach was praised by participants in both cases, for its ability to guide them through the design process. The structured nature of the UCD Sprint process enables students to build upon their understanding incrementally, fostering confidence in applying design principles. Participants particularly valued activities involving direct user engagement, such as interviews, citing their relevance to real-world applications. However, process-related steps were rated lower for long-term usefulness, with participants suggesting that the UCD Sprint could be streamlined for efficiency.

By fostering comfort and competence, the UCD Sprint can equip students with technical skills and a readiness to address user-centred challenges in professional contexts. This case further underscores the importance of early exposure to comprehensive UCD activities, offering valuable insights into creating student-centred, hands-on learning environments that prioritise both engagement and practical application. As a replication study, this case achieved its purpose of building on and extending the findings from Publication III, thus vetting the usefulness and positive perceptions highlighted by students in relation to the UCD Sprint.

4.5 Publication V: Experience-Driven Game Design: A Process for Game Design Focused on Affective Outcomes

Full reference:
G. C. Natucci*, **I. Visescu*** [1], M. K. Larusdottir, M. A. F. Borges, and A. S. Islind, "Experience-Driven Game Design: A Process for Game Design Focused on Affective Outcomes", *Submitted to* The Annual Symposium on Computer-Human Interaction in Play (CHI PLAY) *(Under Review)*

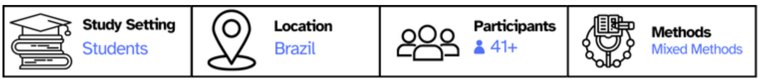

Figure 4.5: Publication V Overview

Overview

Lastly, this fourth case examines the Experience-Driven Game Design process, an adaptation of the UCD Sprint, tailored to address the context of game design by integrating elements that address the cognitive, emotional, and motivational aspects essential for player engagement. This study is set in a Project Management for Software Engineering course at the University of Campinas, Brazil, with Software Engineering Bachelor students in their third year out of four. The course was chosen as students already had substantial technical experience, but lacked formal training in game design. A demographic survey completed by 56 students at the start of the course showed that 75% identified as male and 25% as female. In terms of age, 53.6% were between 18–20 years old, 35.7% between 21–25, and 10.7% were over 26. Regarding professional background, 71.4% had worked or were working in the technology sector, and 26.8% had experience in product or solution design activities, which provided a relevant foundation for engaging with the design-focused aspects of the course content.

As by this point the UCD Sprint was presented to students in Publications III and IV, and was considered successful as an

[1]*These authors contributed equally to this work

educational process for them to practice UCD activities, Publication V explores a new dimension, aiming to probe the dynamic potential of the process, by keeping some of the core UCD Sprint activities, but replacing some with specific game design activities. In this way, this publication maintains a large share of the UCD activities in the UCD Sprint, as well as the UCD Sprint structure, but contextualises them in a different scenario of use - game design. As the UCD Sprint is an unexplored process, this publication adds an extra dimension to highlight the possibilities it can foster.

The Experience-Driven Game Design process includes the structured phases from the UCD Sprint (Discovery, Design, and Reality Check) and aspects of game design such as the Game Design Document (GDD) and Player Sheet to guide game designers in aligning their work with player expectations. Evaluated in an educational setting, this case proposes the new Experience-Driven Game Design process and validates it in an educational context, assessing the perceived experiences of students when interacting with the process.

The evaluation of the Experience-Driven Game Design process is done through experiential and remembrance evaluations, to capture both immediate and retrospective perceptions. The experiential evaluation gathered data after each phase of the Experience-Driven Game Design process (Discovery, Design, and Reality Check). Quantitatively, participants rated the ease of use and ease of understanding of each phase, tools and support material used. Qualitatively, through the Process Evaluation, participants answered open-ended questions about what was useful, what could be improved, and what they found most valuable for their game design journey, enabling comprehensive feedback. The remembrance evaluation assessed participant perceptions of the Experience-Driven Game Design process as a whole after its completion through both the Process and the Activity Evaluations. Quantitatively, participants rated each phase on thought-provocation, usefulness for game design, and likelihood of future use, using a 7-point Likert scale. This scale facilitated comparisons with prior studies included in this thesis. Qualitative feedback explored overall strengths and areas for improvement, prompting participants to share positive and negative experiences with the Experience-Driven Game Design process.

Activities such as playtesting, prototyping, and player interviews were consistently praised for their hands-on nature and direct applicability to tasks, making them highly valued by participants. These activities fostered a sense of player-centeredness, reinforcing the importance of grounding design decisions in real player feedback. Conversely, more abstract tools, which require theoretical understanding and extensive documentation, were less well-received. These tools were often described as confusing and overly complex, indicating a need for clearer templates, practical examples, and step-by-step guidance. Creative brainstorming exercises like the "Crazy 8," although engaging during the process, were not frequently highlighted in remembrance evaluation, suggesting the need for stronger connections between such activities and their perceived long-term design utility. Low-fidelity prototyping was also polarising, as some participants struggled to apply it effectively to their game concepts, pointing to the potential benefit of providing alternative activities or making this step optional.

This case highlights challenges such as time constraints, the complexity of some tools, and the difficulty in bridging theoretical concepts with practical outcomes. Recommendations for improvement include simplifying templates, increasing flexibility in the process, offering genre-specific guidance, and expanding the time allocated for critical activities such as prototyping and playtesting. These adjustments aim to make the Experience-Driven Game Design process more accessible to students while retaining its core focus on player-centredness.

The results demonstrate that the Experience-Driven Game Design process, like the UCD Sprint process, effectively scaffolds student learning. Hands-on activities, in particular, were found to be both engaging and impactful, providing actionable insights into player needs. However, refining the process to address challenges with abstract tools and ensuring clearer connections between activities and their practical applications can enhance the value of the process. By tailoring the process to meet diverse goals and skill levels, the Experience-Driven Game Design process has the potential to become a powerful approach for creating engaging, player-focused games.

Modifying the UCD sprint into the Experience-Driven Game Design process in order to bring UCD into game design shows potential for the UCD Sprint process as dynamic and adaptable, capable of accepting modifications based on context-specific needs.

The overall positive reception of the Experience-Driven Game Design process further reinforces this. The Experience-Driven Game Design process and game design context highlighted challenges faced by students, particularly in terms of course structure and the templates for game-related activities. These difficulties mirror those encountered by students in Publications III and IV, who also struggled with structural elements. Nevertheless, much like in the other two publications, students found prototyping and user testing enjoyable and recognised the user focus as a valuable and enriching aspect of their learning journey.

4.6 Synthesis

Practitioners have highlighted significant challenges in their UCD practices, such as time constraints, lack of management support, and difficulties in prioritising stakeholder needs. Many have expressed frustrations with the disconnect between customer feedback and actual user needs, finding themselves in a position of neglecting end users during requirement gathering and over-reliance on customers as user proxies, leading to inefficiencies in the process. The role the UCD Sprint can have in addressing these challenges is further discussed in section 5.1. The practitioners in Publication I used and valued an extensive share of the activities found in the UCD Sprint, such as interviews, brainstorming design ideas, and high-fidelity prototyping, which in Publication II were all highly rated for their practicality and relevance. This is further discussed in section 5.2. As an educational tool for practitioners, the UCD Sprint could serve in aiding with up-skilling or presenting new activities or a new process. However, time remains of essence, practitioners further emphasising the importance of adaptability, stressing that the UCD Sprint should remain flexible to suit different project contexts, or even that it might be better suited for students contexts rather than practitioners, as some practitioners saw its potential as an educational tool for teaching UCD activities to students. This is further addressed in section 5.3. Overall, the UCD Sprint was praised for promoting user engagement, teamwork, and practical learning, with strong potential for future application in the industry.

In student contexts, the UCD Sprint has been praised for its clear, structured approach. Activities like high-fidelity prototyping and user testing stood out positively in the reviews, as they provided valuable real-world insights and fostered collaborative decision-making. This is discussed in section 5.1, where the results from Publications III, IV, and V are presented in context of the UCD Sprint as a process to address the needs of students learning UCD. The emphasis on hands-on engagement with users through activities like prototype testing and interviews was particularly praised, with participants noting that these activities not only contributed to user-centric designs but also aligned closely with what they perceived to be real-world challenges. Additionally, the UCD Sprint's iterative, feedback-driven nature was appreciated for its ability to promote continuous improvement throughout the design process. However, there were also criticisms regarding certain aspects of the UCD Sprint. Several participants found some activities, such as refining the map and selecting a target, repetitive and less useful in the context of their work. Additionally, activities requiring extensive documentation or theoretical understanding were perceived as too complex and not directly applicable to practical design tasks. Moreover, the low-fidelity prototyping phase was seen as polarising in some contexts, particularly in Publication V, with some participants struggling to see its value in the game design context. This is further discussed in section 5.2. These critiques suggest that, while the UCD Sprint offers valuable structure, there is room for streamlining and adapting its activities to make the process more dynamic, and its activities more accessible and applicable in diverse contexts. This argument is further developed upon in section 5.3.

Chapter 5

Discussion

This chapter synthesises the findings presented in previous chapters, contextualising them in relation to the research questions proposed, and in relation to the type of implications they present.

5.1 Key Findings in Relation to the RQs

This section discusses the main research questions guiding the thesis, drawing on findings from the included publications to explore how the UCD Sprint process meets the needs of both practitioners and students. Each research question is addressed in turn, supported by evidence from the case studies and literature.

RQ1. Practitioner Needs and Results:
How can the introduction of the UCD Sprint process address the key limitations in the current ways of working of UCD practitioners?

Current UCD practices, while conceptually strong, face significant limitations in practical implementation. Time constraints, insufficient managerial support, and conflicting stakeholder priorities frequently impede the integration of UCD principles into workflows, as shown in Publication I [15] and II [33]. These issues often manifest as a reliance on proxies such as customers or other stakeholders during requirement gathering, exclusion of end-users and their wants and needs from critical decision-making phases, and inconsistent feedback mechanisms during iterative development cycles [33]. The introduction of structured processes, like the UCD Sprint, can address some of these challenges by providing a clear framework that encourage cross-disciplinary collaboration, streamlining some of the decision-making, and encouraging a user focus [33].

However, flexibility remains a key concern for UCD practitioners. While structured frameworks like the UCD Sprint offer scaffolding, many practitioners adapt these pre-defined processes to suit their unique project needs, integrating them as part of a broader, customisable toolbox rather than adhering rigidly to prescribed steps. These findings echo the literature [21], [44], [45], this pragmatic approach highlighting the importance of adaptability in UCD practices, particularly in dynamic environments constrained by tight timelines and resource limitations. Additionally, the findings in Publications I and II align with existing literature, such as [46], which underscores the absence of a single dominant design approach and the ongoing need for flexible, user-centred frameworks tailored to project-specific challenges.

Practitioners in both Publication I and II have emphasised the potential of structured processes like the UCD Sprint in enhancing intra-organisational communication. By providing a shared language and a cohesive set of practices, structured design processes can bridge the communication gap between multidisciplinary teams found in the literature [51], enabling effective collaboration even in the face of competing priorities. Publications I and II further validate these claims, showing that practitioners exposed to structured processes recognise their potential for improving their workflows. This positions the UCD Sprint as a tool for learning and application, but also opens the door for the UCD Sprint as an adaptable approach that practitioners can refine to meet evolving project needs.

While practitioner-focused, both Publications I and II highlight the UCD Sprint as a process apt for educational interventions: Publication I through the recommendations and praise received from practitioners related to using the UCD Sprint as a learning material for students who will later become UCD practitioners and will be able to use it as a toolbox; and Publication II through the positive experiences and opinions expressed by practitioners during and after interacting with the UCD Sprint through the course, and the impact of the UCD Sprint in encouraging a heightened user focus in the software design process.

RQ2. Student Needs and Results:
How can the introduction of the UCD Sprint process address the needs of students learning UCD?

In educational contexts, structured design processes like the UCD Sprint are proving instrumental in addressing the needs of students learning UCD students. Problem framing, a critical but challenging skill for students [8], [9], [59], can draw significant benefits from scaffolding provided by structured processes such as the UCD Sprint. Students, who often struggle with premature fixation on solutions and lack strategic intent in prototyping [30], [32], gain confidence and clarity through step-by-step guidance. Publications III and IV show the UCD Sprint encourages iterative exploration, helping students build reflective problem-solving skills through targeted interventions and real-world applications. Publications III and IV highlight the feedback received on the UCD Sprint classroom integration, showing an overall positive view of the process, the activities it contains, and the teaching style. Publication III assesses the UCD Sprint digital aid, which students praised for its structured content and ease of access. Publication IV includes an assessment of pre and post comfort level with core design activities, showing a significant improvement.

The UCD Sprint process and the digital aid not only scaffold student learning but also promote active, problem-based engagement. As shown throughout the literature [59], [64], [65], incorporating structured, cyclical frameworks with multiple stakeholders into educational curricula fosters complex problem-solving skills, encouraging students to develop more holistic sets of skills. Moreover, the use of iterative, cyclical processes within the UCD Sprint encourages the development of empathy and socially responsive skills, essential competencies for tackling complex design problems [66]. The findings in Publications III and IV resonate with this, and further with pedagogical literature such as [68] and [69], who advocate for the integration of UCD activities into software design education to better prepare students for industry challenges. These insights highlight the potential of structured processes not only to address skill gaps but also to bridge the divide between theoretical ideals and practical applications in design education.

Finally, the findings of Publication V demonstrate the potential of context adaptation of the UCD Sprint, by introducing the Experience-Driven Game Design process, which addresses key challenges in game design, by merging the structured UCD Sprint process with a model stemming from game design theory [86] to prioritise player experience. Student experiences with the Experience-Driven Game Design process revealed a strong preference for hands-on, practical activities, which were seen as directly applicable to real-world game design and aligned with findings from all four previous publications. Conversely, abstract activities received mixed feedback, as students struggled to connect these planning-oriented exercises to practical outcomes, which is a challenge similarly noted in game design studies where students face difficulties with complex mechanics and theoretical tools [87].

Ultimately, both the UCD Sprint and the Experience-Driven Game Design process were positively received for fostering user and player-centred experiences, providing a structured approach, and targeted support for students. Nonetheless, both processes could be optimised by providing more context and project-specific flexibility. There is a growing body of literature advocating for structured, user-centred activities in pedagogy [38], [73]. By positioning structured processes as adaptable, collaborative tools, the UCD Sprint can offer a versatile solution that caters to the complex needs of students.

5.2 Theoretical Implications

The findings of this thesis underscore a theoretical understanding of the UCD Sprint, its containing UCD activities, and their usage. The findings highlight a partitioning of UCD activities which can be mapped into three concentric circles based on their centrality and application within the UCD process, and the way the activity is perceived by the people using it. This is represented in the Figure 5.1, and further detailed upon in text, and is used as basis for the recommendations provided thereafter.

The inner circle, representing the core, includes activities that, throughout the five publications contained within this thesis, proved fundamental to the UCD process: mapping, interviews, high-fidelity (HiFi) prototyping, user or play testing, and result analysis. These activities were universally recognised as essential and are central to both students and practitioners, forming the backbone of effective software design workflows.

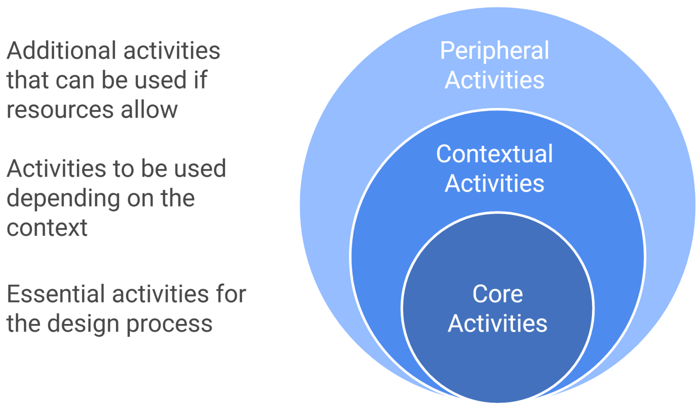

Figure 5.1: Design Activities Overview

In the non-case publication [15], these activities were commonly mentioned by practitioners, with interviews and prototype testing being mentioned by all practitioners included in the study as regular practices within their software design projects. Furthermore, testing is highlighted as the most useful UCD activities in the literature too [43].

These activities received the highest scores in all case papers [33], [37], [88], [89], *or* were seen as instrumental for the UCD process. As seen throughout literature, students struggle with problem scoping [63], and thus, mapping emerges as a complex but much-needed step in the initial stages of the discovery and exploration of a problem. Interviews emerged amongst the activities perceived as most useful within the UCD Sprint process, the knowledge derived from them leading to actionable insights. Similarly, HiFi prototyping and user testing received high scores, being seen as useful and thought-provoking, and consistently being positively mentioned by both practitioners and students. Result analysis is seen as a natural step in the ideation phase, deriving insights into future work.

The second circle, comprising contextual activities, includes activities such as low-fidelity (LoFi) prototyping and user testing, and Brainstorming activities (including Crazy 8s). These activities provide flexibility and adaptability but must be used in the correct context. Some projects might benefit more than others from the usage of these activities. The literature shows practitioners using a wide variety of activities, many times informal ones such as blogs or casual feedback [42], and adapting existing activities and processes to fit their needs [15], [44], [45]. In the non-case paper [15], all practitioners mentioned using or having used Design Sprints, but modifying the process to fit the project or team. Furthermore, in the same publication, more practitioners mentioned using LoFi prototyping than HiFi. However, within the Experience-Driven Game Design process [89], some students found the LoFi prototyping to be cumbersome and ill-fitting to their needs. These activities received polarising reviews, due to their need to be fit for context – they are seen as enriching, useful, and fun when they fit the project context; and cumbersome, useless, and even boring when they do not.

Finally, **the third circle**, representing the periphery, includes exploratory and preparatory activities, as well as iterations of activities from the previous two circles. Activities such as exploring user webs, crafting a design brief, setting experience goals, or iterating on the mapping, find their place here. These activities often serve as supplementary tools, enhancing the depth of the design process but not always being directly necessary. Given the series of challenges, including constraints related to time, resources, and organisational support [17], [33], [34], [47], [48] faced when carrying out UCD activities, activities from this circle are what could be called "nice to have", if the resources and project boundaries allow. Notably, the second and third circles exhibit fluid boundaries, with activities occasionally overlapping or transitioning depending on the project requirements, and the preferences and knowledge of the person applying them.

By organising UCD activities into these circles, this thesis aims to offer a nuanced perspective that bridges student understanding and practitioner expertise, emphasising the flexible but structured nature needed in effective design processes. This being said, despite the diversity of existing software design processes, most follow a fundamental exploration-design-testing structure. This foundational framework not only serves as a guiding principle for the development of effective software design processes but also facilitates the systematic tracking of user needs and project requirements, allowing for iteration and optimisation. However, it is important to acknowledge that, for the educational context, student perceptions of UCD activities may not fully capture their long-term relevance or effectiveness in professional settings. The reliance on student-reported data introduces potential biases, as their immediate engagement or interest in certain methods may not align with industry needs or deeper skill development over time. While practitioner data was also included when developing this overview of activities, this limitation still exists.

The publications related to students presented in this thesis highlight the benefits of structure within educational contexts [37], [88], [89], aligning with previous studies showing a structured process can allow students to focus on the project without feeling overburdened [38]. The publications related to practitioners [15], [33] highlight the need for flexibility and adaptability, in line with previous studies [44], [45].

5.3 Practical Implications

The intended implementation of design processes in both educational and professional contexts highlights a crucial finding: the perceived usefulness of a process is heavily context-dependent.

In student contexts, particularly in undergraduate courses, the complexity of UCD necessitates a structured approach that caters to the varying levels of prior experience and expertise of students, thus the practical findings of this thesis pertain to educators primarily. Scaffolding, the practice of providing temporary support to students [36], is essential for facilitating accessibility, enabling them to grasp core concepts of UCD, make informed decisions within defined boundaries while maintaining a manageable problem scope, ensuring that students can engage with UCD principles without becoming overwhelmed. This can involve breaking down complex tasks into manageable components, enabling students to grasp fundamental concepts before progressing to more advanced UCD activities. Furthermore, the incorporation of decomposition within UCD processes allows educators to split the design cycle into phases, each with specific learning objectives. This strategy aids students in developing a coherent understanding of the workflow, while also fostering critical skills such as analysis, ideation, prototyping, and user testing. Students are seen positively highlighting the structured, step-by-step nature of the UCD Sprint throughout the publications [37], [88], [89]. Although struggling with some of the initial activities, the step-by-step nature is mentioned as helpful and reassuring, making the UCD activities seem more accessible.

In addition to providing scaffolding and decomposition, exposing students to a wide variety of UCD activities is critical for a comprehensive understanding. Exposure to a full design cycle, which encompasses exploration, design, and testing, can allow them to appreciate the interconnectedness of these stages and enhance their ability to address complex problems [59], [64], [65]. This need for a complete process is especially highlighted as we see students struggle with the non-linearity of design [8], [9], [59], and individual activities might appear disconnected if presented out of the context of a full process. This exposure can equip students with the knowledge and skills necessary to navigate each aspect of the UCD process, fostering adaptability and creativity in their future endeavours, but also allowing them to develop the skills needed to see the bigger picture when approaching UCD. As students engage with different UCD activities, they not only develop technical proficiency but also cultivate a holistic perspective of UCD, which can prepare them to tackle real-world challenges effectively. Thus, educators are highly encouraged to use scaffolding and decomposition, introducing students to a wide variety of activities through a structured, complete process, and through a diverse means of delivering information.

The need for context-sensitive processes becomes more evident in the context of practitioners, as practitioners encounter project-specific constraints, stakeholder requirements, or a lack of resources [15], [17], [33], [34]. A flexible UCD process, which retains core design principles while allowing for contextual adaptations, can enhance their ability to address these varied challenges. This being said, practitioners rely heavily on their experience when assessing the context of a project, choosing activities based on it [15]. While this might mean that a rigidly structured UCD process does not necessarily fit them, exposure to new UCD processes may be, nonetheless, a constructive endeavour for the purpose of lifelong learning and exposure to potentially new individual UCD activities. This being said, in the context of practitioners, Roedl and Stolterman [90] have aptly summarised *"In many cases, the research is valuable enough by producing new understandings and does not have to immediately have practical implications"*, a conclusion bringing into focus the reality of practitioner research.

Ultimately, this thesis highlights the importance of a tailored approach to design processes, where educators and practitioners alike must consider their specific contexts, audiences, and objectives when implementing UCD processes.

5.4 Limitations

One of the primary limitations of this research is the homogeneity of the student sample, a large share of which is made up of Icelandic first-semester Computer Science students at Reykjavik University. While there is some variability in terms of age, education, and previous work experience, the Icelandic sample is largely uniform in gender, ethnicity, and socio-economic background. This lack of diversity may restrict the ability to generalise findings to broader populations of UCD students, particularly those from more diverse contexts. It is possible that the behaviours, preferences, and challenges observed in this group may not fully capture the experiences of students in other regions or with differing demographic characteristics. This limitation is partially mediated by the introduction of Publication V, which shares insights into students from the University of Campinas, Brazil, providing diversity in terms of nationality, ethnicity, and socio-economical background, as well as specialisation and interests.

On a similar note, the practitioner studies involve a limited number of participants. Although these individuals bring varied experiences and represent a range of roles and companies, the small sample size inherently constrains the scope of generalisability. The findings may not fully represent the broader spectrum of professional practices in the field of software design, although a deliberate attempt at targeting practitioners with diverse roles, experience levels, and backgrounds was made. Furthermore, UCD experience is hard to quantify. While ideally the experience would function on a spectrum, between complete novice and experienced practitioner, this was not implemented in the current work.

An additional element to be mentioned is the reliance on student data to assess the effectiveness of the UCD Sprint in educational settings. While these data provide valuable insights into student experiences, it is important to acknowledge the potential bias in student responses, as their perceptions of what is interesting or useful may not fully align with long-term skill development or industry relevance. Additionally, the study did not explore student choices if prompted to choose their own methods, which could influence engagement and learning outcomes. This limitation is particularly relevant when considering frameworks like the model presented in Figure 5.1, where deeper layers of expertise and contextual understanding develop over time, with repeated use of certain activities within a variety of projects and contexts. Future research could investigate how giving students more agency in selecting design methods impacts their learning and whether structured processes like the UCD Sprint remain beneficial when learners have greater autonomy.

Chapter 6

Conclusion

This thesis explored the challenges and opportunities inherent in the usage of the UCD Sprint process for both practitioners and students, addressing gaps between theoretical ideals and practical applications. Through the analysis of an applied process, the UCD Sprint, and its adaptation for diverse contexts, this work provides insights into how a structured process can better align UCD approaches with real-world needs.

For practitioners, this research highlights the tension between structure and adaptability in the UCD Sprint process. While structured processes like the UCD Sprint offer clear frameworks that can facilitate collaboration, communication, and user focus, they must remain flexible to accommodate project-specific demands such as time limitations, stakeholder conflicts, and dynamic workflows [33]. The findings show that practitioners often adopt structured processes as adaptable toolboxes rather than rigid approaches, drawing on their experience to selectively integrate activities that align with project priorities [15]. This aligns with broader UCD literature, which underscores the importance of maintaining a balance between systematic, structured processes and creative freedom, as practitioners adapt processes and activities [44], [45]. The UCD Sprint, therefore, is positioned as a toolbox that can enhance consistency and communication [33]. While the findings of this thesis focused on uncovering limitations that can be addressed by the introduction of the UCD Sprint process, and presenting results from what can be considered a successful intervention with practitioners, it can be largely deduced that the

UCD Sprint would not be an ideal fit for practitioners.

From an educational perspective, this thesis better highlights the value the UCD Sprint can provide. Students often struggle with key skills that practitioners develop through practice and trial-and-error, such as problem framing [25], iterative prototyping [30], and reflective practice [32]. By introducing structured processes like the UCD Sprint into educational settings, this research shows how scaffolding can guide students through the complexities of ideation and design [89]. The step-by-step nature of the UCD Sprint can help students navigate critical phases such as exploration, ideation, and testing. The positive student feedback highlights the effectiveness of hands-on, practical activities, which connect abstract concepts to tangible outcomes [37], [88], [89]. However, the mixed responses to abstract exercises emphasise the need for educators to provide clearer contextualisation and demonstrate the relevance of these activities within the larger picture.

In conclusion, this thesis demonstrates that while the UCD Sprint process can be a way of providing clarity, consistency, and guidance, its success ultimately depends on adaptability to specific contexts. Practitioners benefit from flexibility within structured frameworks, using their experience to customise processes to project needs. Students, on the other hand, require scaffolding and decomposition to develop foundational skills and build confidence in applying UCD activities. Therefore, while the UCD Sprint, like other structured processes, may not be ideal for practitioners, it could have a valuable role in educational settings, where students benefit from its structured guidance in developing foundational skills.

Bibliography

[1] P. Yammiyavar, T. Clemmensen, and J. Kumar, “Influence of cultural background on non-verbal communication in a usability testing situation”, *International Journal of Design*, vol. 2, no. 2, pp. 31–40, Aug. 2008.

[2] I. Visescu, “The impact of culture on visual design perception”, *Human-Computer-Interaction – INTERACT 2021*, pp. 499–503, 2021. DOI: https://doi.org/10.1007/978-3-030-85607-6_66.

[3] S. Sayago, “Culture matters in hci”, *Synthesis lectures on human-centered informatics*, pp. 25–40, Jan. 2023. DOI: https://doi.org/10.1007/978-3-031-30243-5_3.

[4] G. Fitzpatrick, *The Locales Framework*. Springer Science Business Media, Jun. 2013, ISBN: 9789401703635.

[5] J. Zimmerman, J. Forlizzi, and S. Evenson, “Research through design as a method for interaction design research in hci”, in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '07*, 2007, ISBN: 9781595935939. DOI: https://doi.org/10.1145/1240624.1240704. [Online]. Available: https://dl.acm.org/citation.cfm?id=1240704.

[6] L. Schmitz, E. Richert, M. K. Lárusdóttir, E. S. Arnardottir, and A. S. Islind, “Nudging with dignity: A critical examination of when and how to use digital nudging”, in *5th Scandinavian Conference on Information Systems*, AIS eLibrary, 2024. [Online]. Available: https://aisel.aisnet.org/scis2024/4/.

[7] C. M. Gray, C. Santos, and N. Bielova, "Towards a preliminary ontology of dark patterns knowledge", in *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems*, Apr. 2023. DOI: https://doi.org/10.1145/3544549.3585676. [Online]. Available: https://colingray.me/wp-content/uploads/2023/03/2023_GraySantosBielova_CHIBLW_OntologyDarkPatterns.pdf.

[8] K. Dorst, "Frame creation and design in the expanded field", *She Ji: The Journal of Design, Economics, and Innovation*, vol. 1, no. 1, pp. 22–33, 2015. DOI: https://doi.org/10.1016/j.sheji.2015.07.003.

[9] B. Paton and K. Dorst, "Briefing and reframing: A situated practice", *Design Studies*, vol. 32, no. 6, pp. 573–587, Nov. 2011. DOI: https://doi.org/10.1016/j.destud.2011.07.002.

[10] L. Sanders, "On modeling an evolving map of design practice and design research", *interactions*, vol. 15, no. 6, p. 13, Nov. 2008. DOI: https://doi.org/10.1145/1409040.1409043.

[11] E. B.-N. Sanders and P. J. Stappers, "Co-creation and the new landscapes of design", *CoDesign*, vol. 4, no. 1, pp. 5–18, Mar. 2008. DOI: https://doi.org/10.1080/15710880701875068. [Online]. Available: https://www.researchgate.net/publication/235700862_Co-creation_and_the_New_Landscapes_of_Design.

[12] D. A. Norman and S. W. Draper, *User Centered System Design: New Perspectives on Human-Computer Interaction*. Jan. 1986.

[13] ISO, *ISO 13407:1999 Human-centred design processes for interactive systems*. Jun. 1999. [Online]. Available: https://www.iso.org/standard/21197.html.

[14] ISO, *ISO 9241-210:2019 Ergonomics of human-system interaction*. Jul. 2019. [Online]. Available: https://www.iso.org/standard/21197.html.

[15] I. Visescu, M. Lárusdóttir, and W. Choi, "Exploration of ucd practice limitations", *Interacting with Computers*, Oct. 2024. DOI: https://doi.org/10.1093/iwc/iwae046.

[16] Y. Inal, T. Clemmensen, D. Rajanen, N. Iivari, K. Rızvanoğlu, and A. Sivaji, "Positive developments but challenges still ahead: A survey study on ux professionals' work practices", *Journal of User Experience*, vol. 15, no. 4, 2020. [Online]. Available: `https://uxpajournal.org/ux-professionals-work-practices/`.

[17] Å. Cajander, M. K. Larusdottir, and J. L. Geiser, "Ux professionals' learning and usage of ux methods in agile", *Information and Software Technology*, p. 107 005, Jul. 2022. DOI: `https://doi.org/10.1016/j.infsof.2022.107005`.

[18] ISO, *ISO 9241-210:2010 Ergonomics of human-system interaction.* Mar. 2010. [Online]. Available: `https://www.iso.org/standard/21197.html`.

[19] J. C. Jones, *Design methods.* New York: John Wiley Sons, 1992, ISBN: 9780471284963.

[20] D. Council, *History of the double diamond - design council*, 2024. [Online]. Available: `https://www.designcouncil.org.uk/our-resources/the-double-diamond/history-of-the-double-diamond/`.

[21] T. Silva da Silva, A. Martin, F. Maurer, and M. Silveira, *User-centered design and agile methods: A systematic review*, Aug. 2011. DOI: `https://doi.org/10.1109/AGILE.2011.24`. [Online]. Available: `https://ieeexplore.ieee.org/abstract/document/6005488`.

[22] G. Venturi and J. Troost, "Survey on the ucd integration in the industry", in *Proceedings of the Third Nordic Conference on Human-Computer Interaction*, ser. NordiCHI '04, Tampere, Finland: Association for Computing Machinery, 2004, pp. 449–452, ISBN: 1581138571. DOI: `10.1145/1028014.1028092`. [Online]. Available: `https://doi.org/10.1145/1028014.1028092`.

[23] I. Hussein, A. Hussain, E. O.C.Mkpojiogu, and Z. Zaba, "The user centred design (ucd) and user experience design (uxd) practice in industry: Performance methods and practice constraints", *International Journal of Recent Technology and Engineering*, vol. 8, no. 2S2, pp. 175–182, Jul. 2019. DOI: `https://doi.org/10.35940/ijrte.b1032.0782s219`.

[24] V. Svihla and R. Reeve, "Facilitating problem framing in project-based learning", *Interdisciplinary Journal of Problem-Based Learning*, vol. 10, no. 2, Oct. 2016. DOI: https://doi.org/10.7771/1541-5015.1603.

[25] C. J. Atman, R. S. Adams, M. E. Cardella, J. Turns, S. Mosborg, and J. Saleem, "Engineering design processes: A comparison of students and expert practitioners", *Journal of Engineering Education*, vol. 96, no. 4, pp. 359–379, Oct. 2007. DOI: https://doi.org/10.1002/j.2168-9830.2007.tb00945.x.

[26] D. C. Wynn and C. M. Eckert, "Perspectives on iteration in design and development", *Research in Engineering Design*, vol. 28, no. 2, pp. 153–184, Apr. 2016. DOI: https://doi.org/10.1007/s00163-016-0226-3.

[27] J. Kim and H. Ryu, "A design thinking rationality framework: Framing and solving design problems in early concept generation", *Human–Computer Interaction*, vol. 29, no. 5-6, pp. 516–553, Jun. 2014. DOI: https://doi.org/10.1080/07370024.2014.896706.

[28] T. Kvan and S. Gao, "Problem framing in multiple settings", *International Journal of Architectural Computing*, vol. 2, no. 4, pp. 443–460, Dec. 2004. DOI: https://doi.org/10.1260/1478077042906186.

[29] P. Lloyd and P. Scott, "Discovering the design problem", *Design Studies*, vol. 15, no. 2, pp. 125–140, Apr. 1994. DOI: https://doi.org/10.1016/0142-694x(94)90020-5.

[30] S. Ahmed, K. M. Wallace, and L. T. Blessing, "Understanding the differences between how novice and experienced designers approach design tasks", *Research in Engineering Design*, vol. 14, no. 1, pp. 1–11, Feb. 2003. DOI: https://doi.org/10.1007/s00163-002-0023-z.

[31] T. Björklund, H. Maula, S. A. Soule, and J. Maula, "Integrating design into organizations: The coevolution of design capabilities", *California Management Review*, vol. 62, no. 2, p. 000 812 561 989 824, Jan. 2020. DOI: https://doi.org/10.1177/0008125619898245.

[32] M. Deininger, S. R. Daly, K. H. Sienko, and J. C. Lee, "Novice designers' use of prototypes in engineering design", *Design Studies*, vol. 51, pp. 25–65, Jul. 2017. DOI: https://doi.org/10.1016/j.destud.2017.04.002. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0142694X17300273.

[33] M. K. Larusdottir, R. Lanzilotti, A. Piccinno, I. Visescu, and M. F. Costabile, "Ucd sprint: A fast process to involve users in the design practices of software companies", *International Journal of Human-Computer Interaction*, pp. 1–18, Nov. 2023. DOI: https://doi.org/10.1080/10447318.2023.2279816.

[34] K. Vredenburg, J.-Y. Mao, P. W. Smith, and T. Carey, "A survey of user-centered design practice", *Proceedings of the SIGCHI conference on Human factors in computing systems Changing our world, changing ourselves - CHI '02*, 2002. DOI: https://doi.org/10.1145/503376.503460.

[35] N. Marsden and K. Holtzblatt, "How do hci professionals perceive their work experience?", Apr. 2018. DOI: https://doi.org/10.1145/3170427.3188501.

[36] D. Wood, J. S. Bruner, and G. Ross, "The role of tutoring in problem solving", *Journal of Child Psychology and Psychiatry*, vol. 17, no. 2, pp. 89–100, 1976.

[37] I. Visescu, M. Lárusdóttir, and A. S. Islind, "Exposure to user-centred design activities: Experiences in higher education", in *Paper accepted for publication at IEEE Global Engineering Education Conference (EDUCON)*, IEEE, Apr. 2025.

[38] E. Arce, A. Suárez-García, J. A. López-Vázquez, and M. I. Fernández-Ibáñez, "Design sprint: Enhancing steam and engineering education through agile prototyping and testing ideas", *Thinking Skills and Creativity*, p. 101 039, Apr. 2022. DOI: https://doi.org/10.1016/j.tsc.2022.101039.

[39] V. Roto, M. Larusdottir, A. Lucero, J. Stage, and I. Šmorgun, "Focus, structure, reflection! integrating user-centred design and design sprint", in *Human-Computer Interaction – INTERACT 2021*, 2021, pp. 239–258, ISBN: 9783030856151. DOI: https://doi.org/10.1007/978-3-030-85616-8_15.

[Online]. Available: http://www.funkydesignspaces.com/publications/2021/roto21_focus.pdf.

[40] I. Visescu, M. Larusdottir, and A. S. Islind, "User-centred design: Experiences from toolbox-based learning", in *HCSE 2024: Lecture notes in computer science*, Springer Science+Business Media, Jun. 2024, pp. 233–240. DOI: https://doi.org/10.1007/978-3-031-64576-1_14.

[41] M. Bano and D. Zowghi, "A systematic review on the relationship between user involvement and system success", *Information and Software Technology*, vol. 58, pp. 148–169, Feb. 2015. DOI: https://doi.org/10.1016/j.infsof.2014.06.011.

[42] Å. Cajander, M. Larusdottir, and J. Gulliksen, "Existing but not explicit - the user perspective in scrum projects in practice", in *INTERACT 2013. Lecture Notes in Computer Science*, vol. 8119, Berlin, Heidelberg: Springer, Jan. 2013, pp. 762–779. DOI: https://doi.org/10.1007/978-3-642-40477-1_52.

[43] Y. Jia, M. Lárusdóttir, and Å. Cajander, "The usage of usability techniques in scrum projects", in *Lecture Notes in Computer Science*, vol. 7623, Berlin, Heidelberg: Springer, Jan. 2012, pp. 331–341. DOI: https://doi.org/10.1007/978-3-642-34347-6_25.

[44] G. Getto and F. Beecher, "Toward a model of ux education: Training ux designers within the academy", *IEEE Transactions on Professional Communication*, vol. 59, no. 2, pp. 153–164, Jun. 2016. DOI: https://doi.org/10.1109/tpc.2016.2561139.

[45] A. Austin, J. Abdelnour Nocera, and T. Clemmensen, ""the era of ferment:" how practitioners and educators frame hci", *Journal of User Experience*, vol. 18, no. 1, pp. 7–40, 2022.

[46] S. Kaplan and M. Tripsas, "Thinking about technology: Applying a cognitive lens to technical change", *SSRN Electronic Journal*, 2008. DOI: https://doi.org/10.2139/ssrn.1008908.

[47] O. Stickel, C. Ogonowski, T. Jakobi, G. Stevens, V. Pipek, and V. Wulf, "User integration in agile software development processes: Practices and challenges in small and medium sized enterprises", *Human–Computer Interaction Series*, pp. 49–76, 2016. DOI: https://doi.org/10.1007/978-3-319-32165-3_2.

[48] C. Ardito, P. Buono, D. Caivano, M. F. Costabile, and R. Lanzilotti, "Investigating and promoting ux practice in industry: An experimental study", *International Journal of Human-Computer Studies*, vol. 72, no. 6, pp. 542–551, Jun. 2014. DOI: https://doi.org/10.1016/j.ijhcs.2013.10.004.

[49] S. Blomkvist, "Towards a model for bridging agile development and user-centered design", in *Human-Centered Software Engineering — Integrating Usability in the Software Development Lifecycle*, Uppsala Sweden: Springer, 2005, pp. 219–244, ISBN: 9781402040276. DOI: https://doi.org/10.1007/1-4020-4113-6_12.

[50] A. Taslim, "Towards a framework for integration of user-centered design and agile methodology", *Journal of Computer Science*, vol. 3, no. 1, Nov. 2018. DOI: https://doi.org/10.31357/jcs.v3i1.3000.

[51] S. Chamberlain, H. Sharp, and N. Maiden, "Towards a framework for integrating agile development and user-centred design", in *XP'06: Proceedings of the 7th international conference on Extreme Programming and Agile Processes in Software Engineering*, 2006, pp. 143–153. DOI: https://doi.org/10.1007/11774129_15.

[52] J. Knapp, J. Zeratsky, and B. Kowitz, *Sprint.* Simon and Schuster, Mar. 2016, ISBN: 9781501121777.

[53] AJSmart, *Design sprint masterclass by ajsmart.* 2024. [Online]. Available: https://go.ajsmart.com/masterclass.

[54] Google, *Design sprint methodology.* [Online]. Available: https://designsprintkit.withgoogle.com/methodology/overview.

[55] H. Southall, M. Marmion, and A. Davies, "Adapting jake knapp's design sprint approach for ar/vr applications in digital heritage", *Augmented Reality and Virtual Reality*, pp. 59–70, 2019. DOI: https://doi.org/10.1007/978-3-030-06246-0_5.

[56] A. Bruun, M. K. Larusdottir, L. Nielsen, P. A. Nielsen, and J. S. Persson, "The role of ux professionals in agile development", in *Proceedings of the 10th Nordic Conference on Human-Computer Interaction - NordiCHI '18*, 2018, ISBN: 9781450364379. DOI: https://doi.org/10.1145/3240167.3240213.

[57] J. S. Persson, A. Bruun, M. K. Lárusdóttir, and P. A. Nielsen, "Agile software development and ux design: A case study of integration by mutual adjustment", *Information and Software Technology*, vol. 152, p. 107 059, Dec. 2022. DOI: https://doi.org/10.1016/j.infsof.2022.107059.

[58] A. Hinderks, F. J. D. Mayo, J. Thomaschewski, and M. J. Escalona, "Approaches to manage the user experience process in agile software development: A systematic literature review", *Information and Software Technology*, p. 106 957, May 2022. DOI: https://doi.org/10.1016/j.infsof.2022.106957.

[59] S. MacNeil, Z. Ding, K. Quan, T. j. Parashos, Y. Sun, and S. W. Dow, "Framing creative work: Helping novices frame better problems through interactive scaffolding", Jun. 2021. DOI: https://doi.org/10.1145/3450741.3465261.

[60] R. Blyth, N. Schadewitz, H. Sharp, M. Woodroffe, D. Rajah, and R. Turugare, "A frame signature matrix for analysing and comparing interaction design behaviour", in *BCS HCI Conference*, Birmingham, Sep. 2012. DOI: https://oro.open.ac.uk/34378/1/BCS%20HCI%20final.pdf. [Online]. Available: https://oro.open.ac.uk/34378/.

[61] V. Goel and P. Pirolli, "The structure of design problem spaces", *Cognitive Science*, vol. 16, no. 3, pp. 395–429, Jul. 1992. DOI: https://doi.org/10.1016/0364-0213(92)90038-V. [Online]. Available: https://www.sciencedirect.com/science/article/abs/pii/036402139290038V.

[62] N. Cross, "Expertise in design: An overview", *Design Studies*, vol. 25, no. 5, pp. 427–441, Sep. 2004. DOI: https://doi.org/10.1016/j.destud.2004.06.002.

[63] H.-J. Chen, Y.-T. Chen, and C.-H. Yang, "Behaviors of novice and expert designers in the design process: From discovery to design", *International Journal of Design*, vol. 16, no. 3, 2022. DOI: https://doi.org/10.57698/v16i3.04.

[64] S. L. Beckman and M. Barry, "Innovation as a learning process: Embedding design thinking", *California Management Review*, vol. 50, no. 1, pp. 25–56, Oct. 2007. DOI: https://doi.org/10.2307/41166415.

[65] A. G. Earle and D. I. Leyva-de la Hiz, "The wicked problem of teaching about wicked problems: Design thinking and emerging technologies in sustainability education", *Management Learning*, vol. 52, no. 5, p. 135 050 762 097 485, Dec. 2020. DOI: https://doi.org/10.1177/1350507620974857.

[66] L. Williams Goodrich, "Sumak kawsay : Social empowerment through participatory user-centred design in ecuador", *International Journal of Art Design Education*, vol. 38, no. 1, pp. 193–206, Sep. 2018. DOI: https://doi.org/10.1111/jade.12175.

[67] B. Westerlund and K. Wetter-Edman, "Dealing with wicked problems, in messy contexts, through prototyping", *The Design Journal*, vol. 20, no. sup1, S886–S899, Jul. 2017. DOI: https://doi.org/10.1080/14606925.2017.1353034.

[68] J. Abdelnour-Nocera, M. Michaelides, A. Austin, and S. Modi, "An intercultural study of hci education experience and representation", in *Proceedings of the 4th international conference on Intercultural Collaboration - ICIC '12*, 2012. DOI: https://doi.org/10.1145/2160881.2160909.

[69] O. St-Cyr, C. M. MacDonald, E. F. Churchill, J. J. Preece, and A. Bowser, "Developing a community of practice to support global hci education", in *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems*, Apr. 2018. DOI: https://doi.org/10.1145/3170427.3170616.

[70] M. K. Larusdottir, "User centred evaluation in experimental and practical settings", Ph.D. dissertation, KTH, School of Computer Science, Communication (CSC), Media Technology, and Interaction Design, MID., 2012. [Online]. Available: https://www.diva-portal.org/smash/record.jsf?pid=diva2%3A527518&dswid=-6970.

[71] W. Roldan, X. Gao, A. M. Hishikawa, *et al.*, "Opportunities and challenges in involving users in project-based hci education", *Proceedings of the 2020 CHI Conference on Hu-*

man Factors in Computing Systems, Apr. 2020. DOI: https://doi.org/10.1145/3313831.3376530.

[72] B. Altay, "User-centered design through learner-centered instruction", *Teaching in Higher Education*, vol. 19, no. 2, pp. 138–155, Aug. 2013. DOI: https://doi.org/10.1080/13562517.2013.827646.

[73] S. Pontis and K. van der Waarde, "Looking for alternatives: Challenging assumptions in design education", *She Ji: The Journal of Design, Economics, and Innovation*, vol. 6, no. 2, pp. 228–253, 2020. DOI: https://doi.org/10.1016/j.sheji.2020.05.005.

[74] V. G. Ferreira and E. D. Canedo, "Design sprint in classroom: Exploring new active learning tools for project-based learning approach", *Journal of Ambient Intelligence and Humanized Computing*, Mar. 2019. DOI: https://doi.org/10.1007/s12652-019-01285-3.

[75] Nordplus, *Nordplus*, Oct. 2024. [Online]. Available: https://www.nordplusonline.org/.

[76] K. Holtzblatt and H. Beyer, *Contextual design : a customer-center approach to software design.* San Francisco, Calif.: Morgan Kaufmann, 1997, ISBN: 9781558604117.

[77] M. Larusdottir, V. Roto, J. Stage, and A. Lucero, "Get realistic! - ucd course design and evaluation", in *Human-Centered Software Engineering. HCSE 2018. Lecture Notes in Computer Science, vol 11262. Springer, Cham.*, Sep. 2018, pp. 15–30. DOI: https://doi.org/10.1007/978-3-030-05909-5_2.

[78] M. Larusdottir, V. Roto, J. Stage, A. Lucero, and I. Šmorgun, "Balance talking and doing! using google design sprint to enhance an intensive ucd course", in *Human-Computer Interaction – INTERACT 2019*, 2019, pp. 95–113, ISBN: 9783030293833. DOI: https://doi.org/10.1007/978-3-030-29384-0_6.

[79] R. K. Yin, *Case Study Research and Applications: Design and Methods*, 6th ed. Thousand Oaks, California: Sage Publications, 2018, ISBN: 9781506336169.

[80] H. Maarouf, “Pragmatism as a supportive paradigm for the mixed research approach: Conceptualizing the ontological, epistemological, and axiological stances of pragmatism”, *International Business Research*, vol. 12, no. 9, pp. 1–12, Aug. 2019.

[81] D. L. Morgan, “Paradigms lost and pragmatism regained: Methodological implications of combining qualitative and quantitative methods”, *Journal of Mixed Methods Research*, vol. 1, no. 1, pp. 48–76, Jan. 2007. DOI: `https://doi.org/10.1177/2345678906292462`.

[82] M. Lárusdóttir and V. Roto, “Evaluating learning experiences-comparison of two student feedback methods”, in *Lecture notes in computer science*, Springer Science+Business Media, Jan. 2024, pp. 171–180. DOI: `https://doi.org/10.1007/978-3-031-64576-1_10`.

[83] D. Magaldi and M. Berler, “Semi-structured interviews”, *Encyclopedia of Personality and Individual Differences*, vol. 1, no. 1, pp. 4825–4830, 2020. [Online]. Available: `https://link.springer.com/referenceworkentry/10.1007/978-3-319-24612-3_857`.

[84] W. Strijbosch, O. Mitas, M. van Gisbergen, M. Doicaru, J. Gelissen, and M. Bastiaansen, “From experience to memory: On the robustness of the peak-and-end-rule for complex, heterogeneous experiences”, *Frontiers in Psychology*, vol. 10, Jul. 2019. DOI: `https://doi.org/10.3389/fpsyg.2019.01705`.

[85] J. R. Lewis, B. S. Utesch, and D. E. Maher, “Umux-lite: When there’s no time for the sus”, in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI ’13*, 2013, ISBN: 9781450318990. DOI: `https://doi.org/10.1145/2470654.2481287`.

[86] G. C. Natucci and M. A. F. Borges, “The experience, dynamics and artifacts framework: Towards a holistic model for designing serious and entertainment games”, in *2021 IEEE Conference on Games (CoG)*, Aug. 2021. DOI: `https://doi.org/10.1109/cog52621.2021.9619144`.

[87] S. Theodosiou and I. Karasavvidis, "Serious games design: A mapping of the problems novice game designers experience in designing games", *Journal of E-Learning and Knowledge Society*, vol. 11, no. 3, Sep. 2015. DOI: https://doi.org/10.20368/1971-8829/1071.

[88] I. Visescu, M. Larusdottir, and A. S. Islind, "Supporting active learning in stem higher education through the user-centred design sprint", in *2023 IEEE Frontiers in Education Conference (FIE)*, IEEE, Oct. 2023, pp. 1–10. DOI: https://doi.org/10.1109/fie58773.2023.10342978.

[89] G. C. Natucci*, I. Visescu*, M. K. Larusdottir, M. A. F. Borges, and A. S. Islind, "From user-centred to player-centred: A game design methodology", *To be submitted to International Journal of Human–Computer Interaction, by 15.01.2025*,

[90] D. J. Roedl and E. Stolterman, "Design research at chi and its applicability to design practice", in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, ser. CHI '13, Paris, France: Association for Computing Machinery, 2013, pp. 1951–1954, ISBN: 9781450318990. DOI: 10.1145/2470654.2466257. [Online]. Available: https://doi.org/10.1145/2470654.2466257.

Appendix A

Declaration of authorship contribution

The table below is intended to serve as a template for how much effort was involved by the Ph.D. student in the various stages of the publication process of a research article. What is excluded in the table is what role the Ph.D. student had, i.e., whether the Ph.D. student took the lead in the project, coordinated it, acted as the driving force, handled all administration, etc., or not. The idea is, therefore, that one of the following abbreviations (ME, EE, CE, or LE) should be entered in each box. Below the tables, a brief explanation is given for each column in the table. This declaration of authorship contribution is to be submitted to the RGCS in the Computer Science department.

- ME = Main effort, includes the main effort in the indicated column.
- EE = Equal efforts, includes that there was a shared equal effort between at least one other author of the paper (this can, for instance, be the case when the work behind the paper was divided or when co-authorship has been equally divided between at least two authors).
- CE = Contributing effort, entails important effort, but there is someone else in the author list that delivered the main effort.

- LE = Learning effort, includes an effort of a learning character, for instance, by assisting with the data collection or the analysis. At least a LE is needed in all columns to fulfill the Vancouver rules for authorship.

Paper name	Idea	Related work & literature	Data gathering	Research design	Artifact design	Analysis & synthesis	Draft	Administration
Paper 1								
Paper 2								

Idea = Crystallising and formulating a clear and novel research idea alongside research question(s) or hypothesis.

Related work and literature = Reading up on the relevant literature and related work, finding the relevant references as well as putting them together in a coherent manner, alongside building up the research gap.

Data gathering = The gathering of data for the paper.

Research design = Decide on how the data gathering should be conducted (randomized clinical trial, qualitative data gathering, mixed methods, devices used for data gathering or quantitative data gathering, for instance).

Artifact design = In case there is a theoretical model, a method, a digital artifact of some sort (or any software), requirements to be tested, or an algorithm (or machine learning model) that was developed in this category would cover it.

Analysis and synthesis = The analysis of the data alongside the discussion and main contributions are drawn from the analysis.

Draft = The first finished draft of the paper.

Administration = Includes all work with the administration of the publication, such as the submissions of the multiple revisions alongside communication with editors, a major effort in writing the revision comments for the journal papers and all communication and inclusion of all authors in the various revision rounds.

Appendix B

Publication I: Exploration of UCD Practice Limitations

Interacting with Computers, 2024, 1–18
https://doi.org/10.1093/iwc/iwae046
Article

Exploration of UCD Practice Limitations

Ioana Visescu[1], Marta Lárusdóttir[1,*] and Won Choi[2]

[1]Reykjavik University, Department of Computer Science, Menntavegi 1, Reykjavík, 102, Iceland
[2]Albert Nerken School of Engineering, Department of Mechanical Engineering ,The Cooper Union 445 E 14th St, New York, NY, 10009
Corresponding author: marta@ru.is

Abstract

The integration of user-centred design (UCD) practices in software development is fundamental for enhancing the overall experiences of software users. In this paper, we summarize the results of various research studies on what the stated limitations of UCD practices are. A process called the UCD Sprint was introduced recently with the goal of addressing some of the existing UCD practice limitations for integrating UCD practices in software development. The guided usage of the step-by-step process has been studied with students and UCD practitioners in courses showing positive results, where participants describe benefits while using the process, such as the speed of the process, its clear structure, guidance. In this paper, we describe results from a synthesis study summarizing results on how guided usage of the UCD Sprint can address UCD practice limitations. Furthermore, we describe results from a series of interviews with UCD practitioners on how they currently practice UCD, the challenges and limitations they experience and their views on how unguided usage of the UCD Sprint would potentially fit their UCD practices. While the interviewees recognize the importance of user involvement, they highlight challenges in aligning user interests with other stakeholders' interests. All participants had used processes like design sprints for structuring their UCD practices. Interviewees have generally tailored the traditional approach of design sprints, showcasing a nuanced understanding of UCD practices. The results show that the UCD Sprint process is considered by UCD practitioners as a promising approach for practicing UCD. The process is viewed with enthusiasm, but the need for clear objectives and adaptability to the work contexts of the UCD practitioners remains essential. UCD practitioners' adaptive strategies of their UCD practices emphasize the need for flexibility and adaptation of UCD practices and processes.

RESEARCH HIGHLIGHTS

- The paper identifies key challenges in aligning user needs with organizational goals in software development.
- We further discuss the effectiveness and limitations of guided and unguided usage of the UCD Sprint process.
- The findings highlight the importance of flexible UCD approaches and intra-organizational support for successful implementation of design processes

Keywords: *User experience (ux); User-centred design (ucd); Ucd practices; Ucd methods; Ucd sprint*

1. INTRODUCTION

The integration of user-centred design (UCD) practices is crucial in software development, as challenging user interfaces create difficulties for software users. Implementing UCD practices improves usability and the overall user experience, leading to favourable business outcomes (Ardito *et al.*, 2014). Especially, the active involvement of users has resulted in a positive impact on the success of software systems (Bano and Zowghi, 2015). Common UCD practices in the software industry include user testing, prototyping and user interviews, as well as user journeys and workshops (Cajander *et al.*, 2022). Informal practices like user blogs and informal prototype feedback from colleagues have also been used (Cajander *et al.*, 2013). A study on the benefits of various UCD practices shows that formal user testing was the highest-rated UCD method by UCD practitioners as a useful UCD practice (Jia *et al.*, 2012).

On the other hand, UCD practitioners describe various challenges and limitations while practicing UCD. The results in Cajander *et al.* (2022) show that UCD practitioners think that the UCD methods and practices are often complex, which results in taking the UCD practitioners too long to learn to use the UCD practices efficiently. Additionally, they find it challenging to integrate new UCD methods and practices into their current ways of working. Chamberlain *et al.* (2006) emphasized the struggle between developers' priorities and designers' focus on user needs in software development, showing developers do not appreciate the UCD practices. Additionally, results from Cajander *et al.* (2022), show that UCD practitioners struggle with managers, who focus on customers rather than on users, resulting in strictly following the business goals without involving the users in the software development. Involving users can be seen as time- and resource-consuming by management making it challenging to convince the management or clients of its need (Larusdottir *et al.*, 2023a). Additionally, the design practitioners in that study, report minimal user involvement in the early stages of software projects, with the customers taking on the role of the end user in pre-go-live and go-live phases.

Having limited user access makes it hard for UCD practitioners to use specific UCD methods, such as user testing. Other challenges include developers' misconceptions of users and usability,

Received: November 29, 2023. **Revised:** May 24, 2024. **Accepted:** July 11, 2024

and their view of integrating UCD practices as being unnecessary (Bach *et al.,* 2009). As an approach to designing user interfaces collaboratively in a team with a fast process, Knapp *et al.* (2016) introduced the Design Sprint, which is a 5-day process for design ideation and prototyping suitable for agile software development in the software industry. The Design Sprint emphasizes individual idea generation and quick visualization. It provides specific instructions for each activity in the process. In the Design Sprint, user input is gathered on the final day with fast user testing including five users. As a response to the lack of user-centredness of the Design Sprint, the UCD Sprint evolved, which includes users three times while conducting the process (Larusdottir *et al.,* 2019; Larusdottir *et al.,* 2021; Roto *et al.,* 2021). It aims to understand user needs and provides a predefined structure with clear goals and deliverables. The process has been taught in courses at universities and at conferences internationally (Larusdottir *et al.,* 2019; Larusdottir *et al.,* 2021; Roto *et al.,* 2021; Larusdottir *et al.,* 2022; Visescu *et al.,* 2023; Larusdottir *et al.,* 2023a; Larusdottir *et al.,* 2023b) showing promising results in the integration of a multitude of UCD methods within a structured, iterative process. The studies report positive feedback from students, particularly towards the UCD practices involving users or catering to user feedback directly. Furthermore, in an interview study with design practitioners on their experience of learning to use the UCD Sprint through guided training (which we define as contexts in which they are formally taught the process and work on completing a project with it), participants reacted positively to using the UCD Sprint during the course and expressed interest in incorporating it in future training and design practices at their company (Larusdottir *et al.,* 2023a).

The scope of this paper is exploring UCD practices in the software industry. More specifically, we explore the current literature on UCD practices, focusing on the challenges and limitations of UCD practices that UCD practitioners describe in research studies. In the first part of the study we analyse case studies, focusing on analysing how the recent UCD Sprint process could compensate for the UCD practice limitations. In the second part of the study, we describe results from interviews with UCD practitioners, focusing on the limitations they experience on the UCD practices and on their opinions on how an unguided usage of the UCD Sprint process could fit their work context. In this case, we refer to unguided usage as encountering the UCD Sprint process without formal training or guidance. The paper is centred around highlighting UCD limitations, as well as exploring the need of new processes such as the UCD Sprint, to address said limitations.

In this paper we aim to answer the following research questions:

RQ1: How do UCD practitioners conduct UCD practices currently?

RQ2. What limitations of UCD practices are faced by UCD practitioners?

RQ3. How does the guided usage of the UCD sprint address UCD practice limitations?

RQ4. How do UCD practitioners perceive the introduction of the UCD Sprint to address the limitations they encounter in their work?

To answer these questions, we have conducted a twofold study:

Part 1: We conducted a synthesis study of 3 cases with 231 participants in total, on what experiences participants in courses have while using the UCD Sprint process. During the courses, the participants went through guided usage of the process, where the instructors and founders guided them. In the synthesis study, we particularly focus on analysing how the UCD Sprint process addresses the limitations of current UCD practices found throughout the literature, to answer the third research question (RQ3).

Part 2: We conducted an interview study with 5 UCD practitioners in Iceland. The aim was to study how the participants conduct UCD, the challenges and limitations of UCD practices the participants have experienced. These results give some answers to the first and the second research question (RQ1 and RQ2). Additionally, we explored the current literature for summarizing the UCD practices and the UCD practice limitations reported there, for comparison and validation purposes, to gather additional answers to the first two research questions (RQ1 and RQ2). Furthermore, we explored in the interview study the perceived potential of adopting unguided usage of the UCD Sprint process in the participants' work to address the limitations they currently face when conducting UCD. This addresses the fourth research question (RQ4).

The contribution of the paper is threefold. First, we summarize from our exploration of the literature and our interview study, the current UCD practices and limitations of UCD experienced in the software industry. Second, we summarize the results from case studies conducted in guided settings through courses on how the recent UCD Sprint process may address the UCD practice limitations. Third, we describe results on the feedback received on the UCD Sprint, optimization points and strengths highlighted by the practitioners. These results are based on results from interviews with UCD practitioners.

2. BACKGROUND

This section explores UCD and its practical application in software development. It briefly describes the theoretical framework, emphasizing ISO standards and outlines methods for gathering user data and defining requirements. It further addresses practical challenges faced by UCD practitioners and efforts to overcome them, including integrating UCD with agile practices and structured approaches like Design Sprints. The section concludes by emphasizing the need for continued innovation and adaptation in UCD practices.

2.1. UCD and UCD practices

Many UCD methods to facilitate UCD practices during software development have been suggested through the years. In this paper, we refer to theoretical UCD adhering to the ISO standard for Human Centred Design, as outlined in ISO 9241-210 (International Organization for Standardization, 2019). Following the principles set forth in this standard, UCD prioritizes the creation of products and systems that effectively meet the needs of users while enhancing usability, accessibility and user experience. However, while theoretical UCD outlines ideal principles, practical UCD varies in application due to various limitations and constraints. Some UCD methods play a pivotal role in the initial stage of exploring the project idea and stating the user needs and requirements. To this end, various data-gathering techniques, such as interviews, questionnaires, workshops, field studies, observations and focus groups, as articulated by Rogers *et al.* (2023), prove invaluable. Furthermore, defining the needs of the users in some detail necessitates the employment of UCD methods like personas, scenarios or user group profiles. Practitioners, independent of the experience level, tend to use a wide variety of methods and tools, adapting methods or creating their own, highlighting the importance of flexible approaches (Austin *et al.,* 2023), and thus the lack of a dominant design (Kaplan and Tripsas, 2008).

Generally, the sketching and creation of the first ideas of the user interface design necessitates a diverse array of methods and tools. Commencing with the development of wireframes, as highlighted by Bruun *et al.* (2018), provides a standard starting point. Subsequently, the process evolves with the generation of mock-ups, sketches and storyboards, culminating in the creation of detailed digital prototypes with high fidelity often constructed in UI design tools like Figma (see www.figma.com). When a version of the UI design has been created, it is time to evaluate how it fits the user needs. Numerous evaluation methods have been established to gather feedback from users or inspect the design by experts. Involving users in the evaluation process can be achieved through techniques like the think-aloud evaluation and conducting formal user testing (Rubin and Chisnell, 2008). Additionally, inspection methods, including Heuristic Evaluation and Cognitive Walkthrough, are instrumental in assessing design quality and usability (Nielsen and Mack, 1994). This being said, studies such as Gray's (2016) highlight that many times design practitioners see design methods in a more flexible manner, resorting to their judgment and 'mindset' when choosing the right approaches, depending on the project, and further reinforced by how difficult it is to teach without including traineeships and mentoring to help create a feel of the methods and approaches (Getto and Beecher, 2016). While these UCD methods are critical in software development, the evolving role of design practitioners and the enablers and challenges they face in applying these methods highlight the dynamic nature of the field.

2.2. Limitations of using UCD methods in practice

In theory, embracing a wide range of user-centred design methods is paramount, acknowledging that design is inherently iterative. However, in the real world, practitioners encounter limitations and challenges hindering the seamless integration of these methods. The gap between theory and practice highlights the reality that navigating the complexities of implementation diverges significantly from the theoretical landscape. Despite improvements in recognition of UCD practices, design practitioners have faced challenges through the years in collaborating with developers, often in multiple projects simultaneously, as shown in 2002 (Vredenburg *et al.*, 2002), and also recently in 2020 (Inal *et al.*, 2020). They often find it difficult to conduct timely user research and usability studies within development processes. This leads to them using methods they are familiar with, and avoiding learning or applying new methods, partly because they find new methods to be too complex or abstract (Cajander *et al.*, 2022).

Additional challenges include integrating UCD methods into software development communities and constraints within existing processes (Bach *et al.*, 2009). Given that more and more companies are adopting agile frameworks, integrating UCD and agile further raises a series of roadblocks (Salah *et al.*, 2014). Time constraints, limited resources and lack of senior management support further exacerbate these challenges and are struggles reiterated throughout time and independent of working style (Vredenburg *et al.*, 2002; Bak *et al.*, 2008; Inal *et al.*, 2020; Cajander *et al.*, 2022). Similarly, Larusdottir *et al.* (2023a) found that practitioners cited various reasons for excluding users from the development process—high costs, resource demands and time constraints, not only potential misunderstandings but also the belief that ultimate decisions rest with the customer rather than end users. In the study by Inal *et al.* (2020) the results show that participants, typically with a decade of experience, worked in small teams within large organizations, mostly employing agile processes and facing similar challenges: limited support, resources and communication.

The challenges faced by human–computer interaction (HCI) professionals while focusing on users were also studied by comparing the challenges faced by other IT professionals (Marsden and Holtzblatt, 2018). The study encompassed various aspects of workplace experience, team collaboration, project impact, managerial support, communication and work–life balance. HCI professionals focusing on users scored their day-to-day experiences more negatively than other IT professionals, indicating substantial challenges within their organizations. The study concludes that HCI professionals focusing on users encounter difficulties in asserting the value of their UCD methods and techniques within their organizational context (Marsden and Holtzblatt, 2018). As all our research questions include the concept of UCD practice limitations, we summarize the current findings found in the literature in Table 1, thus directly addressing and answering RQ1.

2.3. Efforts to address limitations of UCD practices

Efforts to address these challenges include enhancing HCI and UCD understanding among stakeholders, advocating for roles focusing on users within development processes and raising management awareness of user experience as a strategic priority (Gulliksen *et al.*, 2004), as well as upskilling and educating professionals on new processes that could be more time and cost-effective Larusdottir et al. (2023a). Integrating UCD practices with agile practices using personas, scenarios and storyboards has been shown to facilitate communication and collaboration within agile teams (Silva da Silva *et al.*, 2012).

Additional efforts to resolve the challenges involve increased support, financial backing, better internal cooperation, improved tools, additional UCD training and enhanced communication with developers (Inal *et al.*, 2020). In a study reported by Bruun *et al.* (2018) user experience (UX) professionals focusing on users primarily worked during project inception and requirement gathering, conducting workshops and observations. Wireframes were developed, reviewed by technical managers and iterated before delivery to the development team. The teams used the agile software development process Scrum, and during Scrum sprints the UX professionals guided the team by dedicating around one fifth of their time. The study suggests considering complete UCD processes like design sprints during the inception and requirement-gathering phases to improve the UCD practices.

Aiming to integrate design thinking in the software development process in a time-efficient manner, Knapp et al. combined design thinking and agile methodologies, creating the Design Sprint (Knapp *et al.*, 2016). Consistently compared with design thinking (Mendonça de Sá Araújo *et al.*, 2019) or agile (Sandu *et al.*, 2022), the design sprint combines the two into a clear-cut, step-by-step process meant to be run in 5 days and provide a way to 'fast forwards into the future' of a finished product (Knapp *et al.*, 2016). Other structured practices have been developed and used in the industry, however, with limited academic publication history reporting on them and their applicability. Their distance from academia and standardized studies means the usage of the Design Sprint and other similar methods is mainly anecdotal, with many and frequent changes to suit the people using it, some better documented than others (Courtney, 2018; Ferguson, 2018; Southall *et al.*, 2019). Still, some real-world applications of the design sprint framework in the public (Bharosa *et al.*, 2021;

TABLE 1. Summary of limitations of UCD practices described in the literature

Limitation	Definition	Reference
Time constraints	Insufficient time to address the UCD, or the involvement of the practitioner restricted to a limited number of phases in the development process	Larusdottir *et al.*, 2023a; Inal *et al.*, 2020; Cajander *et al.*, 2022; Marsden and Holtzblatt, 2018; Silva da Silva *et al.*, 2012; Salah *et al.*, 2014; Zowghi *et al.*, 2015
Lack of senior management support resulting in limited resources	Top-level management does not provide sufficient backing or resources for UCD initiatives within an organization or a project. Insufficient resources considered necessary for the UCD process (money, equipment, access to users)	Larusdottir *et al.*, 2023a; Inal *et al.*, 2020; Ardito et al., 2011; Bak *et al.*, 2008; Gulliksen *et al.*, 2004; Silva da Silva *et al.*, 2012; Dhandapani, 2016; Ozcelik *et al.*, 2011; Zowghi *et al.*, 2015
Difficulties in stakeholder prioritization	Challenges in determining which stakeholders' needs and interests should be addressed first or given greater emphasis within a project or initiative	Larusdottir *et al.*, 2023a; Bak *et al.*, 2008; Chammas *et al.*, 2015; Herfurth and Sinclair, 2018
Intra-organizational communication	Obstacles hindering effective exchange of insights, feedback, and project updates among team members, impacting the seamless integration of user-centric approaches throughout the design process. Primarily encountered with the development team.	Inal *et al.*, 2020; Bak *et al.*, 2008; Gulliksen *et al.*, 2004; Silva da Silva *et al.*, 2012; Salah *et al.*, 2014; Zowghi *et al.*, 2015
Lack of prioritization of UCD	Absence of emphasis or attention given to UCD principles and methodologies within project planning and execution, resulting in a diminished focus on understanding and meeting user needs effectively	Inal *et al.*, 2020; Larusdottir *et al.*, 2023a; Marsden and Holtzblatt, 2018; Gulliksen *et al.*, 2004; Salah *et al.*, 2014

FIGURE 1. Overview of the UCD Sprint.

Ongwere *et al.*, 2022) and private sectors (Pender and Lamas, 2019; Schouten *et al.*, 2020) can be found.

3. DESCRIPTION OF THE UCD SPRINT

A process called the UCD Sprint process has been suggested (Roto *et al.*, 2021), as one possibility to address the UCD practice limitations described in literature. In this section, we describe briefly the structure of the UCD Sprint process and how each step of the process is conducted.

The UCD Sprint process is divided into three phases: Discovery, Design and Reality Check. Each of the phases has six steps, which include UCD activities. An overview of the process and its steps is shown in Fig. 1.

Each step serves as an input into the next step in the process. The UCD Sprint process paves the way for more detailed design and development processes. The outcome of the UCD Sprint process can serve as a valuable reference point for subsequent design, development and decision-making processes, helping teams align their efforts with user needs and goals. There is no timeframe used for each step nor for conducting the whole process. For some teams, if they have a very tight schedule, they could even skip some of the steps, or do some of the steps fast. Depending on the size of the project, and the extent of the user involvement in the process, the timeframe for conducting the UCD Sprint can vary extensively. The main advantages of the UCD Sprint are its focus, structure and possibility for reflection through the process (Roto *et al.*, 2021).

In the following, we will briefly describe the steps in the three phases of the UCD Sprint in three sections.

3.1. Discovery phase

Initial Mapping: Collaborative and visually driven approach. The team identifies and clarifies the target user groups, defines their primary goals and establishes the essential steps these users need to take to achieve those goals. This method fosters a shared understanding among team members, of the overall idea of the tool to be developed, through visual representation.

User Group Analysis: Systematic and collaborative approach aimed at gaining a deeper understanding of each user group identified in the initial mapping activity. It involves breaking down the characteristics, needs and preferences of these user groups, allowing the project team to develop more tailored and user-centric solutions by analysing: Who, What, Where, When, Why and How for a particular user group based on a template resulting in a complete user group analysis sheet empowering the project team to create solutions that resonate with and benefit the target user groups.

Interviews: Systematic approach to collecting valuable insights and feedback from individuals or groups relevant to the project idea. It involves the preparation, execution and documentation of interviews to gather qualitative data and uncover critical information from potential users. The documented interview outcomes serve as a foundation for data analysis, decision making and project refinement during the whole UCD Sprint. Interviews offer a direct means of engaging with end-users to uncover deep-seated insights, preferences and pain points.

UX Goals: Collaborative approach designed to identify, agree on and prioritize user experience (UX) goals for a project. The 'UX Goals' method results in a prioritized list of three key user experience goals that the project team has agreed upon. By involving multiple team members in the process, this method promotes collaboration and a shared understanding of the project's UX objectives.

Selecting the Target: Strategic approach for refining project goals and determining the focal 'target' for prototyping and user testing through collaborative discussion. Additionally, in this step, the long-term goal is modified so it incorporates the three identified UX goals, ensuring that the project's objective is informed by user experience. Furthermore, the target user group(s) for testing is identified in this step.

Design Brief: Brings together critical information and insights from various stakeholders to inform the design and development process effectively. The 'Design Brief' step results in a document documenting the project stakeholders, user groups, goals, constraints and competitive context.

3.2. Design phase

Exploring Existing Designs: Team members examine existing tools, websites, apps, or other relevant design examples mentioned by interviewees in the interviews in Step 3 in the Discovery phase. By collaboratively analysing these sources of inspiration, the team can extract valuable insights and good design ideas from the best practices and innovative design elements observed in other successful products or experiences. The step's primary outcome is a list of good design ideas to apply in the project, be it in the form of components, or concepts and user desires.

User Testing Preparation: Comprehensive approach to preparing for user testing which covers the development of user testing tasks, materials, planning and coordination with users to ensure a smooth and effective testing process. Furthermore, the method facilitates planning for the user testing sessions, specifying when and where the testing will occur and which users will be involved. Lastly, it assigns roles to team members for each testing session, ensuring that responsibilities are clearly defined.

Brainstorming Design Ideas: Creative and collaborative approach to visualize the first ideas of the UI design for the chosen target. The outcome of the step is a sheet filled with rapid sketches of UI for achieving a particular user task, incorporating the noted ideas from step 1.

Making and Selecting Good Designs: Individual and a collaborative activity aimed at refining the UI design sketches in one design solution per team member and selecting the most promising design solutions as a team effort. It encourages individual design exploration while solidifying the design as a team effort, detailed solution development and informed decision making through a voting and discussion process on which ideas to include in the prototype design.

Making Happy Paths: This step fosters teamwork and collective creativity by engaging team members in pairs to collaboratively design the flow in the user interface that is needed to be able to achieve each of the user tasks, that were defined in Design—Step 2 (material for user tests). The outcome ensures that the user tasks are well-structured, realistic and aligned with the project's objectives, contributing to a more effective and meaningful user testing process.

Making Low-fidelity Prototypes: Systematically designing pages or screens that correspond to each step within the happy paths, the team can create a usable and functional prototype that aligns with winning design ideas from earlier steps. The design can be either on paper, or done in a tool, but should be in a rough form, to encourage the team to be open to change based on feedback from users that would inspire iterations.

3.3. Reality check phase

Low-fi Prototype Testing: Two team members conduct the prototype testing using the material prepared in Design Phase—step 2 and the paper prototype prepared in the previous step. The method culminates in interpreting the results by categorizing valuable user feedback into positive and negative comments, discussing insights gained and making necessary changes to the paper prototype to improve the user experience defined by the user experience (UX) goals.

Prototype Review: Involves seeking input and recommendations from technically skilled experts regarding the feasibility and technical aspects of the iterated prototype. The process can be summarized in two main phases: conducting the review with technical experts and implementing the recommended changes. Experts are asked to recommend changes that would enhance the solution's quality and technical viability.

Realistic Clickable Prototype: Includes designing a higher-fidelity prototype that supports the UX goals and some simulations of the functionality by allowing users to click on buttons and links. The intermediate clickable prototype, typically created in prototyping tools like Figma or Balsamiq, serves as a more accurate representation of the final product to be tested with users in the next step.

Evaluating Clickable Prototypes: The step is designed to assess the user experience of an interactive prototype through user testing by gathering valuable user feedback and identifying issues within the interactive prototype. The outcome is feedback and observed issues from the user testing, along with user responses to questions that help understand the user experience while using the prototype.

Analysing the Test Results: The step involves deriving insights from user testing data by organizing and interpreting the collected data from the prototype testing. Those results are the basis for making informed decisions during the final step of the UCD Sprint process.

Deciding the Next Steps: This step involves evaluating the work accomplished during the sprint and determining the future course of action. It consists of deciding whether to continue working on the initial idea for the software and iterating the prototype or deciding not to do further work based on the idea. If the team wants to continue, they could write a list of user stories to be included in a product backlog, so the results of the UCD Sprint will be useful also after conducting the UCD Sprint process.

TABLE 2. A summary of the cases included in the synthesis part of the study

Study	Research Method(s) (# of participants)	Reference
Case 1—Students	Survey (22);	Roto *et al.*, 2021
Case 2—Students	Surveys I (110); Survey II (70)	Visescu *et al.*, 2023
Case 3—Practitioners	Survey (14); Interviews (15)	Larusdottir *et al.*, 2023a

4. GUIDED USAGE OF THE UCD SPRINT

In this section we describe the methodology used and results from a synthesis study. In the study we summarize the results from three cases, where guided usage of the UCD Sprint was explored. These cases have been published independently, but here we provide a summary of how the results on the UCD Sprint address the limitations of the UCD practices. This part of the study gives some answers to the third research question (RQ3).

4.1. Synthesis method

This section presents a synthesis of cases showcasing quantitative and qualitative feedback on the UCD Sprint, considering perspectives from both students learning software engineering and practitioners. The authors analysed the three cases presented, examining the results and feedback received. The synthesis is presented in the context of the limitations highlighted throughout literature, summarized in Table 1.

Surveys with a total of 216 responses, as well as 15 interviews were conducted. In Table 2, an overview of three distinct studies focusing on the practical applications of the UCD Sprint is given. The studies encompass feedback gathered from two academic cases and one involving practitioners, aiming to broaden our understanding of UCD Sprint implementation and adaptation across varied contexts. Each study offers insights into how the participants in the studies employ the UCD sprints in real-world scenarios, highlighting nuances observed in academic and practical settings.

4.2. Summary of results from the cases

The description below summarizes the feedback obtained from the studies presented in Table 2, offering reflections on how the insights address the broader limitations of UCD highlighted in the existing literature.

The first case presented a study focusing on the development and evaluation of a two-week interaction design course integrating UCD Sprint and Google Design Sprint (GDS) methodologies in academic settings (Roto *et al.*, 2021). The study centred on the course structure and student feedback on the User-Centred Design Sprint process. Notable contributions include the course structure, evaluation results and recommendations for teaching such a course. Two editions of the course were compared, with significant improvements observed in the revised structure, particularly in the integration of UCD activities before and after GDS. Students appreciated the structured approach, with positive feedback highlighting the usefulness of UCD methods, such as user interviews and summative evaluations, and the structured nature of GDS. Challenges included managing teamwork dynamics, pacing the design process and fostering reflection. Recommendations for teaching UCD Sprint emphasized facilitating teamwork, finding a suitable pace, balancing theory and practice, providing real-life examples, clarifying process phases and promoting reflection on learning. Overall, the study underscored the importance of a structured approach and effective facilitation in teaching UCD Sprint methodologies in academic settings.

This second case delved into the integration of the UCD Sprint into a Bachelor's level Computer Science course at Reykjavik University, during a 7-week period through lectures and on-site problem-solving sessions, with a particular focus on student feedback and the utilization of a digital aid (Visescu *et al.*, 2023). The study unveiled three key aspects: students' perceptions of the UCD Sprint, their experiences with the digital tool meant to aid them throughout the UCD Sprint process and recommendations for refining digital aids in higher education. Despite varied feedback influenced by course-related factors, students generally viewed the UCD Sprint positively, appreciating its structured approach. The digital aid, while well-received overall, prompted suggestions for improvements, such as increased visual content and enhanced usability. The study highlighted the importance of iterative improvements and active learning methods in teaching the UCD Sprint, aligning with literature supporting problem-based learning approaches. It underscored the necessity for ongoing refinement to meet evolving user needs and educational requirements, emphasizing flexibility and user-centricity in design sprint adoption within academia.

Finally, the third case was in corporate settings. The UCD Sprint was assessed through a case showing the implementation of the UCD Sprint process within IT companies in Italy (Larusdottir *et al.*, 2023a). It involved interviewing practitioners to understand their current design processes and reluctance to involve users due to perceived resource constraints, through a course taught for 4 days with assigned homework between course days. Findings revealed that users are typically engaged only during certain phases of software development, with the initial requirements being set by the customer or other stakeholders. The study then explores the practitioners' experiences with a course on the UCD Sprint process, highlighting the value they found in activities like low-fidelity prototyping and user testing. While some aspects of the course structure received criticism for its pace, practitioners overall expressed interest in incorporating more UCD principles into their design practices. Moreover, the study examines practitioners' willingness to modify their traditional design processes based on their exposure to the UCD Sprint, with many acknowledging the importance of user involvement despite challenges posed by existing company practices. The practitioners involved, previously facing time and cost constraints, found the UCD Sprint to be a time and cost-effective solution, streamlining their design processes and fostering efficient collaboration. The structured approach of the UCD Sprint enabled them to condense activities, facilitating thorough user-centred design within manageable timeframes. As a result, practitioners expressed interest in integrating more user-centred activities into their design processes, recognizing the value of prioritizing user needs and feedback.

4.3. Addressing UCD practices limitations with the guided usage of the UCD Sprint

Overall, the research underscores the potential of the UCD Sprint process to enhance UCD practices by prioritizing user needs and fostering a more user-centred approach, despite some existing challenges and limitations in its implementation. However, the common limitation of all three cases presented above stems from the prompted and taught nature of the usage of the UCD Sprint methodology by the participants. In each scenario, participants underwent a course on the methodology, before being asked for their opinions on it. However, to better understand the potential efficacy and inherent challenges of the UCD Sprint, there is a need to explore unprompted and unguided usage and opinions. This approach allows for a more organic and authentic assessment of the methodology's strengths and weaknesses, providing valuable insights into its real-world applicability beyond the confines of structured learning environments.

In Table 1, we summarized the limitations experienced by UCD practitioners derived from the literature. In Table 3, we summarize findings based on the results gained from the case studies on how the UCD Sprint helps UCD practitioners to mitigate the UCD practice limitations. The arguments are contextualized with the help of the three cases summarized in chapter 4.2, and with the help of findings from the literature overview provided in Table 1, for increased soundness.

5. RESULTS FROM INTERVIEWS WITH UCD PRACTITIONERS

In this part of the study, interviews were conducted to understand how UCD practitioners including designers, product managers and project managers in the Icelandic software industry conduct their UCD practices and what limitations they experience in their work. Furthermore, the UCD Sprint was introduced to them as a new user-centred process, and the UCD practitioners were asked about the potential integration of the UCD Sprint in their work context.

In this section we describe how the interview data was gathered, the background of the participants and how the data was analysed.

5.1. Method

In this section we describe the participants of the interview study, the interview process and the data analysis method.

Two researchers from Reykjavik University conducted interviews using a selective sampling approach, consciously aiming to capture diverse perspectives. We sought participants from various industries, spanning different project scopes and company sizes, ensuring diversification of experiences and insights. Five individuals (4 f, 1 m) within the Icelandic software development industry were interviewed. The participants represented diverse roles within design, collected in this study under the umbrella term of 'UCD practitioners'. One participant served as a product manager with expertise in design processes and user research, a participant was a project manager leading a design team focusing on a variety of projects with private and public institutions, two UX consultants working with public and private institutions, and finally, a product manager specializing in healthcare app development. The inclusion of these individuals provided a well-rounded perspective on UX practices within the Icelandic IT industry. More information on their background can be seen in Table 4.

5.1.1. *Interview process*

The aim of the interviews was to give some answers to the following three research questions:

RQ1: How do UCD practitioners conduct UCD practices currently?

RQ2. What limitations of UCD practices are faced by UCD practitioners?

RQ4 How do UCD practitioners perceive the introduction of the UCD Sprint to address the limitations they encounter in their work?

The semi-structured interviews were conducted in three parts. In the first part, we asked the UCD practitioners about their professional backgrounds, their current ways of working and which UCD methods they use for including users to answer the first research question (RQ1). We further asked about the challenges and the limitations they have experienced while practicing UCD, focusing on answering RQ2. In the second part, we handed out a one-page description of the UCD Sprint to the participants. It included a figure showing the structure of the UCD Sprint and text on the foundation of the process and the methods used. In the third part of the participants were asked about the potential of unguided usage of the UCD Sprint in their work context. In this part, the focus was on receiving feedback for optimizing the UCD Sprint, as well as gauging their interest in using structured processes such as the UCD Sprint in their work, thus answering RQ4. More details on the interviews' structure and the questions used can be seen in Table 5.

As the interviews followed a semi-structured format, follow-up questions were asked on a case-by-case basis. This allowed for a comprehensive exploration of participants' expertise, user-centred practices and limitation faced and opinions on the potential of the UCD Sprint's effectiveness in the Icelandic software development industry. The interviews lasted approximately one hour each, as can be seen in Table 4, and were recorded and transcribed verbatim.

5.1.2. *Data analysis*

During data analysis, two of the authors read the transcripts and observations were noted. The transcripts underwent a comprehensive labelling (coding) procedure to capture significant ideas by each of the researchers individually. Employing *in vivo* coding as the analytical framework, several key themes emerged from the interviews including:

1) participants discussed the various design methods they employed during the sprints, shedding light on the diverse approaches taken within the UCD framework;
2) noteworthy insights also centred on the challenges encountered during the sprints and the adaptive measures implemented to address them;
3) furthermore, participants shared valuable feedback on the UCD sprint, providing a nuanced understanding of its effectiveness and potential areas for improvement.

The interviews focused on the points iterated above, offering valuable perspectives on the work approaches taken by UCD practitioners, the limitations they face in their work, feedback and optimization points of the UCD Sprint process and its potential impact and integration into diverse professional settings.

5.2. Current UCD practices

In this section we describe results on which UCD methods the UCD practitioners used, the challenges the UCD practitioners

TABLE 3. Arguments for how the UCD Sprint process could address UCD practice limitations

Limitation	Definition	Arguments
Time constraints	Insufficient time for the UCD practitioners to address the UCD practices, or the involvement of the UCD practitioner is restricted to a limited number of phases in the development process	As shown by Bano and Zowghi (2015), user involvement can decrease the risk of additional changes after implementation, reducing the overall time of the development process. Salah *et al.*, 2014 also highlight that user involvement can reduce the time used to iterate designs. The UCD Sprint includes instructions and guidelines that enable participants in the process to conduct the steps in a fast way, including the users throughout. Throughout Case 3, participants highlight the UCD Sprint as a time-efficient process. However, when in their regular work environment, practitioners did not employ the UCD Sprint in its entirety, which underlines the need for adaptability and project-related molding of the process.
Lack of senior management support resulting in limited resources	Top-level management does not provide sufficient backing or resources for UCD initiatives within an organization or a project. Resources considered necessary by the UCD practitioners are insufficient (money, equipment, access to users)	Bano and Zowghi (2015) highlight through a literature review that user involvement improves management practices, management facing less resistance. Furthermore, the same review lists reducing the costs of the system as a benefit of user involvement. The UCD Sprint provides a somewhat expedited manner of including users throughout the process. Case 3, in particular, is highlighted as an eye-opening experience for several of the UCD practitioners involved, who have mentioned the process to be a less resource-demanding approach, making user involvement cheaper and faster than originally perceived.
Difficulties in stakeholder prioritization	Challenges in determining which stakeholders' needs and interests should be addressed first or given greater emphasis within a project or initiative	The aim of the UCD Sprint process is to help UCD practitioners to focus on users as the primary stakeholder. We have seen in Case 3, that sometimes there are conflicting needs from various stakeholders, when focusing on customers instead of users (Case 3). The UCD Sprint does not resolve this limitation in a direct way.
Intra-organizational communication	Obstacles hindering effective exchange of insights, feedback, and project updates among team members, impacting the seamless integration of user-centric approaches throughout the design process. Primarily encountered with the development team.	As highlighted by (Salah *et al.*, 2014), engaging developers in creating a shared design vision through techniques such as sharing design artefacts, as well as creating a continuous communication channel, can mediate some of the challenges between developers and designers. A whole team works through the UCD Sprint process together, with guidance on how to effectively exchange insights, design ideas, and artefacts in many steps of the process (presented and highlighted throughout Case 1, 2, and 3). It has not been determined how the team using the UCD Sprint should be composed. Including members with various backgrounds could address this limitation. Teaching the UCD Sprint in educational contexts (Case 1 and 2), offers the opportunity to expose future developers to design concepts during their studies, thus engraining the importance of UCD design concepts early on. In educational contexts, the UCD Sprint is praised for its structure and step-by-step instructions, and the students appreciate the full UCD Sprint for its educational potential.
Lack of prioritization of UCD	Absence of emphasis or attention given to UCD principles and methodologies within project planning and execution, resulting in a diminished focus on understanding and meeting user needs effectively	Synchronizing the activities of UCD practitioners and the ones of developers can lead to better acknowledgement and increased visibility of the work of UCD practitioners (Salah *et al.*, 2014). By involving users three times throughout the process, the UCD Sprint aims at extending the understanding of user needs within the development team, and helping the UCD team to meet the user needs effectively (Cases 1, 2 and 3). The increased communication between the development team and the designers can seamlessly include UCD aspects throughout the development process, making user involvement less of a foreign concept and more of a natural part of the process. Creating a shared design vision early on, can aid with this, including the UCD practitioners in the planning and execution, and highlighting them as an important part of the process (Salah *et al.*, 2014). This limitation was also highlighted in Case 3 (Case 3).

TABLE 4. Overview of the background of the participants

Participant number	Job title	Education	Work Experience	Interview duration (min)
1	Product Manager	BA (Business Management), BA in French	HR Director	63
2	Project Manager	MS in IT, Design, Communication and Media	Climate change project	44
3	UX Consultant	BS in Computer Science	Website for cosmetics	65
4	Product Manager	BS in Computer Science& HCI	Website and app development	63
5	UX Consultant, Project Manager	MS in Psychology, Computer Science, HCI	Web development for 112 and 911 operators	53

TABLE 5. The high-level interview guide for the interviews

Interview part	Questions asked and information given
Part I: Current UCD practices	• Could you start by introducing yourself and your work? • What are some methods in your work that you use to connect with users? • What challenges or limitations do you deal with while working with UCD? • Do you, or have you used design sprints in your work? Why/why not? • Do you adapt the sprints or the UCD practices you use in any ways? How/Why?
Part II: UCD Sprint	• Introduction of the UCD Sprint by showing a one-page hand-out
Part III: Potential usage of the UCD Sprint	• Do you see any potential in the UCD Sprint being used in your work?

experience while conducting UCD, adaptations of UCD practices they described and the potential usage of the UCD Sprint in their work context.

5.2.1. *UCD methods used*

Participants employed various UCD methods for focusing on and for involving users in the development process. All participants were conducting user interviews and user testing with direct user participation. The consensus among participants was that focusing on users when creating a product is important. One participant shared an example highlighting how users often bring up points that the development team overlooks:

> *it's so interesting how the team can be so focused on something when developing and sketching and doing the prototype that something gets totally lost. And then the users came and said like, but who's the employee? Like for whom is this equipment? And we're like, we forgot* (P1).

This being said, at times the user interest and the interest of other parties involved may not align. Participants confessed they had to advocate for user involvement in their company's development process, either to their company or to their clients, highlighting the potential time, cost and effort savings that come with user feedback:

> '*that's extra time, we have to sell them that extra time.' And I'm like, no, we don't need extra time. We just need to tell them that we are actually using the time better. [...] you don't have to add extra hours because if we're talking to users, we don't have to waste the last hours fixing stuff.* (P3 when referring to conversations with clients and managerial misconceptions).

Additionally, participants highlighted the potential disparity between development assumptions and focusing on user needs through using UCD methods, emphasizing the importance of actively involving the whole team in the development process.

> *I know you're a developer and get paid for writing code. But tomorrow for three hours you're just going to sit and take notes. You're going to look at people, it's like that's what you're getting paid for because you're building an app for people like these. [...] And this is the most productive thing you're going to do ever. People don't believe you when you say it. But give them time and they realize that there are people with colour blindness. It was just you couldn't hit the front button because it was too small. You need to make the buttons bigger. Because things like that don't make it into the notes necessarily it's the user couldn't complete the task—it was because the button was too small.*
>
> *It's the facial expressions and those things where you build empathy and you get people thinking about other people rather than just engineer stuff*. (P5).

Similar feelings were expressed by P1, and P4 communicated their strategy of bringing UCD methods within their company through exposure:

> *'[...] expose more people in the company to end users. The magic bullet in making an organization more UX centred is just exposure. Have people watch other people.'* (P4).

While all participants acknowledged the significance of involving users in the development process and followed some of the more traditional methods of doing so, there were also diverging opinions and personalized methods they mentioned. For example, one participant stated:

> *There are very few workshops that I run that are exactly the same, or you know there are some methods that I use that may follow a certain kind of pattern. But how I put them together and how I adapt them for each team and each purpose that's very different* (P5)

Furthermore, one participant highlighted the difficulties faced in recruiting interviewees due to the time-consuming nature of interviews.

TABLE 6. An overview of the UCD methods used by the UCD practitioners

UCD Methods Included in UCD Sprint	P1	P2	P3	P4	P5
Initial mapping	X	X			X
User group analysis	X				
Interviews	X	X	X	X	X
Selecting a target	X				
Design Brief	X	X			
Brainstorming design ideas	X	X	X		
Happy paths	X				
Low-fi prototyping	X		X	X	X
Low-fi prototype evaluation	X			X	
High-fi prototyping	X				
High-fi prototype evaluation	X	X	X	X	X
UCD Methods NOT Included in UCD Sprint	**P1**	**P2**	**P3**	**P4**	**P5**
Personas	X	X			X
Brainstorming	X	X			
Client/stakeholder interviews		X	X		

> *I don't run all the interviews myself, we do them as a team, but I think mostly it's really time-consuming, and it can be challenging to fit it into their work hours.* (P2)

A participant justified the diversity of methods as a needed adjustment depending on the company, their goals and their end users by saying:

> *I tend to get a lot of satisfaction about designing my own workshops and approaches always, again with the focus on what is the question is or what is that the company wants to get answered or the outcome that they want to get out of this, and then whatever we heard from the users and then how can we melt this together so that the company gets what they need, but based on what we know about the customer.* (P5)

This highlights a key challenge for UCD practitioners: achieving an optimal balance between accommodating the demands of both the companies and their users in the dual aspects of software development—designing the right software and ensuring it is designed correctly.

In summary, we show the UCD methods used by the practitioners in Table 6, in the context of the existing methods within the UCD Sprint.

For the UCD methods not included in the UCD sprint, we list the methods where at least 2 practitioners used the methods. The UCD methods that only one UCD practitioner mentioned using were Surveys, Expert user groups, Group user testing, AB testing, Observational studies, Highlight reels (a curated selection of video clips edited from feedback sessions, to efficiently provide user insight (Usertesting.com, 2019)), User workshops, Product description documentation and Expert interviews.

5.2.2. *Challenges and limitations related to UCD practices*

Although design sprints emerged as a prominent method to include users in the development process, with all participants having worked in sprints at one point in time, all participants mentioned adaptations they have made to the sprint for different projects or to fit different teams. It became apparent that participants do not work by the book when it comes to design sprints, personalizing them in a variety of manners, and sometimes even being apprehensive to call it a sprint:

> *I never say UX and I never say design Sprint or design thinking or anything like that. Because I find that derails the conversation* (P5)

As above mentioned, all participants had previous experience with design sprints, with two out of the five UCD practitioners having used the AJ & Smart sprint version. This version is a more condensed version of the Knapp Design Sprint (2016), adding up to 4 days, and has been done in collaboration with Jake Knapp, which is why it is sometimes considered a 2.0 version of the original sprint (AJ&Smart, 2015).

Among the challenges mentioned most often, participants reported experiencing challenges due to time constraints, sprint structure, lack of diversity in sprint participants and lack of knowledge about UX.

Sprint Structure and Time Constraints : Participants unanimously expressed that design sprints do not provide sufficient time to understand users, gather background information and make informed decisions about the feasibility of designs or plans. Similarly, participants felt restricted by the sprint structure or found it not fitting for some challenges or projects.

> *So they have really different opinions about what's important, but I think this kind of takes it out. Because up until that point, the design Sprint is so much about working alone together and voting, right? And it's such a good process. When it came to the story part, all of a sudden it was designed by meeting which is not good, no?* (P1)

> *[...] my main issue with the Sprint is you almost do the discovery in day one, but I feel that the discovery needs much more time.* (P4)

One participant stated that while sprints are a valuable tool for generating ideas, they often require post-sprint changes due to limited research opportunities and access to vital information, such as technological feasibility or legal matters. This highlights the need for additional time to address these constraints.

it's more like a great tool to give you an idea what it could look like, but I have never, finished developing a product after Sprint and it's what we came up with in the Sprint, it's always a LOT of changes after. Also because in four days we cannot do the research to talk to the lawyers in the company. Is this possible? Can we really do this? You know, get all the actual information that we need to know if this is possible (P3)

Lack of User Involvement : Another challenge identified was the lack of user involvement during design sprints. A participant stated that there isn't a lot of 'getting to know the user' in design sprints. They also observed that the focus of sprints was primarily on driving progress rather than addressing the users' needs.

So my feeling was always that the focus and the use of the sprint was more to break this inertia rather than to be user-focused and get a proper user input into, but rather to just in a few days we can create something that is, you know, that would take us months to do. (P5)

Lack of Diversity in Teams : Participants emphasized the criticality of diverse team composition, particularly in design sprints, highlighting the significance of incorporating varied expertise and positions while involving users.

A participant recalled an instance where a sprint skewed towards developers, resulting in a technical focus rather than considering the user's perspective.

you have to make sure that you have a good mixture of somebody from marketing, a good designer. Not too heavy on the developer side. (P1)

One participant conveyed that a diverse team composition can provide different perspectives, and therefore lead to better results

Because if you have a homogeneous group, they're just gonna all have the same idea. But mixing it up so the opposite of groupthink it's like to have five people solve the same problem in five or six or seven different ways that also you know you can create things like increase empathy (P4).

However, another participant noted that securing a full commitment from teammates for extensive periods of time, such as a sprint, requires top management support. This is further derived from the fact that introducing user-centred activities is seen as an expensive endeavour.

You can only get that if you have the go-ahead from top management. (P5)

So we had the same discussions when I was in the states as I see the companies do here, which is that when they make a bid to something or they want to start something, the UX part is so expensive it adds time. It adds, you know it costs more, which I think is a fundamental misunderstanding of what UX is and what it does, because I think it's always cheaper to start off with UX. (P5)

This insight underscores a broader principle in project management and organizational behaviour: the critical role of leadership support in enabling and legitimizing team efforts. In the context of design sprints, where diverse expertise and dedicated time are essential, top management's backing not only facilitates resource allocation but also signals the strategic importance of the project, thereby fostering a more committed and collaborative team environment.

In Table 7, we present findings from the interviews in the context of the limitations of UCD practices found throughout the literature.

A consistent trend among interviewees is a collective predisposition to adapt the design sprint and its implementation. Participants universally stated the necessity of modifying the design sprint framework to align with projects and teams, on a case-by-case basis. The participants tell the story of a prevailing inclination toward customization, from nuanced adjustments to substantial structural alterations:

Because I think if you have a tool that doesn't exactly fit the purpose, if people feel that you're trying to put a square box in a round hole and it doesn't fit. So you always have to kind of make a little bit of adaptations. (P1)

As far as I know and (from) speaking with colleagues, people always adapt it in some way. (P5)

One participant adapted the traditional design sprint by adjusting time allocations, adding icebreaker activities, and using a detailed sprint script. Another participant developed a customized process for improvement-focused projects instead of relying on the traditional sprint, while one other shifted towards a continuous discovery-based design process but still selectively used sprints. Lastly, one participant adopted a four-day structure for their design sprint, involving idea validation, user engagement and prototype iteration.

The participants frequently mentioned how sprints are and should be task-specific (P1, P3), and team-specific (P1, P2). At times the adaptations were based on the project, while at other times, they came from the company itself (P5), or were a personal choice of the UCD practitioners (P1):

The version I did was rather interesting. It was an in-house adaptation. It was not my adaptation, it was the adaptation of the company I was working with. (P5)

And then I think what's maybe missing from the sprints and what I've done myself is I just always create a script and a timed script so that I can see: I need to give this 5 minutes then we need to break here for 10 and I need to give this. And for this I said OK, this might be a 10 minute exercise in the original Sprint, but I need to give it like 30 minutes. Because I really need to give different stakeholders, time to express themselves here. (P1)

The interviews showed a predominant perspective among participants, with the majority characterizing design sprint usage in the industry not as rigid structures but rather as versatile toolboxes. Participants emphasized the importance of viewing design sprints as adaptable frameworks, enabling a dynamic and context-specific approach. These methodologies should be employed as flexible instruments rather than prescriptive guides. This nuanced perspective advocates for a more flexible application of design sprints, fostering adaptability in practice, and a mix-and-match approach, rather than a one-size-fits-all solution. One participant stated that while sprints are a valuable tool for generating ideas, they often require post-sprint changes due to limited research opportunities and access to vital information, such as technological feasibility or legal matters. This highlights the need for additional time to address these constraints.

TABLE 7. Findings on UCD limitations experienced by the interviewed UCD practitioners

Limitation	Definition	Interviews
Time constraints	Insufficient time to address the UCD, or the involvement of the practitioner restricted to a limited number of phases in the development process	*'I don't run all the interviews myself, we do them as a team, but I think mostly it's really time-consuming, and it can be challenging to fit it into their work hours.' (P2)*
Lack of senior management support resulting in limited resources	Top-level management does not provide sufficient backing or resources for UCD initiatives within an organization or a project. Insufficient resources considered necessary for the UCD process (money, equipment, access to users)	*So we had the same discussions when I was in the states as I see the companies do here, which is that when they make a bid to something or they want to start something, the UX part is so expensive it adds time. It adds, you know it costs more, which I think is a fundamental misunderstanding of what UX is and what it does, because I think it's always cheaper to start off with UX.* (P5) *'You can only get that if you have the go-ahead from top management.'* (P5)
Difficulties in stakeholder prioritization	Challenges in determining which stakeholders' needs and interests should be addressed first or given greater emphasis within a project or initiative	*'that's extra time, we have to sell them that extra time.' And I'm like, no, we don't need extra time. We just need to tell them that we are actually using the time better. [. . .] you don't have to add extra hours because if we're talking to users, we don't have to waste the last hours fixing stuff.* (P3) *I tend to get a lot of satisfaction about designing my own workshops and approaches always, again with the focus on what is the question is or what is that the company wants to get answered or the outcome that they want to get out of this, and then whatever we heard from the users and then how can we melt this together so that the company gets what they need, but based on what we know about the customer.* (P5) *And then I think what's maybe missing from the sprints and what I've done myself is I just always create a script and a timed script so that I can see: I need to give this 5 minutes then we need to break here for 10 and I need to give this. And for this I said OK, this might be a 10 minute exercise in the original Sprint, but I need to give it like 30 minutes. Because I really need to give different stakeholders, time to express themselves here.* (P1)
Intra-organizational communication	Obstacles hindering effective exchange of insights, feedback, and project updates among team members, impacting the seamless integration of user-centric approaches throughout the design process. Primarily encountered with the development team.	*I know you're a developer and get paid for writing code. But tomorrow for three hours you're just going to sit and take notes. You're going to look at people, it's like that's what you're getting paid for because you're building an app for people like these. [. . .] And this is the most productive thing you're going to do ever. People don't believe you when you say it. But give them time and they realize that there are people with colour blindness. It was just you couldn't hit the front button because it was too small. You need to make the buttons bigger. Because things like that don't make it into the notes necessarily it's the user couldn't complete the task—it was because the button was too small. It's the facial expressions and those things where you build empathy and you get people thinking about other people rather than just engineer stuff. (P5)* *'[. . .] expose more people in the company to end users. The magic bullet in making an organization more UX centred is just exposure. Have people watch other people.' (P4)*
Lack of prioritization of UCD	Absence of emphasis or attention given to UCD principles and methodologies within project planning and execution, resulting in a diminished focus on understanding and meeting user needs effectively	*'it's so interesting how the team can be so focused on something when developing and sketching and doing the prototype that something gets totally lost. And then the users came and said like, but who's the employee? Like for whom is this equipment? And we're like, we forgot'* (P1)

> *It's more like a tool to give you an idea what it could look like, but I have never finished a product after Sprint and it's what we came up with in the Sprint, it's always a lot of changes after. Also, in four days we cannot do the research to get all the information that we need to know if this is possible.* (P3)

They also highlighted the importance of teaching the sprints in academic context in a similar fashion—as a tool:

> *What I would try to teach the students is – this is a tool.* (P3)

This once again states the importance of recognizing that the application of these methodologies in real-world industry settings is inherently dynamic, evolving and nuanced, according to project requirements and team dynamics.

5.3. Results on the feedback and potential unguided usage of the UCD Sprint

All participants expressed interest and regarded the UCD Sprint as a potential-filled approach to gain a deeper understanding of users. Participants also acknowledged that the UCD Sprint would allow individuals to express their opinions. One participant expressed that the UCD Sprint would facilitate collaboration and help teams overcome negative sentiments, while another praised the early inclusion of users in the design process, which they found was lacking in the other design sprints:

> *I think it's a great idea because as I said before, I like to talk to users when they're still open-minded and not fitting them in, in the boxes that you've made for them. Yeah, I think there's a lot of value in that.* (P3)

However, while participants expressed enthusiasm for the potential of the UCD Sprint in gaining a deeper understanding of users, concerns were consistently raised about the efficiency of design springs without clear goals, and their utilization as a one-size-fits-all solution. Participants highlighted the importance of establishing clear goals and limitations before initiating sprints. One participant acknowledged the challenge of adhering to sprints in a business context, conveying the need for a well-defined project idea to effectively execute sprints:

> *I think that maybe for businesses it can be difficult to fit these sprints so strictly. But I don't know with other companies, at least for us. I mean, the only time we can really create very defined sprints is when we know what we're going to do.* (P2)

Similarly, another participant mentioned the influence of budget constraints on sprints, underscoring the importance of aligning resources and objectives before undergoing the UCD Sprint.

> *And then also it depends on how the design Sprint is set up. Is it set up with a way to start a fully funded project or is it set up as an exploration into how we might want to do something? Which means that in the first case, when you end, you already have a fully funded project and you can just go ahead, you have the power and the resources that you need to get it done. In the other case, that's when the sales process begins, is when you've done the two week Sprint and now we have this idea, we really want to do it and they're just like, 'yeah, yeah, nobody has this on the budget for this year'. That may influence, you know the whole Sprint.* (P5).

Additionally, the time constraints of the UCD Sprint were highlighted.

In summary, all the participants recognized the potential of UCD sprints in facilitating a better understanding of users, but emphasized the need for clear goals to overcome challenges related to business context and time constraints. They also highlighted the potential of design sprints in general to be regarded as toolboxes rather than strict structures to be followed, in order to create more room for changes and adaptations needed depending on the project at hand and the teams involved.

6. DISCUSSION

In this section we discuss our results on the current UCD practices in the software industry and the challenges and limitations to UCD practices experienced by UCD practitioners. Furthermore, we discuss the findings on the guided usage of the UCD Sprint for addressing UCD practice limitations, and finally the potential usage of unguided usage of the UCD Sprint process is discussed.

6.1. Current UCD practices

The results underscore the varied approaches participants employ in integrating UCD methods into the software development process. UCD commonly employs approaches, such as user testing, brainstorming and interviews, as can be seen throughout the literature, as well as through the interviews, summarized in Table 6. The unanimous recognition among participants of the importance of focusing on users during the design process is evident through the widespread use of UCD methods. This contrasts with the findings of Larusdottir et al., (2023a), which found UCD practitioners resort to a minimal user involvement in the design process.

The results shed light on the necessity of active involvement from the entire development team, challenging traditional assumptions and emphasizing the transformative power of empathetic understanding in design. The participants stressed the need for developers to step away from coding temporarily, dedicating time to observing and understanding user experiences. This shift towards empathy-building encounters challenges in convincing others within the organization, leading participants to propose strategies like exposure to end users to foster a more user-centric organizational culture. Furthermore, cross-team and managerial support are highlighted as dire needs. Participant 5 emphasizes that flexible scheduling, facilitated by supportive managers, plays a crucial role, which is similar to the views practitioners held in the study by Larusdottir et al. (2023a).

Despite a consensus on the significance of involving users, the study also unveils diverse and personalized methods among participants, as highlighted in several other studies (Getto and Beecher, 2016; Gray, 2016; Austin *et al.*, 2023). This divergence includes unique adaptations of workshops and approaches, with the challenge of striking a balance between organizational goals and user needs emerging as a central theme. The findings show the multifaceted nature of UCD practices implementation and the ongoing efforts required to bring together the divergent interests of companies and users in the software development landscape.

6.2. Current UCD practices challenges and limitations

Participants acknowledged the challenge of aligning user interests with those of other involved parties, which seemingly always requires advocacy. This advocacy, as expressed by some participants, involves persuading clients of the long-term benefits in terms of time, cost and effort savings that result from integrating user feedback early in the development process, or sometimes higher-ups and team members that are not directly focused on design, but whose input can be valuable to the process. This aligns with the literature, which finds that costs and time are factors of importance and the lack thereof is a general issue encountered by practitioners in the industry (Vredenburg *et al.*, 2002; Bak *et al.*, 2008; Inal *et al.*, 2020; Cajander *et al.*, 2022). Furthermore, two participants mentioned the challenges they face in assembling diverse groups of collaborators for sprints, attributing this difficulty to the time limitations. This underscores a common predicament faced by UX designers, who often encounter obstacles when collaborating with other members of the organization (Inal *et al.*, 2020; Bak *et al.*, 2008; Gulliksen *et al.*, 2004; Silva DaSilva *et al.*, 2012). The provided examples illustrate the potential oversight of crucial elements by development teams, emphasizing the pivotal role users play in identifying overlooked aspects.

The adaptive behaviour observed in tailoring traditional design sprints indicates a strategic response to the challenges identified.

In the Icelandic software industry, UCD practitioners have showcased a nuanced understanding of user-centred design methods. Notably, the adjustments in time allocations, incorporation of icebreaker activities and the use of detailed sprint scripts underscore their conscious effort to navigate time constraints and articulate clear project objectives. As previously highlighted, design sprints play a pivotal role in user involvement, with all participants tailoring them for specific projects. The modifications made by these UCD practitioners, exemplified by one participant's adaptation of the traditional design sprint through refined time management, creative icebreakers and a detailed script, demonstrated a proactive approach. This approach is not merely a deviation but a strategic calibration to better suit the unique demands of their projects, which can be seen in other projects as well (Pender and Lamas, 2019).

One participant described the development of a customized process for improvement-focused projects, another participant shifted towards a continuous discovery-based design, and a third participant adopted a structured 4r-day design sprint to showcase the diversity of adaptive strategies. This diversity is a testament to UCD practitioners' commitment to refining methodologies in response to project-specific challenges and goals. Adjustments in time allocations, incorporation of icebreaker activities and the use of detailed sprint scripts reflect a conscious effort to address time constraints and establish clear goals. These limitations come from a range of factors—internal or external, from personal, stakeholder, or managerial lack of knowledge, to a lack of time or resources (Cajander *et al.*, 2022; Larusdottir *et al.*, 2023a). However, their approach to dealing with these challenges signifies UCD practitioners' nuanced understanding of the limitations associated with design methods and their commitment to refining methodologies for effective user inclusion, based on their experience and feel for what can be the right method, as seen needed in Gray (2016) and Getto & Beecher (2016).

In line with Gulliksen's research (Gulliksen *et al.*, 2004), and Cajander *et al.* (2022) which advocates for increasing management awareness of the significance of UCD activities and their integral role in the development process, two participants emphasized the importance of fostering a diverse pool of individuals involved in design sprints and the development process. One participant further advocated for exposing more employees to end users, irrespective of their expertise in user experience, as this would foster empathy and ultimately contribute to the creation of a superior product. Both participants emphasized that such endeavours would only be possible with the support of managers who can facilitate flexible scheduling, allowing employees to dedicate more time to participating in the development process.

Throughout the interviews it is highlighted that the UCD practitioners' modifications go beyond a one-size-fits-all mentality, indicating a deeper commitment to effective user inclusion. These adaptations, situated within the broader scope of user-centred design methods, reflect an awareness of the limitations associated with standard sprints. These recommendations suggest that obtaining early user input, promoting diverse participation with managerial support, and exploring different sprint approaches are key strategies for integrating users effectively into the development process. During the interviews, when asked about potential improvements to enhance user involvement in the development process, one participant stressed the importance of obtaining input from experts and users prior to commencing sprints, as early input can significantly influence the outcome of the prototype. Another participant explained that this approach can allow for more open-minded input and proposed the exploration of different sprint methods to identify the most effective approach, highlighting the need for ongoing experimentation and adaptation in optimizing the sprint process. These modifications are in line with the proposed methodology—the UCD Sprint, which introduces early user input through interviews.

6.3. The UCD Sprint in the context of UCD practice challenges and limitations

Findings from the case studies in chapter 4 (Roto *et al.*, 2021; Visescu *et al.*, 2023; Larusdottir *et al.*, 2023a) contribute to addressing the broader limitations of UCD practices outlined in the existing literature. By comparing the feedback from participants across different scenarios, we identify key areas where the UCD Sprint process aligns with and enhances UCD principles. These include streamlining design processes, prioritizing user needs, fostering intra-organizational communication and integrating user-centric approaches throughout project planning and execution. However, the chapter also acknowledges the limitations inherent in the prompted and guided nature of the studies, suggesting a need for further exploration of unprompted and unguided usage to provide a more authentic assessment of the methodology's real-world applicability, which is highlighted throughout chapter 5.

In Larusdottir *et al.* (2023a), UCD practitioners learned to use the UCD sprint with guidance from instructors in a course aimed specifically at UCD practitioners. Reception of activities like sketching, storyboarding and evaluating high-fidelity prototypes can be seen in the UCD practitioners' course feedback. The UCD practitioners unfamiliar with prototyping found these activities especially valuable. Some criticisms of the course structure's fast pace arose, but the UCD practitioners expressed interest in the UCD Sprint nonetheless. The study results echoed results from studies on the UCD Sprint conducted in academic settings with university students (Roto *et al.*, 2021; Visescu *et al.*, 2023). In these studies, the students generally appreciated more the UCD activities that involved users directly or were directly related to the users. Here, despite acknowledging its potential, participants suggested viewing design sprints more as toolboxes than rigid structures, allowing for greater flexibility and adaptation based on specific project requirements and team dynamics, which is once again in line with findings from other practitioners (Larusdottir *et al.*, 2023a). This was even further highlighted as a need in the educational context, echoing the findings of Getto and Beecher (2016). In essence, while participants recognized the UCD Sprint's promise in enhancing user understanding, they stressed the imperative of clear goals to address challenges associated with business context, time limitations and resource constraints. The call for a flexible approach to design sprints reflects a nuanced understanding of their potential within the broader spectrum of design methodologies, while their appreciation for the UCD Sprint in a guided context highlights a previously stated need throughout literature, of fortifying academia-industry collaborations (Austin *et al.*, 2023).

The results from the interviews in this study indicate a shared enthusiasm among participants for the UCD Sprint as an effective approach to gaining a profound insight into user perspectives, which caters to some of the adaptations they have made to other design sprints. Overall, the practitioners interviewed in this study already utilize most of the methods found in the UCD Sprint, as seen in Table 6, although in various combinations tailored to their projects. This shows the validity of the individual methods, while underscoring the importance of process flexibility. Flexibility is needed to acknowledge the practitioners' experience and ability to assess the specific needs of each project effectively, leaving room for a case-by-case adaptation.

However, despite the overall positive reception, concerns emerged regarding the efficiency of design sprints in general, and particularly that design sprints are not a one-size-fits-all solution but have to be adjusted to the particular context of their usage. This complies the research of Gray (2016), which emphasizes the personalized approach of each practitioner while practicing UCD.

Participants in the interviews in our study consistently emphasized the necessity of establishing well-defined objectives and limitations before conducting sprints, like the UCD Sprint, also seen in the work of Joshi *et al.* (2018), where a correlation between the level of detail in the problem statements and requirements and the final level of detail in the solutions is found. Furthermore, the time constraints of the UCD Sprint surfaced as a common concern among participants, which is a recurring theme throughout the literature (Cajander *et al.*, 2022; Larusdottir *et al.*, 2023a).

The participants in studies of the UCD Sprint, when guided usage was explored generally gave positive feedback on the UCD Sprint (Roto *et al.*, 2021; Visescu *et al.*, 2023; Larusdottir *et al.*, 2023a). But through the results from the interviews, we can see that the participants were more hesitant about the process's future usage than those conducting the guided usage. For UCD practitioners to implement new approaches and processes requires training and facing resistance to change is common, since there is usually a fast pace in software development. Additionally, organizational reluctance from managers could hinder the adoption of UCD Sprint.

6.4. Feedback and shortcomings of the UCD Sprint

Through the interviews, it has been highlighted that the UCD Sprint does come with a series of shortcomings addressing the UCD practice limitations, similar to other design sprint approaches.

Firstly, the compressed timeframe in each step may hinder thorough user research and clear objective setting while using the UCD Sprint, potentially leading to ambiguous outcomes. In the UCD Sprint process, the steps are not scheduled to a particular date as in Knapp's (2016) design sprint, so the timing of each step is more flexible. This can be seen throughout section 4, where the UCD Sprint assumes a different structure and time frame in each case presented. Furthermore, when the UCD Sprint was used in courses with a fast pace, the participants reacted positively towards that, praising the structure and the step-by-step approach (Roto *et al.*, 2021; Visescu *et al.*, 2023; Larusdottir *et al.*, 2023a).

Secondly, concerns about the UCD Sprint's adaptability to diverse project contexts and team dynamics are raised, as it may struggle to accommodate unique project requirements without significant modifications. In the instructions for how to conduct the UCD Sprint, there are no guidelines on how to form the team participating, so that is up to each team to decide. A possible lack of team diversity in UCD Sprint teams could limit perspectives instead of stressing the importance of intra-organizational UCD approaches, which can increase the already existing resistance to change within organizations, impeding its effective implementation.

Addressing these above-mentioned limitations requires guidance in the careful consideration of team diversity, strategies to overcome resistance to change and acknowledgement of the potential challenges associated with UCD Sprint adoption in software industries, and previously highlighted in the literature (Salah *et al.*, 2014; Bano and Zowghi, 2015). In order for the UCD Sprint to be fully embraced and for practitioners to take full advantage of its benefits, streamlined communication between developers and designers must be a priority. Acknowledging and recognizing the work of UCD practitioners is crucial, and addressing the stakeholder prioritization issue within the company is essential. While no process can solve all limitations, the UCD Sprint tackles several challenges outlined in the paper. Educating managers, stakeholders and developers about the benefits of user inclusion is key, demonstrating that UCD does not need to be time-consuming or expensive. The UCD Sprint is highlighted as an effective methodology for this, with cases 1 and 2 focusing on educating future developers and Case 3 showing it as a process perceived by the practitioners as to streamline design, making it both time and cost-effective. The findings suggest the need to tailor the UCD Sprint to specific project needs and promote diverse participation with managerial support. This emphasizes the importance of a guided approach to learning UCD methods, as unguided usage may exacerbate challenges. Ultimately, the study underscores the ongoing need for refining UCD practices to better serve both users and organizations.

7. LIMITATIONS OF THE STUDY AND FUTURE RESEARCH

We acknowledge certain limitations in this study. Firstly, the number of practitioners interviewed was limited, which may restrict the generalizability of the findings. Additionally, the homogeneity of the sample, comprised entirely of Icelandic practitioners, may limit the broader applicability of the results beyond this specific context. In Iceland the number of UCD practitioners is limited. However, the participants recruited for this interview series are considered representative of a wide variety of roles, industries and company sizes. Future research could aim to address these limitations by including a more extensive list of participants, from different backgrounds and geographic locations to provide a more comprehensive understanding of the integration of UCD practices into software development practices.

Building on the findings of this study, future research should prioritize practical areas that can enhance UCD practices. Particularly, we would like to study how much tailoring of the UCD Sprint process is needed for UCD practitioners to be able to use the process efficiently and how much guidance and which forms of instructional support material are needed for UCD practitioners to adopt the process. There is a need to further explore how the guided use of the UCD Sprint can be improved for adaptability and flexibility to different contexts. We would like to give various types of guided courses for exploring the flexibility of the process and how UCD practitioners can adapt its usage to their work contexts. Additionally, creating accessible support materials for educators, students and practitioners could make UCD methods more widely understood and used. Furthermore, an exploration of the UCD Sprint's adaptability beyond the Icelandic context is necessary, in order to investigate its relevance across the diverse global software industry environment. Lastly, efforts to optimize the overall UCD Sprint process should be explored to overcome the challenges highlighted in this study. By focusing on these practical aspects, future research can contribute to making the UCD Sprint more effective and accessible for all involved.

8. CONCLUSION

In conclusion, the findings of this study show a diverse landscape of UCD methods employed by UCD practitioners in the Icelandic software industry. As mentioned throughout, the contribution of the paper is threefold, examining current UCD practices in the software industry and highlighting limitations found throughout literature and practitioner interviews, exploring how the UCD Sprint can address these limitations via guided case studies and evaluating the potential of unguided UCD Sprint adoption.

The unanimous acknowledgement of the importance of user involvement in the design and development processes are found throughout the participants' experiences, with user interviews and testing being central to their methodologies. However, the study also shows the challenges faced in advocating for user involvement, particularly in the context of design sprints. The challenges related to design sprints, as articulated by the participants, underline the need for a more flexible and adaptive approach. Time constraints, structural limitations and the lack of diversity in sprint participants emerged as recurrent themes, prompting UCD practitioners to adapt traditional design sprints to suit their specific project and team needs. The adaptations made by participants are a strategic response to the identified challenges, reflecting a nuanced understanding of UCD methodologies.

The study further introduced the participants to the UCD Sprint process, which participants viewed with enthusiasm as a potential approach to gaining a deeper understanding of users. However, concerns were raised about the efficiency of design sprints without clear goals and their applicability as one-size-fits-all solutions. Participants emphasized the necessity for well-defined objectives and limitations before initiating sprints in general, recognizing the importance of flexibility and adaptation based on project requirements. While there is no necessity for a new process to be followed step-by-step, introducing new methods and new toolboxes is seen as a potentially more fruitful approach, especially in education settings.

Overall, this study highlights the dynamic and context-specific nature of UCD practices in the Icelandic software industry. The participants' adaptive strategies highlight the importance of adapting methodologies to meet the unique demands of each project, challenging rigid structures in favour of versatile toolboxes. This nuanced perspective emphasizes the need for ongoing experimentation, adaptation and a mix-and-match approach to effectively integrate users into the development process. As the industry evolves, embracing these flexible and user-centric methodologies will be crucial for UCD practitioners to navigate the intricate landscape of software development successfully, and crucial to teach to students when preparing them for entering the work market.

Acknowledgements

We would like to thank all the interviewees for their time, effort and valuable contribution to this study.

Data Availability

The data underlying this article cannot be shared publicly due to the privacy of the individuals who participated in the study, as per the consent they provided prior to being interviewed. The data will be shared upon reasonable request to the corresponding author.

References

Ardito, C., Buono, P., Caivano, D., Costabile, M. F. and Lanzilotti, R. (2014) Investigating and promoting UX practice in industry: an experimental study. *International Journal of Human-Computer Studies*, **72**, 542–551. https://doi.org/10.1016/j.ijhcs.2013.10.004, https://doi.org/10.1016/j.ijhcs.2013.10.004.

AJ&Smart *Article: How to Design Sprint: A Step-by-Step Guide*. (2015). Ajsmart.com; AJ&Smart. https://www.ajsmart.com/how-to-design-sprint

Austin, A., Abdelnour Nocera, J. and Clemmensen, T. (2023) The "era of ferment:" how practitioners and educators frame HCI. *Journal of User Experience*, **18**, 7–40. https://uxpajournal.org/era-ferment-how-practitioners-educators-hci/.

Bach, P. M., DeLine, R. and Carroll, J. M. (2009) Designers wanted. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '09)*. Association for Computing Machinery, New York, NY, USA, 985–994. https://doi.org/10.1145/1518701.1518852.

Bak, J., Nguyen, K. A., Risgaard, P., & Stage, J. (2008). *Obstacles to usability evaluation in practice: a survey of software development organizations. In Proceedings of the 5th Nordic conference on Human-computer interaction: building bridges (NordiCHI '08)*. Association for Computing Machinery, New York, NY, USA, 23–32. https://doi.org/10.1145/1463160.1463164

Bano, M. and Zowghi, D. (2015) A systematic review on the relationship between user involvement and system success. *Inf. Softw. Technol.*, **58**, 148–169. https://doi.org/10.1016/j.infsof.2014.06.011.

Bharosa, N., Marangio, F., Petti, C. and Janssen, M. (2021) Engaging citizens in digital public service innovation ecosystems—insights from the Netherlands and Italy. *Data Archiving and Networked Services (DANS)*. In *Proceedings of the 14th International Conference on Theory and Practice of Electronic Governance (ICEGOV '21)*. Association for Computing Machinery, New York, NY, USA, 509–512. https://doi.org/10.1145/3494193.3494269.

Bruun, A., Larusdottir, M. K., Nielsen, L., Nielsen, P. A., & Persson, J. S. (2018). The role of UX professionals in agile development. *Proceedings of the 10th Nordic Conference on Human–Computer Interaction—NordiCHI '18*. Association for Computing Machinery, New York, NY, USA, 352–363. https://doi.org/10.1145/3240167.3240213

Cajander, Å., Larusdottir, M., & Gulliksen, J. (2013). *Existing but Not Explicit—The User Perspective in Scrum Projects in Practice*. In: Kotzé, P., Marsden, G., Lindgaard, G., Wesson, J., Winckler, M. (eds) *Human-Computer Interaction – INTERACT 2013. INTERACT 2013. Lecture Notes in Computer Science, vol 8119*. Springer, Berlin, Heidelberg. 762–779. https://doi.org/10.1007/978-3-642-40477-1_52

Cajander, Å., Larusdottir, M. K. and Geiser, J. L. (2022) UX professionals' learning and usage of UX methods in agile. *Inf. Softw. Technol.*, **151**, 107005. https://doi.org/10.1016/j.infsof.2022.107005.

Chamberlain, S., Sharp, H. and Maiden, N. (2006) Towards a framework for integrating agile development and user-centred design. *Extreme Programming and Agile Processes in Software Engineering*, In: Abrahamsson, P., Marchesi, M., Succi, G. (eds) *Extreme Programming and Agile Processes in Software Engineering. XP 2006. Lecture Notes in Computer Science, vol* 4044. Springer, Berlin, Heidelberg. 143–153. https://doi.org/10.1007/11774129_15.

Chammas, A., Quaresma, M. and Mont'Alvão, C. (2015) A closer look on the user centred design. *Procedia Manufacturing*, **3**, 5397–5404. https://doi.org/10.1016/j.promfg.2015.07.656.

Courtney, J. (2018). *The Design Sprint 2.0: What is it and what does it look like? | Inside Design Blog*. Invisionapp; Invisionapp INC. https://www.invisionapp.com/inside-design/design-sprint-2/

Define Highlight Reel | What is a Highlight Reel. (2019). Usertesting.com.; UserTesting. https://www.usertesting.com/glossary/h/highlight-reel

Dhandapani, S. (2016). *Roadblocks to UCD Integration*. First International Conference on Multimedia and Image Processing (ICMIP), Bandar Seri Begawan, Brunei, 2016, pp. 95-98 https://doi.org/10.1109/icmip.2016.18

Ferguson, D. (2018, October 5). *Google Design Sprint Conference 2018*. Voltage Control; Voltage Control. https://voltagecontrol.com/blog/google-design-sprint-conference-2018/

Getto, G. and Beecher, F. (2016) Toward a model of UX education: training UX designers within the academy. *IEEE Trans. Prof. Commun.*, **59**, 153–164. https://doi.org/10.1109/tpc.2016.2561139.

Gray, C. M. (2016). "It's More of a Mindset Than a Method." *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. Association for Computing Machinery, New York, NY, USA, 4044–4055. https://doi.org/10.1145/2858036.2858410

Gulliksen, J., Boivie, I., Persson, J., Hektor, A., & Herulf, L. (2004). Making a difference. *Proceedings of the Third Nordic Conference on Human–Computer Interaction—NordiCHI '04*. Association for Computing Machinery, New York, NY, USA, 207–215. https://doi.org/10.1145/1028014.1028046

Herfurth, L., & Sinclair, K. (2018, June). *From user-centred to stakeholder-oriented service design: Implications for the role of service designers and their education based on an example from the public sector. ServDes2018—Service Design Proof of Concept*. Linköping University Electronic Press. Politecnico di Milano. https://ep.liu.se/ecp/150/008/ecp18150008.pdf

Inal, Y., Clemmensen, T., Rajanen, D., Iivari, N., Rızvanoğlu, K. and Sivaji, A. (2020) Positive developments but challenges still ahead: a survey study on UX professionals' work practices. *Journal of User Experience*, **15**, 210–246. https://uxpajournal.org/ux-professionals-work-practices/.

International Organization for Standardization. (2019). *ISO 9241-210:2019*. ISO, Geneva, Switzerland. https://www.iso.org/standard/77520.html

Jia, Y., Lárusdóttir, M. and Cajander, Å. (2012) The usage of usability techniques in scrum projects. *Lect. Notes Comput. Sci*, 331–341, vol 7623. Springer, Berlin, Heidelberg.. https://doi.org/10.1007/978-3-642-34347-6_25.

Joshi, S., Morkos, B. and Summers, J. D. (2018) Mapping problem and requirements to final solution: a document analysis of capstone design projects. *Int. J. Mech. Eng. Educ.*, **47**, 338–370. https://doi.org/10.1177/0306419018780741.

Kaplan, S. and Tripsas, M. (2008) Thinking about technology: applying a cognitive Lens to technical change. *SSRN Electron. J.* 04-039. https://doi.org/10.2139/ssrn.1008908.

Knapp, J., Zeratsky, J. and Kowitz, B. (2016) *Sprint*. Simon and Schuster ,New York, NY.

Larusdottir, M., Roto, V., Stage, J., Lucero, A., & Šmorgun, I. (2019). Balance Talking and Doing! Using Google Design Sprint to Enhance an Intensive UCD Course. *Human–Computer Interaction—INTERACT 11747*, 95–113. Lecture Notes in Computer Science(), vol 11747. Springer, Cham. https://doi.org/10.1007/978-3-030-29384-0_6

Larusdottir, M., Roto, V., & Cajander, Å. (2021). Introduction to User-Centred Design Sprint. *Human–Computer Interaction—INTERACT 12936*, 253–256. Lecture Notes in Computer Science(), vol 12936. Springer, Cham. https://doi.org/10.1007/978-3-030-85607-6_17

Larusdottir, M. K., Roto, V., Lanzilotti, R., & Duta Visescu, I. (2022). Tutorial on UCD Sprint: Inclusive Process for Concept Design. *Adjunct Proceedings of the 2022 Nordic Human-Computer Interaction Conference (NordiCHI '22)*. Association for Computing Machinery, New York, NY, USA, Article 19, 1–3. https://doi.org/10.1145/3547522.3558901

Larusdottir, M. K., Lanzilotti, R., Piccinno, A., Visescu, I., & Costabile, M. F. (2023a). UCD Sprint: A Fast Process to Involve Users in the Design Practices of Software Companies. *International Journal of Human–Computer Interaction*. Taylor & Francis, Inc., 530 Walnut Street, Suite 850, Philadelphia, PA 19106. https://doi.org/10.1080/10447318.2023.2279816

Larusdottir, M., Roto, V., Lanzilotti, R., & Visescu, I. (2023b). The UCD Sprint: A Process for User-Centered Innovation. *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems (CHI EA '23)*. Association for Computing Machinery, New York, NY, USA, Article 557, 1–3. https://doi.org/10.1145/3544549.3574176

Marsden, N., & Holtzblatt, K. (2018). *How Do HCI Professionals Perceive Their Work Experience? Insights from the Comparison with Other Job Roles in IT. In Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems (CHI EA '18)*. Association for Computing Machinery, New York, NY, USA, Paper LBW522, 1–6. https://doi.org/10.1145/3170427.3188501

Nielsen, J. and Mack, R. L. (1994) *Usability Inspection Methods*. John Wiley & Sons, Inc., USA.

Ongwere, T. *et al.* (2022) Challenges, tensions, and opportunities in designing ecosystems to support the Management of Complex Health Needs. *CHI Conference on Human Factors in Computing Systems Extended Abstracts.(CHI EA '22)*. Association for Computing Machinery, New York, NY, USA, Article 71, 1–7. https://doi.org/10.1145/3491101.3503714.

Ozcelik, D., Quevedo-Fernandez, J., Thalen, J., & Terken, J. (2011). Engaging users in the early phases of the design process. *Proceedings of the 2011 Conference on Designing Pleasurable Products and Interfaces—DPPI '11*. Association for Computing Machinery, New York, NY, USA, Article 13, 1–8. https://doi.org/10.1145/2347504.2347519

Pender, H.-L., & Lamas, D. (2019). *The Challenging Front Ends of Accelerated Transdisciplinary Design Processes*. In *Proceedings of the 9th International Conference on Digital and Interactive Arts (ARTECH '19)*. Association for Computing Machinery, New York, NY, USA, Article 44, 1–8. https://doi.org/10.1145/3359852.3359886

Rogers, Y., Sharp, H. and Preece, J. (2023) *Interaction Design: Beyond Human-Computer Interact Ion*. Wiley, Sixth Edition.

Roto, V., Larusdottir, M., Lucero, A., Stage, J. and Šmorgun, I. (2021) Focus, structure, reflection! Integrating user-centred design and design sprint. *Human–Computer Interaction—INTERACT*, **12933**, 239–258. https://doi.org/10.1007/978-3-030-85616-8_15, https://doi.org/10.1007/978-3-030-85616-8_15.

Rubin, J. and Chisnell, D. (2008) *Handbook of usability testing : how to plan, design, and conduct effective tests*. Wiley Pub, Hoboken, New Jersey.

Mendonça de Sá Araújo, C. M. M., Miranda Santos, I., Dias Canedo, E., & de Araújo, A. P. F. (2019). Design Thinking Versus Design Sprint: A Comparative Study. *Design, User Experience, and Usability. Design Philosophy and Theory*, 291–306, HCII 2019. Lecture Notes in Computer Science(), vol 11583. Springer, Cham. https://doi.org/10.1007/978-3-030-23570-3_22

Salah, D., Paige, R. F., & Cairns, P. (2014). A systematic literature review for agile development processes and user centred design integration. *Proceedings of the 18th International Conference on Evaluation and Assessment in Software Engineering—EASE '14*. Association for Computing Machinery, New York, NY, USA, Article 5, 1–10. https://doi.org/10.1145/2601248.2601276

Sandu, R., Wangsa, K., Chugh, R. and Karim, S. (2022) A comparative study between design thinking, agile, and design sprint methodologies. *International Journal of Agile Systems and Management*, **15**, 225. https://doi.org/10.1504/ijasm.2022.10049716.

Schouten, B., Klerks, G., Den Hollander, M., & Brodersen Hansen, N. (2020). *Action Design Research Shaping University-Industry Collaborations for Wicked Problems*. In *Proceedings of the 32nd Australian Conference on Human-Computer Interaction (OzCHI '20)*. Association for Computing Machinery, New York, NY, USA, 36–44. https://doi.org/10.1145/3441000.3441078

Silva da Silva, T., Selbach Silveira, M., Maurer, F. and Hellmann, T. (2012) User experience design and agile development: from theory to practice. *J. Softw. Eng. Appl.*, **05**, 743–751. https://doi.org/10.4236/jsea.2012.510087.

Southall, H., Marmion, M., & Davies, A. (2019). Adapting Jake Knapp's design sprint approach for AR/VR applications in digital heritage. In: tom Dieck, M., Jung, T. (eds); *Augmented Reality and Virtual Reality*, Progress in IS. Springer, Cham. 59–70. https://doi.org/10.1007/978-3-030-06246-0_5

Visescu, I., Larusdottir, M., & Islind, A. S. (2023). Supporting active learning in STEM higher education through the UCD Sprint. *Proceedings of the IEEE Frontiers in Education Conference 2023*. College Station, TX, USA, 2023, pp. 1–10. https://doi.org/10.1109/FIE58773.2023.10342978

Vredenburg, K., Mao, J.-Y., Smith, P. W., & Carey, T. (2002). A survey of user-centered design practice. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems Changing Our World, Changing Ourselves—CHI '02*. Association for Computing Machinery, New York, NY, USA, 471–478. https://doi.org/10.1145/503376.503460

Zowghi, D., da Rimini, F., & Bano, M. (2015). Problems and challenges of user involvement in software development. *Proceedings of the 19th International Conference on Evaluation and Assessment in Software Engineering (EASE '15)*. Association for Computing Machinery, New York, NY, USA, Article 9, 1–10. https://doi.org/10.1145/2745802.2745810

Appendix C

Publication II: UCD Sprint: A Fast Process to Involve Users in the Design Practices of Software Companies

Taylor & Francis
Taylor & Francis Group

International Journal of Human–Computer Interaction

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/hihc20

UCD Sprint: A Fast Process to Involve Users in the Design Practices of Software Companies

Marta K. Larusdottir, Rosa Lanzilotti, Antonio Piccinno, Ioana Visescu & Maria Francesca Costabile

To cite this article: Marta K. Larusdottir, Rosa Lanzilotti, Antonio Piccinno, Ioana Visescu & Maria Francesca Costabile (2024) UCD Sprint: A Fast Process to Involve Users in the Design Practices of Software Companies, International Journal of Human–Computer Interaction, 40:23, 8360-8377, DOI: 10.1080/10447318.2023.2279816

To link to this article: https://doi.org/10.1080/10447318.2023.2279816

Published online: 20 Nov 2023.

INTERNATIONAL JOURNAL OF HUMAN–COMPUTER INTERACTION
2024, VOL. 40, NO. 23, 8360–8377
https://doi.org/10.1080/10447318.2023.2279816

UCD Sprint: A Fast Process to Involve Users in the Design Practices of Software Companies

Marta K. Larusdottir[a], Rosa Lanzilotti[b], Antonio Piccinno[b], Ioana Visescu[a], and Maria Francesca Costabile[b]

[a]Department of Computer Science, Reykjavik University, Reykjavik, Iceland; [b]Department of Computer Science, University of Bari Aldo Moro, Bari, Italy

ABSTRACT

Several studies have shown that involving users in design processes is a key factor in understanding user needs and essential for designing computer systems capable of providing valuable user experiences. However, many practitioners do not emphasize user needs sufficiently and neglect user involvement in software design and development. The UCD Sprint is a recently proposed, step-by-step, cost-effective process that focuses on involving users in design activities. This article reports a mixed-method study in which, for the first time, practitioners working in companies used the UCD Sprint; the study's main objective was to investigate the impact of the UCD Sprint on practitioners' design practices. The results show that, among the various activities associated with this process, those that involved users were particularly appreciated by practitioners. Thus, the UCD Sprint can enhance the innovativeness of company design practices; it enables practitioners to obtain sufficient information to create systems that fit users' needs.

KEYWORDS

User-centred design; user involvement; empirical study; user experience; software design

1. Introduction and motivation

The benefits and drawbacks of involving users in software development in a face-to-face setting to understand their needs and expectations more accurately have been explored by researchers for several years. A literature review published in 2003 claimed that user involvement generally has positive effects, especially on user satisfaction with the delivered system (Kujala, 2003). Bano and Zowghi report that user involvement positively affects software system success (Bano & Zowghi, 2015), i.e., it permits the desired benefits to be obtained if it is carefully planned and managed. Additionally, Maramba et al. (2019) found that involving users in testing eHealth apps has increased in recent years, thereby providing valuable results. Despite these positive results, practitioners face several challenges when involving users in their software design, namely, a lack of support from top management, a lack of resources, a lack of good communication and lack of qualified user experience professionals (Inal et al., 2020). Another study showed that user experience (UX) professionals struggle to position themselves within their company and prove that their methods and techniques are valuable (Marsden & Holtzblatt, 2018). To address these challenges, practitioners expect more support from top management, more money, better internal cooperation, better organization-wide tools, and more training on user-centred design (UCD). While the field of Human-Computer Interaction (HCI) offers many methods to help understand users, designers often view themselves as proxies for or representatives of intended users when assessing their needs and requirements (Islind & Lundh Snis, 2018).

The User-Centred Design Sprint (UCD Sprint for short) was recently proposed by Roto et al. (Roto et al., 2021). It is a step-by-step and cost-effective process that emphasizes user involvement in the early stages of software design. Eighteen UCD steps are included in the process, which also defines how the results of one step are used in subsequent steps. The main objective of the process is to involve users from the very beginning of software development to discover their needs and expectations and to generate different ideas based on this information to create early interface designs, which are evaluated through quick and informal formative user testing. The UCD Sprint originated from experiences in intensive courses with university students (Larusdottir et al., 2019a, 2019b; Roto et al., 2021). Participants in these courses claimed that the process was fast, focused, and structured but also gave them time for reflection (Roto et al., 2021). The UCD Sprint has also been taught in short courses at conferences (Larusdottir et al., 2021, 2022, 2023).

The motivation for our research is to promote user involvement and UCD activities in the design processes of software companies as well as in the context of public administration because these activities are key elements in the creation of systems that are capable of meeting users' needs. Previous research on the design practices of software companies has highlighted how infrequently UCD activities

CONTACT Marta K. Larusdottir marta@ru.is Department of Computer Science, Reykjavik University, Reykjavik, Iceland

are performed; moreover, time and costs have often been cited as reasons that deter practitioners from involving users in design and development processes (see, e.g., Ardito et al., 2014a, 2014b; Teka et al., 2017; Bak et al., 2008). The UCD Sprint has received positive feedback from university students, but the implementation of this process has not yet been studied in the context of practitioners. We wanted to explore whether and how practitioners can apply the UCD Sprint process to their software design. Thus, we performed a study whose overall research question focused on whether the UCD Sprint process is valuable with regard to providing UCD activities that involve users and are feasible for practitioners to introduce into their software design practices. It is the first study carried out by one of the researchers who defined the UCD Sprint in which practitioners have been involved.

As reported in this article, the study was conducted in accordance with a research methodology featuring three parts. In the first part, semi-structured interviews were conducted with 7 practitioners to understand their current ways of working, and how they involve users in their software design practices. In the second part, 14 practitioners attended a course on a new version of the UCD Sprint, during which they performed the activities of the process; the course was organized in a novel way, and it lasted 4 days to account for the time constraints faced by companies' employees; feedback was collected from participants to provide both quantitative and qualitative data that could enable us to understand how they valued the activities of the UCD Sprint process as well as the course structure and content. In the third part of the study, 8 course participants were interviewed seven weeks after the course with the goal of understanding how they envision the future implementation of the UCD Sprint process in their design approaches. The study results highlight the value of the UCD Sprint with regard to focusing on software users, who are the main stakeholders whom designers must address when developing software that is capable of providing good user experiences.

The paper is organized as follows. Section 2 reports related work. Section 3 describes how the UCD Sprint has evolved since its original conception and how a course on the UCD Sprint has been crafted to be suitable for practitioners. Section 4 describes the study conducted, and Section 5 discusses the results obtained thereby. Section 6 describes the limitations of the study, and Section 7 concludes the article while simultaneously highlighting future work that can address some of the limitations of this study.

2. Related work

This section first describes some literature on the approaches and methods used to involve users in software design and on how that is accomplished in practice; then, it reports the results of studies on the integration of UCD methods in agile processes; and finally, it briefly describes the design sprints that inspired the UCD Sprint.

2.1. The implementation of UCD methods in practice

Designing software based on an inappropriate or incomplete understanding of user needs due to a lack of user input is a major source of unusable software (e.g., ISO, 2020; Hussain et al., 2016). Several approaches, methods and processes for focusing on and involving users have been suggested to improve the understanding of various factors pertaining to users and their involvement in the software being designed. The most cited process in this context is the Human-Centred Design (HCD) process, which is also referred to as User-Centred Design (UCD) process and was illustrated in ISO (2020). It includes four major activities: (a) understanding and specifying the context of use; (b) specifying the user requirements; (c) producing design solutions to meet these requirements; and (d) evaluating the designs against the requirements. These major activities are quite broad, so IT professionals must select UCD methods and techniques that are sufficiently detailed to perform the major activities stipulated in the standard.

A recent study identified the UCD methods that are most frequently used by UX professionals, i.e., professionals who focus on users' needs and UX (Inal et al., 2020). The typical UX professional included in that study had more than a decade of work experience working in small teams using agile development processes within large organizations. The study involved 422 participants from 5 countries. More than 70% of the participants noted that they followed a UCD process, and more than 80% claimed that they focused on user experience. The most frequently used standard UCD methods pertained to prototyping, namely, wireframing, sketching, mockups, and digital prototyping. Two-thirds of the participants reported engaging in face-to-face contact with end users. The most common UCD method for this contact was usability testing featuring three or more rounds, and six or more users in total were included in such projects. Three out of four UX professionals followed up with the development teams after completing the UCD activities. UX professionals found it to be difficult to choose among the various UCD methods available and asked for more structured ways of working. UX professionals also described the need for more structured UX methods in a study by Cajander et al. (2022).

Often, the UCD methods used to gather user requirements, such as interviews, questionnaires, and observations, are viewed in the industry as resource-consuming (Ardito et al., 2014a). Partnerships between universities and industry have been suggested in an attempt to educate students in UCD practices more effectively (Getto & Beecher, 2016). Approaches such as design sprints and agile processes can productively incorporate structure and speed into design processes, combining the needs of the professionals with those of users, given that the focus is kept primarily on the user and UCD methods are well integrated into time-bound sequences.

2.2. Integrating UCD methods into agile processes

Since the beginning of this century, researchers have investigated the combination of UCD with agile design methodologies: both approaches are based on similar principles, namely, user involvement, iterative design, continuous testing and prototyping (Blomkvist, 2005). Some studies have indicated that the UCD-agile combination poses two important problems. The first such problem pertains to communication between developers and designers. Developers are more focused on software architecture and functionality, while designers are more focused on user requirements (see, e.g., Chamberlain et al., 2006). The other problem pertains to the distinction between two different actors who might be involved in this process: customers and users. In most cases, these two actors are very different: the customer is the person who requires the system and is paying for its development, while users are those who will use the system. Agile methodologies usually require customer participation in the software lifecycle only as part of a collaborative partnership based on daily interaction with developers and a lack of user participation (Highsmith, 2002). UCD is primarily based on user involvement in the software lifecycle. Often, customers do not know users' needs, expectations, and desires well; thus, user requirements expressed solely by customers are insufficient for creating products that are capable of exhibiting a positive UX. In the literature, some studies have explored fruitful customer and user participation in agile software development projects (Kautz, 2011). In these studies, customers played an informative, consultative and participative role, while users guaranteed the appropriate flexibility of the product during the whole design and development process. The result was very good: both the project and the final product were considered to be a success by the customer and the developing organization.

The integration of UCD methods into agile development has been discussed in the literature (see, e.g., Ardito et al., 2017; Bruun et al., 2018; Cockton et al., 2016; Persson et al., 2022). In particular, in a study conducted at a software development company in Denmark with a focus on the UX of their software, a total of 10 IT professionals, including UX professionals, developers, and managers, were interviewed about user involvement in their software development process (Bruun et al., 2018; Persson et al., 2022). The primary outcome indicated that UX professionals typically work full-time on projects during the inception and requirement-gathering phase before the agile development process is initiated. During these implementation sprints, the UX professionals typically spend 20% of their time on the projects, which mostly involves guiding the development team when questions arise regarding implementing sketches or wireframes and only occasionally involves users.

2.3. Design sprints

Processes for helping developers in the early steps of design have been identified. These processes include design sprints, in which context a dedicated team solves certain questions, challenges or uncertainties by making prototypes and testing them with target users (Larusdottir et al., 2023). One such process was popularized by the IDEO design agency as a human-centred and efficient way of promoting innovation in 2010 (Brown & Wyatt, 2010). While academics have criticized this process for failing to build on design theories, the practical guidance people can obtain from this approach has been popular in innovation-oriented organizations. Another process called *Design Sprint* was proposed by Knapp et al. (2016). This process consists of a step-by-step collaborative design process involving seven or fewer people with different backgrounds, such as management, finance, marketing, customer research, and technology. The Design Sprint is scheduled in detail over a period of 5 days, Monday to Friday (Knapp et al., 2016). A facilitator who has experience with the sprint process guides the team by providing specific instructions and timing for each activity. On the first day, the Design Sprint focuses on mapping out the whole idea and discussing it with experts; the next day, a small part is selected for further work, and the interaction design starts; the third day, the focus is on designing the flow of the interaction; and the fourth day, a detailed prototype is created. Users are involved during the final day of the Design Sprint in through five 30-minute user testing sessions, which are analyzed during the final afternoon of the sprint. The process includes both team discussions and individual idea development. It has been argued that a fixed schedule for the Design Sprint ensures that the work remains productive and fast, and through sprints, feasible solutions can be explored (Knapp et al., 2016).

Design sprints take place before implementation starts, i.e., during the phase that involves defining what to implement, unlike sprints in the context of agile processes, which have the main goal of implementing software (Schwaber, 2004). Once a design sprint has found a promising candidate solution, an agile development project can start and implement the digital parts of the solution. Both design and implementation sprints share the mindset of avoiding wasting time by planning too far ahead. Instead, they wait to plan the details until the team is ready to focus on them and keep the design to a minimum at the beginning of the project (Adikari et al., 2009). In both cases, it is essential to accept a state of uncertainty regarding how well the design fits the users and how good the overall idea is. Additionally, learning from each iteration is emphasized (Knapp et al., 2016).

Leading researchers in the UCD field have studied how UCD activities and design sprints can be merged (Larusdottir et al., 2019b). A process called the *UCD Sprint* has been defined (Roto et al., 2021). The main objective of the UCD Sprint process is to focus on users and their needs, more than is done in Knapp's Design Sprint process (Knapp et al., 2016) or the IDEO design sprint process. Another objective pertains to the integration of good design practices drawn from Knapp's Design Sprint into the UCD Sprint.

3. The UCD sprint process

In this section, we describe the evolution of the UCD Sprint. We also illustrate how a course on this process has been structured for practitioners working in IT companies to fit their needs more effectively.

3.1. Evolution of the UCD sprint process

The UCD Sprint process originated from the addition of UCD activities to Knapp's Design Sprint. Two versions were tested in two-week intensive courses in higher education. In the first version, Knapp's Design Sprint was conducted during the first week, while more specialized UCD activities were conducted during the second week, as described by Larusdottir et al. (2019b). Specifically, the added activities included stating UX goals, redesigning the prototypes to fit the UX goals, evaluating the UX, redesigning it according to the results and evaluating it once again. The three activities that were ranked the highest in terms of being useful during the course were a) sketching, including the Crazy 8 activity used in the UCD Sprint to sketch different ideas, b) creating a storyboard to design the flow from one screen to another in the prototype and c) making high-fidelity prototypes. The lowest scores were given to setting UX goals since participants commented that this activity took place too late. Additionally, participants noted that more user interaction should happen at the beginning of the process.

In the second version of the course, some UCD activities, namely, sketching a vision, analyzing user groups, conducting interviews with users, identifying UX goals and identifying usability requirements, were conducted before Knapp's design sprint activities. This structure was based on the feedback obtained from the previous version of the course. After the activities described in Knapp's design sprint, the prototypes were iterated according to the results of the user evaluations and evaluated once again. The feedback from participants during that course was positive with regard to the whole process, i.e., both the UCD part and Knapp's Design Sprint part. The process was called *UCD Sprint* (Roto et al., 2021). The course activities that received the highest rating with regard to being useful were high-fidelity prototyping and user evaluations of high-fidelity prototypes.

The goal of the UCD Sprint process is to involve users from the beginning of software design to enhance the designers' understanding of user needs. This approach is especially applicable when the idea for the software is unexplored and the potential users have various backgrounds, unlike the developers. At INTERACT 2021, a course was also held to explain the UCD Sprint process to conference participants (Larusdottir et al., 2021). Because of limited time, the course focused on introducing the process and practicing two steps of the process. Subsequent discussions with academics working in the field of HCI and further experiences led to a new version of the UCD Sprint process, which is illustrated in Figure 1. The UCD Sprint is now organized into three phases, i.e., *Discovery, Design and Reality Check*, each of which includes 6 steps; UCD activities are performed at each step.

The process is not bound to any particular timing or linked to particular days of the week; thus, it is more flexible than Knapp's Design Sprint. Additionally, the UCD Sprint is a step-by-step process that offers developers a structured way to involve users on 3 occasions, i.e., during interviews, during low-fidelity prototype evaluation and during high-fidelity prototype evaluation. The initial involvement of users occurs already at the third step of the 18-step process. In Knapp's Design Sprint, users are involved only in testing high-fidelity prototypes as one of the last activities in the process. Furthermore, the UCD Sprint process has been refined in light of findings from previous studies on UCD activities and the experience obtained during courses (Jia et al., 2012; Larusdottir et al., 2019b; Roto et al., 2021). This version of the UCD Sprint process has been presented during a tutorial at NordiCHI 2022 (Larusdottir et al., 2022) and in a course at CHI 2023 (Larusdottir et al., 2023).

As shown in Figure 1, the UCD Sprint spends ample time understanding the needs of the target user group. Interviews are conducted with users before the prototyping starts. UCD Sprint differs from a more general UCD process by providing a clear structure and methods for each step of the design process. Like Knapp's Design Sprint, the step-by-step process of UCD Sprint allows less experienced teams to apply the methodology, so it also fits well in the context of design education. The UCD Sprint was developed through intensive interaction design courses in which students with different backgrounds worked on design challenges in teams. The original UCD Sprint process is two weeks long and includes time for teaching the methods. When applied by professional developers who are familiar with UCD methods, the process can be shorter.

3.2. UCD sprint course for practitioners

Our research aims to promote user involvement and UCD activities to practitioners, particularly in the design processes of software companies. Therefore, we decided to structure a new course on the UCD Sprint that could enable practitioners to understand how useful they would find the UCD Sprint both during the course and for future integration in their design processes. Our experience with IT companies provided evidence suggesting that corporate practitioners know very little or nothing about the UCD methods; thus, it was decided that the course should entail some practice on the UCD activities used in the UCD Sprint. However, practitioners usually face strict time constraints, so it was clear to us that we could not offer a 10-day course but should rather modify the course structure to suit practitioners' needs. Ultimately, the course was designed to be taught for 4 days with assigned homework between course days. An overview of the activities in the UCD Sprint course for practitioners is provided in Figure 2.

This course was offered as part of the study reported in Section 4. More specifically, this course was organized as follows. Each course day started at 9:00 and continued until 17:00, including breaks as needed, usually one in the morning, one for lunch, and one in the afternoon. The first day was a Thursday, the second was a Friday, the third was a Tuesday the following week and the last day of the course was a Wednesday. Hence, the participants first had two course days in succession and were assigned homework in the evening both days (see Figure 2). The third and fourth

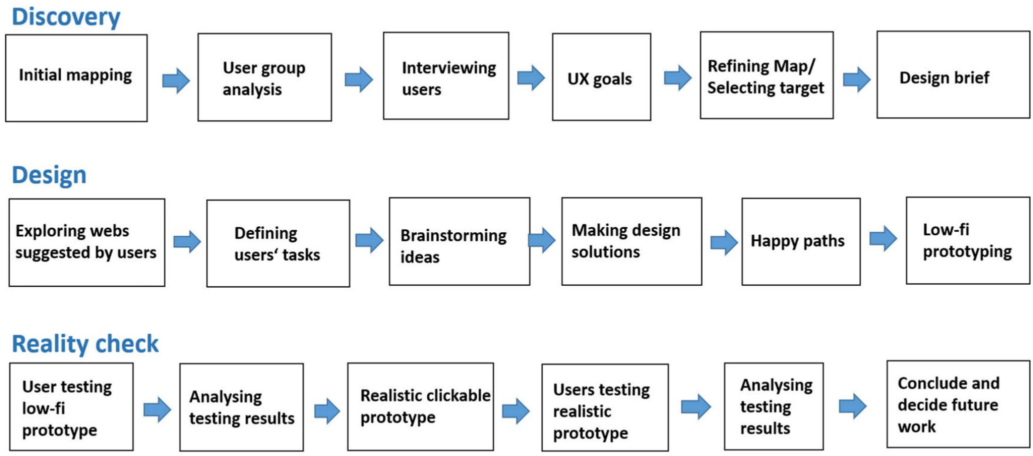

Figure 1. An overview of the structure of the UCD Sprint.

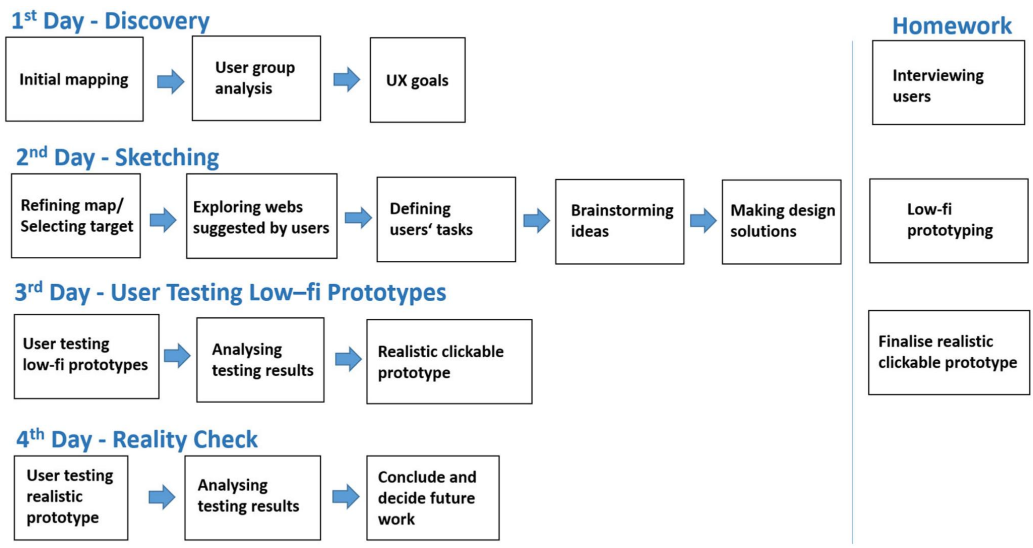

Figure 2. An overview of the UCD activities conducted during the UCD Sprint course and their timing.

days followed in succession. At the beginning of the course, the first task for the participants' groups was to select a design idea on which they wanted to work during the four days of the course. They were given 5 design ideas, three of which were chosen. The course covered 16 out of the 18 steps in the UCD Sprint process (see Figure 1). The steps "Design brief" in the Discovery phase and "Happy paths" in the Design phase were not covered because of practitioners' strict scheduling requirements.

The participants were asked to provide quick feedback on the benefits, drawbacks and potential improvements at the end of the second day of the course to enable us to correct any flaws thus identified directly. Generally, the participants commented positively on the course structure, the cooperative and activity-based learning approach, and the UCD Sprint process; thus, no revision of the course structure was needed.

4. UCD sprint for practitioners: the study

This section describes the study conducted with practitioners working in Italian software companies. First, Section 4.1 describes the objectives of the study, specifying the research questions and illustrating the research methodology adopted for the study, which is organized in three parts. Then, Sections 4.2, 4.3 and 4.4 report the details of participants, methods and results of the three parts of the study, respectively.

4.1. Study objectives, research questions and methodology

The main objective of the study was to investigate whether the UCD Sprint is a valuable process that practitioners can adopt for focusing on and involving users in their software design practices. Since it was the first time that the course on the UCD Sprint was offered to practitioners, a secondary objective was to investigate the positive and negative aspects of the course from the perspective of participants. More specifically, our study explored the following research questions:

1. What are practitioners' current ways of working; specifically, how do they address users and involve them in their software design practices? (RQ1)
2. How do practitioners rate the usefulness of the UCD Sprint process? (RQ2)
3. What do practitioners consider to be the positive and negative aspects of the UCD Sprint course? (RQ3)
4. How do practitioners envision the future implementation of the UCD Sprint process in their design approaches? (RQ4)

The study was guided by a research methodology featuring three parts, as shown in Figure 3. In Parts 1 and 3, semi-structured one-on-one interviews were conducted to address RQ1 and RQ4, respectively. In Part 2, to address RQ2 and RQ3, 14 practitioners attended a 4-day course on the new version of the UCD Sprint described in Section 3.2, as part of which they performed the activities associated with the process.

The participants, data gathering, data analysis and results of each of the three parts of the study are reported in sections 4.1, 4.2 and 4.3, respectively.

4.2. Part 1: Current ways of working

Semi-structured interviews were conducted with 7 employees involved in the design/development of their company products. The interviews were conducted from November 2021 to January 2022. Their aim was to address RQ1: *What are practitioners' current ways of working; specifically, how do they address users and involve them in their software design practices?*

4.2.1. Participants, data Gathering and data analysis

The 7 participants were selected through convenience sampling: we contacted company managers who indicated the person(s) involved in the design/development practices of their company. Of the 7 participants in this study, 2 identified themselves as development managers, 2 as user interface and UX (UI/UX) managers, and 1 as a developer; the remaining 2 participants noted that they are professional service (PS) managers, i.e., people who interact with customers to define product requirements. Interviewees signed a digital consent form that informed them about the collection of audio recordings and the management of sensitive data. Interviewees were not given any remuneration or reward for participating in this study.

The interviewees worked at 4 companies operating in the area around [particular place, country]. Companies with different characteristics were intentionally selected. One employee from the smallest company was interviewed, and two employees from the other three companies were interviewed. The smallest company had 16 employees, most of whom were developers, and a turnover of fewer than 1 million Euros. Its core business was software system design and development, but it also focused on industrial research, Information and Communications Technology (ICT) consulting, and e-Health applications. The second company had 40 employees and a turnover of approximately 2.2 million Euros. It had two offices in Italy and one in the UK as well as multiple international partnerships. This company focused on creating software to support laboratories in managing tests of their products. The other two companies were larger. One of these companies was among the leading Italian players in international business consulting and system integration; this company had approximately 2000 employees (800 in the [city] office) and a turnover of approximately 170 million Euros. It delivered software solutions of different types, such as solutions pertaining to financial services, energy and utilities, transportation, public administration, and international institutions. The fourth company was a global leader in IT professional resourcing; it had approximately 1500 employees (67 in the [city] office) and a turnover of 440 million Euros. Its products were primarily focused on the fields of IT, transportation, and automation.

The semi-structured interview was composed of 5 sections. After welcoming the interviewee, the first section asked about the interviewee's role in the company, the type of software products that the company develops, the development approach used to create the company's products in terms of models, methods, and activities, whether they take users' needs into account and which activities they perform to collect information regarding those needs. The second section was related to UX; specifically, we asked interviewees to report whether they investigate how their users experience their products in terms of, for example, ease of use, engagement, satisfaction, or esthetics. The questions in the third section investigated whether and how interviewees

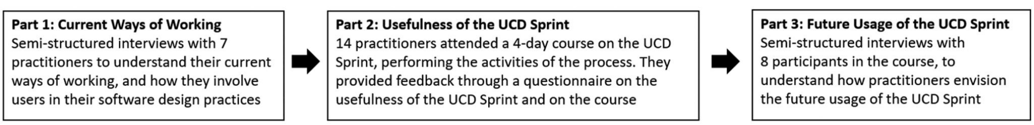

Figure 3. The study methodology consisting of three parts.

perform activities aimed at identifying the tasks that end users will perform using the future product. The fourth section concerned how they address the user interface design and, in particular, the possible use of prototypes and tools to develop them. The fifth section pertained to the evaluation activities performed to investigate the quality of the software products they create and whether and how they have previously involved users.

Two researchers were involved in each interview: one researcher served as the interviewer, and the other researcher assisted by taking notes. The interviews were audio-recorded. Each interview was transcribed before analysis.

Inductive thematic analysis was used to analyze the data collected during the interviews. Themes were identified through in vivo coding. More specifically, two researchers independently analyzed the interview transcripts to identify patterns, opinions, and behaviours as well as other issues that sound interesting, grouping them in themes that synthetically describe each group. As required in this kind of analysis, 70% of the results were double-checked for inter-rater reliability. The analysts ultimately reached consensus regarding all the identified themes. The same process was adopted in the analysis of the qualitative data of Part 2 and Part 3 of the study.

4.2.2. Results regarding current ways of working

The identified themes are summarized in Table 1 alongside their definitions and the main results that emerged from the analysis. The results are reported for each theme.

4.2.2.1. Process. Regarding this first theme, the analysis of the answers provided by the interviewees showed that all the companies employ an agile-based development process. After the company and the customer agree to develop the product, the first activity is a kickoff meeting at which the company PS manager and his team meet with the customer to discuss and agree upon the initial set of product requirements.

4.2.2.2. Requirements. Interviewees noted that requirements are defined in collaboration with the customer; no interviewees claimed that users are involved in the analysis of requirements. The company can suggest other requirements based on the experience it has acquired in previous projects. The customer can choose whether to approve the new requirements, and in the end, a document containing specific requirements is produced and signed by the customer. As one interviewee explained, "*The defined requirements could also change later based on feedback received from users once they work with the released product*" (*PS manager*; note that the words in parentheses after each excerpt indicate the role of the interviewee). However, in these cases, such changes are not formally reported but merely communicated to the development team. In most cases, the focus is on functional requirements. Three interviewees noted that they identify user needs; however, such needs are identified in consultation with the customer. One interviewee remarked that the customer *"plays the role of the final user"* (UI/UX manager). As another interviewee said, "*User profiles are defined, and for each of them, a user journey is written*" (Manager). User journey is a method that companies often use to describe the experience that users will undergo within a given scenario (Endmann & Keßner, 2016); consequently, different use cases are defined and discussed within the team. Initially, a user journey is described in an Excel file with a requirement/user table, following which it is described in detail using PowerPoint slides. These slides are shared with the UI/UX expert of the company, who is responsible for the UI design.

4.2.2.3. Prototyping. Only one interviewee made the following claim: *"In my company, mockups are used, especially*

Table 1. Overview of the themes, their definitions and the main results.

Themes	Definition	Main results
Process	The process that the company uses to develop its products	• All companies follow an agile-based design/ development process.
Requirements	Approaches that the company uses to collect project requirements	• Requirements are defined in collaboration with the customer. • Requirements are possibly integrated with other requirements derived from the experience of the company with other products.
Prototyping	Use of prototypes and their types	• Little use of prototypes. One company uses mockups. • Prospective users are never involved.
Evaluation and Test	Types of evaluations and tests that the company performs	• Functional tests are always performed on the products. • In one case, the product was evaluated by the customer, who was also an end user of the product. • Some evaluation of the released product is conducted.
User Involvement	Involvement of the users in the different phases of the development process	• Users are not involved in the product development. • Only when the product is released do users interact with the product and can provide feedback. • User involvement is too expensive.

when important or complex requirements are difficult to explain using words. The mockups are sent to the UI/UX manager, who, using Figma[1] *or Balsamiq*[2]*, creates running prototypes, which are then checked with the PS team*" (PS manager). It is worth noting that the PS manager used the terms "usable interaction"; however, when she was asked about the meaning of these two words, she said only that a low number of clicks is an indicator of good usability. This finding shows that some practitioners do not completely understand the meaning of usability. If the UI/UX manager believes that the mockups produced by the PS team are insufficient, they can produce new prototypes from scratch; such prototypes are discussed with the PS teams. An initial brainstorming session takes place at which the UI/UX manager explains the pros and cons of the various proposals with the goal of understanding possible obstacles or factors that might be encountered in the development phase. When a consensus is reached regarding the final prototype, it is shared with the PS manager and the development team. Prototypes are generally evaluated within the company itself. The prospective user is never involved.

As one interviewee from another company said, "*The prototypes are presented as a demo in an informal meeting with both the PS team and the support service team; these people provide feedback based on their experience*" (PS manager). This presentation is considered to be a fruitful activity, but as another interviewee emphasized, "*Unfortunately, COVID and smart working have stopped this activity!*" (Manager).

As one interviewee who works as a developer in a company noted, "*I receive the requirements for a new product and start developing the product using the final technology*" (Developer). The UI/UX manager of the same company claimed that "*I'm moved from one project to another when it is time to develop or redesign the interface.*" Her name is Maria; as she said, "*When they talk about UX, they call Maria!*" She added that "*The role of the UX expert is confused with the role of the graphical designer*" (UI/UX manager), highlighting the fact that UX is not properly considered while the company focuses only on the product's visual appearance.

4.2.2.4. Evaluation and test. The results regarding this theme show that before each product release, which occurs periodically (e.g., every week, every two weeks, or monthly), no evaluation with users is performed; rather, only functional tests are performed to fix possible bugs. Once the users work with the final product, they might send feedback to the development team by email or phone; in a few cases, this feedback is discussed in meetings between the PS team and the customer. Indeed, as one interviewee noted, "*The problems arise during the pre-go-live phase when users use the system*" (PS manager). Another interviewee noted that "*The real work begins after the final system is released*" (Manager). The same interviewee commented that even if the customer was involved during the design and development phases, "*The problems emerged only when the users started using the product*"; he added that "*the solutions to the problems had to be implemented in the new software release.*" It is worth remarking that, despite all these concerns, users are still not involved in the design/development process.

4.2.2.5. User involvement. In general, interviewees claimed that there is no user involvement during the early sprints; in the pre-go-live and go-live phases, the customer plays the role of the end user. In an ongoing project in one company, the customer is also the end user. As an interviewee from that company noted, "*Different prototypes of the product were evaluated with the customer during the biweekly meetings*" (PS manager). He also explained that each meeting was divided into two phases: a first phase in which the PS team showed the prototype, highlighting the improvements made based on the suggestions received at the previous meeting, and a second phase in which the customer used the prototype and provided new feedback. As this interviewee said, "*Being that the customer is also the user, it was also very important for him to define user needs. This work must be done by four hands!*" (PS manager).

The interviewees offered several reasons to explain the exclusion of users from the development process, which are already well known in the literature (Ardito et al., 2014b). User involvement is still viewed as "*too expensive*" (Manager) and resource-demanding both in terms of time and difficulties in user recruitment. As one interviewee said, "*We don't involve end users because of time issues and because misunderstandings can be created*" (UI/UX manager). Another interviewee exclaimed that "*The user requires 3000 things!*" (Manager). As one manager said, "*In the end, the customer decides, not the users.*"

4.3. Part 2: Usefulness of the UCD sprint

The main goal of the second part of the study was to address both *RQ2: How do practitioners rate the usefulness of the UCD Sprint process?* and *RQ3: What do practitioners consider to be the positive and negative aspects of the UCD Sprint course?* Practitioners were invited to participate in the 4-day course on the UCD Sprint described in Section 3.2, which was held at the [Particular University, particular place] on April 28th and 29th and May 3rd and 4th, 2022. All authors contributed to the course, although they played different roles, and they did not receive any remuneration for the course.

4.3.1. Participants, data gathering and data analysis

The course had 14 participants, including four females and ten males between the ages of 24–42; they were selected through convenience sampling to ensure that practitioners could attend the four-day course. For the interviews, we contacted the companies' managers, and with their participation, we selected the practitioners who were most suitable to participate in the course in terms of both competence and availability. The participants had mixed personal and educational backgrounds. Specifically, 4 participants were employed full-time at IT companies as designers/developers, 8 were designers/developers working part-time at IT companies while pursuing their PhDs in Computer Science (industrial PhDs), 1 had a background and a strong interest in UCD and was working as a freelancer while pursuing his Computer Science studies, and 1 was a freelancer with experience in graphic design. The participants were split into 3 working groups to ensure a varied mix of backgrounds in each group. All participants signed a digital consent form that informed them about the management of any sensitive data collected. Participants were not given any remuneration or reward for participating in this study.

Data were gathered at the end of the course using a questionnaire that featured four parts: 1. participants' backgrounds; 2. positive and negative aspects of the course as perceived by participants; 3. participants' ratings of the usefulness of the steps involved in the UCD Sprint process covered in the course; and 4. participants' overall experiences during the course. Each part was presented on one page.

The questions concerning participants' backgrounds in Part 1 included both open and closed questions that aimed to collect information regarding participants' educational backgrounds, work backgrounds and experience as well as some demographic data, including their age and gender. The data thus collected are summarized in the description of participants above.

To answer RQ2, Part 3 was a formal questionnaire that collected participants' ratings of the usefulness of each step of the UCD Sprint process performed during the course. The questions asked were as follows: 1) Was it [the step] thought-provoking? 2) Was it [the step] useful for the course? 3) Do you think that you will use this method in your job/education? The participants evaluated these dimensions on a scale from 1 to 7, from "Not at all" to "Extremely so," and "Not likely" to "Extremely likely," respectively. This part of the questionnaire has also been used in other iterations of a course on UCD Sprint (Larusdottir et al., 2019b; Roto et al., 2021). The raw data collected through Part 3 were inserted into an Excel file to calculate the average ratings, which are discussed in Section 4.2.2.

Parts 2 and 4 of the questionnaire were used to gather data to answer RQ3. In Part 2, qualitative data were collected using the Retrospective Hand technique, which is an informal qualitative questionnaire that features 5 items and has also been used in previous courses (Larusdottir et al., 2019b; Roto et al., 2021). The participants were asked to provide feedback regarding of the course aspects that captured their attention. More specifically, the participants were asked to describe their experiences in the UCD Sprint course according to the following five categories: 1) This was good; 2) I want to point this out; 3) This was not as good; 4) I will take this home; and 5) I would have liked more of this. In Part 4 of the questionnaire, the participants could provide any comments they wanted to provide on a final blank page. The analysis of the data collected through Parts 2 and 4 of the questionnaire consisted of a priori thematic analysis based on themes drawn from Steyn et al., (2019) alongside some added definitions and themes specific to the analysis of the UCD Sprint (Larusdottir et al., 2019b). The themes used are shown in Table 2. For this analysis, two researchers independently examined the collected data. The interrater reliability was 70%. At this point, 30% of the data were double-checked for interrater reliability, and a consensus was reached.

4.3.2. Results regarding the usefulness of the UCD sprint

The quantitative results of Part 3 of the questionnaire, i.e., the participants' ratings of the usefulness of the UCD Sprint activities, are shown in Table 3.

The activity with the highest score in terms of being thought-provoking, useful for the course, and useful for the future was the analysis of the results of the user testing. Other steps, such as low- and high-fidelity prototyping and user testing of high-fidelity prototypes, also received high scores. The user testing of high-fidelity prototypes was conducted with users who were not involved in the course, and each session lasted for 30 minutes. After each user testing session, post-it notes containing notes and important points drawn from the user testing were put on the blackboard in line with the appropriate task. Gradually, a visualization of the results emerged. The activities that received the lowest scores from the participants with regard to thought-provoking were refining the map and selecting a target for making the prototypes. The activity that received the lowest score from the participants with regard to being useful for the course and the future was examining the webs suggested by the users.

To answer RQ3, we collected data from participants regarding the positive and negative aspects of the course. We received 66 comments in total in Parts 2 and 4 of the questionnaire. Small sample sizes precluded detailed statistical analysis. That fact notwithstanding, the comments were generally positive. Specifically, the data included 50 (76%) positive comments and 16 (24%) negative comments; thus, the comments were quite positive overall. The comments were analyzed based on the themes described in 4.3.1, and the results are shown in Table 4.

The positive comments clustered mainly into five themes that covered 84% of the comments in total. These themes included soft skills, course content, teaching methods, experience, and course structure. Two examples of positive comments on soft skills were "a new way of thinking and working" and "working in a team." These comments were classified as positive since the participants gave these comments when they were asked about what aspects of the course were good. The comments in the course content category were more closely related to the UCD Sprint process itself. Participants appreciated "gathering more info from users," "designing on paper" and "repetitive user testing." Examples of comments on teaching methods included "You learn by doing" and "The course is practical." Two examples of the experience theme were "the overall organization" and "the human touch."

In terms of negative comments, the dominant theme was the course structure, covering 10 out of the 16 negative comments. Examples of negative comments in that category

Table 2. Themes used to analyze the qualitative data regarding the course on the UCD Sprint.

Theme	Definition
Assessment	ASSESSMENT: Assessment standards, structure, schedule, criteria and feedback.
Staff quality	WHO: Tutor and lecturer availability, teaching skills, quality and frequency of communication with participants.
Learning environment	WHERE: Quality of lecture hall equipment, the size and comfort of the course venue and the quality of the learning environment created through group project work.
Learning support	PREPARATION: Adequate preparation for assessments and the provision of additional learning support, e.g., intervention by the observers if requested by participants.
Learning resources	ADDITIONAL: The provision of additional resources and the quality, timeliness and affordability of resources provided.
Teaching methods	HOW: How the participants learn, i.e., the format of activities on the course.
Course content	WHAT: The material presented to the participants.
Course administration	SET UP: Practical arrangements such as team formation and practical course information
Course structure	WHEN: Structure and scheduling of the course activities and days when the learning activities take place
Soft skills	SKILLS acquired by participants: Critical thinking, problem-solving, leadership and responsibility, communication, and collaboration (e.g., teamwork)
People	RELATIONSHIPS: Personal relationships, selection of people for the course
Overall experiences	OVERALL EXPERIENCES: Overall course experience, level of motivation, atmosphere, free time activities, lunch and snacks, accommodations

Table 3. Participants' ratings of the usefulness of the steps involved in the UCD process (RQ2).

	Was it thought-provoking?	Was it useful for the course?	Will you use it in your job/education?
Initial mapping	5.46	5.92	5.46
User group analysis	5.36	6.00	5.14
UX goals	5.50	5.79	5.50
Interviewing users	5.36	5.71	5.14
Refining map/Selecting a target	5.00	5.64	5.00
Exploring webs from users	5.21	5.36	4.79
Defining users' tasks	5.50	6.07	5.21
Brainstorming ideas (Crazy 8)	6.00	5.93	5.21
Design solutions	5.71	5.79	5.43
Low-fi prototyping	6.15	6.21	5.50
User testing low-fi prototype	5.50	6.07	4.86
Realistic clickable prototype	6.07	6.21	5.79
User testing realistic prototype	6.07	6.36	5.36
Analyzing testing results	6.23	6.38	5.85
Highest score	6.23	6.38	5.85
Lowest score	5.00	5.36	4.79

Table 4. Positive and negative aspects of the course according to participants.

	Positive	%	Negative	%
Soft skills	11	22%		
Course content	10	20%	1	6%
Teaching methods	8	16%	2	13%
Experience	7	14%	1	6%
Course structure	6	12%	10	63%
Staff quality	3	6%		
People	2	4%		
Assessment	1	2%		
Learning environment	1	2%		
Course administration	1	2%	1	6%
Learning support				
Learning resources			1	6%
Total	50	76%	16	24%

included "5 days instead of 4 was going to be more ideal"; "too many breaks"; and "insufficient time to build a prototype."

Overall, the participants praised the way in which the course encouraged cooperation, interactivity, and theory-exercise iteration. The participants praised the activities involving users, primarily user testing. With regard to negative feedback, time constraints, especially when asked to deliver a prototype, were often mentioned. Moreover, the participants expressed a desire for more time for exploration and more in-depth tool guidance regarding software such as Figma[3] (the tool used in the course for rapid prototyping). While they appreciated the time spent on and focus placed on becoming familiar with the users, once they had started to understand the users, they occasionally found the allocated task time to be insufficient.

4.4. Part 3: Future implementation of the UCD sprint

This last part of the study addressed *RQ4: How do practitioners envision the future implementation of the UCD Sprint process in their design approaches?* In particular, we were interested in how participants perceived the course on UCD Sprint several weeks after the course, their possible application of the process in the context of their practical projects, and the potential for employing the UCD Sprint to understand user needs. Thus, seven weeks after the course, specifically from June 21 - July 14, 2022, follow-up semi-structured interviews were conducted.

4.4.1. Participants, data gathering and data analysis

A total of 8 of 14 course participants were interviewed. We selected course participants who were available at the time of the interviews. Specifically, 4 interviewees were full-time employees working at IT companies as designers/developers, 3 interviewees were working part-time at IT companies as designers/developers while pursuing their PhDs in Computer Science (industrial PhDs), and 1 was a freelancer with a background and a strong interest in UCD who was pursuing studies in Computer Science. In the usual manner, interviewees signed a digital consent form informing them about the collection of audio recordings and the management of sensitive data. Participants were not given any remuneration or reward for participating in this study.

The follow-up interview was structured in 4 sections. The first section focused on current projects on which the interviewee was working at the time of the interview. The second section collected data on the course the interviewee had attended, namely, the interviewee's opinions, feelings, and experiences with using the UCD Sprint during the course. In the third section, we first investigated whether the interviewee had already had the opportunity to use the UCD Sprint in ongoing projects. If the answer to this question was yes, we asked whether the whole process or only some steps were applied and requested further details regarding this application. We primarily investigated whether the interviewee would like to apply the UCD Sprint process in the future and how he or she would promote its adoption by the management team. The fourth section focused on the interviewee's opinion regarding whether using the UCD Sprint is instrumental for focusing on user needs appropriately and on the specific methods involved in the process that are the most important for this goal.

Two researchers were involved in each interview: one researcher served as the interviewer, and the other interviewer assisted by taking notes. The interviews were audio-recorded. Each interview was transcribed before analysis. An inductive thematic analysis of the collected data was performed. Two researchers independently examined the interview transcripts and analyzed them in terms of themes. The interrater consistency was 70%. The remaining 30% of the results were discussed until consensus was reached.

4.4.2. Results regarding future implementation of the UCD sprint

Table 5 shows the identified themes, their definition and the main results that emerged from the analysis.

4.4.2.1. Process. This theme concerns the overall opinions, feelings, and experiences of the interviewees with regard to the UCD Sprint process. Participants considered the process to be useful for companies; they appreciated the methods it involves and, reflecting on such methods in the weeks after the course, they believed that they are useful for supporting the design of usable products that are able to create a positive UX. As one interviewee explicitly stated, "*The process is valuable because it uses effective methods that are resource-saving*" (Full-time designer/developer). Another interviewee claimed that "*The methods it [UCD Sprint] uses involve important stakeholders*" (Freelancer). Two interviewees noted that *"The UCD Sprint involves the whole team, not just the developers as is done in the company"* (Part-time designer/developer) and *"Working in a team, members understand why one makes a decision. Working together means getting to a goal together"* (Full-time designer/developer). One interviewee noted that managers still need to change their way of thinking to foster the use of UCD Sprint. This opinion was also expressed by others; two interviewees working in the same company noted that, after the course, they organized a seminar for their colleagues in which they reported their experiences at the course and explained the value of the UCD Sprint. Many people attended the seminar, including managers, developers, and analysts. The main message they wanted to convey is that the application of UC methods is not a waste of time; in contrast, as explicitly reported in the interviews by one of these interviewees, *"It is an investment and offers economic benefits to the customer. It is a starting point. Such methods are not commonly used. There is a need for them in the company!"* (Full-time designer/developer)

Interviewees greatly appreciated the user tests. As one participant claimed, *"The two user tests ensure the development of a truly quality product"* (Part-time designer/developer). As another interviewee stated, *"Evaluating both paper and digital prototypes are very important steps. The former permits us to verify that the identified features are those that the user needs. The latter allows us to refine the features."* (Freelancer). However, half of the interviewees noted that the low-fidelity paper prototypes could be eliminated while still performing two user tests. They observed that with current prototyping tools, an interactive low-fidelity prototype can be created very quickly, which can then be evaluated through a user test. The successive high-fidelity prototype can also be evaluated through a user test. One interviewee noted that *"We prefer to develop a rudimentary prototype that is a digital one because the user needs to click!"* (Full-time designer/developer).

4.4.2.2. Course. The second theme pertaining to the UCD Sprint course attended by the interviewees refers to the overall opinions, feelings, and experiences of the interviewees with regard to the course from a didactic point of view. The thematic analysis of the answers highlighted the fact that the participants appreciated the course highly and found it to be very interesting, as it allowed them to broaden their work background. One key positive aspect that all interviewees mentioned is that the course structure is didactically effective, alternating between theory and practice and thus allowing participants to apply the proposed techniques. As one interviewee noted, *"The course was not heavy at all!"* (Part-time designer/developer). In addition, two interviewees indicated that they appreciated the course structure, which allowed them to test a prototype immediately. Another interviewee noted that *"You learn to apply the process very easily!"* (Full-time designer/developer). As still another interviewee indicated, *"It was a wonderful experience, a course that was different from those suggested by my*

Table 5. Themes, their definitions and main results.

Theme	Definition	Main results
Process	Overall opinions, feelings, and experiences pertaining to the UCD Sprint process and its use in a company	• UCD Sprint is viewed as suitable for companies that create software systems. • The methods used are effective and resource-saving. • This approach requires the involvement of the main stakeholders, including end users. • The tests are essential for evaluating the quality of the prototype. • The paper-based low-fidelity prototype could be substituted with a digital low-fidelity prototype. • The discovery phase is not feasible because it resembles retracing what has already been approved by the customer.
Course	Overall opinions, feelings, and experiences regarding the UCD Sprint course	• The course structure is didactically effective. • The phases are well organized and defined in terms of time. • The multidisciplinarity of the course group is positive.
Use in Practical Projects	Experiences regarding the use of the UCD Sprint in their current projects or future ones.	• Some practitioners are now performing user testing; in general, they do not yet employ the complete UCD Sprint. • One practitioner created digital prototypes for the interface of a product and tested them.
Understanding of Users' Needs	The potential of the process or some of the methods proposed to collect data concerning user needs	• Users' involvement in the design process is important. • The interview is very useful for collecting users' needs. • User tests allow users' needs that are not identified by the customer to be collected.

company" (Full-time designer/developer). She explained that, generally, company courses are less practical, and participants are more passive. Another interesting aspect of the course was the multidisciplinary nature of the group (for example, *"I truly enjoyed the multidisciplinary nature of the group"* (Part-time designer/developer) and *"Multidisciplinarity of the team is crucial for the success of the product"* (Part-time designer/developer)). This multidisciplinarity allowed group members to exchange experiences and knowledge: *"Comparing the ideas of people with different backgrounds helps a lot when defining new ideas."* (Full-time designer/developer)

4.4.2.3. Use in practical projects. Regarding this theme, 6 of 8 interviewees had no way to apply any methods used in the UCD Sprint because they were working on projects that were already at an advanced stage of development. However, all interviewees claimed that they would gladly apply the whole process. Only two interviewees were performing user tests. In particular, one of these interviewees noted that *"I'm working on a project that is already in progress. I have performed two user tests on digital prototypes of the user interface I created"* (Full-time designer/developer). She involved four colleagues who worked in the same company as back-end developers and who acted as end users. She asked participants what they thought about the interface, what happened if they clicked on some buttons, and what could be improved. As she reported, *"I received some useful comments. For example, participants thought they were getting to one output while instead the button took them to another, so I added intermediate steps"* (Full-time designer/developer). She refined her prototypes based on the comments she received and then asked her colleagues to review them once again. Indeed, she claimed that one evaluation was insufficient and that at least one iteration is necessary. She added the following: *"Rather than getting to the finished product and not liking it, perform intermediate evaluations and get to a better final product."*

4.4.2.4. Understanding of users' needs. This final theme refers to whether the overall approach or, at least, some of the proposed methods were perceived as useful with regard to collecting data concerning user needs. As one interviewee said, *"The course allowed me to better understand the importance of involving users in a system design process as well as the need for iteration, which was especially evident in the final part of the approach with the execution of two user tests"* (Full-time designer/developer). Several interviewees claimed that the interview was important because it provides a good understanding of users' needs. However, it is often the case that the company develops the same type of product. In this case, interviews are not essential because the requirements are defined based on the knowledge gained by the company's employees from their previous experiences. Evaluations of the low-fidelity and high-fidelity prototypes facilitate the identification of further user needs for that specific project.

5. Discussion

In this section, we consider the three parts of the study reported in Section 4 and discuss the main findings, as well as their implications and/or contributions.

5.1. Current ways of working

In the first part of the study, practitioners working in IT companies were interviewed to understand their current design process and the extent to which they involve users. For many years, researchers have acknowledged that involving users in the software development process positively impacts the quality of the product and enhances user satisfaction (e.g., Kujala, 2003; Bano & Zowghi, 2015). Nevertheless, practitioners are very often reluctant to perform user research primarily because they think that the available methods are very resource-demanding and that no methods suitable for companies' needs are available (see, e.g., Ardito et al., 2014a; Katsini et al., 2016; Teka et al., 2017). A more recent study by Inal et al. (2020) specifically involved UX professionals; even if more than 70% of such professionals claimed that they employ a UCD approach to develop their product, they complain about the obstacles they face when conducting user research due to a lack of support by the company's top management, which still neglects the importance of UX.

The interviewees in our study were not UX professionals who appreciate user research and UCD approaches; rather, they were practitioners involved in the design of interactive software. Their answers indicated that their current design processes had not changed from the approach reported in previous studies, e.g., (Ardito et al., 2014a), which generally neglects user research. These interviews were thus instrumental to show that it is necessary to teach practitioners new processes that focus on user research.

In the companies at which our respondents work, users are not generally involved in the design of software products. In some cases, users are consulted only during the pre-go-live and go-live phases, when a stable version of the developed product is released. However, it is well known that at this stage of software development, it could be too late to correct any serious errors that might impact the software product's usability and the corresponding UX. These late changes could also be costly. Thus, the false belief that user involvement is time-consuming and ineffective remains.

All interviewees said that they work in companies that employ agile processesThey reported that the only stakeholder involved in the process is the customer, who plays the role of the user both in the initial phases of the process with regard to illustrating the users' needs and in the activities associated with prototype evaluation. Our interviewees argued that it is the customer who pays for the software product being developed and thus that they needed to comply with the requirements indicated by the customer, who accepts and signs the document containing the specified requirements that developers must consider in their work. Similar results have been reported by Bruun et al. (2018) and (Persson et al., 2022), who claimed that users are involved only during the initial phases of software design, whereas during the development phase, the software is assessed by members of the development team, who often lack usability and UX skills.

Interviewees claimed that they generally do not produce paper prototypes; in their company, some designers create prototypes using PowerPoint or more professional tools such as Figma and Balsamiq. Only one company manager indicated that this company creates a prototype when the requirements are difficult to describe; thus, the prototype is valuable simply to verify whether the team understood the customer's requests. This finding is in line with the results reported by (Cajander et al., 2013; Bruun et al., 2018), according to which UX specialists made wireframe prototypes to verify with the development team or the chief technical officer whether the design was possible to implement in a cost-effective manner.

5.2. The usefulness of the UCD Sprint process

In the second part of the study, practitioners were invited to attend a course that enabled them to practice using the UCD Sprint process. Two previous studies on the UCD Sprint process used during two-week courses in 2018 and 2019 that involved students in higher education were conducted (Larusdottir et al., 2019b; Roto et al., 2021). The first study showed that the activities of sketching and storyboarding were highly rated (Larusdottir et al., 2019b). In both studies, high-fidelity prototypes received a high ranking, while in the latter study, the evaluation of such prototypes with users was rated highly (Roto et al., 2021).

In the study described in this paper, the activities that received a high rating with regard to being useful were low-fidelity prototyping, high-fidelity prototyping, user testing of high-fidelity prototypes and the analysis of the test results. Notably, our participants claimed that they were not used to making prototypes, so for some of them, this represented a new activity that they found useful. This is a great contribution of our study, it indicates that the practice of the UCD Sprint can convince the practitioners of the importance of performing activites, such as prototyping, that are fundamental for designing useful and usable software (see, e.g., [rif. a libro su prototyping, chiedere a Paolo]). Actually, the participants called for more time and more in-depth tool guidance regarding Figma[4], the tool used in the course for rapid prototyping, because they greatly appreciated the support of this software in the creation of prototypes at different levels. Due to their lack of familiarity with the creation of such prototypes, participants required more time for these activities, which was one reason they complained about the structure of the course; they would prefer a course that lasted an additional day, i.e., a total of 5 days instead of 4. These results are in line with the results drawn from the previous courses. In particular, high-fidelity prototyping was valued highly in both previous courses attended by university students. The results regarding the high ranking of user testing of high-fidelity prototypes in this paper are in line with the results previously reported by Inal et al. (2020), who indicated that user testing was the most frequently used method. The value of informal user testing with the thinking-aloud protocol has been well known since the seminal book by Nielsen (1993); this method is highly appreciated and used widely, especially in formative evaluation or in situations in which resources are limited or evaluators are less experienced. Such informal user testing is currently widely used in the website evaluation protocols adopted by several Italian public administration institutions (see, e.g., Federici et al., 2019; Federici et al., 2021).

The activities that received the lowest scores from the participants with regard to being thought-provoking were refining the map and selecting a target. This finding is understandable since the initial mapping had already been accomplished in Step 1, and now the participants were asked to revisit the map after conducting interviews with the goal of reflecting on how the map should be changed. The activity that received the lowest score with regard to being useful in the course as well as in the future was examining the webs suggested by the users. The participants did not have much time to accomplish this activity since other steps took longer than expected; thus, it is unsurprising that they believed that this step was not particularly useful.

In our study and in both studies on previous courses, the participants were asked to provide their impressions of the course itself. The course structure was the most frequently mentioned aspect in our results, receiving the highest frequency of negative comments, most of which remarked that the pace was too fast and that the participants were not given sufficient time to complete the homework of conducting interviews and developing prototypes. However, the feedback revealed that, in general, the course structure was suitable for practitioners. The participants' consensus regarding the successful nature of the course alongside the interest they expressed in including this course as part of company training programs or as part of their education in general indicate an encouraging step toward similar attempts in the future.

5.3. Future implementation of the UCD Sprint

The objective of the third part of the study was to investigate whether and how practitioners would modify their traditional design practices to include some of the activities proposed by the UCD Sprint. We were specifically interested in collecting information regarding the participants' willingness to involve users and apply UCD Sprint in their design processes. We also wanted to know what they thought about the course after some time had passed.

The participants were convinced that the UCD Sprint should be applied to the task of designing software in their IT companies, but they had not yet applied it to their ongoing projects. Some practitioners indicated their willingness to perform user tests. One practitioner reported performing two user tests involving her colleagues, who acted as final users. She was happy to discover problems that she would not have identified without the involvement of users.

Involving users in the design process was highlighted as positive by two other practitioners. They appreciated the course highly and organized a seminar at their company one week after the course to demonstrate the importance of user involvement. People with different roles in the company, ranging from managers to developers, attended the seminar and appreciated the user-based cost-effective process provided by the UCD Sprint.

The practitioners found the reality check phase to be important and highlighted that the user test results are indeed useful for refining user requirements. They also emphasized the fact that what is not identified by customers is undoubtedly discovered during user tests because observing users' interactions with a system prototype can easily reveal the product's shortcomings.

Surprisingly, some practitioners claimed that the interviews with users during the discovery phase could be eliminated. They clarified that requirements are defined and approved by the customer at the beginning of the design process in their companies. Thus, it is useless to conduct interviews without having the possibility of modifying the identified requirements. Participants were convinced of the value of user interviews with regard to collecting important information from users, but unfortunately, the current practice imposed by top management required only customer involvement. Some participants doubted the significance of paper prototyping but confirmed the importance of performing prototype testing twice with users during the sprint. They indicated that designing digital low-fidelity prototypes would be more straightforward in IT companies. This finding stands in contrast to the results of previous research that has highlighted the advantages of an initial paper prototype (Snyder, 2003).

All practitioners appreciated the course content and structure. The main difference between this course and other courses proposed by their companies was that they could more readily apply the techniques the approach suggests in this context. The course enabled them to "experience first-hand" the real potential of the user-based process and to appreciate the reduced resources required for user involvement. The practitioners explicitly noted that user involvement was not as costly as they had believed and that it is instrumental in the design of systems that offer a good user experience.

6. Limitations of the study

In this section, we address the limitations of the performed study by discussing some issues that may have threatened the internal and external validity of our study (Lazar et al., 2017). We also report how we mitigated the most critical issues regarding the three parts of the study.

Internal validity refers to the extent to which one can be confident that a cause-and-effect relationship established in a study cannot be explained by other factors. It can be threatened by various hidden factors that can compromise the achieved results, as discussed in the following.

6.1. Subject experience

We involved practitioners from companies with different roles, and the companies thus selected were of different sizes. The companies operate in the area around Bari. We plan to perform other interviews involving practitioners from different countries. For Part 2, the subject experience threat was alleviated because none of the subjects had any experience with the UCD Sprint process.

6.2. Method authorship

We eliminated the biases entailed by different interviewers since the same person interviewed the participants to avoid possible incoherence the conduct of interviews in Parts 1 and 3. Regarding Part 2, we addressed the possibility of bias resulting from different course teachers the same teacher was responsible for every course session. In this way, we avoided any variability in training.

6.3. Intelligibility of the material

For Parts 1 and 3, the questions of the two interviews were validated by three authors, who are also software designers, to verify their intelligibility. For Part 2, the course, which featured a different structure, but which involved the same activities, had already been held three other times, thus enabling us to guarantee the correctness of its structures and the materials available to the participants.

6.4. Available time

This issue pertains only to Part 2. Course participants had limited time to complete the process activities and their homework; however, they were aware of the fact that they were participating in a didactic course and that the course's main goal was to illustrate the activities that the UCD Sprint proposes. We constrained the time available to participants to avoid overloading them with excessive work that could encourage them to downgrade their performance and perceptions, thus leading to useless results.

The external validity of a study refers to the possible approximation of the truth of its conclusions to generalize the study's results to different contexts. In this respect, the main threats to our study are the following.

6.5. Sampling bias

The size, complexity and time-criticality of participants' projects limited the validity of the study. In addition, the participants were people working in different companies in southern Italy. Thus, they represent only a small section of the entire population. We plan to perform other studies involving people from different countries and more companies of different sizes, as part of which we will ask them to practice the UCD Sprint on projects on which they are working.

6.6. Situation effect

This issue pertains only to Part 2. The course was held in a lecture room of a university department that is similar to any lecture room that can be used in a company. Thus, this environment should not create any problems. However, the members of each group were drawn from different companies, and the case study on which they worked was not an actual project of any member. We are in contact with companies to organize future courses in which participants can use the UCD Sprint to support a company project.

6.7. Testing effect

Part 2 of the study involved only one group of practitioners who attended the course. No baseline or control group was considered. We plan to perform a comparative study to obtain further insights into whether the UCD Sprint process increases awareness of the importance of user involvement and whether it could be successfully adopted by companies to enhance the innovativeness of their design practices.

7. Conclusion

The UCD Sprint discussed in this article is a step-by-step and cost-effective process that is based on user involvement in the early stages of software design and that aims to enhance our understanding of users' needs. This process originated from experiences in intensive courses with university students (Larusdottir et al., 2019a, 2019b; Roto et al., 2021). One motivation for our research is to promote user involvement and UCD activities in the design processes of software companies since they are key elements in the creation of systems that are capable of meeting users' needs. Since the UCD Sprint process received positive feedback from university students (Visescu et al., 2023), we wanted to explore whether and how it is suitable for practitioners with regard to software design. Thus, we performed the study reported in this paper, which was conducted according to a research methodology featuring three parts.

Our overall research question focused on whether the UCD sprint is a valuable process for emphasizing and involving users in practitioners' software design practices. The results of the study show that participants were impressed by the activities involving users, particularly the user test; they appreciated that even quick and informal tests with users are capable of highlighting many problems that can be easily solved in the initial designs. We were slightly surprised that the interviews with users that aimed to collect user requirements were not as well received by the practitioners. We asked them to clarify this point, and they indicated that the current practices imposed by the top management of their company require the customer to define requirements at the beginning of the design process and to accept and sign a document containing the specified requirements. Thus, even if participants are convinced of the value of user interviews for collecting important information from users, they have not yet performed interviews in their current practices.

The study was the first to involve practitioners. We discussed its limitations and how we plan to address these issues in future studies. More specifically, we will perform interviews and organize other courses for practitioners from various companies and countries. We are also planning to conduct comparative studies to obtain more results regarding the value of the UCD Sprint process.

The theoretical value of the UCD model, as has also been reported in ISO (2020), has been well known and acknowledged since the late 1980s. The work reported in this article contributes primarily to the practice of UCD. It has been shown that the UCD Sprint is a fast process that incorporates a focus on users into design practices; it involves UCD activities involving users, which practitioners valued highly. By using the UCD Sprint process, the practitioners obtained a structured and fast way of working toward the goal of creating products with a good UX.

Notes

1. https://www.figma.com/
2. https://balsamiq.com/
3. https://www.figma.com/
4. https://www.figma.com/

Acknowledgments

The authors thank Dr. Virpi Roto and the other founders of the UCD Sprint. The version of the UCD Sprint presented in this article has been adapted from their original version. The authors also acknowledge the companies that allowed their employees to participate in the study.

Author contributions

Author 1, *Author 2, Author 4* and *Author 5* conceptualized the idea of studying the UCD Sprint in practice in IT companies and designed the study. *Author 1* restructured the UCD Sprint process and reorganized the course accordingly. *Author 1* prepared the didactic material and led all the classes; the other authors participated in the course as observers and guided students' teamwork. *Author 2* conducted the interviews (in Italian) with the assistance of *Author 1* and *Author 3. Author 2* and *Author 3* analyzed the data collected through Parts 1 and 3 of the study; *Author 1 and Author 4* analyzed the data collected through Part 2. All authors discussed the collected data and contributed to the writing and revision of the article.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This research is partially supported by the Apulia Region, P.O. FESR 2014 - 2020, Regional Regulation 17/2014, Title II Chapter 2 - notice "PIA small enterprises," Project TITANUX - "CreaTing hIgh qualiTy ANd secure systems that emphasize UX," proposing enterprise Eusoft Srl, Code Z85MUK8. The support of the University of Bari, Italy, through a grant for visiting professors given to Prof. Marta Larusdottir is also acknowledged; Marta worked for a total of three months at the Department of Computer Science of the University of Bari during the period November 2021–June 2022.

ORCID

Marta K. Larusdottir http://orcid.org/0000-0003-0256-5710
Rosa Lanzilotti http://orcid.org/0000-0002-2039-8162
Antonio Piccinno http://orcid.org/0000-0003-1561-7073
Ioana Visescu http://orcid.org/0000-0002-5304-9006
Maria Francesca Costabile http://orcid.org/0000-0001-8554-0273

References

Adikari, S., McDonald, C., & Campbell, J. (2009). Little design up-front: A design science approach to integrating usability into agile requirements engineering. In J. A. Jacko (Ed.), *Human-Computer Interaction. New Trends. HCI 2009*. Lecture Notes in Computer Science (Vol. 5610). Springer. https://doi.org/10.1007/978-3-642-02574-7_62

Ardito, C., Buono, P., Caivano, D., Costabile, M. F., & Lanzilotti, R. (2014a). Investigating and promoting UX practice in industry: An experimental study. *International Journal of Human-Computer Studies*, *72*(6), 542–551. https://doi.org/10.1016/j.ijhcs.2013.10.004

Ardito, C., Buono, P., Caivano, D., Costabile, M. F., Lanzilotti, R., & Dittrich, Y. (2014b). Human-centered design in industry: Lessons from the trench. *Computer*, *47*(12), 86–89. https://doi.org/10.1109/MC.2014.355

Ardito, C., Baldassarre, M. T., Caivano, D., & Lanzilotti, R. (2017). *Integrating a SCRUM-based process with human-centred design: An experience from an action research study* [Paper presentation]. IEEE/ACM 5th International Workshop on Conducting Empirical Studies in Industry (CESI) (pp. 2–8). https://doi.org/10.1109/CESI.2017.7

Bak, J. O., Nguyen, K., Risgaard, P., & Stage, J. (2008). *Obstacles to usability evaluation in practice: A survey of software development organizations* [Paper presentation]. Proceedings of the 5th Nordic Conference on Human-Computer Interaction: Building Bridges (pp. 23–32). https://doi.org/10.1145/1463160.1463164

Bano, M., & Zowghi, D. (2015). A systematic review on the relationship between user involvement and system success. *Information and Software Technology*, *58*, 148–169. https://doi.org/10.1016/j.infsof.2014.06.011

Blomkvist, S. (2005). Towards a model for bridging agile development and user-centered design. In A. Seffah, J. Gulliksen, M. C. Desmarais (Eds.), *Human-Centered Software Engineering—Integrating Usability in the Software Development Lifecycle*. Human-Computer Interaction Series (Vol. 8). Springer. https://doi.org/10.1007/1-4020-4113-6_12

Brown, T., & Wyatt, J. (2010). Design thinking for social innovation. *Development Outreach*, *12*(1), 29–43. https://doi.org/10.1596/1020-797X_12_1_29

Bruun, A., Larusdottir, M. K., Nielsen, L., Nielsen, P. A., & Persson, J. S. (2018). *The role of UX professionals in agile development: A case study from industry* [Paper presentation]. Proceedings of the 10th Nordic Conference on Human-Computer Interaction (pp. 352–363). https://doi.org/10.1145/3240167.3240213

Cajander, Å., Larusdottir, M., & Geiser, J. L. (2022). UX professionals' learning and usage of UX methods in agile. *Information and Software Technology*, *151*, 107005. https://doi.org/10.1016/j.infsof.2022.107005

Cajander, Å., Larusdottir, M., Gulliksen, J., Kotzé, P., Marsden, G., Lindgaard, G., Wesson, J., & Winckler, M. (2013). Existing but not explicit - the user perspective in scrum projects in practice. In *Human-Computer Interaction – INTERACT 2013. INTERACT 2013*. Lecture Notes in Computer Science (Vol. 8119). Springer. https://doi.org/10.1007/978-3-642-40477-1_5

Chamberlain, S., Sharp, H., & Maiden, N. (2006). Towards a framework for integrating agile development and user-centred design. In P. Abrahamsson, M. Marchesi, G. Succi (Eds.), *Extreme Programming and Agile Processes in Software Engineering. XP 2006*. Lecture Notes in Computer Science (Vol. 4044). Springer. https://doi.org/10.1007/11774129_15

Cockton, G., Lárusdóttir, M., Gregory, P., & Cajander, Å. (2016). *Integrating user-centred design in agile development* (pp. 1–46). Springer International Publishing. https://doi.org/10.1007/978-3-319-32165-3

Endmann, A., & Keßner, D. (2016). User journey mapping–A method in user experience design. *i-com*, *15*(1), 105–110. https://doi.org/10.1515/icom-2016-0010

Federici, S., Mele, M. L., Bracalenti, M., De Filippis, M. L., Lanzilotti, R., Desolda, G., Borsci, S., Gaudino, G., Cocco, A., Amendola, M., & Simonetti, E. (2021). A chatbot solution for eglu-box pro: The usability evaluation platform for Italian public administrations. In M. Kurosu (Ed.), *Human-Computer Interaction. Theory, Methods and Tools. HCII 2021* (Vol. LNCS 12762, pp. 268–279). Springer. https://doi.org/10.1007/978-3-030-78462-1_20

Federici, S., Mele, M. L., Lanzilotti, R., Desolda, G., Bracalenti, M., Buttafuoco, A., Gaudino, G., Cocco, A., Amendola, M., & Simonetti, E. (2019). Heuristic Evaluation of eGLU-Box: A semi-automatic usability evaluation tool for public administrations. In M. Kurosu (Ed.), *Human-Computer Interaction. Perspectives on Design. HCII 2019.* (Vol. LNCS 11566, pp. 75–86). Springer. https://doi.org/10.1007/978-3-030-22646-6_6

Getto, G., & Beecher, F. (2016). Toward a Model of UX Education: Training UX Designers Within the Academy. *IEEE Transactions on Professional Communication*, *59*(2), 153–164. https://doi.org/10.1109/TPC.2016.2561139

Highsmith, J. A. (2002). *Agile Software Development Ecosystems*. Addison-Wesley Professional.

Hussain, A., Mkpojiogu, E. O., & Kamal, F. M. (2016). The Role of Requirements in the Success or Failure of Software Projects. *International Review of Management and Marketing*, *6*(7), 306–311. https://doi.org/10.1063/1.4960886

Inal, Y., Clemmensen, T., Rajanen, D., Iivari, N., Rizvanoglu, K., & Sivaji, A. (2020). Positive developments but challenges still ahead: A survey study on UX Professionals' Work Practices. *Journal of Usability Studies*, *15*(4), 210–246.

Islind, A. S., & Lundh Snis, U. (2018). From co-design to co-care: designing a collaborative practice in care. *Systems, Signs & Actions*, *11*(1), 1–24.

ISO (2020). *ISO 9241-210:2019(en), Ergonomics of human-system interaction—Part 210: Human-centred design for interactive systems*. https://www.iso.org/obp/ui/#iso:std:iso:9241:-210:ed-2:v1:en

Jia, Y., Larusdottir, M. K., & Cajander, Å. (2012). The Usage of Usability Techniques in Scrum Projects. In M. Winckler, P. Forbrig, & R. Bernhaupt (Eds.), *Human-Centered Software Engineering* (pp. 331–341). Springer. https://doi.org/10.1007/978-3-642-34347-6_25

Katsini, C., Avouris, N., Lanzilotti, R. (2016). *Usability engineering practices in software development organizations: The Greek and the Italian case study* [Paper presentation]. Proceedings of the International Working Conference on Advanced Visual Interfaces (pp. 322–323).

Kautz, K. (2011). Investigating the design process: Participatory design in agile software development. *Information Technology & People*, *24*(3), 217–235. https://doi.org/10.1108/09593841111158356

Knapp, J., Zeratsky, J., & Kowitz, B. (2016). *Sprint: How to solve big problems and test new ideas in just five days*. Simon and Schuster.

Kujala, S. (2003). User involvement: A review of the benefits and challenges. *Behaviour & Information Technology*, *22*(1), 1–16. https://doi.org/10.1080/01449290301782

Larusdottir, M., Roto, V., & Cajander, Å. (2021). *Introduction to User-Centred Design Sprint* [Paper presentation]. IFIP Conference on Human-Computer Interaction (pp. 253–256). https://doi.org/10.1007/978-3-030-85607-6_17

Larusdottir, M. K., Roto, V., Lanzilotti, R., & Duta Visescu, I. (2022). *Tutorial on UCD Sprint: Inclusive Process for Concept Design* [Paper presentation]. Adjunct proceedings of the 2022 nordic human-computer interaction conference (pp. 1–3). https://doi.org/10.1145/3547522.3558901

Larusdottir, M., Roto, V., Lanzilotti, R., & Visescu, I. (2023). The UCD sprint: Bringing users along to sprint. In J. Abdelnour Nocera, M. Kristín Lárusdóttir, H. Petrie, A. Piccinno, M. Winckler (Eds.), *Human-Computer Interaction – INTERACT 2023. INTERACT 2023. Lecture Notes in Computer Science* (Vol. 14145). Springer. https://doi.org/10.1007/978-3-031-42293-5_19

Larusdottir, M., Roto, V., Stage, J., & Lucero, A. (2019a). Get Realistic! - UCD course design and evaluation. In C. Bogdan, K. Kuusinen, M. Lárusdóttir, P. Palanque, M. Winckler (Eds.), *Human-Centered Software Engineering. HCSE 2018*. Lecture Notes in Computer Science (Vol. 11262). Springer. https://doi.org/10.1007/978-3-030-05909-5_2

Larusdottir, M., Roto, V., Stage, J., Lucero, A., & Šmorgun, I. (2019b). Balance talking and doing! using google design sprint to enhance an intensive UCD course. In D. Lamas, F. Loizides, L. Nacke, H. Petrie, M. Winckler, P. Zaphiris (Eds.), *Human-Computer Interaction – INTERACT 2019. INTERACT 2019*. Lecture Notes in Computer Science (Vol. 11747). Springer. https://doi.org/10.1007/978-3-030-29384-0_6

Law, E. L.-C., Roto, V., Hassenzahl, M., Vermeeren, A. P., & Kort, J. (2009). *Understanding, scoping and defining user experience: A survey approach* [Paper presentation]. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 719–728). https://doi.org/10.1145/1518701.1518813

Lazar, J., Feng, J. H., & Hochheiser, H. (2017). *Research methods in human-computer interaction*. Morgan Kaufmann.

Maramba, I., Chatterjee, A., & Newman, C. (2019). Methods of usability testing in the development of eHealth applications: A scoping review. *International Journal of Medical Informatics*, *126*, 95–104. https://doi.org/10.1016/j.ijmedinf.2019.03.018

Marsden, N., & Holtzblatt, K. (2018). *How Do HCI Professionals Perceive Their Work Experience? Insights from the Comparison with Other Job Roles in IT* [Paper presentation]. Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems (pp. 1–6). https://doi.org/10.1145/3170427.3188501

Nielsen, J. (1993). *Usability Engineering*. Morgan Kaufmann. https://doi.org/10.1016/c2009-0-21512-1

Persson, J. S., Bruun, A., Larusdottir, M. K., & Nielsen, P. A. (2022). Agile software development and UX design: A case study of integration by mutual adjustment. *Information and Software Technology*, *152*, 107059. https://doi.org/10.1016/j.infsof.2022.107059

Roto, V., Larusdottir, M., Lucero, A., Stage, J., & Šmorgun, I. (2021). *Focus, structure, reflection! Integrating user-centred design and design sprint* [Paper presentation]. IFIP Conference on Human-Computer Interaction (pp. 239–258).

Schwaber, K. (2004). *Agile project management with Scrum*. Microsoft press.

Snyder, C. (2003). *Paper prototyping: The fast and easy way to design and refine user interfaces*. Morgan Kaufmann.

Steyn, C., Davies, C., & Sambo, A. (2019). Eliciting student feedback for course development: The application of a qualitative course evaluation tool among business research students. *Assessment & Evaluation in Higher Education*, *44*(1), 11–24. https://doi.org/10.1080/02602938.2018.1466266

Teka, D., Dittrich, Y., Kifle, M., Ardito, C., & Lanzilotti, R. (2017). User involvement and usability evaluation in Ethiopian software organizations. *The Electronic Journal of Information Systems in Developing Countries*, *83*(1), 1–19. https://doi.org/10.1002/j.1681-4835.2017.tb00616.x

Visescu, I., Larusdottir, M., Islind, A. S. (2023). Supporting active learning in STEM higher education through the UCD Sprint [Paper presentation]. Proceedings of the IEEE Frontiers in Education Conference 2023.

About the authors

Marta K. Larusdottir is a Professor at the Department of Computer Science at Reykjavik University. Marta has researched user-centred design (UCD) activities, especially the integration of UCD activities into agile processes in the software industry. Recently, Marta has suggested new methods for extending the usage of UCD activities in software design.

Rosa Lanzilotti is a Professor at the Department of Computer Science of the University of Bari. She promotes usability and UX practices in companies and public institutions. She coordinated projects aimed at developing eGLU-Box PA, a web platform used by Italian institution staffs to perform usability evaluation of their websites.

Antonio Piccinno is an Associate Professor of the Department of Computer Science of the University of Bari. His research interests focus on Human-Centered Design (HCD) and End-User Development (EUD). He promotes the Interplay between Human-Computer Interaction and Software Engineering and, more recently, Secure Software Analysis and Design.

Ioana Visescu is a PhD student in the Department of Computer Science at Reykjavik University under the supervision of Dr. Marta Larusdottir. With a background in business and technology and interest in user experience, her research focuses on design sprints and design methodologies and their applications in academia and practice.

Maria Francesca Costabile is Professor at the Department of Computer Science of the University of Bari. She was a pioneer of HCI in Italy, with a focus on HCD and usability, and promoted the ACM SIGCHI Italian Chapter in 1995. In 2018, she received the ACM SIGCHI Lifetime Service Award.

Appendix D

Publication III: Supporting Active Learning in STEM Higher Education Through the User-Centred Design Sprint

Supporting Active Learning in STEM Higher Education Through the User-Centred Design Sprint

Ioana Visescu
Department of Computer Science
Reykjavik University
Reykjavik, Iceland
0000-0002-5304-9006

Marta Larusdottir
Department of Computer Science
Reykjavik University
Reykjavik, Iceland
0000-0003-0256-5710

Anna Sigridur Islind
Department of Computer Science
Reykjavik University
Reykjavik, Iceland
0000-0002-4563-0001

Abstract— **Software development presents technical and social challenges for new entrants to the field, particularly in empathizing with potential users. That can lead to misunderstanding of users' needs and requirements, affecting the user experience. Research has shown that implementing user-centred design (UCD) methods during software development positively impacts the overall user experience. Thus, teaching higher education students UCD methods from the beginning of their undergraduate studies is preferable, as upskilling later in their professional work can be a more complex endeavour. A process called the User-Centred Design Sprint (the UCD Sprint) covering 14 UCD methods was introduced to first-semester undergraduate Computer Science students at Reykjavik University, during a 7-week period through lectures and on-site problem-solving sessions. As additional support, the students were provided with a digital aid on the UCD Sprint, supporting the learning process. Feedback on the learning of the UCD Sprint process was collected through in-person surveys with 70 respondents, and qualitative digital aid evaluations through student reporting from 110 respondents. The findings show that the students rated direct interaction with users, especially high. On the opposite end, the students rated methods aimed at refining the initial ideas on the lower side of the rating scale. The students mentioned seeing the value of using the UCD Sprint process when developing software to better empathize with and cater to users' needs. The students used the digital aid provided alongside tools such as in-class slides, the textbook, and internet-based support. Overall, the student feedback on the digital aid was positive, with students appreciating clear instructions for conducting the methods in the UCD Sprint process. This paper reports a mixed-method study with results diverging into a three-fold contribution. Firstly, it reports the perceived usefulness of the UCD Sprint process and the experience of using it during the course. Secondly, findings from the usage of a digital aid to accompany the UCD Sprint process are reported. This provides the basis for the third contribution, which is presented in terms of recommendations that others can utilise when developing digital aids for assisting students in higher education.**

Keywords— Active learning, User-Centred Design, User Experience, Software Design, Education

I. INTRODUCTION

Many higher education students and new graduates in Science, Technology, Engineering and Mathematics (STEM) fields face challenges empathizing with users that are different from them, be it in gender, age, or national and ethnic background, as well as working with users where a disproportionate power dynamic exists [23, 33]. Fostering and training a base of skills to students empathising with users thus needs to be strongly encouraged early in their education. Teaching students that are about to enter the work market how focusing on users can be beneficial in the long run. This can have implications not only for the company and the field overall, but also for the employability of the student and the work they are to do in the future.

As the Human-Computer Interaction research field is and has been highly interdisciplinary, a multitude of methods and tools exist for focusing on users, which are highly rated by practitioners [20]. But studies have also shown that practitioners find User Centred Design (UCD) methods unstructured and ask for more structured ways of working [10] and few consistent patterns of a systematized body of knowledge have been suggested [26]. There are numerous handbooks on applying user-centred design in industrial settings but limited research on the cultivation of user-centered design as an embedded element in higher education [39].

Still, the initiative for including UCD methods in higher education has been growing [1]. In order to guide students through the best combination of methods when approaching user-centred design, design educators are encouraged to anticipate potential hurdles and offer students a base set of methods to rely on to foster and cultivate their skill development [40]. Some parallels have been drawn between user-centred design and active learning methods, encouraging learner-centric approaches that follow similar principles to the user-centred design approaches [5]. Furthermore, with a lot of workplaces and education environments going online or hybrid, digital tools for education have also received increased attention in recent years.

The UCD Sprint process was developed for structuring the usage of various UCD methods and to systematically include a vast body of knowledge from academia into the early stages of software development [42]. The target audience for the UCD Sprint process is software development practitioners and higher education students. The UCD Sprint evolved through three occasions of a higher education intensive course on user-centred design [30, 31, 42]. The course was iterated based on data collected from students from a wide range of backgrounds and ages.

The UCD Sprint has been taught using highly problem-based approaches, which have shown promising results in enhancing student motivation and active learning [16]. The approach has varied depending on the course and target audience, however, the in-class approach presented in the current paper has many parallels with activities presented in active learning theory [9], continuously engaging the students and allowing them to learn by doing.

The study described in this paper, explores the perception of higher education students of the UCD Sprint process and experiences of using a digital tool accompanying the process in a computer science course for 7 weeks.

2023 IEEE Frontiers in Education Conference (FIE) | 979-8-3503-3642-9/23/$31.00 ©2023 IEEE | DOI: 10.1109/FIE58773.2023.10342978

We stated the following research questions:

1) How do undergraduate students rate the usefulness of the UCD Sprint?

2) How do undergraduate students experience the usage of the UCD Sprint in the context of a CS course?

3) What are the experiences of students using a digital aid accompanying the UCD Sprint process?

II. Related Work

In this section, the related work on active learning, in general, is briefly described. Then user-centred design methods and their role in education are described, followed by design sprints and the UCD Sprint in particular, and concluding by describing related work on digital tools for learning.

A. Active Learning

Active learning was first defined in the early 90s by Bonwell and Eison [8] as "anything that involves students in doing things and thinking about the things they are doing". Active learning in all its shapes presents a promising approach. The term functions as an umbrella term for approaches such as problem, project, case, or even team-based learning [16, 38]. In the very fittingly named Alphabet Soup of Active Learning, Hopper [21] presents problem-based (PRL), case-based (CBL), and team-based learning (TBL), showing their advantages in the strive of integrating soft skills in higher education to better prepare students for tackling wicked problems in their future workplaces. While many methods and acronyms have arisen in recent years, active learning under its many shapes has proved to increase the performance of students in undergraduate STEM degrees [18].

Strategies for using active learning to create an exciting learning environment have been reported [8]. More recently, guidelines aimed specifically at STEM educators have emerged [24], guiding educators in the attempt of integrating active learning in their teaching in an inclusive way, as a manner of embracing and fostering diversity in STEM. A variety of methods have been presented for integrating active learning in the classroom [2, 9], encouraging critical thinking, active reflection, and teaching students how to interact with wicked problems.

When presented in in-person and online courses, active learning shows an increased student performance compared to lectures alone and a narrowed achievement gap for underrepresented students, promoting equity and inclusivity [43]. Due to this, active learning is seen as useful and desired by educators and students alike [37].

A literature review containing 29 studies showed that active learning shows improved self-reports of learning, participation in the activities, and course satisfaction, while providing some guidelines on how to better implement active learning strategies in classroom [37]. Examples of negative feedback from students on active learning, when implemented in STEM courses are a lack of guidance, lack of time, increased workload and logistics [45]. However, in spite of their success, active learning approaches are still not as prevalent as they could be, especially in undergraduate STEM fields, where lectures are still the dominating way of teaching [22].

B. UCD Methods and their Role in Education

As the Human Computer Interaction (HCI) field is and has been highly interdisciplinary, a multitude of methods and tools exist, with few consistent patterns of a systematized body of knowledge [26]. In order to guide students through the best combination of methods when approaching UCD, many encourage design educators to anticipate potential hurdles and offer students a base set of methods to encourage the creation of holistic practices to rely on to foster and cultivate their skill development [40]. Some parallels were drawn between UCD and active learning methods, encouraging learner-centric approaches that follow similar principles to the UCD ones [5]. Furthermore, with a lot of workplaces and education environments going online or hybrid, digital tools for education have received increased attention in recent years, thus a brief section on digital tools is included in the related work.

UCD approaches have been applied within the industry over the past few decades, but while the industry embraces these practices at an increasing rate, the push for classroom introduction grows as well. Professors, researchers, and educators have proposed courses focused on UCD methods for decades.

HCI educators are encouraged to foresee potential obstacles and provide students with a foundational set of methods to encourage the creation of holistic practices that they can rely on to foster and cultivate their skills in solving complex and interconnected problems. This is because the HCI field is highly interdisciplinary, with numerous and varied methods and tools available [10]. As technology evolves and new technologies emerge, the types of interactions users have also changed and evolve, thus it is important to provide up-to-date, continuously iterated methods.

On a similar note, Finken, Culén and Gasparini [17] make a push for nurturing group creativity in graduate courses, and Culén [14] further puts forward that introducing design thinking can increase innovation, adaptability, and creativity. In an earlier 2014 workshop [15], the combination of design thinking and HCI to foster innovation is explored. Other instances of embedding design thinking in education can be seen worldwide [7, 34], showing successful outcomes. Other researchers advance the idea that HCI in general, and its underpinnings of social nature that are brought to a generally technical field can be better addressed through active learning methods [38], incorporating creativity and fostering the interest for the non-technical, more social aspect of HCI.

C. Design Sprints and the UCD Sprint

As students need to develop a mix of hard and soft skills to increase employability [12], creativity and transversal competencies are crucial for new graduates [34]. It is more difficult to introduce methods after they have entered the work market, thus presenting them with a set of methods during their studies can be the perfect building block for a User Experience (UX) centred approach to software creation. However, informal methods are often used for user-centred design in the industry, and the lack of standardization can make it difficult to translate them into classroom materials. Aiming at integrating design thinking in the software development process in a time-efficient manner, Google Ventures combined design thinking and agile methodologies, creating the Google Design Sprint (GDS). Other structured practices such as the 5-day GDS have been developed and used in the industry, however with limited academic publication history reporting on it, and their applicability.

Although widely used in the industry, design sprints are less investigated in the context of academia. This leads to the usage of the GDS and other similar methods to be mainly anecdotal, with many and frequent changes to suit the people using it, e.g. [13]. However, when applied as part of university courses, benefits directly related to the sprint structure such as increased student satisfaction and grade improvement, were shown [6]. The authors integrated a sprint structure within STEAM (Science, Technology, Engineering, Arts, and Maths) courses showing advantages in the form of student satisfaction and grade improvement. For this, the authors introduced a design sprint methodology to a course of 56 first-year students, and in addition to the grade improvement, they suggest the sprint provided simplicity, and improved time management in the student workload, as all activities are pre-planned. The authors suggest the methodology is multipurpose, its applications extending to a variety of other fields too.

The UCD Sprint is a collection of methods, that has been refined and iterated over the course of several years [42]. Initially developed by HCI researchers in the Nordic countries, the process has been iterated in courses with university students and industry courses alike. The process was developed to introduce more user-centred methods in design sprints. Design sprints introduce a clear, pre-defined layout, and well-managed goals and deliverables, providing an ideal structure for students. The UCD Sprint in its current form contains 18 steps, split into 3 phases: the Discovery, the Design, and the Reality Check. Through the 18 steps, the students learn to better understand and connect with potential users, pinpoint their needs, define desired experiences for them, develop and finally test a solution with the users.

The UCD Sprint, as a course as well as a process, has been presented at a variety of courses and conferences worldwide, such as INTERACT [28], NordiCHI [32], CHI [29], Uppsala University (Sweden), University of Bari (Italy), Reykjavik University (Iceland), and University of Campinas (Brazil). The sprint is currently implemented in several courses within Reykjavik University, where it is analysed and further optimised based on student feedback. In the university context, the process brings a series of steps that rely on active learning and encourage students to nurture their empathy for the users they are developing for, which is an approach diverging from the more traditional, theory-based courses presented in Computer Science departments. Adapted structures such as the UCD Sprint [42] can serve as starting points for classroom material, potentially replicating the results seen in the Acre et al. study [6], with an increased focus on the users, with a goal of iteration and optimization to fit the students and the labour market they will further be part of.

D. Digital Tools and Universal Design for Learning

Following the COVID19 worldwide context of the most recent three years, many countries worldwide have chosen to move part of or all educational and training activities online. This has exposed not only difficulties of technological sorts, but also a deep need of adapting the educational system to more digital alternatives, encouraging a plethora of digital support tools to appear or expand.

While in-person education is the norm and its needs and approaches might be more clear-cut in this aspect, the last two years have brought a multitude of studies and papers on the topic of online education and online tools. Recent studies have found a definite preference of students for face-to-face teaching and training, with papers such as Aguilera-Hermida's [3], which shows emergency online learning solutions had a negative impact on the motivation, self-efficacy, and cognitive engagement of students. The study suggests that emergency online learning has also impacted teachers and professors, affecting their teaching styles and strategies. The paper pushes for preparation and adoption of techniques that boost student motivation and engagement. However, when distance education is considered, the creation of websites as digital aids for the students is seen as a positive, engaging opportunity, as shown by a study of at-distance education in social studies [4].

As online education does not seem to cater to every student's needs, involving a variety of means of presenting content to students can be the key to facilitate learning and make it more accessible to a wider audience. Methods such as the Multiple Means of Representation proposed by Universal Design for Learning (UDL) have received positive feedback from students [25, 27], and introducing additional tools, digital or not, can further help students in their learning process. This can not only facilitate learning but also make it more accessible by design [43]. This accessibility extends to academically diverse classrooms [11], and this can be of use, especially to professors presenting content to students in their first semester, as coming from different backgrounds, cultures, and educational environments leaves the course at hand as the only great equalizer. Similarly, Moro [35] discusses the plethora of options students can be exposed to, and argues for a mix of information presentations, for the benefit of students.

To sum up, active learning, as a versatile umbrella term, has demonstrated its effectiveness in improving student performance and engagement. UCD methods, with their interdisciplinary nature, offer students valuable skills for problem-solving and creativity, helping them to adapt to the evolving technological landscape, promote inclusivity, and address potential hardships that might arise from having a diverse pool of users. The introduction of design sprints, particularly the UCD Sprint, can bring structured approaches to user-centered design in education, enabling novice designers to more easily empathise with users and enhancing the overall learning experience. Finally, the discussion on digital tools and the shift to online education methods emphasises the need for flexible and inclusive teaching methods, such as Universal Design for Learning, to cater to diverse student needs. As education continues to evolve, these insights into active learning, UCD, and digital tools seek to provide a foundation for creating engaging, effective, and accessible learning environments that prepare students for real life challenges.

III. Teaching the UCD Sprint in Higher Education

The UCD Sprint was introduced to students in the context of a mandatory 12 week course - Software Requirements and Design, in the autumn of 2022 at Reykjavik University. The course had 240 students registered, and is given in the first semester of the first year, so the students are generally inexperienced in the presented topics. The course covers a series of methods meant to teach students to design, analyse, and test software, with a focus on the user and user needs. The students are introduced to the methods through presentations and lectures, and they apply them through individual projects and three group projects. The teaching style approaches the theory through an active learning lens, encouraging group work, reflection-based activities, and student-driven projects. For the course session presented in this paper, the students benefited from a digital aid in the form of a website presenting the content in an accessible, short format. The digital aid was presented to students and they were encouraged to use it throughout the semester, for studying, working on assignments, and even during the exam, and for revisiting theory, examples, and templates.

The course presents user-centred software development methods in an agile manner, through the UCD Sprint methods, throughout the first 7 weeks. A second part of the course is dedicated to UML, for a duration of 3 weeks. Finally, there are two weeks used for method summarisation and a Q&A for the entire course. The students worked in groups of three to four people using the UCD Sprint through problem-solving classes with teaching assistants' support, and three group assignments conducted as home assignments. The students handed in one group assignment for each of the phases of the UCD Sprint process, depicted in Figure 1:

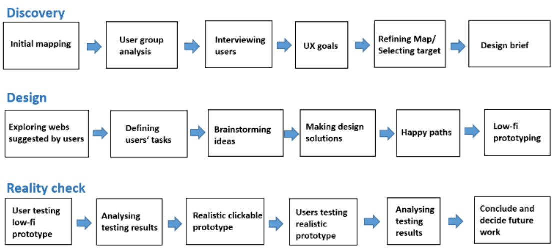

Figure 1: An Illustration of the structure of the UCD Sprint process

IV. Methods

The study used two data-gathering methods, a survey and a qualitative digital aid evaluation through student reporting. In this section, we describe the participants, the data-gathering process and the corresponding data analysis methods.

A. The Survey

1) Participants

The participants in the study were students in the Computer Science bachelor's programme at Reykjavik University. Out of the 103 students present in person during the class in which the questionnaire was handed out, 68% handed in their responses, with some filling only parts of it in. The students were rather evenly split age-wise, with 33% from 17 to 20 years old, 45% from 21 to 25, and 22% over 26. Some of the students had a previous degree or some work experience. Only 17% of respondents identified as female, with the rest of 83% identifying as male.

2) The Data Gathering Process

During the course, data was gathered with the help of a questionnaire containing three distinct data-gathering sections, in a mixed-method format.

Section 1: The Retrospective Hand Technique

A qualitative, open comment format section, with a focus on the entire course method, was used for the gathering of qualitative data. Also known as the Retrospective Hand Technique, this method was used in gathering data on the previous iterations of the sprint too, with productive outcomes [30, 41]. In this, the students were asked to provide feedback on the positives, negatives, and areas of potential optimization of the course and the support material.

Section 2: The method evaluation

This section asked the students to respond to a three-part fill-in survey that was aimed at gathering feedback on the methods learnt during the course. They evaluated the 14 methods based on three criteria: how thought-provoking they are, how applicable they are to the course, and how likely the students are to use them in subsequent academic or professional settings. The students rated these methods on a scale from "Not at all" to "Extremely so," and from "Not likely" to "Extremely likely,". Unstructured comments were also encouraged.

Section 3: Quantitative Digital Aid Evaluation

This quantitative part asked the students a series of practical questions – from an estimation of the number of visits they made to the course website (www.ucdsprint.com) to a rating of its usefulness and design.

Theme	**Explanation**
Assessment	Assessment standards, structure, schedule, criteria and feedback
Staff quality	Tutor and lecturer availability, teaching skills, quality and frequency of communication with students and the number of lecturers on the module
Learning environment	Quality of lecture hall equipment, the size and comfort of lecture and tutorial venues and the quality of the learning environment created through group project work.
Learning support	Adequate preparation for assessments and the provision of extra learning support (e.g. workshops or guest lecturers)
Learning resources	The provision of additional resources and the quality, timeliness and affordability of resources provided.
Teaching methods	HOW the students learn, i.e., the format of activities on the course. The outcome of the design exercise.
Course content	WHAT the students learn in the course
Course administration	Practical arrangements such as team formation and availability of practical course information
Course structure	Structure and schedule of the activities, days, and course. WHEN the learning activities take place
Soft skills	Critical thinking, problem-solving, leadership and responsibility, communication, and collaboration (e.g., teamwork)
People	Personal relationships, selection of people on the course
Experience	Overall course experience, level of motivation, atmosphere, free time activities, lunch and snacks, accommodation
UCD Sprint content	Methods the students learn through the UCD Sprint
UCD Sprint structure	The steps and the flow in the UCD Sprint
UCD skills	What UCD skills are gained through the UCD sprint process
UCD sprint experience	The overall experience of learning to use the UCD Sprint - the feeling students get while using the process

Table 1: Themes for Data Analysis

3) The Data Analysis of the Survey

The analysis of the retrospective Hand Technique (Section 1) follows a thematic approach, facilitating a comparison between this paper and the 2021 course paper's results [42].

This required a transcription from paper to a digital format, translation to English in the case of the qualitative feedback, and assignment to the themes used in the 2021 paper, with 4 additional themes added specifically for this instance of the course, deriving from text analysis. The themes can be seen above, in Table 1, with UCD Sprint Content, UCD Sprint Structure, UCD Skills, and UCD Sprint Experience being the 4 additional themes. The qualitative comment analysis was done in the form of open coding, in two rounds, independently by two of the authors. After the individual analysis, the two were compared for a final consensus. During the comparison, 46% were in agreement, 46% in initial disagreement but reached a consensus on one of the proposed themes, and 8% had a new theme arise from the discussion, different from either of the ones initially proposed.

The method evaluation (Section 2) and quantitative digital aid evaluation (Section 3) were analysed by creating average scores for each method based on the scoring received, as well as looking at the minimum and maximum scores.

B. The Qualitative Digital Aid Evaluation

1) Participants

For the qualitative digital aid evaluation, the comments from 110 students were gathered in the form of a peer interview. The responses were anonymous, and no demographic data was collected for this section. The interviews were further compiled in three sections. These sections analyse the additional support material they have used, the overall experience of using the website as a digital aid, and the changes they would bring to the UCD Sprint website, for experience optimisation.

2) Data Gathering Process

In the second last week of the course, the students were asked to interview each other in pairs on their opinions of the www.UCDSprint.com website. For this, they received an interview template and interviewed each other during the in-class problem-solving sessions. After completing the interviews, they submitted the results in a report, anonymising the interviewee. The interviewer asked a series of questions, out of which the following four were considered for this paper, with the last two questions being combined during the analysis:

- What support material have you used in the course?
- What is your experience using the UCD Sprint website as a digital aid to the course?
- Is there anything that you think should be added to the ucdsprint.com website?
- Is there anything that you think should be removed or changed on the ucdsprint.com website?

3) Analysis of the Data

The student reports were coded by theme, in a single round, as they were more clearly targeted. The themes used for the digital aid reviews were once again derived following the through thematic analysis, with themes emerging from the text itself. For the experience of using the website, the themes and their explanations are listed in Table 2.

Theme	Explanation
Positive experience	Participant specifically mentions a positive experience, with wording such as "good", "positive experience", etc
Neutral	Participant specifically mentions a neutral experience
Negative experience	Participant specifically mentions a negative experience, with wording such as "bad", "negative experience", etc
Easy to navigate	Participant mentions the website was easy to navigate, the information was easy to find, intuitivity, etc
Easy to follow	Participant mentions the website information was easy to understand, etc
Difficult to use	Participant mentions the website was difficult or unpleasant to use
Helpful	Participant mentions the website was or will be helpful, be it during assignments, design processes, etc
Good design	Participant mentions the website design specifically, in a positive manner
Clear	Participant expresses positive views over the simplicity of the website or the information presentation
Unclear	Participant negatively references the simplicity of the website or the quality of the information presentation
Overwhelming information	Participant expresses negative views regarding the amount of information presented on the website

Table 2: Themes for data analysis of qualitative digital aid evaluations

For the material used, the themes were clear and were as follows: Slides, Internet, Google, Textbook, Notes, Youtube, Help from other students, Class reading material, and Wikipedia. Similarly, for the changes suggested the following themes emerged: Add examples, Change of design, Add visual content (images or videos), Add more details, Adjust to better fit class assignments, and Add an Icelandic language option.

V. RESULTS

In this section, the results are presented, split in results on the course, results on the UCD Sprint methods, and finally the results on the digital aid usage.

A. Student Feedback on the Course

For the qualitative feedback, the total number of comments received from the students summed up to 136 distinct course-related comments. Out of them, 70 were for the "Positive" category, 50 were for the "Negative" category, and 16 were for the "Point out" category, which consisted of both negative and positive comments. These were grouped with the positive and the negative comments during the analysis phase – 3 as positive and 13 as negative. The frequency of the comments analysed in each theme is shown below, in Table 3.

A vast majority of student comments on the course were focused on Learning Resources, the Course Experience, the UCD Sprint Experience, and the UCD Sprint structure. The percentages are further split into Positive, Negative, and Point out sections, as can be seen in the detailed breakdown below.

In the Positive section, the feedback collected 70 comments. From these, 27% were regarding the UCD Sprint Experience, followed closely by 21% on the Learning Resources. The content of the course and of the UCD Sprint, as well as the Soft Skills received the lowest number of comments, from 4% to 3%. In the Negative section, the feedback collected 50 comments, with the highest percentage of them addressing Learning Resources and the Course Experience – with 58% combined.

Most of the negative comments addressed a discrepancy between the material and the assignments, as well as wishes for less work and a more "fun" structuring of the course. The UCD Sprint structure received 5 negative comments, mostly addressing wishes for fewer steps or a simplification of the existing ones, and a more engaging structure. Amongst the comments, 14 of the positive ones and 21 of the negative ones addressed the usability of the website.

Theme	Total Comments (N=136)	Percentage	Positive Comments (N=73)	Negative Comments (N=63)
Learning Resources	*41*	30%	21%	41%
Course Experience	20	15%	12%	17%
UCD Sprint Experience	20	15%	27%	-
UCD Sprint Structure	14	10%	11%	10%
UCD Skills	9	7%	11%	2%
Course Content	8	6%	5%	6%
Teaching Methods	*8*	6%	-	13%
Learning Support	6	4%	7%	2%
Course Structure	5	4%	-	8%
Soft Skills	2	1%	3%	-
UCD Sprint Content	2	1%	3%	-
Course Administration	1	1%	-	2%
Total	**136**	**100%**	**100%**	**100%**

Table 3: Overview of frequency of comment themes and their percentages

B. The Usefulness of the UCD Sprint Methods

As shown in Table 4 below, the results are overall positive, with Hi-fi prototyping and its testing scoring the highest throughout the fields.

The students found the methods to be highly relevant in the course context, and the score representation of their likelihood of reusing the methods in the future is promising. The students rated the activities that provided direct user interaction or activities that were directly tied to users (such as the interviews or the testing sessions) highly (scores over 4.63), while the lower end of the scale was taken by more process-related methods (such as refining the map/selecting a target or initial mapping). The average score was 4.76, with a minimum score of 3.93 and a maximum score of 5.90. The participants were also asked to rate the overall UCD Sprint, with scores in all 3 categories being over 4.5.

On the opposite end of the scale, we find activities directly addressing the user interaction or activities that were directly tied to users (such as the interviews or the testing sessions) highly (scores over 4.63), with Hi-Fi prototyping and the testing of the Hi-Fi prototype being the highest scoring methods throughout all three dimensions scored. From the qualitative feedback it can be noticed that students enjoyed learning and working with Figma, and they considered it not only a skill they will use in their future jobs, but also an entertaining activity.

Method	Thought-provoking	Useful in the course	Useful in the future
Initial Mapping	4.47	4.94	4.21
User Group Analysis	4.54	5.03	4.73
User Experience Goals	4.41	4.65	4.26
Interviews	4.63	5.40	4.94
Refining the map & Selecting a Target	4.08	4.46	3.97
Design Brief	4.22	4.48	4.18
Exploring Webs	3.93	4.68	4.61
Defining the tasks	4.51	5.29	5.02
Brainstorming Designs and Crazy 8	4.78	4.97	4.10
Design Solutions and Happy Paths	4.42	5.08	4.48
Lo-fi Prototype	4.53	5.08	4.48
User Testing Lo-fi Prototype	4.64	5.40	4.53
Hi-fi Prototype	5.08	**5.90**	**5.53**
User Testing Hi-fi Prototype	**5.10**	5.87	5.34
User Test Analysis	4.90	5.23	5.23
Overall UCD Sprint	4.66	5.29	4.58
Lowest Score	**3.93**	**4.46**	**3.97**
Highest Score	**5.10**	**5.90**	**5.53**

Table 4: Rating of the usefulness of the UCD methods used in the course

A highly relevant scoring column when discussing the long-term relevancy of the methods is the future usage in this case. This can be considered the overall takeaway value of the individual methods and of the UCD Sprint itself. For this, several methods scored about 5, with 3 out of 4 being Hi-fi prototype related – its creation, its testing, and the analysis of the results obtained. During these phases, the students had the opportunity to see their work from previous methods come to life, and also present it to others and see potential interactions, which brings a new perceived value to it. Some students mentioned that the initial steps seemed confusing, and they only understood the whole picture towards the end - "It was a bit confusing at first but after going through each step it starts to come together and make sense".

For the prototyping steps, the students were encouraged to find a varied group of users to test the prototypes with, from different age groups and backgrounds, in order to receive more constructive, diverse feedback. The students have mentioned they enjoyed the process of testing with users, and that they saw the value of using the UCD Sprint in order to provide better products to their user base - "I think the user experience will be better with the UCD sprint process and more tailored to the user", "the UCD sprint process is a great tool to turn an idea into reality and make sure you are actually making something users want".

As seen from the results, the students rated the activities that provided direct user interaction or activities that were directly tied to users highly, while the lower end of the scale was taken by more process-related methods. The average score was 4.76, with a minimum score of 3.93 and a maximum score of 5.90. The participants were also asked to rate the overall UCD Sprint, with scores in all 3 categories being over 4.5 out of the maximum 7. Participants expressed enthusiasm for the UCD-Sprint overall, the cooperative active learning approach, and the course structure. The course's engaging nature and its applicability, as well as the iteration of theory and practice, were cited as positive.

C. *The Digital Aid Evaluation Results*

Out of the 67 responses collected for the quantitative digital aid evaluation, 33% of participants claimed they have visited the website serving as digital support between 1 and 10 times during the semester. The rest of 67% had visited the website more than 10 times. When asked to assess the usefulness of the digital aid in completing course assignments, they rated it as a 5.31 out of 7. Participants further rated the design of the digital aid as 4.03 out of 7, and the likelihood of revisiting the website as 3.37 out of 7.

For the qualitative digital aid evaluation, one of the foci of the feedback gathered on the digital aid was the student use of other materials used in parallel to it. Students were asked to mention what they used in their studying process for the course, in addition to the digital aid provided. Most students said they have used the UCD Sprint website alongside the slides provided by the professor, and several internet resources (with the umbrella term Internet being most often mentioned, but Google, Youtube, and Wikipedia also being mentioned separately), and the textbook and notes later down the list. Help from other students was also mentioned, although at a low rate as can be seen in Table 5, below.

Used the digital aid alongside	**Frequency**	**Percentage**
Slides	73	41%
Internet	30	17%
Google	29	16%
Textbook	24	13%
Notes	9	5%
Youtube	6	3%
Help from other students	5	3%
Class reading material	3	2%
Wikipedia	1	1%
Total	**180**	**100%**

Table 5: Other aid used alongside the digital aid provided

When asked about their experience using the digital aid, the students mentioned they had found the website to be easy to navigate and follow.

Theme	**Frequency**	**Percentage**
Positive experience	54	34%
Easy to navigate	25	16%
Helpful	20	13%
Neutral	16	10%
Easy to follow	13	8%
Good design	6	4%
Negative experience	6	4%
Difficult to use	5	3%
Unclear	4	3%
Clear	4	3%
Overwhelming information	4	3%
Total	**157**	**100%**

Table 6: Overview of the reported experiences of the students when using the digital aid

The feedback received on the digital aid as a tool covered a variety of topics, and was primarily positive, with 83 out of the 110 students mentioning they had a positive or very positive experience with using the website as part of the course as shown in Table 6 below.

Finally, the students were invited to provide feedback on changes they saw needed. The students mentioned a series of changes that can be brought to the design of the website, including the addition of a dark mode, a search bar, and Icelandic translations, as shown in Table 7. Regarding the content, the addition of more examples, as well as the addition of extra material, were the most common changes mentioned.

Change suggested	**Frequency**	**Percentage**
Add visual content (images or video)	56	35%
Change of design	44	28%
Add examples	35	22%
Add more details	12	8%
Adjust to better fit class assignments	7	4%
Add an Icelandic language option	6	4%
Total	**160**	**100%**

Table 7: Changes to the design of the website suggested by students

VI. Discussion

This paper presents the current structure of the UCD Sprint and its application in a Bachelor's level Computer Science course within Reykjavik University. The key contributions of this paper are threefold: a) describing the students' feedback on the UCD Sprint process, b) describing the experiences of using a digital aid accompanying it, and c) a set of recommendations for developing digital aids for assisting students in higher education. The initial research questions are answered below, with the help of context through literature, and the analysis of data presented in the Results chapter.

A. *How do undergraduate students rate the usefulness of the UCD Sprint?*

The students rated the usefulness of the methods for both the course they were taking and the future. Seeing the average scores for the "Useful in the course" and "Useful in the future" dimensions are 5.11 and 4.64 out of 7 respectively, and the overall positive qualitative feedback on the UCD Sprint directly, it can be concluded that the process was seen as useful by the students.

In the context of the course, students found the UCD methods highly relevant, with the lowest score being of 4.46 out of 7, which was given to "Refining the map and Selecting a target". The same method has the lowest average score when comparing the methods scores, added throughout the 3 dimensions, at a 4.17. As this method requires reflection and revisiting a previous method, the importance of reflection might have escaped the students. However, reflection is an important part of knowledge acquisition, and experts in effective teaching and learning methodologies have advocated for deliberate reflection practices [19, 41].

B. *How do undergraduate students experience the usage of the UCD Sprint in the context of a CS course?*

The scoring of the overall UCD Sprint was lower compared to both 2018 [30] and 2019 [42] versions of the UCD Sprint, although no score was under the 3.5 value. However, as the UCD Sprint was presented as part of a mandatory university course in this study, it can be argued that the students in this class should be regarded as a group with varied interests, unlike the courses presented before which were optional courses with fewer participants.

When comparing the UCD Sprint presented in this paper to the structures presented previously, in other courses, the current process brought several additions to the one presented in 2018 and 2019. Among the added UCD methods are Refining the map, Exploring webs, Lo-fi prototyping and Lo-fi Prototype Testing. Some methods such as Voting on design solutions, Speed critique, and Storyboard related activities were removed or changed.

The perception of the UCD Sprint process can be affected by course-related factors like assignments and grading. The UCD Sprint is no longer perceived as a self-standing process, but as a course material by which the students are graded on, and as a mandatory part of their education. This can be more evidently seen in the qualitative feedback, where many students provided feedback on the assignments and the grading rather than on the process itself. However, it is important to mention that students saw the value of bringing users into the design process and enjoyed the UCD Sprint and its methods, although at times they expressed they see a discrepancy between their future careers as Computer Scientists and the processes taught in the course. The students enjoyed the structure provided by the UCD Sprint, showing similar results as reported by Arce et al. [6], but as presented by Shekhar et al. [45] the students also perceived an increased workload due to the course and assignment structure.

C. *What are the experiences of students using a digital aid accompanying the UCD Sprint process?*

With overall positive reviews, the digital aid as a supplementary tool proved to be a positive addition. As suggested throughout the literature [25, 27, 35] students enjoyed having multiple means of accessing information and consistently used the digital aid alongside other material, such as lecture slides, the book, or YouTube.

The students have provided positive and negative feedback, including feedback on the digital aid content and design. Students show a pattern of requiring visual content as well as searching for more examples to create a context for the assignment at hand. The design changes suggested by the students, such as the addition of videos and images may, in the long term, facilitate the students' usage of the digital aid as a primary method, lowering the need to use websites such as Youtube. Furthermore, adding examples and more information as suggested, could lead to a better understanding of the material, increased credibility of the digital aid as a primary source of information, and an overall better experience for the students.

VII. Recommendations for Digital Aid

The recommendations below can be used as a starting point for future digital aid optimisation in our case, and for others to use when embarking on the design and development of digital aids for undergraduate students.

1. Examples are vital:

Students need applied examples for creating a better learning context. Problem-based approaches are in dire need of examples to explain the process and ease understanding.

2. Visual aids are recommended:

The heavy use of visual aids is encouraged, as students have a vast repository of information available online, which they will access, thus it is better to provide them with trustworthy, pre-approved content. Most commonly, students seem to use short-format visual content.

3. Consistent usage of colours & interactive elements:

Use colours and other interactive elements in a structured way to distinguish the methods from the cases, etc. This creates more engaging content, in what can be a more accessible approach.

4. Include templates:

By using templates the students can understand how to use the learning material fast and with minimal effort. This allows them to learn the information needed, without placing as much emphasis on format.

5. Present content in multiple ways:

As suggested in UDL guides, presenting students with content in multiple formats (videos, slides, reading material, etc) can lead to a more accessible classroom experience. Gathering and presenting this content in one place, through a website, can facilitate students' search for information.

VIII. Final Conclusions

Bringing design sprints to academic environments is a work in progress and it requires continuous iterations and a rigorous data-gathering and analysis process. Fostering creativity, teamwork, and analysis through active learning, in the context of the UCD Sprint through user involvement implies difficulties encountered on both the teaching and the learning side, which need to be addressed through constant iterations and optimizations of the material. This being said, teaching the UCD Sprint with the help of active learning methods, and with a focus on problem-based learning is not only reinforced by literature such as Freeman et al. [18] or Nguyen et al. [37], but also enjoyed by students.

While students bring favourable feedback to the UCD Sprint and the experience they underwent by using the digital aid as a tool, their negative feedback and concerns should also be fed back into the iteration process of the UCD Sprint and its aid materials. The main perk of introducing design sprints in any form to academia should be the flexibility to present time-bound activities in a manner that not only fosters intense spurs of creativity but also changes to fit the needs and requirements of the users. Practising the very values preached by the UCD Sprint – the need of catering to users in the development process also applies to the UCD Sprint itself.

Acknowledgment

We would like to express our gratitude towards the students participating in this course, for their engagement and permission to use the feedback provided.

REFERENCES

[1] Abdelnour-Nocera, J., Michaelides, M., Austin, A. and Modi, S. (2012). An intercultural study of HCI education experience and representation. Proceedings of the 4th - ICIC '12. doi:https://doi.org/10.1145/2160881.2160909.

[2] Active Learning Network (2022). Ideas for Active Learning. doi:https://doi.org/10.20919/opxr1032.

[3] Aguilera-Hermida, A.P. (2020). College students' use and acceptance of emergency online learning due to COVID-19. International Journal of Educational Research Open, doi:https://doi.org/10.1016/j.ijedro.2020.100011.

[4] Akyol, C., Avcı, G. and Dikicigil, Ö. (2021). Prospective teachers' views about creating websites for social studies teaching in distance education. Pegem Journal of Education and Instruction, 11(4). doi:https://doi.org/10.47750/pegegog.11.04.02.

[5] Altay, B. (2013). User-centered design through learner-centered instruction. Teaching in Higher Education, 19(2), pp.138–155. doi:https://doi.org/10.1080/13562517.2013.827646.

[6] Arce, E., Suárez-García, A., López-Vázquez, J.A. and Fernández-Ibáñez, M.I. (2022). Design Sprint: enhancing STEAM and engineering education through agile prototyping and testing ideas. Thinking Skills and Creativity, p.101039. doi:https://doi.org/10.1016/j.tsc.2022.101039.

[7] Beckman, S.L. and Barry, M. (2007). Innovation as a Learning Process: Embedding Design Thinking. California Management Review, 50(1), pp.25–56. doi:https://doi.org/10.2307/41166415.

[8] Bonwell, C.C. and Eison, J.A. (1991). Active learning : creating excitement in the classroom. San Francisco: Jossey-Bass.

[9] Brame, C.J. (2016). Active Learning. [online] Vanderbilt University.

[10] Cajander, Å., Larusdottir, M. and Geiser, J.L. (2022). UX professionals' learning and usage of UX methods in agile. Information and Software Technology, [online] 151, p.107005. doi:https://doi.org/10.1016/j.infsof.2022.107005.

[11] Chandler, R., Zaloudek, J.A. and Carlson, K. (2017). How Do You Intentionally Design to Maximize Success in the Academically Diverse Classroom? New Directions for Teaching and Learning, 2017(151), pp.151–169. doi:https://doi.org/10.1002/tl.20254.

[12] Clarke, M. (2017). Rethinking graduate employability: the role of capital, individual attributes and context. Studies in Higher Education, [online] 43(11), pp.1923–1937. doi:https://doi.org/10.1080/03075079.2017.1294152.

[13] Courtney, J. (2018). The Design Sprint 2.0: What is it and what does it look like? | Inside Design Blog. [online] Invisionapp.com

[14] Culén, A.L. (2015). HCI Education: Innovation, Creativity and Design Thinking. International Conferences on Advances in Computer-Human Interactions, [online] pp.125–130. doi:http://hdl.handle.net/10852/46215.

[15] Culén, A.L. and Følstad, A. (2014). Innovation in HCI. Proceedings of the 8th Nordic Conference on Human-Computer Interaction: Fun, Fast, Foundational. doi:https://doi.org/10.1145/2639189.2654845.

[16] Dolmans, D.H.J.M., Loyens, S.M.M., Marcq, H. and Gijbels, D. (2015). Deep and surface learning in problem-based learning: a review of the literature. Advances in Health Sciences Education, [online] 21(5), pp.1087–1112. doi:https://doi.org/10.1007/s10459-015-9645-6.

[17] Finken, S., Culén, A., and Gasparini, A. (2014) Nurturing Creativity: Assemblages in HCI Design Practices, in Lim, Y., Niedderer, K., Redström, J., Stolterman, E. and Valtonen, A., Design's Big Debates - DRS International Conference 2014, 16-19 June, Umeå, Sweden.

[18] Freeman, S., Eddy, S.L., McDonough, M., Smith, M.K., Okoroafor, N., Jordt, H. and Wenderoth, M.P. (2014). Active learning increases student performance in science, engineering, and mathematics. Proceedings of the National Academy of Sciences, [online] 111(23), pp.8410–8415. doi:https://doi.org/10.1073/pnas.1319030111.

[19] Gibbs, G. (1988). Learning by doing: a Guide to Teaching and Learning Methods. London: Oxford Further Education Unit.

[20] Gulliksen, J., Göransson, B., Boivie, I., Blomkvist, S., Persson, J. and Cajander, Å. (2003). Key principles for user-centred systems design. Behaviour & Information Technology, 22(6), pp.397–409. doi:https://doi.org/10.1080/01449290310001624329.

[21] Hopper, M.K. (2018). Alphabet Soup of Active Learning: Comparison of PBL, CBL, and TBL. HAPS Educator, pp.144–149. doi:https://doi.org/10.21692/haps.2018.019.

[22] Hora, M.T. and Ferrare, J.J. (2013). Instructional Systems of Practice: A Multidimensional Analysis of Math and Science Undergraduate Course Planning and Classroom Teaching. Journal of the Learning Sciences, 22(2), pp.212–257. doi:https://doi.org/10.1080/10508406.2012.729767.

[23] Islind, A.S. and Willermark, S.M.J. (2022). Becoming a Designer: The value of sensitive design situations for teaching and learning ethical design and design theory. Scandinavian Journal of Information Systems, [online] 34(1).

[24] Johnson, K.M.S. (2019). Implementing inclusive practices in an active learning STEM classroom. Advances in Physiology Education, 43(2), pp.207–210. doi:https://doi.org/10.1152/advan.00045.2019.

[25] Kennette, L.N. and Wilson, N.A. (2019). Universal Design for Learning (UDL): Student and Faculty Perceptions. Journal of Effective Teaching in Higher Education, [online] 2(1), pp.1–26.

[26] Kou, Y. and Gray, C.M. (2018). Towards Professionalization in an Online Community of Emerging Occupation. Proceedings of the 2018 ACM Conference on Supporting Groupwork. doi:https://doi.org/10.1145/3148330.3148352.

[27] Kumar, K.L. and Wideman, M. (2014). Accessible by Design: Applying UDL Principles in a First Year Undergraduate Course. Canadian Journal of Higher Education, [online] 44(1), pp.125–147.

[28] Larusdottir, M., Roto, V. and Cajander, Å. (2021). Introduction to User-Centred Design Sprint. Human-Computer Interaction – INTERACT 2021, pp.253–256. doi:https://doi.org/10.1007/978-3-030-85607-6_17.

[29] Larusdottir, M., Roto, V., Lanzilotti, R. and Visescu, I. (2023). The UCD Sprint: A Process for User-Centered Innovation. Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems. doi:https://doi.org/10.1145/3544549.3574176.

[30] Larusdottir, M., Roto, V., Stage, J., Lucero, A. and Šmorgun, I. (2019). Balance Talking and Doing! Using Google Design Sprint to Enhance an Intensive UCD Course. Human-Computer Interaction – INTERACT 2019, pp.95–113. doi:https://doi.org/10.1007/978-3-030-29384-0_6.

[31] Larusdottir, M., Virpi Roto, Stage, J. and Lucero, A. (2018). Get Realistic! - UCD Course Design and Evaluation. [online] pp.15–30. doi:https://doi.org/10.1007/978-3-030-05909-5_2.

[32] Larusdottir, M.K., Roto, V., Lanzilotti, R. and Duta Visescu, I. (2022). Tutorial on UCD Sprint: Inclusive Process for Concept Design. Adjunct Proceedings of the 2022 Nordic Human-Computer Interaction Conference. doi:https://doi.org/10.1145/3547522.3558901.

[33] Lindsay, S., Jackson, D., Schofield, G. and Olivier, P. (2012b). Engaging older people using participatory design. Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems - CHI '12. doi:https://doi.org/10.1145/2207676.2208570.

[34] Llamas, B., Storch de Gracia, M.D., Mazadiego, L.F., Pous, J. and Alonso, J. (2019). Assessing transversal competences as decisive for project management. Thinking Skills and Creativity, [online] 31, pp.125–137. doi:https://doi.org/10.1016/j.tsc.2018.11.009.

[35] Moro, J. (2018). The Emergence of Digital Course Materials in Higher Education and Their Effectiveness in Teaching and Engaging Students. Publishing Research Quarterly, [online] 34(3), pp.417–429. doi:https://doi.org/10.1007/s12109-018-9594-z.

[36] Moroz-Lapin, K. (2008). Active learning in the education of human computer interaction. [Accessed 29 Mar. 2023].

[37] Nguyen, K.A., Borrego, M., Finelli, C.J., DeMonbrun, M., Crockett, C., Tharayil, S., Shekhar, P., Waters, C. and Rosenberg, R. (2021). Instructor strategies to aid implementation of active learning: a systematic literature review. International Journal of STEM Education, [online] 8(1). doi:https://doi.org/10.1186/s40594-021-00270-7.

[38] Patrick, L.E., Howell, L.A. and Wischusen, W. (2016). Perceptions of Active Learning between Faculty and Undergraduates: Differing Views among Departments. Journal of STEM Education: Innovations and Research, [online] 17(3), pp.55–63.

[39] Prince, M. (2004). Does Active Learning Work? A Review of the Research. Journal of Engineering Education, [online] 93(3), pp.223–231. doi:https://doi.org/10.1002/j.2168-9830.2004.tb00809.x.

[40] Roldan, W., Gao, X., Hishikawa, A.M., Ku, T., Li, Z., Zhang, E., Froehlich, J.E. and Yip, J. (2020). Opportunities and Challenges in Involving Users in Project-Based HCI Education. Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems. doi:https://doi.org/10.1145/3313831.3376530.

[41] Rolfe, G., Freshwater, D. and Jasper, M. (2001). Critical Reflection for Nursing and the Helping Professions: A User's Guide. [online] Philpapers.org.

[42] Roto, V., Larusdottir, M., Lucero, A., Stage, J. and Šmorgun, I. (2021). Focus, Structure, Reflection! Integrating User-Centred Design and Design Sprint. Human-Computer Interaction – INTERACT 2021, pp.239–258. doi:https://doi.org/10.1007/978-3-030-85616-8_15.

[43] Saha-Gupta, N., Song, H. and Todd, R. (2019). Universal Design for Learning (UDL) as Facilitating Access to Higher Education. [online] doi:https://doi.org/10.5281/zenodo.3370001.

[44] Sandrone, S., Scott, G., Anderson, W.J. and Musunuru, K. (2021). Active learning-based STEM education for in-person and online learning.Cell,184(6),pp.1409–1414. doi:https://doi.org/10.1016/j.cell.2021.01.045.
[45] Shekhar, P., Borrego, M., DeMonbrun, M., Finelli, C., Crockett, C. and Nguyen, K. (2020). Negative Student Response to Active Learning in STEM Classrooms: A Systematic Review of Underlying Reasons. Journal of College Science Teaching, [online] 49(6), pp.45–54.
[46] St-Cyr, O., MacDonald, C.M., Churchill, E.F., Preece, J.J. and Bowser, A. (2018). Developing a Community of Practice to Support Global HCI Education. Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems. doi:https://doi.org/10.1145/3170427.3170616.

Appendix E

Publication IV: Exposure to User-Centred Design Activities: Experiences in Higher Education

Exposure to User-Centred Design Activities: Experiences in Higher Education

1st Ioana Visescu
Department of Computer Science
Reykjavik University
Reykjavik, Iceland
0000-0002-5304-9006

2nd Marta Lárusdóttir
Department of Computer Science
Reykjavik University
Reykjavik, Iceland
0000-0003-0256-5710

3rd Anna Sigridur Islind
Department of Computer Science
Reykjavik University
Reykjavik, Iceland
0000-0002-4563-0001

***Abstract*—Studies on how the skills needed to carry out user-centred design (UCD) activities can be taught and learnt have been limited, although the impact of UCD is widely recognised in professional settings. Conducting UCD activities in educational contexts within the constraints of university courses remains a challenge, specifically when students are in their first year and are just beginning to engage with the complexities of software development. In this paper, we argue for the importance of early exposure to a variety of UCD activities, with the help of scaffolding and decomposition, through the step-by-step UCD Sprint process. We explore the integration of the UCD Sprint process for 7 weeks in a 12-week, first-semester, first-year Computer Science undergraduate course, focusing on how students experience exposure to a wide range of UCD activities. Data is gathered using two questionnaires: the background questionnaire completed by 215 students at the start of the course, gathering data on demographic information, and the perceived experience questionnaire completed by 57 students, gathering data on comfort levels with UCD activities and overall feedback on the UCD Sprint process. The students rated the UCD Sprint steps as generally thought-provoking, particularly valuing steps involving direct user engagement, such as interviews and high-fidelity prototyping. However, process-related steps were rated lower for perceived long-term usefulness. Qualitative feedback highlighted the UCD Sprint process as clear and beneficial. Suggestions for improvements to the process included reducing its complexity and optimising the learning materials for guiding the students in using the process. Statistically significant increases in comfort levels with UCD activities, including user research, evaluation, and design were observed post-course. The main contribution of this paper lies in its insights into the student experiences with the individual UCD activities contained within the UCD Sprint, assessing how early exposure to UCD activities can enhance their comfort with performing core UCD activities. By offering early, scaffolded exposure to UCD activities through the UCD Sprint, we are actively designing a student-centred learning environment that prioritises hands-on experience and engagement with UCD principles. This approach not only fosters student comfort and competence in UCD activities but also empowers them to take an active role in their learning journey, encouraging them to become more adept at understanding and addressing user needs, ultimately preparing them for future careers in a rapidly evolving, user-focused tech industry.**

***Index Terms*—User-centred design (UCD), UCD Activities, Empirical Study, Higher Education, Computer Science, Software Engineering, STEM, Methodology**

I. Introduction

Developing software based on an inappropriate or incomplete understanding of user needs is one of the major sources of software failure [1]. The aim of user-centred design (UCD) is to understand and interpret the needs of users to provide a good user experience (UX) [2]. Studies suggest that user involvement generally yields positive effects, enhancing user satisfaction with the delivered system [40], [43]. Furthermore, taking users as a primary information source for requirements capture has proved to be an effective approach [40].

UCD responsibility goes beyond just designers and UX experts [44]. For example, software developers see themselves as partially accountable for aspects like UX, considering it intertwined with usability and accessibility [6], [20]. This creates challenges for UCD as developers might undervalue user-related work [21]. Conducting UCD activities requires a complex mix of soft and hard skills and competencies [3].

It is important to note that a majority of Computer Science (CS) graduates go on to be employed in Software Development [56]. The challenges faced by software developers while conducting UCD activities underscore the importance of guiding CS and Software Engineering (SE) students early in their education in learning to conduct UCD activities. This approach not only benefits companies and the field as a whole but also enhances students' employability and prepares them for future work challenges. However, while there is extensive literature addressing UCD activities through approaches such as participatory design and user involvement in the design and development processes [18], [19], [22], previous research does not fully address the implementation of these UCD activities in educational settings, especially within the constraints of an academic course.

Integrating UCD activities into first-semester undergraduate courses requires a balance between empowering students and providing necessary guidance. Furthermore, design problems have become increasingly complex and difficult to frame [41], making it a difficult process for beginners to grasp. In order to aid students, instructors can scaffold the process by providing clear steps and templates. By combining structured activities with guided decision-making, the UCD Sprint process [23] provides a framework for students to navigate the complexities of design in a supportive environment. This structured approach allows them to experiment, learn from each other, and ultimately develop a user-centered design solution. The UCD Sprint process emphasises understanding user needs from project inception [27]. It encapsulates the principles of UCD, divided into three phases: Discovery, Design, and Reality Check. The Discovery phase focuses on understanding users through research; the Design phase translates research into solutions with prototypes, and finally, the Reality Check phase involves evaluating prototypes, gathering user feedback, and refining the design. The process has been optimised in previous studies, offering a structured but flexible framework for education [11], [23], [25], [28]. The findings indicate favourable experiences for learners, allowing for focused steps and user feedback reflection.

The research question guiding this study is:

How do first-semester students experience exposure to a wide range of UCD activities through the UCD Sprint process?

In this paper, we study the perceived experiences of conducting UCD activities with first-semester undergraduate CS students, analysing student comfort and feedback on UCD activities through pre- and post-course questionnaires, with thematic analysis and t-tests assessing changes in comfort levels. The main contribution outlines an illustration of the perceived experiences of using the UCD Sprint process, and shows the impact of using it to support exposure to UCD activities. Firstly, we highlight the process of integrating a wide variety of UCD activities into higher education curricula through the UCD Sprint, and present students' perceived experience with the process. Secondly, we show that the UCD Sprint process enhanced students' comfort with UCD activities, as there is a notable increase in perceived comfort levels across all dimensions of UCD post-course. Throughout, we illustrate the importance of integrating UCD early on in CS curricula as exposure to UCD activities is not only vital for preparing students for the demands of the job market but also for cultivating soft skills, which are of great importance for design [8], for their employability [9], but also for a more innovative and user-centric workforce.

II. Related Work

This section describes the existing related work, focusing on the complexity of design, the skill gap this creates and some of the educational initiatives meant to address it.

A. The Skill Gap

Design is inherently complex and iterative, relying on ongoing problem framing to define and structure ill-defined issues. Problem framing is essential in articulating the boundaries and contexts of a problem, setting the stage for solutions. This initial step, coupled with continuous reframing as solutions evolve, is fundamental to navigating design challenges successfully. Research highlights problem framing as critical, particularly in the early stages of design frameworks [45]–[47]. Framing issues early enhances decision-making by clarifying boundaries and highlighting possible directions within a non-linear design process [48], [49]. However, as novices transition from well-defined tasks to open-ended problems, they often struggle with this complex framing and reframing process [50].

This underscores the importance of teaching design activities to help students develop these competencies early on. However, since problems and solutions often co-evolve, ongoing re-evaluation is necessary throughout the design process [51], [52]. Expert designers excel at problem framing due to their experience and domain-specific knowledge, allowing them to scope complex issues effectively. However, this is a skill novice designers lack, leading them to fixate on solutions prematurely [53]. This skill gap is particularly relevant in UCD, where software developers play a pivotal role. While developers see themselves as partially responsible for accessibility [6], [20], UX and usability experts often regard developers as obstacles to UCD due to their lack of training and holistic user understanding [12]–[14], [16]. Developers, responsible for implementing changes and possessing domain knowledge are crucial at the intersection of user-centeredness and software creation. Studies indicate that training software developers in usability engineering can increase their comprehension of usability principles and UX, enhancing their ability to advocate for usability [4], [30]–[32]. In this way, domain knowledge becomes a strength, allowing developers to better address usability issues [30]–[32].

Upskilling in UCD activities is one approach to closing this skill gap, but lifelong learning and the integration of complex activities into agile frameworks are challenging. UCD skills, although essential, are viewed as resource-intensive by industry stakeholders, creating barriers to upskilling support [10], [11], [14], [54]. Limited training also makes it difficult for developers to meaningfully analyse and apply gathered data. Research by [5] reveals that software developers encounter difficulties when analysing gathered data when training is limited to specific activities. [31] also observed challenges in interpreting observations, while [30] identified issues in substantiating observations with data. Additionally, [30] found that while developers might identify potential issues, they can struggle to comprehend how these findings could drive design changes.

B. Educational Initiatives

For these reasons, it is critical to expose developers to a wide range of design activities and a comprehensive understanding of the design process rather than limiting them to a small set of techniques. This broader educational foundation prepares future software developers to navigate complexity, make informed decisions, and connect data with design solutions. However, a broad design education can be time-intensive and costly, making it unsuitable for upskilling in a developer's career. Thus, a more efficient approach would be integrating UCD education directly into CS and SE programmes, exposing students early to UCD activities to build a robust foundation in design skills. Early exposure ensures software developers graduate with the UCD skills necessary to enhance the quality of the software they create. With workforce readiness as the goal, educators are increasingly encouraged to anticipate and address potential hurdles by equipping students with a foundational set of design activities [7], promoting holistic practices, and fostering soft skills essential for the workplace. To do that at an appropriate level for students early in their education, scaffolding can represent an opportunity. [42] introduced the concept of scaffolding in education. This approach provides temporary support for novice learners, with the level of assistance gradually decreasing as their competence increases. UCD activities within an educational context, like user interviews and initial testing sessions, can be guided by instructors to ensure students grasp core UCD concepts. Students can thus be encouraged to make informed decisions within defined boundaries, empowering them to personalise their design journey, while keeping the problem scope manageable.

In [55], an integrated Design Thinking and Design of Experiments in an engineering course is presented, used to enhance students' soft skills such as empathy, innovation, and problem-solving skills. By focusing on creating solutions for users with disabilities, students gained technical skills alongside a deeper appreciation for social responsibility, providing a final product that had a meaningful impact on its users. Similarly, [36] aimed to create a dynamic learning experience in an Engineering Drawing course by integrating real-world relevance and applying the Design Sprint methodology [37]. Designed to blend theory with hands-on practice, the course focused on both technical and interpersonal skills. A group of 56 first-year students completed 18 different projects. Feedback was gathered via surveys regarding the implementation of the Design Sprint, and results reflected high levels of student satisfaction and improved grades, highlighting the success of the Design Sprint approach in creating an interactive, manageable, and broadly applicable learning framework.

Additional studies [23], [27] examined the integration of UCD activities with Design Sprint methodology [37] in intensive design courses, where feedback led to course revisions, particularly in integrating UCD activities before and after Design Sprint activities [23]. This approach, termed the UCD Sprint, has received positive feedback internationally, including in Brazil, Finland, Italy, Iceland, and Sweden, with refinements to the process and learning materials informed by participant feedback [11], [23], [25], [28], [54].

To summarise, the literature emphasises a significant skills gap among software developers when it comes to design. Without strong problem-framing skills, developers tend to focus prematurely on solutions, especially in complex, iterative design environments. As UCD requires an understanding of user needs and accessibility, the limited training in usability and user experience developers possess often leads to gaps in their ability to analyse and apply design data effectively, becoming barriers in the process. This has led to calls for integrated UCD training within CS and SE programs, rather than as part of upskilling, which can be resource-intensive and limited. Educational initiatives that introduce a wide range of design activities, scaffolded support, and soft skills training in these programs can help students develop a solid foundation in UCD. Thus, embedding a structured design process within CS and SE educational programmes can introduce students to a wide range of design activities as part of a complete design process, but also help them develop the soft skills and problem-solving abilities critical for professional success. This foundation can empower them to navigate real-world complexities, enhancing their capacity to deliver user-centred, innovative software solutions.

III. Methods

This section presents details on the course content and context, as well as participant demographics.

A. *Course Design and Context*

This study takes place within the context of a 12-week, mandatory first-year course titled Software Analysis and Design, in the CS degree program at Reykjavik University, Iceland. The course, taught in person, is structured to introduce students to foundational design and requirements analysis methodologies, primarily focusing on a user-centred approach to software development. Students are exposed to various techniques for eliciting and organising software requirements, analysing user needs, and designing systems in a manner that emphasises usability and user experience. Learning objectives of the course include an understanding of the primary activities for requirements analysis, software design, and user interface principles. Students gain knowledge of usability standards that support user-centred design. Skills development is emphasised in areas such as functional and non-functional requirements specification, and prototyping and testing designs. In addition to technical skills, students practice communicating with users and stakeholders, and presenting their design process and resulting designs clearly through comprehensive reports, models, and prototypes.

A significant aspect of the course is the UCD Sprint, a structured framework that guides students through an entire design process, from the initial concept to the design and testing phases. In the course, the students are given a software idea, and are required to apply the UCD Sprint process, for gathering user needs, making design solutions, prototyping and evaluating those with users to develop a user-centred solution. The first seven weeks of the course are dedicated to the UCD Sprint, where students progressively build their understanding of requirements generation, analysis, early-stage prototyping and evaluation of the prototypes with users.

The course uses an online digital resource to aid with the learning of the UCD Sprint - www.ucdsprint.com, featuring guides on each phase of the UCD Sprint, along with templates, examples, and guidelines. This website serves as a practical reference throughout the semester and is accessible for assignments and project work. To enhance engagement, the course employs an active learning approach, combining theory with practical exercises and encouraging collaborative work, including problem-solving classes and reflective activities. Students work both individually and in groups of three to four members, completing a series of individual and group assignments aligned with the UCD Sprint phases.

B. Participants

Participants in this present study were students enrolled in the course, most of whom were Icelandic. The students were rather evenly distributed across age groups, with 38% aged 17-20, 28% aged 21-24, 13% aged 25 to 28, and the remaining 22% aged 28+. The gender breakdown showed that 25% identified as female, 73% identified as male, and 1% identified as non-binary (rounded values).

C. Data Gathering and Analysis

The study used two main data-gathering methods: i) a digital questionnaire for gathering data on the background of the students, and ii) a survey on paper gathering data on the experience of using the UCD Sprint.

The background questionnaire was shared at the beginning of the course, and it included questions on the student background and their comfort levels with a series of UCD activities. It received 215 answers. This is a voluntary questionnaire containing two sections. Section one included the general background of the students, such as age, gender and previous education. This data is given numerical values and the demographics data is summarised in section III A above. Section two contained questions on students' comfort level with UCD and is detailed in Part 2 of section III C.

The perceived experience questionnaire was distributed near the end of the course via a voluntary paper survey, which 57 students filled out. The data is digitised, and translated from [language excluded] to English. This questionnaire has three distinct parts.

Part 1 contained two open questions on the general UCD Sprint experiences.: 1) "What do you think is good about the UCD Sprint process?"; 2) "What do you think could be improved in the UCD Sprint process?". This gave the students the opportunity to describe their experiences in a qualitative way. Some of the answers provided contained more than one comment, or comments on a variety of aspects. Due to this, the answers were divided into multiple shorter segments. That resulted in 83 positive comments for the first question, and 73 comments containing suggestions for improvements. Among the respondents, 5 indicated that they have no opinion. Therefore, the analysis proceeded with the 68 remaining improvement suggestions. The segmented comments were initially categorised into themes using a thematic analysis method outlined by [38], yielding three overarching themes: UCD Sprint Structure and Content, UCD Sprint Overall Experience, and Course and Learning Material. The three themes were further separated for a more detailed analysis, positive comments being associated with a total of 12 themes, while the improvement-related comments were linked to 17 themes.

Part 2 of the data-gathering survey focused on students' experiences with each method of the UCD process, evaluating thought provocation, course usefulness, and the likelihood of using this in their future job/education, through the following three questions: 1) "Was this method thought-provoking?" 2) "Was this method useful in the course?" 3) "Do you think you will use this method in your future job/ education?". The students rated each method on a scale from 1 to 7, where 1 indicated "Not at all" or "Not likely" and 7 indicated "Extremely so" or "Extremely likely." This approach aligns with previous studies on UCD Sprint courses [11], [23], [25], [28], ensuring comparability. The raw data were compiled into an Excel spreadsheet for further statistical analysis, including averaging the ratings for overall perceived effectiveness. The analysis presented in the paper examines these average scores, highlighting the steps with the highest and lowest average ratings to enhance understanding of student experiences.

Finally, part 3 consisted of one question spanning over 6 dimensions, measuring students' comfort levels with UCD activities generally involved in a design process, rated on a 5-point scale from very uncomfortable to very comfortable. The question was phrased as "How would you rate your comfort level when it comes to the following activities:". These activities encompassed interviewing users, user need analysis, low fidelity (Lo-Fi) prototyping techniques (such as sketching and paper prototyping), high-fidelity (HiFi) prototyping, user testing, and evaluating with individuals beyond users, including peers, colleagues, and experts. These numerical ratings were compared to the overall ratings from student responses from the initial background questionnaire. The analysis involved calculating the average comfort scores for each dimension before and after the course. Subsequently, to find out whether there is a statistically significant change in perceived comfort levels with these activities, a t-Test is employed. Understanding whether the observed improvements are likely attributed to the intervention or occurred randomly is a crucial step in assessing its effectiveness.

IV. Results

This section presents details on the results, separated by the data collection type.

A. Perceptions on the UCD Sprint

The students were invited to provide feedback by responding to two questions regarding their perceptions of the UCD Sprint process; one focused on its positive aspects, and the other on potential improvement areas. Several students provided multiple open-ended comments for each question, resulting in a total of 73 positive comments and 83 suggestions for improvements (referred to as improvement suggestions in Table I). Despite the specific prompt to evaluate the UCD Sprint process, many responses encompassed broader aspects of the course or its materials rather than focusing solely on the UCD Sprint process. Consequently, a thematic analysis is conducted on the student comments, identifying three primary all-encompassing themes: UCD Sprint process Structure and Content, UCD Sprint process Overall Experience, and Course and Learning Material. Table I provides an overview of

TABLE I
OVERVIEW OF STUDENTS' COMMENTS ON POSITIVE EXPERIENCES AND SUGGESTED IMPROVEMENTS

Theme	Positive Comments # (%)	Improvement Suggestions # (%)
UCD Sprint Structure and Content	24 (29%)	13 (19%)
UCD Sprint Overall	43 (52%)	12 (18%)
Course and Learning Material	16 (19%)	43 (63%)

TABLE II
THE AVERAGE RATINGS FOR EACH ACTIVITY OF THE UCD SPRINT PROCESS (RANGING FROM 1 TO 7)

Activity	Thought-provoking	Useful in the course	Usage in the future	Overall
Initial Mapping	4.28	4.94	3.79	4.34
User Groups	4.77	5.45	4.90	5.04
UX Goals	4.19	4.62	3.88	4.23
Interviews	4.96	5.57	4.71	5.08
Refining the map / Selecting a Target	4.26	4.71	3.71	4.23
Design Brief	4.17	4.69	3.98	4.28
Exploring Webs from Users	4.80	5.40	4.66	4.95
Defining the tasks	4.72	5.32	4.89	4.98
Brainstorming Designs including Crazy 8	5.09	5.34	4.23	4.89
Design Solutions /Happy Paths	4.81	5.31	4.43	4.85
Lo-Fi Prototyping (paper prototyping)	4.91	5.23	3.94	4.69
User Testing Lo-Fi Prototypes	5.09	5.48	4.27	4.95
Hi-Fi Prototyping	5.57	6.11	5.23	5.64
User Testing Hi-Fi Prototype	5.27	5.90	5.06	5.41
User Test Analysis	5.30	5.53	5.04	5.29
Overall UCD Sprint	4.90	5.46	4.04	4.80

TABLE III
COMFORT SCORES, DIFFERENCE OBSERVED, AND TWO-TAILED P VALUE BEFORE AND AFTER THE COURSE FOR EACH UCD DIMENSION (RANGING FROM 1 TO 5)

UCD Activities	Before	After	Difference	P(T<=t) two-tail
Interviewing users	3.1	3.5	+0.39	0.048
User need analysis	3.1	3.6	+0.56	0.000
Lo-Fi Prototyping (e.g., sketching, paper prototyping)	3.0	3.7	+0.67	0.000
HiFi prototyping (e.g., Figma)	2.9	3.7	+0.83	0.000
User testing	3.1	3.6	+0.46	0.005
Evaluating with others than users	3.1	3.8	+0.66	0.000

the distribution of comments within each of these thematic categories.

Many of the positive comments are general comments on the overall experience of using the UCD Sprint process, while many of the suggestions for improvements are in the context of the study, such as the course and the learning material used. The most frequent comments illustrate the UCD Sprint process as easy to use and useful. Many students also found the UCD Sprint process clear and detailed. Some students mentioned that it is fun to experience, with others focusing more on its learning value over time, stating that they liked the learning curve. The most common comment on the UCD Sprint process structure and content is that the students like its step-by-step structure. Several students commented favourably about their learning experience, and the cultivation of their design skills through the UCD Sprint process. Over half of the suggestions for improvements were targeted towards improvements of the overall course and its material. Many of the suggestions illustrate the need for a wider array of examples on the website, and present suggestions for engaging with more generic content as a part of the learning material, pointing towards the importance of highlighting transferability between contexts when utilising UCD activities. In addition to these suggestions, there were concrete examples, such as a call for more visual material on the website through photos and videos. The need for alternative learning material is also highlighted by the students' need for more targeted, short, and clear instructions. The rest of the improvement suggestions on the course and the course material were on the instructions given, as students observed inconsistencies between the instructions in the project descriptions and the instructions given on the website.

The suggestions for improvements on the UCD Sprint process and its structure were mostly based on the complexity of the process, as shown by the comments on the process having too many steps. Some students questioned the usefulness of some of the steps or criticised their clarity. Others had more concrete suggestions on how to proceed with utilizing the

UCD Sprint process by applying some steps within it in tandem while skipping others. A dimension of soft skills emerged from the analysis, with some students finding it difficult to engage with users directly, sometimes finding the process of interviewing uncomfortable. Some students thought the process is confusing, hard to understand, time-consuming, and not fun. That is illustrated through a variety of comments. The depth of their insights shows that the cultivation of skills cannot only be done through a clear process, but must also include diverse interest-driven examples which can be engaged with, during the use of the UCD Sprint process.

B. Rating the UCD Sprint Activities

Across all dimensions assessed, students consistently rated the activities in the UCD Sprint process as stimulating, with scores ranging from 4.17 to 5.57 out of 7 in the thought-provoking section. Particular highlights are the overall high evaluation of steps involving direct user engagement. The steps that are specifically targeted toward user engagement are, for instance, interviews - scoring 5.08 and the Hi-Fi prototype testing, scoring over 5.27 out of 7. The Hi-Fi prototyping is deemed highly beneficial both within the context of the course and for future applications, receiving scores ranging from 5.23 to 6.11 out of 7. Notably, Lo-Fi prototyping garnered relatively lower scores for future usefulness (3.94) compared to its usefulness in the course (5.23), indicating a potential disparity in its perceived long-term value.

Steps that were oriented towards process-related activities and lacked direct user engagement, such as refining the map/selecting a target, UX Goals, and the design brief, received lower scores for perceived usefulness in the future (3.71 to 3.98 out of 7). These steps represent a section of the activity planning, as well as activities requiring reflection on the information gathered. This preference for activities involving direct user interaction, testing, and the tangible realisation of their ideas into a final product suggests a greater enjoyment and engagement with active steps over those centred around process and documentation, such as the design brief creation and sketching. Furthermore, this inclination towards active involvement aligns with active learning principles and problem-based teaching methodologies. The detailed results for each step are presented in Table II.

C. Perceived Comfort with UCD Activities

In order to assess the students' comfort levels with various dimensions representing UCD activities, we assessed them both before and after the course. These dimensions comprised critical aspects such as interviewing users, conducting user need analysis, engaging in prototyping activities (including Lo-Fi, such as sketching and paper prototyping), utilising higher-fidelity (Hi-Fi) prototyping tools like Figma, conducting user testing sessions, and evaluating designs with individuals beyond users, such as peers, colleagues, and experts.

The analysis of the data showcased an increase in perceived comfort levels across all dimensions post-course. Particularly significant improvements were observed in both Lo-Fi and Hi-Fi prototyping activities. The mean comfort scores before and after the course for each UCD activity are outlined in Table III, as well as the difference between the two scores, and a calculated two-tail P value for each individual skill. It is highlighted that there is a consistent upward trend in comfort levels across all dimensions.

Statistical analyses were performed to determine the significance of these observed changes. The results, presented in Table III, reveal statistically significant differences between the mean comfort scores before and after the course across all dimensions ($P < 0.05$). The calculated t-statistic values demonstrated substantial positive trends, indicating a pronounced increase in comfort levels post-course.

V. DISCUSSION

As noted by [7], academic exploration of translating design activities in educational contexts remains somewhat limited. This study contributes to filling the gap of integrating UCD in educational settings, providing valuable insights into both quantitative and qualitative outcomes associated with the UCD Sprint process.

The UCD Sprint process is generally well-received by students, particularly in activities involving direct user engagement, which scored notably high in terms of future usefulness. As observed in previous studies [28], [34], challenges remain in effectively teaching UCD activities in academic settings. While the students positively received the course structure and approach, there is room for improvement in some of the steps in the UCD Sprint process focused on process-related tasks. Future iterations of the UCD Sprint process could address this by providing additional support or hands-on exercises to reinforce these concepts, aligning with recommendations from [11] for ongoing improvements and interactive teaching methods in UCD education, and building on the findings from [28] on digital aid and other potential support materials and strategies.

The significant increase in students' perceived comfort levels with UCD activities post-course across all dimensions, combined with the high scores for activities with direct user involvement, such as interviews and user testing, shows an increased awareness and interest in a user-centric development that can potentially be transferred to future projects. By providing students with the necessary tools and techniques to conduct user interviews, analyse user needs, prototype designs, conduct user tests, and collaborate effectively with stakeholders, the UCD Sprint process can empower a more user-centred approach to software development that these future developers will work with later in their careers. The findings align with existing literature, which highlights the importance of hands-on exposure to UCD activities in enhancing awareness and capabilities among developers [4], [31]. The findings of the present study support the idea that students' comfort with the activities is enhanced when exposed to user-centric activities, which is reflected in their self-reported increases in comfort levels across all dimensions (see Table III). While the results in the present study address comfort, parallels can be drawn with [4], where hands-on exposure to design activities is shown to improve capabilities among developers, suggesting that undergraduate students might also benefit from direct exposure to UCD activities.

Echoing the reflections provided by practitioners in [54], the UCD Sprint can provide the needed exposure to a wide variety of UCD activities that will later allow students to make informed decisions regarding design approaches in real-life projects, similar to providing them with a toolkit to build on from. Our findings show that exposing students to processes like the UCD Sprint during their early undergraduate studies is feasible, being a potentially preferable alternative to training professionals who are already in the workforce.

The results indicate that incorporating UCD activities into undergraduate curricula could be a feasible and impactful approach to fostering user-centred development skills in future software development professionals. Given that training professionals in the workforce to adopt UCD practices often involves overcoming organizational resistance and logistical hurdles, as highlighted by [1], [10], and [54], introducing UCD skills at the university level offers a proactive alternative. The structured environment of an educational setting provides students with a low-stakes opportunity to learn UCD without the resource constraints typically present in professional settings.

By integrating UCD activities into undergraduate curricula through structured processes, universities not only prepare students for the demands of the job market but also cultivate a more user-centric base for future skills to be built upon. As such, we suggest integrating UCD activities into undergraduate curricula, as modern STEM programs can mould a more innovative and user-centric workforce of the future, ultimately enhancing software quality and UX in the broader technological landscape. Continued research and optimisation of instructional interventions such as the UCD Sprint process are essential for ensuring the continued success of UCD in preparing higher education students for future challenges they are to encounter when entering the work market.

VI. Limitations and Future Work

The primary limitation of this study lies in its reliance on self-reported comfort levels with UCD activities, which were not substantiated by direct assessments of students' practical UCD skills. The reliance on self-assessment data, though valuable for capturing personal reflections and experiences, does not offer a concrete measurement of skill advancement, which could have been observed through expert evaluation of students' project outputs or direct skill assessments. This limitation reduces our ability to determine whether perceived comfort aligns with actual skill acquisition or performance. Additionally, the study's focus on a single, structured educational intervention (through the UCD Sprint) without comparison to alternative teaching methods constrains the ability to generalise results across different educational environments or methodologies. There may be other effective approaches to embedding UCD principles in curricula, and comparative studies could provide a clearer picture of the relative impact of the UCD Sprint method.

To address these limitations, future research could adopt a more diverse methodology by including qualitative data collection such as in-depth interviews or focus groups with both students and instructors. This approach would allow a more nuanced exploration of the UCD Sprint's impact, capturing not only students' comfort but also the specific challenges and successes they encounter with UCD concepts. A longitudinal approach would be valuable to assess the sustained impact of UCD Sprint exposure on students' abilities and their application of UCD principles post-graduation. Tracking students into their professional careers would provide insights into how effectively they translate their training into real-world practices, thus evaluating the UCD Sprint's lasting educational value and applicability in professional settings.

VII. Conclusion

The findings of this study highlight the potential of integration of the UCD Sprint process into higher education curricula for CS and SE programmes in particular, demonstrating a notable increase in students' perceived comfort across multiple UCD dimensions, particularly in hands-on activities like prototyping and user involvement. This aligns with prior research underscoring the importance of experiential learning in UCD education and suggests that direct exposure to UCD activities promotes a deeper understanding and application of user-centred design principles.

Despite the observed positive outcomes, challenges remain, particularly in teaching certain process-related UCD activities. These areas could benefit from iterative improvements, such as the addition of targeted exercises and refined instructional resources, to reinforce the foundational UCD concepts. Integrating a wide range of UCD activities within the curriculum, through the UCD Sprint process, offers a proactive alternative to workplace training, potentially equipping graduates with a skillset that aligns more closely with industry needs.

In conclusion, embedding structured UCD processes like the UCD Sprint in undergraduate curricula can nurture a more user-centric mindset among future software developers. Through intentional curricular design and continued iterative refinement, universities can foster a culture of user-centric software development, ultimately leading to enhanced software quality and user experiences.

VIII. Acknowledgements

References

[1] International Organization for Standardization, "ISO 9241-210:2019," ISO, 2019. https://www.iso.org/standard/77520.html

[2] F. Tosi, "From User-Centred Design to Human-Centred Design and the User Experience," Springer Series in Design and Innovation, pp. 47–59, Nov. 2019, doi: https://doi.org/10.1007/978-3-030-33562-5_3.

[3] M. Nieminen, "User-Centered Design Competencies - Construction of a Competency Model," Aalto University, 2015. Available: http://urn.fi/URN:ISBN:978-952-60-6127-6

[4] T. Øvad, N. Bornoe, L. B. Larsen, and J. Stage, "Teaching Software Developers to Perform UX Tasks," Dec. 2015, doi: https://doi.org/10.1145/2838739.2838764.

[5] T. Øvad and L. B. Larsen, "Templates: A Key to Success When Training Developers to Perform UX Tasks," Human-computer interaction series, pp. 77–96, Jan. 2016, doi:https://doi.org/10.1007/978-3-319-32165-3_3.

[6] Y. Yesilada, G. Brajnik, M. Vigo, and S. Harper, "Exploring perceptions of web accessibility: a survey approach," Behaviour & Information Technology, vol. 34, no. 2, pp. 119–134, Dec. 2013, doi: https://doi.org/10.1080/0144929x.2013.848238.

[7] W. Roldan et al., "Opportunities and Challenges in Involving Users in Project-Based HCI Education," Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems, Apr. 2020, doi: https://doi.org/10.1145/3313831.3376530.

[8] A. Ganci and M. Lahey, "Uncovering the importance of soft skills in user interface design-related fields," Communication Design, vol. 5, no. 1–2, pp. 5–20, Jul. 2017, doi: https://doi.org/10.1080/20557132.2017.1398924.

[9] A. P. Nazaré de Freitas and R. Assoreira Almendra, "Teaching and Learning Soft Skills in Design Education, Opportunities and Challenges: A Literature Review," Springer Series in Design and Innovation, pp. 261–272, 2022, doi: https://doi.org/10.1007/978-3-030-86596-2_20.

[10] C. Ardito, P. Buono, D. Caivano, Maria Francesca Costabile, and R. Lanzilotti, "Investigating and promoting UX practice in industry: An experimental study," International Journal of Human-Computer Studies, vol. 72, no. 6, pp. 542–551, Jun. 2014, doi: https://doi.org/10.1016/j.ijhcs.2013.10.004.

[11] M. K. Larusdottir, R. Lanzilotti, A. Piccinno, I. Visescu, and M. F. Costabile, "UCD Sprint: A Fast Process to Involve Users in the Design Practices of Software Companies," International Journal of Human–Computer Interaction, Nov. 2023, doi: https://doi.org/10.1080/10447318.2023.2279816.

[12] J. Bak, K. A. Nguyen, P. Risgaard, and J. Stage, "Obstacles to usability evaluation in practice," Oct. 2008, doi: https://doi.org/10.1145/1463160.1463164.

[13] J. Gulliksen, I. Boivie, J. Persson, A. Hektor, and L. Herulf, "Making a difference," Proceedings of the third Nordic conference on Human-computer interaction - NordiCHI '04, 2004, doi: https://doi.org/10.1145/1028014.1028046.

[14] Y. Inal, T. Clemmensen, D. Rajanen, N. Iivari, K. Rızvanoğlu, and A. Sivaji, "Positive Developments but Challenges Still Ahead: A Survey Study on UX Professionals' Work Practices," Journal of User Experience, vol. 15, no. 4, 2020, Available: https://uxpajournal.org/ux-professionals-work-practices/

[15] N. Marsden and K. Holtzblatt, "How Do HCI Professionals Perceive Their Work Experience?," Apr. 2018, doi: https://doi.org/10.1145/3170427.3188501.

[16] T. Silva da Silva, M. Selbach Silveira, F. Maurer, and T. Hellmann, "User Experience Design and Agile Development: From Theory to Practice," Journal of Software Engineering and Applications, vol. 05, no. 10, pp. 743–751, 2012, doi: https://doi.org/10.4236/jsea.2012.510087.

[17] A. S. Islind and U. L. Snis, "From Co-Design to Co-Care: Designing a Collaborative Practice in Care.," Systems, Signs & Actions, vol. 11, no. 1, pp. 1–24, Aug. 2018.

[18] S. Lindsay, K. Brittain, D. Jackson, C. Ladha, K. Ladha, and P. Olivier, "Empathy, participatory design and people with dementia," Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems - CHI '12, 2012, doi: https://doi.org/10.1145/2207676.2207749.

[19] S. Lindsay, D. Jackson, G. Schofield, and P. Olivier, "Engaging older people using participatory design," Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems - CHI '12, 2012, doi: https://doi.org/10.1145/2207676.2208570.

[20] J. Lazar, A. Dudley-Sponaugle, and K.-D. Greenidge, "Improving web accessibility: a study of webmaster perceptions," Computers in Human Behavior, vol. 20, no. 2, pp. 269–288, Mar. 2004, doi: https://doi.org/10.1016/j.chb.2003.10.018.

[21] P. M. Bach, R. DeLine, and J. M. Carroll, "Designers wanted," Human Factors in Computing Systems, Apr. 2009, doi: https://doi.org/10.1145/1518701.1518852.

[22] E. B.-N. . Sanders and P. J. Stappers, "Co-creation and the new landscapes of design," CoDesign, vol. 4, no. 1, pp. 5–18, Mar. 2008, doi: https://doi.org/10.1080/15710880701875068.

[23] V. Roto, M. Larusdottir, A. Lucero, J. Stage, and I. Šmorgun, "Focus, Structure, Reflection! Integrating User-Centred Design and Design Sprint," Human-Computer Interaction – INTERACT 2021, pp. 239–258, 2021, doi: https://doi.org/10.1007/978-3-030-85616-8_15.

[24] M. K. Larusdottir, V. Roto, R. Lanzilotti, and I. Duta Visescu, "Tutorial on UCD Sprint: Inclusive Process for Concept Design," Adjunct Proceedings of the 2022 Nordic Human-Computer Interaction Conference, Oct. 2022, doi: https://doi.org/10.1145/3547522.3558901.

[25] M. Larusdottir, V. Roto, and Å. Cajander, "Introduction to User-Centred Design Sprint," Human-Computer Interaction – INTERACT 2021, pp. 253–256, 2021, doi: https://doi.org/10.1007/978-3-030-85607-6_17.

[26] M. Larusdottir, V. Roto, R. Lanzilotti, and I. Visescu, "The UCD Sprint: A Process for User-Centered Innovation," Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems, Apr. 2023, doi: https://doi.org/10.1145/3544549.3574176.

[27] M. Larusdottir, V. Roto, J. Stage, A. Lucero, and I. Šmorgun, "Balance Talking and Doing! Using Google Design Sprint to Enhance an Intensive UCD Course," Human-Computer Interaction – INTERACT 2019, pp. 95–113, 2019, doi: https://doi.org/10.1007/978-3-030-29384-0_6.

[28] I. Visescu, M. Larusdottir, and A. S. Islind, "Supporting active learning in STEM higher education through the UCD Sprint ," Proceedings of the IEEE Frontiers in Education Conference 2023, 2023, doi: https://doi.org/10.1109/FIE58773.2023.10342978

[29] L. M. Spencer and S. M. Spencer, Competence at work: models for superior performance. New York; Chichester: John Wiley, 1993.

[30] A. Bruun and J. Stage, "Barefoot usability evaluations," Behaviour & Information Technology, vol. 33, no. 11, pp. 1148–1167, Feb. 2014, doi: https://doi.org/10.1080/0144929x.2014.883552.

[31] E. Eriksson, Å. Cajander, and J. Gulliksen, "Hello World! – Experiencing Usability Methods without Usability Expertise," Lecture notes in computer science, pp. 550–565, Jan. 2009, doi: https://doi.org/10.1007/978-3-642-03658-3_60.

[32] N. Bornoe and J. Stage, "Usability Engineering in the Wild: How Do Practitioners Integrate Usability Engineering in Software Development?," Human-Centered Software Engineering, pp. 199–216, 2014, doi: https://doi.org/10.1007/978-3-662-44811-3_12.

[33] Å. Cajander, M. K. Larusdottir, and J. L. Geiser, "UX Professionals' Learning and Usage of UX Methods in Agile," Information and Software Technology, p. 107005, Jul. 2022, doi: https://doi.org/10.1016/j.infsof.2022.107005.

[34] G. Getto and F. Beecher, "Toward a Model of UX Education: Training UX Designers Within the Academy," IEEE Transactions on Professional Communication, vol. 59, no. 2, pp. 153–164, Jun. 2016, doi: https://doi.org/10.1109/tpc.2016.2561139.

[35] M. K. Larusdottir, "User Centred Evaluation in Experimental and Practical Settings," DIVA, 2012. https://www.diva-portal.org/smash/record.jsf?pid=diva2%3A527518&dswid=-9154 (accessed Mar. 01, 2023).

[36] E. Arce, A. Suárez-García, J. A. López-Vázquez, and M. I. Fernández-Ibáñez, "Design Sprint: enhancing STEAM and engineering education through agile prototyping and testing ideas," Thinking Skills and Creativity, p. 101039, Apr. 2022, doi: https://doi.org/10.1016/j.tsc.2022.101039.

[37] J. Knapp, J. Zeratsky, and B. Kowitz, Sprint. Simon and Schuster, 2016.

[38] V. Clarke and V. Braun, "Thematic Analysis," Encyclopedia of Critical Psychology, pp. 1947–1952, 2014, doi: https://doi.org/10.1007/978-1-4614-5583-7_311.

[39] A. S. Islind and S. M. J. Willermark, "Becoming a Designer: The value of sensitive design situations for teaching and learning ethical design and design theory," Scandinavian Journal of Information Systems, vol. 34, no. 1, 2022, Available: https://aisel.aisnet.org/sjis/vol34/iss1/1

[40] S. Kujala, "User involvement: A review of the benefits and challenges," Behaviour & Information Technology, vol. 22, no. 1, pp. 1–16, Jan. 2003, doi: https://doi.org/10.1080/01449290301782.

[41] S. Pontis and K. van der Waarde, "Looking for Alternatives: Challenging Assumptions in Design Education," She Ji: The Journal of Design, Economics, and Innovation, vol. 6, no. 2, pp. 228–253, 2020, doi: https://doi.org/10.1016/j.sheji.2020.05.005.

[42] D. Wood, J. S. Bruner, and G. Ross, "The Role of Tutoring in Problem Solving," Journal of Child Psychology and Psychiatry, vol. 17, no. 2, pp. 89–100, 1976.

[43] M. Bano and D. Zowghi, "A systematic review on the relationship between user involvement and system success," Information and Software Technology, vol. 58, pp. 148–169, Feb. 2015, doi: https://doi.org/10.1016/j.infsof.2014.06.011.

[44] A. Bruun, M. K. Larusdottir, L. Nielsen, P. A. Nielsen, and J. S. Persson, "The role of UX professionals in agile development," Proceedings of the

10th Nordic Conference on Human-Computer Interaction - NordiCHI '18, 2018, doi: https://doi.org/10.1145/3240167.3240213.
[45] B. Paton and K. Dorst, "Briefing and reframing: A situated practice," Design Studies, vol. 32, no. 6, pp. 573–587, Nov. 2011, doi: https://doi.org/10.1016/j.destud.2011.07.002.
[46] K. Dorst, "Frame Creation and Design in the Expanded Field," She Ji: The Journal of Design, Economics, and Innovation, vol. 1, no. 1, pp. 22–33, 2015, doi: https://doi.org/10.1016/j.sheji.2015.07.003.
[47] S. MacNeil, Z. Ding, A. Boone, A. B. Grubbs, and S. P. Dow, "Finding Place in a Design Space," Proceedings of the ACM on human-computer interaction, vol. 5, no. CSCW1, pp. 1–30, Apr. 2021, doi: https://doi.org/10.1145/3449246.
[48] D. C. Wynn and C. M. Eckert, "Perspectives on iteration in design and development," Research in Engineering Design, vol. 28, no. 2, pp. 153–184, Apr. 2016, doi: https://doi.org/10.1007/s00163-016-0226-3.
[49] V. Svihla and R. Reeve, "Facilitating Problem Framing in Project-Based Learning," Interdisciplinary Journal of Problem-Based Learning, vol. 10, no. 2, Oct. 2016, doi: https://doi.org/10.7771/1541-5015.1603.
[50] R. Blyth, N. Schadewitz, H. Sharp, M. Woodroffe, D. Rajah, and T. Ranganai, "A Frame Signature Matrix for Analysing and Comparing Interaction Design Behaviour," BCS Learning & Development, Jan. 2012, doi: https://doi.org/10.14236/ewic/hci2012.45.
[51] J. Kim and H. Ryu, "A Design Thinking Rationality Framework: Framing and Solving Design Problems in Early Concept Generation," Human–Computer Interaction, vol. 29, no. 5–6, pp. 516–553, Jun. 2014, doi: https://doi.org/10.1080/07370024.2014.896706.
[52] T. Kvan and S. Gao, "Problem Framing in Multiple Settings," International Journal of Architectural Computing, vol. 2, no. 4, pp. 443–460, Dec. 2004, doi: https://doi.org/10.1260/1478077042906186.
[53] C. J. Atman, R. S. Adams, M. E. Cardella, J. Turns, S. Mosborg, and J. Saleem, "Engineering Design Processes: A Comparison of Students and Expert Practitioners," Journal of Engineering Education, vol. 96, no. 4, pp. 359–379, Oct. 2007, doi: https://doi.org/10.1002/j.2168-9830.2007.tb00945.x.
[54] I. Visescu, M. Lárusdóttir, and W. Choi, "Exploration of UCD Practice Limitations," Interacting with Computers, Oct. 2024, doi: https://doi.org/10.1093/iwc/iwae046
[55] A. M. L. Turcios-Esquivel, E. G. Avilés-Rabanales and F. Hernández-Rodriguez, "Enhancing Empathy and Innovation in Engineering Education Through Design Thinking and Design of Experiments," 2024 IEEE Global Engineering Education Conference (EDUCON), Kos Island, Greece, 2024, pp. 1-5, doi: 10.1109/EDUCON60312.2024.10578618.
[56] A. Stepanova, A. Weaver, J. Lahey, G. Alexander, and T. Hammond, "Hiring CS Graduates: What We Learned from Employers," ACM Transactions on Computing Education, vol. 22, no. 1, pp. 1–20, Mar. 2022, doi: https://doi.org/10.1145/3474623.

Appendix F

Publication V: Experience-Driven Game Design: A Process for Game Design Focused on Affective Outcomes

Experience-Driven Game Design: A Process for Game Design Focused on Affective Outcomes

The gaming industry is evolving, shifting from entertainment to immersive, emotionally engaging experiences. Designing such experiences is challenging, requiring a balance of cognitive, emotional, and motivational elements. Many designers rely on intuition over player insights, leading to high failure rates, and existing methods provide tools but often overlook the integration of emotional and experiential aspects. This study introduces the Experience-Driven Game Design (EDGD) process, a novel framework combining the User-Centred Design Sprint and the Experience Dynamics and Artifacts Model to prioritize player feedback throughout the design process. Evaluated in an educational context, the EDGD process proved effective in hands-on activities, fostering engagement and actionable insights. However, challenges highlight areas for improvement. The findings demonstrate the potential of the EDGD process to offer actionable guidance for educational and industry contexts, and by refining its structure and adaptability, it can better support designers in creating engaging, experience-centred games.

CCS Concepts: • **Software and its engineering** → **Interactive games**; • **Human-centered computing** → **User models**; **User centered design**; • **Information systems** → *Multimedia information systems*; • **Applied computing** → *Computer games.*

Additional Key Words and Phrases: experience-centred design, user-centred design, game design, user experience, software design

ACM Reference Format:

. 2025. Experience-Driven Game Design: A Process for Game Design Focused on Affective Outcomes. In *Proceedings of ACM on Human Computer Interaction (HCI) (CHI PLAY '25).* ACM, New York, NY, USA, 30 pages. https://doi.org/XXXXXXX.XXXXXXX

1 Introduction

The gaming industry is one of the fastest-growing industries globally [36], everchanging and continuously evolving. Video games have evolved beyond entertainment means, becoming immersive digital experiences that engage players on deep emotional levels. However, designing and planning these digital experiences is a very complex and hard task as designers need to balance elements pertaining to the cognitive-affective, engagement, learning, and motivational foundations [48] to create a meaningful experience. Particularly, to attract and retain players, games require emotional and sensorial engagement from them [5, 44]. However, many designers primarily rely on their personal perspectives rather than player or market demands when creating games [59]. This contributes to high failure rates in the industry, and with this, the need for centring the players and their experiences has emerged [56]. User-centred Design is an approach that emphasises prioritising user needs, goals, and behaviours throughout the design of a product or system, to enhance the user experience (UX), aligning with the principles outlined in the ISO 9241-210 standard [20, 28]. Key UCD activities include understanding users, their tasks, and their context, and iteratively refining software designs based on user feedback gathered. The UCD approach can lead to user productivity, accessibility, and good overall experience while contributing to sustainable and appealing software [1, 6, 19]. For conducting UCD, many processes have been devised,

Author's Contact Information:

Manuscript submitted to ACM

out of which the UCD Sprint stands out for its applicability in educational settings, as a structured process containing a variety of UCD methods, which was employed in educational contexts with both students and practitioners [32, 62].

da Silva et al. [15] conducted research on the use of UX activities in game development, specifically examining Brazilian studios, gathering data for an exploratory study on studio practices from 41 studios distributed across five regions through interviews and questionnaires. The findings reveal that although many studios have limited familiarity with UX techniques, most have adopted practices such as competitive analysis, prototyping, playtesting, and benchmarking. These techniques have significant benefits, including enhancing game quality, reducing player frustration, and leveraging feedback for improvements. However, they encounter challenges such as financial constraints, time limitations, and difficulties in validating games. Out of the 41, 10 studios do not use UX techniques, often citing a lack of knowledge or time to explore them.

However, unlike other more traditional software solutions and applications, video games can allow themselves to prioritise player experience over other, more practical aspects, aiming to elicit strong, sometimes even negative emotions. Games introduce challenges, at times frustration, and even negative emotions such as fear. But many times, the designers act on limited or incorrect information about the players they are designing for [27]. While one might think that player-centred design is user-centred design translated to the game environment, that is not necessarily the case. In player-centred design, designers are encouraged to put themselves in the shoes of the player [2], and the player is mostly involved in the later part of the process only, being heavily relied on during playtesting [21, 46].

Introducing the UCD core principle of understanding users and their tasks in game design can lead to an optimised player and experience-centred approach, further aiding in refining game design processes by multiple testing rounds not only for prototypes but also for ideas and adjusting the design of the game based on player feedback, ensuring that the final game aligns with player experience expectations from the outset [12]. An experience-centred design process emphasises player experience and thus introduces the player feedback early in the design process, and not only through prototyping and playtesting, to create engaging and meaningful interactions in games [5]. Essentially, a successful experience-centred game design process would build on user-centred design and would militate an approach in which the needs, desires, and perspectives of players, but also feedback from them, serve as the driving force behind every design decision [30].

To tackle such complexities of designing games while keeping the focus on the player primary experiences during gameplay (i. e. the act of playing the game), several frameworks/models have been proposed in the literature. One model that stands out in this scenario is the Experience Dynamics and Artifacts Model, which explicitly considers all game foundations, especially the affective ones, summarising all the potential troublesome design components and their interaction in a simple to understand model [43]. However, while great for modeling game design complexity and listing all its underlying components, EDA lacks a more practical and step-by-step approach that allows designers to use it during game design while keeping the focus on player experience [43, 44]. Existing methods like the EDA and the UCD Sprint by themselves fall short in addressing the unique demands of game design. The EDA, for instance, provides a comprehensive framework for understanding game components but lacks practical, actionable steps for implementation; the UCD Sprint, on the other hand, offers a structured process but does not account for the emotional and experiential aspects central to games. An approach that integrates the UCD Sprint structure with the EDA experience-focused insights can better ensure that player feedback shapes games from the outset, creating more engaging and successful experiences.

In this paper, we propose a design process called the Experience-Driven Game Design process, as an all-encompassing game-design toolset, combining the methodological approach of UCD through the structured UCD Sprint process [32, 62] with the modelling capacity and specificity of the EDA model [43]. The objective of proposing the process is to highlight the importance of prioritising players and their experience in game design from the early stages of game design, especially focusing on their experience and affective outcomes.

As main contributions, we highlight the introduction of the EDGD process, a new design process that combines principles from UCD through the UCD Sprint, and experience-centred game design through the EDA to increase the focus on players and their experience in the design of games. Further, the paper presents the results from a study of integrating EDGD process within a university course, as a first step towards its validation. Undergraduate students in a Software Engineering major were tasked with designing games using the EDGD process. We explore their experiences engaging with the EDGD process, through a mixed-methods approach to evaluate the experiences of using it. This paper is guided by the following research questions:

- RQ_1 How can the UCD Sprint and the EDA be integrated to extend the focus on the player experience in the game design process?
- RQ_2 How is the resulting EDGD process experienced by participants with no game design knowledge?
- RQ_3 What specific areas can be improved within the EDGD process, based on the participant feedback?

2 Related Work

This section describes approaches and explores recent studies within UCD and game design which were foundational to creating the EDGD process.

2.1 Approaches for User-Centred Design

UCD is an approach that prioritises the needs, goals, and behaviours of users throughout the design process of a product or system [12]. This approach underscores the importance of involving users throughout the design process to ensure the final product caters to the users and their experiences. Grounded in ergonomic and usability principles, UCD is formalised by the ISO 9241-210 standard, a widely recognised standard, that offers a comprehensive framework emphasising principles and guidelines for designing interactive systems with user needs at the forefront [20]. According to the standard, key principles of UCD include an explicit understanding of users, their tasks, and their environments. The design process itself is generally perceived as iterative, refined through multiple evaluation cycles to progressively improve the final product.

UCD encompasses the entire user experience, considering usability, and emotional responses, and involves multidisciplinary teams to ensure a holistic approach to problem-solving [20]. Involving users offers numerous advantages, amongst which enhancing user productivity and operational efficiency by creating products tailored to users' specific tasks and needs, promoting broader accessibility, and creating inclusive designs that accommodate diverse user populations, improving usability and user experience [1, 7, 19, 29].

Although incorporating a wide range of UCD activities is found to be a valuable approach, UCD practitioners face significant challenges in their real-world application. Practitioners often resort to familiar methods and avoid new ones due to their complexity [10]. High costs, resource demands, lack of managerial support and misunderstandings about user involvement further exacerbate these issues [6, 10, 18, 25, 32, 38, 54]. Consequently, these challenges include a persistent gap between theory and practice, difficulties in collaborating with developers, and constraints in conducting timely user research and usability studies [63].

2.1.1 The UCD Sprint Process. Attempting to combat some of these challenges, the UCD Sprint was introduced, as a process refined through academic studies and professional experiences, emphasising user involvement from the early design stages [51]. The UCD Sprint presents a structured, step-by-step approach, where the design process is condensed into a series of suggested UCD activities, guided through the process structure. The UCD Sprint contains 18 steps, divided into 3 phases: Discovery, Design, and Reality Check as presented in 1.

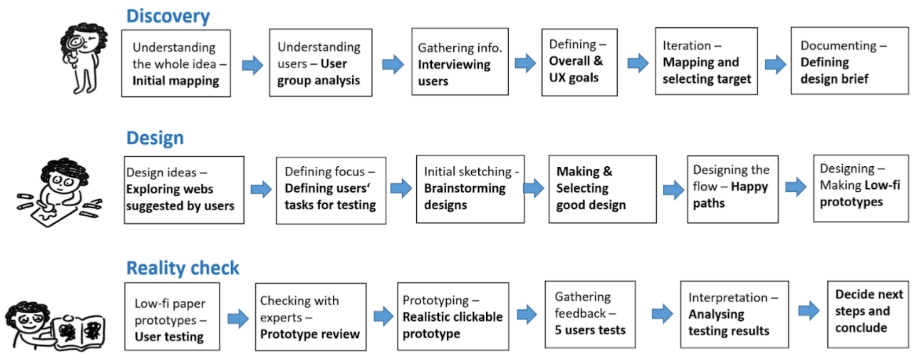

Fig. 1. Structure of the UCGD Sprint.

This structured format offers a clear roadmap for UCD practitioners for conducting UCD, making it particularly appealing to early practitioners or students who may benefit from a guided approach. This process facilitates effective collaboration, informed decision-making, and iterative design refinement, ultimately enhancing user experiences and project outcomes [32, 51, 62].

In Larusdottir et al. [32], UCD practitioners facing time and cost constraints found the UCD Sprint to be a time and cost-effective appproach, streamlining their design processes and fostering efficient collaboration. The structured process of the UCD Sprint enabled them to focus on UCD activities and facilitate thorough user-centred design within manageable timeframes. As a result, UCD practitioners expressed interest in integrating more UCD activities into their design processes, recognising the value of prioritising user needs and feedback. In academic environments, Roto et al. [51] found that the structured UCD Sprint process enhanced student learning through practical application and positive feedback. Visescu et al. [62] highlighted the importance of active learning and iterative improvement in integrating the UCD Sprint in education, emphasising the role of digital tools and student feedback in optimising the process. The UCD Sprint process can be beneficial, especially for novice practitioners and learners, as it streamlines the design process and ensures a focused approach with step-by-step instruction. It thus introduces UCD through a scaffolded approach [65], leveraging decomposition [55] to address the novice struggle of framing and reframing problems [13] through structure and assisted learning.

The integration of UCD principles into game design has gained significant attention, particularly in the context of enhancing player experiences. UCD, which emphasises iterative design based on the needs and behaviours of users, shares many parallels with player-centred design in the gaming industry. Both approaches advocate for early and continuous involvement of the end user, whether a player or a product user, throughout the design process.

2.2 Game Design Approaches

Game design has been defined as: "the act of deciding what a game should be" [52], encompassing decisions related to all building blocks of a game. Due to this general definition, several authors have attempted to compile all decisions and building blocks into an abstract model or a methodology. One of the most accepted models proposed in the literature is the MDA model [24], consisting of: (1) (M)echanics, or the actions, behaviours and control mechanisms afforded to the player during gaming, (2) (D)ynamics which describe the emergent behaviour of the player interacting with the game's mechanics, and the interactions between mechanics themselves, and finally (3) (A)esthetics, which are the desired emotional response to be evoked in the player. The MDA model formalises these components counterparts from a designer perspective. Further the game experience is defined by three components: (1) Fun, (2) System, and (3) Rules.

Although the MDA has been widely accepted in both industry and academia, it has also been extensively criticised due to its ambiguity in defining the game components [64]. For example, the Aesthetic component is entirely made by the player experience, but the user interface, art style, and other experience-related components are deferred to Mechanics. Due to these issues, several other conceptualisations of game design were proposed (e. g. Schell's Elemental Tetrad [52], the Design, Dynamics, and Experience model [64]). However, these models still fail to grasp all the complexities involved in playing (and designing) a game, especially those that fall outside the commercial environment, such as serious or educational games. Furthermore, these approaches oversimplify the player experience into a simple unified construct rather than a composition of sociocultural, cognitive-affective, motivational, engagement, and learning foundations [48]. Besides, most existing general frameworks, including the MDA, grant designers so much freedom that they can focus on their own preferences to the detriment of the player's own experience [5]. If game designers want to avoid alienating players, they could opt for not only testing their own vision with real players, which is a practice commonly known as playtesting but also actively seek player feedback from the very first idea of the game, effectively including a player-centred perspective into the design.

2.2.1 The Experience Dynamics and Artifacts Model. The Experience Dynamics and Artifacts Model (EDA) was proposed to address the issues with games design approaches [43]. It unifies the main elements described in commercial-oriented models, such as the MDA, with the latest theoretical findings about player experience and their foundations, while also addressing important elements related to educational and serious games [44]. In line with known acronyms such as the MDA, the EDA stands for three main components that guide the game design process, which are:(1) (E)xperience, (2) (D)ynamics and (3) (A)rtifacts. The acronym itself represents the order in which a designer should think about a game, that is the designer should start with the player experience, highlighting the experience-centred nature of the process. Then the designer should focus on the dynamics and the artifacts in the game. A simple illustration of how these three components interact is shown in Figure 2: Experience stimulate interactions with Artifacts, which in turn respond and restructure their behaviour into new Dynamics, providing new feedback that creates another Experience; this constant cycle of interaction, behavioural change and feedback is called the game loop.

The Experience component describes all impressions obtained by the player during and after interacting with the game. To better structure such impressions and their storage mechanisms from a psychological perspective, the Experience component is divided into three subcomponents: (1) Perception, which is defined as the sum all impressions left after playing the game; (2) Persona, which models the player's personality traits, behavioural tendencies, prior beliefs, knowledge and metacognitive skill when playing the game, and (3) Appraisal, which represents all possible interpretations and subjective results from the Persona-game interactions, following the psychological appraisal construct as defined by Scherer [53]. When playing a game, the Persona iteratively decide how their interaction in the

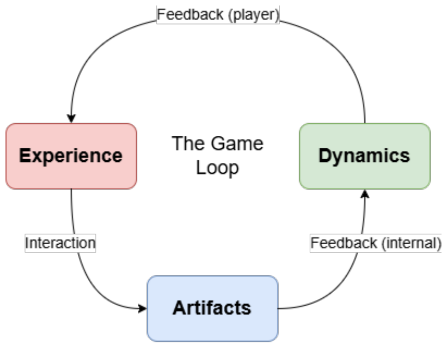

Fig. 2. Simplified view of the EDA model, adapted from [43]. Experience fosters a new interaction with the game's Artifacts, which in turn causes internal responses that yield a new Dynamics, which are then relayed back to a new Experience through player feedback.

game is stored as a Perception. It is important to notice that the Persona do not represent the player in its entirety, but it is rather a construct that represents the player during gameplay (i. e. the Persona is the one that interacts with the game). Additionally, given the highly abstract nature of Appraisal, its encompassing subjective evaluations can be subdivided in 1) interpreted narrative, or the player's mental representation of the game narrative; 2) player engagement, consisting of cognition, behaviour, and sociocultural elements [48]; and 3) affect, the emotional reactions and outcomes arising from interacting with the game. Even though the affect can be considered as a part of engagement [23, 48], it was isolated and highlighted in EDA due to its importance for both learning and entertainment. A summarized view of EDA's Experience component is shown in Figure 3.

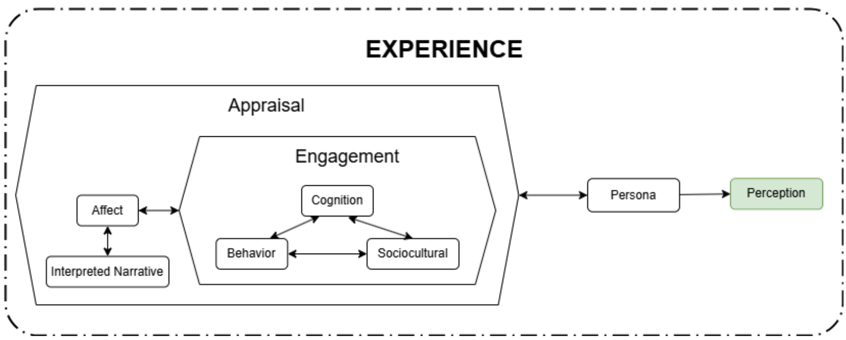

Fig. 3. Detailed view of the Experience component, as shown in [43].

The Dynamics component in the EDA includes all emergent behaviour that occurs during player-Artifact interactions, through gameplay. For its ever-changing nature, it is further divided into three subcomponents: Challenge, Pacing and Emergent narrative (the narrative that comes from playing the game, considering the order of the player's actions). Pacing is a common game design tool inspired by music, and in this context defined as: "the general order and rhythm of activities and events" in a game [66]. In the context of learning, pacing is often described as scaffolding, a term used to describe when an expert tutors someone who is less competent in solving a problem/executing a particular task [48]. A summarized view of EDA's Dynamics component is shown in Figure 4.

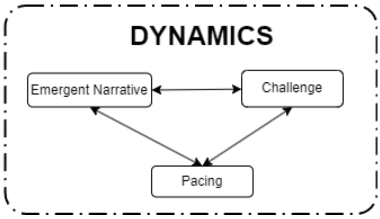

Fig. 4. Detailed view of the Dynamics component, adapted from [43].

The Artifacts component of the EDA includes any artificial objects and systems used to structure the Experience and Dynamics components [43]. They can be structurally organised into four subcomponents: (1) medium, referring to the technological structures used to design the game (digital vs analogue, game engine, use of controls, etc); (2) embedded narrative, which refers to the stories and themes told by the designer through the use of game and narrative mechanics; (3) mechanics, comprised of the game building blocks and fundamental elements, such as rules, procedures and randomness. Due to the vast amount of structures that comprise this last subcomponent, it can be further divided into: (1) game mechanics, which are elements used by designers to create and manipulate challenges; (2) narrative mechanics, or elements used by the designer to advance the story and plot throughout the game, for example, by utilising a narrator or a character background to advance the story; (3) Learning mechanics, or elements used by the designer to teach the player how to do/achieve something in the game (e. g. tutorials) and (4) Aesthetics, or the elements that are utilised to design the look and feel of the game. Figure 5 shows all the subcomponents of EDA's Artifacts component and their interactions.

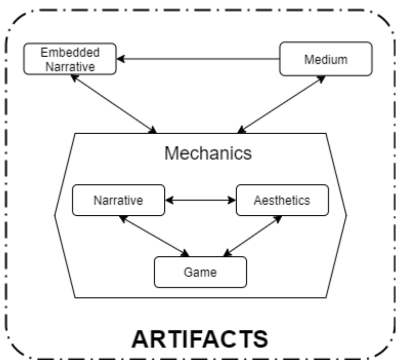

Fig. 5. Detailed view of the Artifacts component, as shown in [43].

3 The Experience-Driven Game Design process (EDGD process)

In this paper, we propose the EDGD process, which combines the UCD Sprint with EDA to simultaneously highlight their strengths and alleviating their shortcomings. The process is divided into three phases: Discovery, Design, and Reality Check, adapting UCD Sprint activities for game design, such as transforming "User Group Analysis" into "Player Group Analysis" and integrating methods like playtesting and low-fidelity prototyping. Central to the process is the Game Design Document (GDD), derived from EDA, which serves as a comprehensive guide throughout the design process, documenting all aspects of the game's Artifacts, Dynamics, and Experience.

The EDGD process process aims to provide clear guidance for both novice and experienced designers, ensuring an experience-focused approach while maintaining the structured workflow of the UCD Sprint and incorporating game design-specific methods.

The resulting EDGD process process has 14 steps, divided in 3 phases, each with distinct activities. The Discovery Phase includes Player Group Analysis, Game Design Document (GDD) creation, Interviews, and Exploring Games to understand player preferences. The Design Phase involves Planning Testing, Brainstorming Solutions, Selecting Designs, Creating Happy Paths, Low-Fi Prototyping and Playtesting. Finally, the Reality Check Phase refines the game through Hi-Fi Prototyping, Expert Evaluation, Playtesting, and Analysing Testing Results, ensuring iterative improvements based on feedback, as can be seen in Figure 6.

4 Methodology

In order to validate to what extent the EDGD process helps designers focus on players and their experience when creating games, we applied it in a classroom environment where participants in the course had to use the EDGD process to design a game. Over the duration of the course, data about the usefulness of the EDGD process, how it was perceived by participants, and feedback for improving the process were collected through a mixed-methods approach, combining quantitative and qualitative measurements. The participants were encouraged to provide formal and informal feedback throughout the learning process.

The course selected for this study was a project management undergraduate course for software engineering students in their third year (of a four-year program), due to the nature of the project proposed fitting perfectly into both the course purpose and the motivation required to adhere to the EDGD process. Furthermore, students had experience in software development in general and were enrolled to learn both traditional and agile project management methodologies, thus already presenting enough technical knowledge to develop a game, albeit lacking the proper game design background and tools.

Demographic-wise, a survey at the beginning of the course answered by 56 course participants showed 75% of them identified as male and 25% as female; 53.6% were between 18 and 20 years old, 35.7% were between 21 and 25, and 10.7% were over 26 years old; 71.4% of them had or were working as technology professionals; and finally, 26.8% had or were working in product and solution design activities.

Among the 60 hours of evening classroom between March 4, 2023, and July 11, 2023, participants were taught the subjects of game design and how to use the EDGD process from April 4, 2023, to June 6, 2023. In this section within the course structure, the primary focus of this paper, emphasises player and experience-centred game design through the usage of the EDGD process. As part of this section of the course, students were divided into groups of 4, and undertook an independent project, which was to develop a game utilising the proposed process. The students had six deadlines

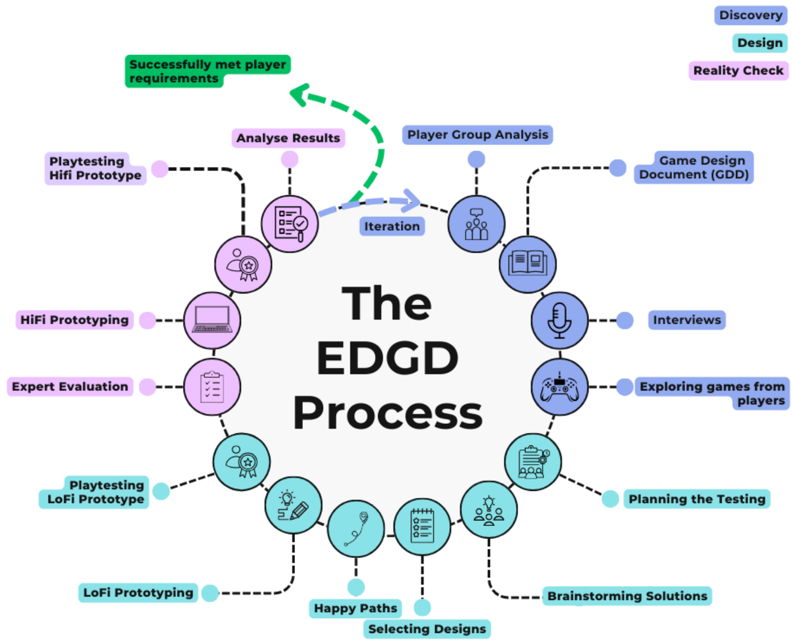

Fig. 6. Summarized view of all steps and phases of the proposed Experience-Driven Game Design process.

while using the EDGD process, the first after the Discovery Phase, the second after the Design Phase, the third after the first part of the Reality Check phase and the fourth after the Reality Check phase was concluded. At the end of the UCD process, participants were encouraged to iterate any of the steps they considered necessary, according to their project and progress, and received the fifth deadline to report iterations after using the UCD process. The sixth deadline was to deliver the final game. This was an attempt to consolidate their knowledge and optimise the results from using the UCD process. The deadlines are presented in Figure 7.

4.1 Data Gathering

In line with results that indicate that there are significant differences between experiencing a particular event and reliving it [58], this work evaluated the EDGD process quantitatively in two ways: (1) the experiential evaluation, translated to ad-hoc evaluations conducted while the participants were using the EDGD process, and (2) the remembrance evaluation, which evaluates the EDGD process as a whole after the participants went through it in its entirety (i. e. remembering what happened rather than actually experiencing it).

This distinct way of evaluating participant experience is particularly useful for assessing how useful the EDGD process is for facilitating game design, since a good process in that regard would keep designers engaged and motivated while using it (i. e. positive experiential evaluation), and would also leave a lasting positive experience so that the

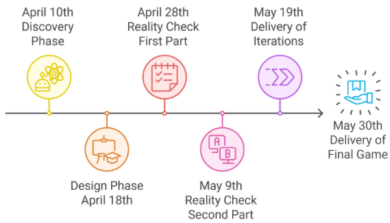

Fig. 7. Deadlines and timeline of the experiment conducted with the proposed Experience-Driven Game Design process.

designer is encouraged to use EDGD process again in future endeavours. Figure 8 shows a breakdown of data collection with dates, types, and participants. In the following subsections, we present details on each of the steps presented in this figure.

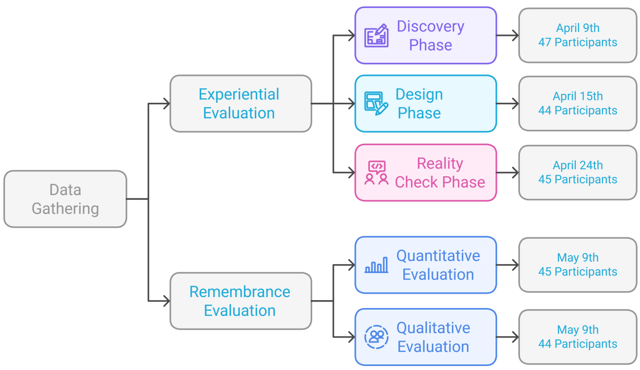

Fig. 8. Data gathering strategy and participation in this study.

4.1.1 The experiential evaluation. The data gathering for the experiential evaluation was conducted after each of the three phases, with participant numbers as follows: 47 for Discovery, 44 for Design, and 45 for Reality Check.

Quantitative evaluation. For assessing the experiential evaluation, participants were asked to fill in the standardised shortened version of Usability Metric for User Experience LITE version (UMUX-LITE), designed to get a measurement of usability (efficiency, effectiveness, satisfaction) using two simple statements [34]. The statements in this case are: (1) "The (method/phase/tool) was easy to understand"; and (2) "The (method/phase/tool) fulfilled my requirements/expectations". This assessment was prompted to participants after each main phase of the EDGD process (i. e. Discovery, Design, Reality Check), and sought to evaluate each individual step within the respective phase (e. g. during the Discovery phase, participants had to evaluate usability of the Player Group Analysis steps) and any templates/scaffolding tools provided within that step (e. g. evaluating the Player Sheet template and Discovery Canvas templates in the Discovery

Phase). Given that this assessment was coupled with the qualitative evaluations conducted after each step, and according to recent evidence that show no significant statistical impact between utilising 5 or 7 point Likert scale for the UMUX-LITE [33], in order to avoid low response rates from participants (i. e. survey fatigue), the UMUX-LITE assessment in this work was conducted as a 5-point Likert scale.

Qualitative evaluation. As for qualitative evaluation, five qualitative questions were asked at each individual phase of the EDGD process: (1) what was good/useful in that phase; (2) what they wanted to highlight (positively or negatively); (3) what could be improved in that phase, and in the activities and documents included in it; (4) what was most useful in that phase to the design of their game, and what do you learn from that that would help in your future; (5) Which item, activity, or method they would they like to see in more detail in that phase? (6) whether or not participants had any other feedback about that phase. Although some of these questions seem redundant, they were designed to look for inconsistencies in the participant's feedback (e.g. contradictory assessments in some of these questions). Additionally, they allow participants to answer more freely and give further feedback on each phase without having to attain to polarizing questions.

4.2 The remembrance evaluation

The data gathering for the remembrance evaluation was conducted once participants have gone through all of the activities of the EDGD process. The quantitative evaluation garnered responses from 45 participants, while the qualitative evaluation garnered responses from 44 participants.

Quantitative evaluation. To assess the remembrance evaluation, after participants had gone through the entire EDGD process, they were asked to rate the its steps and phases using a 7-point Likert-scale, through answering the following questions: (1) "Was it thought-provoking?" (2) "Was it useful for game design?" (3) "Do you think you will use it in your future job/education?". This evaluation method (and its 1 to 7 scale) was selected based on other studies that have previously utilised the UCD Sprint, foundational to the newly proposed EDGD process [32, 51, 62]. This allows for comparison grounds between previous publications and the current study.

Qualitative evaluation. For the qualitative part of remembrance evaluation, the following questions were given to participants: (1) "What was good about EDGD process?"; (2) "What was not good/could be improved about EDGD process?" (3) "What would they like to highlight about EDGD process (either positively or negatively)". Similarly to the experiential evaluation, these questions were designed to grasp strengths and weaknesses of the overall EDGD process, and at the same time provide participants the opportunity to give feedback in a non-polarizing way.

4.3 Data Analysis

4.3.1 Quantitative Data Analysis. The data collected from the quantitative evaluations were analysed by the first two authors, to determine the perceived value of each step across the specified dimensions. Descriptive statistics, including mean scores, were calculated for each method to provide insights into participant perceptions. To gain further insights into the ratings, statistical analyses were conducted to examine the differences between the methods across the three dimensions: thought-provoking, usefulness for game design, and likeliness to use the step in their future job/education. Additionally, comparative analyses were conducted to identify any significant differences in the ratings across the various methods, and across different course context. This analysis aimed to identify which methods were most perceived as most useful by students and how they contributed to their learning and future application in the field of game design.

4.3.2 Qualitative Data Analysis. The analysis of qualitative data in the present study was conducted using grounded theory, employing in vivo coding techniques to capture participants' authentic expressions and insights. For remembrance qualitative evaluation (i. e. after intervention), authors incorporated several preexisting themes identified from prior assessments of the UCD Sprint process in both educational and professional contexts [31, 32, 51, 62], allowing a comparison between this work and others presented in the literature. The following themes were adopted and adapted from previous publications: UCD Sprint structure, Staff quality, Course structure, UCD Sprint content, UCD Sprint experience, Learning support, Teaching Methods, Learning Resources, Course administration, and Assessment. This dual approach of using some preexisting themes and creating new ones through in-vivo coding allowed for a more nuanced understanding of the data, integrating fresh perspectives with established frameworks to comprehensively analyse the effectiveness and adaptability of the new game design methodology. As for the experiential evaluation, given the amount of qualitative information gathered for each phase, and to facilitate the evaluation/avoid any type of author's biases, the qualitative responses were analysed and grouped by a Large Language Model (Gemini1), through the usage of Computational Grounded Theory [45]. Categories suggested by the model were then manually analysed and cross checked by the authors.

5 Results

5.1 Experiential Evaluation

5.1.1 Perceived Usefulness of the EDGD process (Quantitative). Following UMUX-LITE's easy of use and usefulness dimensions, different stages within EDGD process's phases (i. e. Discovery, Design, and Reality Check) were evaluated based on their usefulness in game design and ease of understanding. The stages in the Discovery phase, like making the GDD and interviewing players generally met participant needs well, scoring around 4.1 to 4.4 out of 5 for usefulness, with "Interviewing Potential Players" standing out with a 4.5 score out of 5 for ease of understanding. The Design phase stages, such as "Selecting Good Design" and "Exploring games from players" received similarly high scores, particularly for their practicality, scoring 4.3 to 4.5 out of 5. The Reality Check phase, involving prototype testing and expert evaluation, scored similarly high, with "Expert Evaluation" being the most beneficial and easy to follow, receiving scores of 4.5 and 4.6 out of 5, respectively. We further focused on specific activities within the EDGD process, evaluating how well they met participants' needs, as well as their clarity. Most activities, like "Defining the Game Experience" and "Defining the Game Learning," scored highly in both criteria, with 4.4 for usefulness and 4.1 to 4.3 out of 5 for ease. "Defining the Game Narrative" and "Defining the Technologies Used to Make the Game" were particularly well-received, with a balanced score of 4.4 in both aspects. However, activities such as "Defining the game's core loop and its dynamics with players" showed a slight dip in clarity, scoring at 3.8 out of 5, pointing towards potentially useful, but also more challenging to understand and execute. Finally, we evaluated various documents used throughout the EDGD process phases in terms of their utility and ease of use during game design. In the Discovery phase, the "List of Experiences" document was rated the highest with 4.6 in both usefulness and clarity. On the opposite end of the spectrum, the "GDD/Discovery Canvas" was found less useful and harder to follow, with the lowest scores, 3.9 and 3.1 out of 5. In the Design phase, documents such as the "Game Review Template" and "Experiment/Testing Session

Planning Template” were highly valued, with scores around 4.3 to 4.5 out of 5, indicating their significant role in aiding the design process. The Reality Check phase documents, such as the ”Expert Evaluation Template” and ”Playtesting Spreadsheet” were also positively received, with scores showing both usefulness and clarity ranging from 4.2 to 4.4 out of 5.

5.1.2 Impressions of the EDGD process during its use (Qualitative). For the experiential qualitative evaluation, a total of 534 comments were categorised and grouped by the Large Language Model, evaluating categories according to each question and phase, and then manually revised by the authors. Summarised information for the feedback received for each phase is described in the next sections.

Discovery Phase. The main category identified in the comments was related to the creation of the GDD/Discovery Canvas and the Player Sheet, which results from the Player Group Analysis, with both mentions to them in 38 comments. Participants overall found the Discovery Canvas "confusing", "not intuitive, with the need for an extensive training/explanation of each section before its use", and it "left us questioning whether or not [the Discovery Canvas/Player Sheet] would really help us designing the game". This is echoed in 18 out of 38 comments. In fact, several suggestions were made to improve the Discovery Canvas: 11 comments mentioned that "a more linear presentation [of the Canvas], and a description of each section would be more helpful" and that "Canvas was somewhat disorganised since we had difficulties locating where should we put each specific information". However, 10 comments stated that "[Discovery Canvas/Player sheet were very useful and helped us guide our game". In terms of specific components of the Canvas, 8 comments suggested that the element of the "Core loop", an integral part of the Discovery Canvas and a crucial element of EDA, should also be discussed in more depth. Two other comments also mentioned the need to better understand "mechanics, and core loop".

Another emerging category is related to the importance of understanding the player: 5 comments positively mentioned the experience list provided in the Player Group Analysis step, and how it was "very beneficial to select a desired [game/player] experience as the first step [of the EDGD process]". Seven other comments mentioned positively the concept of "understanding the player as a user, and where/how this person was going to play the game". Finally, 4 others mentioned user interviews as "very important to understand what the player wants in a game in order to have fun", 9 others would like to see "how to conduct the interviews" in more detail and "have a fixed number of questions" or "a script" to conduct the interviews by. Additionally, 7 comments mentioned the abstract and complex nature of Discovery, stating that they "had many doubts executing the phase, and had to rely on the group’s help for clarity", and that the "process is too abstract, without much guidance".

Design Phase. In the Design phase, most comments were concerning the process of idea generation and exploration: 22 comments highlighted the Brainstorming, and the "Crazy 8" exercise, specially the fact that the "group could explore a diverse set of solutions", "provides a starting point [for developing the game]", and it helped "define the game mechanics" and to "show what each group member thought about the game".

Other major category is related to the process of Low-Fi prototyping: 11 comments mentioned this step as "very useful to understand if the proposed experience [from Discovery] is actually coming through the game". Furthermore, 5 comments mentioned the playtesting as an important aspect of the Design Phase, and another 4 comments would like to see this in more depth.

Another category emerging from the comments is related to the Exploring Games from Players step: 7 comments mentioned this step positively, stating that "it was very useful to decide the mechanics [of their game]". Additionally,

Activity	Thought-Provoking	Useful for Game Design	Useful in further Job/Education
GDD	5.8	5.7	4.2
Player Groups	5.3	5.4	4.5
Interviews	6.2	6.3	5.6
GDD Iteration	4.7	4.9	4.0
Exploring Games from Players	5.4	5.3	4.8
Overall Discovery Phase	5.9	5.9	5.0
Planning the Testing	4.9	5.1	4.7
Brainstorming Solutions	5.9	6.0	5.8
Selecting Designs	5.8	6.0	5.4
Happy Paths	5.3	5.4	4.7
Lo-fi Prototype	5.3	5.2	4.0
Playtesting Lo-fi Prototype	5.0	5.2	4.5
Overall Design Phase	5.6	5.8	5.0
Expert Evaluation	5.9	6.1	5.9
Hi-fi Prototype	5.9	6.3	5.8
Playtesting Hi-fi Prototype	5.8	6.1	5.6
Analyse Results	5.7	6.2	5.9
Overall Reality Check	5.6	5.9	5.3
Overall EDGD process	5.6	6.0	5.0

Table 1. Average Ratings of Game Design Methods in EDGD process.

another emerging category is the concreteness of starting to develop the games, which is positively mentioned in 4 comments.

Reality Check Phase. For the last phase, one emerging category was related to the Expert Evaluation step: 15 comments positively highlighted its usefulness and importance, as "it was great for having ideas/insights for our game" and was "extremely relevant for aligning the development of the digital prototype". However, one comment suggested that "albeit useful, it did not bring in any new insights when compared to the playtesting sessions", and that it "should be more focused on project details, like if the prototype is actually testing out the core loop or not".

Another category relates to the Playtesting steps: 34 comments positively mentioned the playtesting as something that "helped [the group] in changing the game", and "improve some points that [the group] had planned for the game". However, some participants were still over reliant on the Low-Fi prototype during this phase, with 4 comments highlighting that "some game mechanics could not be replicated" during playtesting phases. Similarly, prototyping was also mentioned positively in 29 comments, with one highlighting that "the transition from static [low-fi] to MVP [Hifi]" was interesting.

5.2 Remembrance Evaluation

5.2.1 Perceived Usefulness of the EDGD process (Quantitative). Participants rated the usefulness of various activities in terms of being thought-provoking, useful for game design, and useful in their future jobs or education. The average scores for each activity across these dimensions are presented in Table 1.

Category	Description
Assessment	How student performance is evaluated throughout the course (exams, assignments)
Course Administration	Logistical aspects of the course, such as communication with instructors, scheduling, and so on.
Course Structure	Organization and flow of the course content, like sequencing of lessons.
Documentation	Resources provided to students, such as guides and supplementary documents.
Hard Skills	Technical skills that students are expected to acquire, such as programming, data analysis, or domain-specific expertise.
Iteration	Iterative process of applying EDGD process multiple times during the course
Learning Support	Support provided by instructors during the course
EDGD process Method	Steps and activities carried out within the EDGD process, such as structured workflows and tasks.
Relevance	How relevant aspects of the EDGD process were to the game design
EDGD process Content	EDGD process in general (no focus on its structure or steps)
EDGD process Experience	Overall experience of participating in the EDGD process.
EDGD process Structure	Organization and execution of the EDGD process, including its structural division and suggested steps.
Teaching Methods	Pedagogical approaches applied during the EDGD process class

Table 2. Qualitative categories used in remembrance evaluation of EDGD process

The activities with the highest scores for thought-provoking were 'Interviews' and 'User testing hi-fi prototype'. These activities also scored highly for their usefulness in game design and for their usefulness in other work or educational settings. Similarly, 'Brainstorming Solutions' and 'Lo-fi Prototype Playtesting' were highly rated across all dimensions, indicating their perceived usefulness to foster creativity and practical skills. Students found methods involving players directly, such as "Interviews" and "User Testing" of both low-fi and hi-fi prototypes, to be particularly useful. On the lower end, activities such as "Happy Paths", "Game Design Document", and its iteration received lower scores, particularly considering how useful it would be for future use in job or educational settings. Process-related methods like the "Happy Paths" were rated on the lower end of the scale, though they still maintained relatively high average scores.

The lowest individual score is 4.0 for the 'useful in future jobs or education' of Low-Fi prototyping, and the highest is 6.3 for the 'useful for game design' for interviews and HiFi prototyping. The highest average rating for thought-provoking activities was for "Interviews". The methods perceived as most useful for future work or educational settings were the 'Expert Evaluation' and 'Analyze Results', closely followed by 'HiFi prototyping' and 'Brainstorming Solutions'. Overall methods were were well-received, especially those involving user interaction and prototyping.

5.2.2 Feedback on the EDGD process (Qualitative). The qualitative analysis conducted after the experiment was coded by two researchers independently, considering existing categories from previous UCD Sprint works, but also enabling the emergence of new categories inspired by the data analysis. Researchers got 68 qualitative notes about EDGD process, which were then broke down to 167 statements, and after 3 rounds of coding and reviews, were aggregated into 12 categories, as shown in Table 2.

In terms of overall qualitative experience, comments roughly address two main types of feedback received from participants: one related to the overall implementation and introduction of the EDGD process within the context of the undergraduate course (i. e. Pedagogical feedback) and another related to the technical aspects of the EDGD process

A majority of comments suggested that time constraints were a big issue when effectively applying the EDGD process within the course (22 out of the 26 comments). Specifically, they stated that "short development time", and "high number of deliverables" were major pain points. Assessment-related improvements highlighted that "there was no clear direction on what was expected during the game development". However, in terms of Learning support, comments were mostly positive, with participants highlighting the "help and support from teachers".

As for technical aspects of the EDGD process, it received the highest number of comments overall (most of them positive). Seven comments highlighted the playtesting as "very important", with "constant testing with participation and player feedback". Low-Fi prototyping was also highlighted positively in 10 comments, stating that the paper prototyping was "one of the parts that [they] liked the most", that it "gave a good insight into what the game would be", allowing them to "include the opinion of the players into the game". Low-Fi prototyping also received some improvement suggestions: 2 comments stated that "this step should not be mandatory within the sprint". Discovery Canvas was also mentioned in 6 comments highlighting that "the GDD was very important to keep all project members with the same vision", that it "unifies the project members ideas in a fast way", and "it organized the creative aspects of game design". However, the canvas structure caused some confusion among participants, which suggested that "the templates for both Discovery Canvas and Player sheet were confusing, generating the need to constantly consult with teachers in order to clarify how to fulfil it", and that "disposition of canvas was confusing", suggesting that "in the future you should verticalize/order the topics within the template". High-Fi prototyping also received praise from participants, with two positive comments, stating that "the [Hi-Fi] digital prototyping was essential to learn more about which tools the team would use in the actual development of the game". Player Group Analysis was also highlighted positively in three comments, stating that "interviews helped design a foundation for the game".

Regarding the EDGD process Structure, 13 comments positively highlighted that the process "avoids rework" and "facilitate the act of designing the game". Two other comments highlighted the focused nature of the EDGD process, particularly stating that it "is very useful even for someone who did not have any experience designing games and gives [the designer] several paths to help filter the objectives of the game". Four comments suggested improvements in the flexibility of the EDGD process as a whole, stating that "initial phases of the process were open to creativity, but not the other phases". Three other comments suggested that the process is "too complex", which also "causes delays" in the development of the game, and it "is too focused on the design/ideation of the game, neglecting the actual process of development/following up the progress of the actual game [as a product]".

As for overall EDGD process Experience, all 12 comments highlighted positively the "use of the methodology itself", "the experience of developing a game and getting outside the box". The EDGD process Content category follows the same trend, with 12 comments stating that "EDGD process explores idea generation and helps in generating/identifying good ideas", with "constant feedback" and "facilitated the delivery of the desired game experience". In terms of Documentation, most comments suggested that the "excessive documentation" and even the "excessive fulfilling of assessment forms" could be improved. As for Hard Skills, participant positively highlighted learning about the "process of developing a game", but 3 comments suggested that the "lack of [programming] skills to actually develop a game" was an issue. Finally, some suggestions were made in terms of EDGD process Iteration: participants suggested that "the process itself [is unnecessary] once you have the foundation of your game", that "some steps were repetitive". As for Relevance, all three comments were related to the fact that "some steps were not needed or relevant [for our game]".

6 Discussion

In this section, we discuss the results in the context of the research questions set at the beginning of this work.

6.1 Development of the EDGD process

The literature shows that game design studios have limited familiarity with UX techniques, but they adopt practices from UCD and UX nonetheless [15]. Acknowledging these techniques can provide significant benefits and pave the way for cementing their importance. The biggest challenges identified, such as financial constraints, time limitations, and difficulties in validating games could further be aided by the introduction of structured processes [63].

The proposed EDGD process merges the UCD Sprint and EDA to create an experience-centred game design process. The EDGD process thus retains the structured approach of the UCD Sprint, as presented by Visescu et al. [62] but adapts its activities to a gaming context, focusing on the player experience throughout. The EDA model, traditionally focused on understanding player experience and game dynamics [43], is fully incorporated into the Discovery phase of the EDGD process. Central to this approach are tools like the GDD and Player Sheet, which streamline and organise critical design elements such as player dynamics, mechanics, and narratives. These tools provide a cohesive structure for the game design and ensure that every aspect is aligned with player expectations. The Player Sheet and Discovery Canvas offer a nuanced understanding of player behaviour, cultural influences, and motivations, directly mapping these insights to gameplay elements such as goals, rewards, and challenges, as seen in theory by Mäyrä [42], Pichlmair and Johansen [47], Schell [52]. This mapping enables designers to better understand how sociocultural influences shape player interactions with the game, and supports an understanding of how to better approach these aspects for a stronger emotional impact to create a successful experience [5, 35].

To further refine the process, the EDGD process incorporates methods from the UCD Sprint, such as the Player Group Analysis, brainstorming, prototyping, and iterative playtesting. These techniques are applied systematically throughout the game development lifecycle, from initial conceptualisation to testing and refinement, allowing consistent and timely feedback. Player feedback is integrated into the process, which further translates into adjustments that can enhance player experiences. Low- and high-fidelity prototypes and structured playtesting provide actionable insights into how players interact with the game, enabling iterative improvements based on real-world player experiences. By merging the structured, user-centred approach of the UCD Sprint with the player-centred emphasis of the EDA model, the EDGD process bridges the gap between technical execution and experiential design. The inclusion of tools like the GDD, combined with interviews, and iterative prototyping and playtesting, the process ensures that designers focus on player needs, emotions, and expectations at every stage of development, as opposed to the end only, as it is seen as the most common approach in game design [21]. This process provides a clear, iterative path for designers, novice or experienced, to create games that are both technically sound and engaging.

Ultimately, the EDGD process aims to provide designers with the tools and methodologies needed to prioritise player feedback throughout the design process and align design goals with player experiences.

6.2 Reception of the EDGD process

Having no prior game design knowledge, the gathered data shows a spectrum of insights into how the EDGD process was received. This was to a degree expected, given the setting of the course, in which different participants worked with different ideas and game mechanisms. The mixed-methods approach, combining quantitative ratings and qualitative feedback aims to provide a comprehensive understanding of how these participants perceived the game design process use, while learning the process itself.

The quantitative results show a positive reception of the methods taught in the EDGD process. There is a preference for activities such as interviewing the players and playtesting, which highlights the importance of practical, hands-on activities that provide real-world applicability and foster a deeper understanding of player experience - a crucial component of game design [60]. Participants favoured methods that provided immediate, practical insights over more abstract or theoretical approaches. Activities like Game Design Documentation (GDD) and iterative processes received lower scores, possibly due to a lack of understanding of their relevance. This suggests that those without prior game design experience may struggle to see the value in planning and documentation unless linked to tangible outcomes. The trend is reinforced by students consistently rating hands-on, player-focused activities higher than abstract planning or analysis, highlighting a gap in connecting conceptual exercises to practical game design skills.

Lo-Fi prototyping proved to be a highly polarising method, with students showing mixed responses regarding its usefulness and relevance. While some valued it for fostering creativity and experimentation, others found it confusing or unrelated to their game design needs. This divide likely stems from differing learning styles and the specific games students aimed to create. The findings suggest a need for better instructional framing to clarify the benefits of Lo-Fi prototyping. The lower scores in ease of understanding and applicability suggest that novices might require more scaffolding or examples to grasp the value of these planning-oriented activities to a greater extent.

These results echo the conclusions drawn from applications of the UCD Sprint process in different contexts as well. A comparative analysis of teaching methods used across three distinct courses - Visescu et al. [62] with novice participants (first-semester Computer Science students) from Iceland; Larusdottir et al. [32], a course for practitioners in Italy; and the current EDGD process and setting of the current study, provides insights into how each process performed within these different educational contexts, and shows both strengths and potential areas for improvement. Across all courses, methods involving high fidelity prototyping, such as "Hi-fi Prototype" and "User Testing Hi-fi Prototype," consistently received high scores for being thought-provoking. These methods effectively encourage deep reflection and critical thinking among participants. Regarding usefulness within the course, "Interviews" and "Hi-Fi Prototyping" were particularly valued in the EDGD process course context. This trend was also observed in studies of the UCD Sprint [32, 62] , suggesting that early interaction with users or players is crucial for what are to be perceived as a successful process and course. When considering the future application of these methods, "Interviews," "Brainstorming Designs" and "Crazy 8," and "Hi-fi Prototype" were consistently rated highly, showing perceived value as transferable skills beyond the classroom.

Positive feedback on the overall process often focused on the practical, hands-on nature of the activities, such as prototyping and playtesting, which were seen as engaging and directly applicable to real-world game design. The structured, step-by-step approach of the EDGD process was appreciated and the process was highlighted as allowing participants to contribute to the design process, promoting a sense of ownership and collaboration. However, the feedback also pointed to several areas of difficulty, particularly regarding the time constraints of the course and the clarity of some steps and documents. The most common negative feedback centred around the lack of time to fully develop and implement the game design concepts within the EDGD process context. This concern was compounded for students who were balancing coursework with full-time jobs. Additionally, the qualitative data revealed confusion regarding some templates and documents, such as the Discovery Canvas and Player Sheet, which participants found unclear or overly complex. Interestingly, both remembrance and experiential evaluations also highlighted the importance of utilising the Discovery Canvas, suggesting that the struggle was mostly related to formatting and lack of proper scaffolding, rather than perceived usefulness. This difficulty is also explained by the fact that all the game design knowledge from EDA is condensed in these documents, which could be overwhelming for novice designers. This result is also in line with previous studies, which suggests that novice designers struggle with game-specific elements such as mechanics and obstacles Theodosiou and Karasavvidis [61]. This suggests that while the EDGD process provides a valuable structured approach for novices, it could benefit from incorporating more adaptive elements that accommodate varying levels of experience and different types of game projects.

6.3 Points of Optimisation

The findings suggest several key implications for future iterations of the EDGD process. First, future iterations should continue to emphasise practical, hands-on activities, such as iterative prototyping and user testing, given their positive reception. Second, to improve the clarity and perceived relevance of abstract activities like the GDD and the GDD Iteration, educators should provide more context and examples that link these theoretical exercises to practical game design, integrating them with more hands-on components. Interestingly, this emphasis on further prototyping and playtesting is also reflected in the game design industry. After analysing over 200 game design launches, Politowski et al. [49] also proposes the use of continuous playtesting as a solution to the top two main industry game design problems: Unclear Design Vision and Game Design complexity. This means that not only this problem is universal to the game design in general (regardless of expertise levels and professional environment), but that EDGD process can help alleviate such problems by further focusing on its playtesting steps. Third, the templates utilised in the Discovery phase (specifically, Discovery Canvas and Player Sheet) need to be reformulated to avoid confusion, being presented in a more linear manner, and with explicit examples and suggestions on how to use them. Fourth, the framework should offer greater flexibility to accommodate diverse game design projects, allowing for optional steps or alternative methods tailored to individual needs and projects. For example, low-fi prototyping, although well-received by most participants, was still a pain point for some specific groups and their game ideas. Hence, this step could become optional for those cases. Additionally, some qualitative comments mentioned the need for specifying the game genre throughout the process, also suggesting that a more flexible approach would benefit designers. This result is also in line with previous studies of game design tools, which suggest that game designers generally look for standardised tools that do not sacrifice their freedom [3].

When comparing qualitative experiential vs. remembrance evaluation, some interesting trends come forth: although the process of brainstorming and creativity-fostering tools such as "Crazy 8" were highly praised in the experiential evaluations, they were not mentioned heavily in the experience ones. This suggests that such activities are important for keeping designers engaged in the EDGD process, especially for the Discovery phase, which was the most critiqued one. Similarly, the concept of core loop and how to use it to design games was also mentioned as an improvement point during qualitative and quantitative experiential evaluations, but not heavily mentioned in the experiential ones. This could mean that: (1) the concept of core loop was particularly difficult to understand when it was first presented, but participants were able to grasp it after further iterations; or (2) the concept somehow lost importance during the next phases. In either case, this suggests that further scaffolding is needed in explaining such concept, and in highlighting its importance for a successful game.

Finally, to address concerns about time constraints, educators could extend the course duration, along with increasing support for students unfamiliar with specific game development-related tools and technologies. From an industry perspective, this is also a major pain point in game development, which can be mitigated balancing the workload among designers, as well as balancing level of expertise within design team [49]. Based on this industry-related solution, one could also state that EDGD process would be more effective by combining designers with various degrees of expertise during its application. From an educational perspective, training students and novices in using a process like the EDGD process can bring the much-needed UX focus that is already attempted in the industry, but that is at times hindered by the lack of knowledge within the team [15].

Overall, while the EDGD process was generally well-received, particularly for its practical and player and experience-centred focus, there are several areas where adjustments could enhance the experience. Refining the structure, improving clarity, and providing greater flexibility and support, educators can better meet the diverse needs of participants, and professional and novice designers alike can apply it to create player-centred experiences through games.

6.4 Limitations and Future Work

This study has some limitations that we acknowledge. Firstly, the participants were a homogenous group of students sharing similar socioeconomic backgrounds, age, and nationality, which may influence the feedback and results. Given the uniformity in their experiences, a more diverse group, may result in different conclusions being drawn on the process and the experience. Future work should include a broader demographic to explore how feedback might vary based on factors such as experience, cultural context, or gaming familiarity. Secondly, while the study employed a mixed-methods approach, more qualitative data, such as detailed interviews with participants, could provide deeper insights into their experiences and challenges. Tracking feedback in relation to the specific types of games designed (e. g. , entertainment vs. serious games) can further enrich the information on whether certain genres are suited for the EDGD process. Lastly, expert opinions from qualified game designers can aid the assessment of the applicability of the EDGD process in professional environments. These limitations open the way for future research and process optimisation opportunities.

7 Conclusion

This paper contributes to understanding how the UCD Sprint and EDA can be merged to form an experience-centred game design process, resulting in the creation of the EDGD. The UCD Sprint's structure is maintained but adapted to a game design context. The EDA model's contribution, particularly in understanding player behaviour and sociocultural influences, enriches it, allowing designers to align game mechanics, goals, and rewards with player needs from the very beginning of the design process. This merging offers a holistic methodology that balances structured design approaches and a focus on player experience.

The EDGD process, when applied in an educational setting with participants lacking prior game design experience, was generally well-received, particularly for its hands-on, practical components. These activities and methods offered immediate insights into player needs and created a deeper connection between the design process and the final player experience. Participants found theoretical activities less engaging and harder to understand and follow, showing a need for better scaffolding and clearer connections between abstract planning activities and their practical design outcomes.

We further identified areas for process optimisation, which show that refining the clarity, offering more adaptive elements, and balancing the practical with the theoretical could enhance the way the EDGD process is perceived in future applications.

References

[1] Ulrike Abelein and Barbara Paech. 2015. Understanding the Influence of User Participation and Involvement on System Success – a Systematic Mapping Study. *Empirical Software Engineering* 20, 1 (Feb. 2015), 28–81. doi:10.1007/s10664-013-9278-4

[2] Ernest Adams. 2014. *Fundamentals of Game Design* (3rd ed.). New Riders Publishing, USA.

[3] Marcos Silvano Orita Almeida and Flávio Soares Corrêa da Silva. 2013. A Systematic Review of Game Design Methods and Tools. In *Entertainment Computing – ICEC 2013 (Lecture Notes in Computer Science)*, Junia C. Anacleto, Esteban W. G. Clua, Flavio S. Correa da Silva, Sidney Fels, and Hyun S. Yang (Eds.). Springer, Berlin, Heidelberg, 17–29. doi:10.1007/978-3-642-41106-9_3

[4] Sylvester Arnab, Theodore Lim, Maira B. Carvalho, Francesco Bellotti, Sara de Freitas, Sandy Louchart, Neil Suttie, Riccardo Berta, and Alessandro De Gloria. 2015. Mapping learning and game mechanics for serious games analysis. *British Journal of Educational Technology* 46, 2 (2015), 391–411. doi:10.1111/bjet.12113

[5] Shahrel Nizar Baharom, Wee Hoe Tan, and Mohammad Zaffwan Idris. 2014. Emotional Design for Games: A Framework for Player-Centric Approach in the Game Design Process. *International Journal of Multimedia and Ubiquitous Engineering* 9, 10 (Oct. 2014), 387–398. doi:10.14257/ijmue.2014.9.10.37

[6] Muneera Bano and Didar Zowghi. 2015. A systematic review on the relationship between user involvement and system success. *Information and Software Technology* 58 (Feb. 2015), 148–169. doi:10.1016/j.infsof.2014.06.011

[7] Zowghi Didar Bano Muneera. 2015. A systematic review on the relationship between user involvement and system success. *Information and Software Technology* 58 (Feb 2015), 148–169. doi:10.1016/j.infsof.2014.06.011

[8] Julia Ayumi Bopp, Klaus Opwis, and Elisa D Mekler. 2018. "An Odd Kind of Pleasure" Differentiating Emotional Challenge in Digital Games. In *Proceedings of the 2018 CHI conference on human factors in computing systems*. 1–12.

[9] Broccoli Broccoli Studio. [n. d.]. Punhos de Repúdio (Game). https://store.steampowered.com/app/1425760/Punhos_de_Repudio/

[10] Åsa Cajander, Marta Larusdottir, and Johannes L. Geiser. 2022. UX professionals' learning and usage of UX methods in agile. *Information and Software Technology* 151 (Nov. 2022), 107005. doi:10.1016/j.infsof.2022.107005

[11] Joseph Campbell. 1949. *The Hero with a Thousand Faces* (3ª edição ed.). Joseph Campbell Foundation.

[12] Adriana Chammas, Manuela Quaresma, and Cláudia Mont'Alvão. 2015. A Closer Look on the User Centred Design. *Procedia Manufacturing* 3 (Jan. 2015), 5397–5404. doi:10.1016/j.promfg.2015.07.656

[13] Hsi-Jen Chen, Yan-Ting Chen, and Chia-Han Yang. 2022. Behaviors of Novice and Expert Designers in the Design Process: From Discovery to Design. (2022). doi:10.57698/V16I3.04 Publisher: International Journal of Design.

[14] Paul Cobley. 2008. Culture: Definitions and Concepts. In *The International Encyclopedia of Communication*. American Cancer Society. doi:10.1002/9781405186407.wbiecc173 _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1002/9781405186407.wbiecc173.

[15] Felippe Fernandes da Silva, Matheus Henrique C. Leme, André F. Zanella, Guilherme Corredato Guerino, Renato Balancieri, and Gislaine Camila Lapasini Leal. 2024. User Experience Techniques Adopted by Brazilian Game Development Studios: An Exploratory Study. *International Journal of Computer Games Technology* 2024, 1 (2024). doi:10.1155/2024/1857881 _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1155/2024/1857881.

[16] Alena Denisova, Paul Cairns, Christian Guckelsberger, and David Zendle. 2020. Measuring perceived challenge in digital games: Development & validation of the challenge originating from recent gameplay interaction scale (CORGIS). *International Journal of Human-Computer Studies* 137 (2020), 102383.

[17] Alena Denisova, Christian Guckelsberger, and David Zendle. 2017. Challenge in digital games: Towards developing a measurement tool. In *Proceedings of the 2017 chi conference extended abstracts on human factors in computing systems*. 2511–2519.

[18] Sowmya Dhandapani. 2016. Integration of User Centered Design and Software Development Process. In *2016 IEEE 7th Annual Information Technology, Electronics and Mobile Communication Conference (IEMCON)*. 1–5. doi:10.1109/IEMCON.2016.7746075

[19] Björn Fischer, Alexander Peine, and Britt Östlund. 2020. The Importance of User Involvement: A Systematic Review of Involving Older Users in Technology Design. *The Gerontologist* 60, 7 (Oct. 2020), e513–e523. doi:10.1093/geront/gnz163

[20] International Organization for Standardization. 2019. ISO 9241-210:2019. https://www.iso.org/standard/77520.html

[21] Tracy Fullerton. 2008. *Game Design Workshop-A Playcentric Approach to Creating Innovative Games*. Elsevier.

[22] Geert Hofstede. 2011. Dimensionalizing Cultures: The Hofstede Model in Context. *Online Readings in Psychology and Culture* 2, 1 (Dec. 2011). doi:10.9707/2307-0919.1014

[23] Geoffrey Hookham and Keith Nesbitt. 2019. A Systematic Review of the Definition and Measurement of Engagement in Serious Games. In *Proceedings of the Australasian Computer Science Week Multiconference (ACSW 2019)*. Association for Computing Machinery, Sydney, NSW, Australia, 1–10. doi:10.1145/3290688.3290747

[24] Robin Hunicke, Marc Leblanc, and Robert Zubek. 2004. MDA: A Formal Approach to Game Design and Game Research. *AAAI Workshop - Technical Report* 1 (Jan. 2004).

[25] Yavuz Inal, Torkil Clemmensen, Dorina Rajanen, Netta Iivari, Kerem Rizvanoglu, and Ashok Sivaji. 2020. Positive developments but challenges still ahead: a survey study on UX professionals' work practices. *J. Usability Studies* 15, 4 (Aug. 2020), 210–246.

[26] Gustav Jahoda. 2012. Critical reflections on some recent definitions of 'culture'. *Culture & Psychology* 18 (2012), 1–15. doi:10.1177/1354067X12446229

[27] Aphra Kerr. 2002. Representing users in the design of digital games. In *Computer Games and Digital Cultures Conference Proceedings*. Tampere University Press.

[28] Sari Kujala. 2003. User involvement: A review of the benefits and challenges. *Behaviour & Information Technology* 22, 1 (Jan. 2003), 1–16. doi:10.1080/01449290301782 Publisher: Taylor & Francis.

[29] Sari Kujala. 2003. User involvement: A review of the benefits and challenges. *Behaviour Information Technology* 22, 1 (Jan 2003), 1–16. doi:10.1080/01449290301782

[30] Janaki Kumar. 2013. Gamification at Work: Designing Engaging Business Software. In *Design, User Experience, and Usability. Health, Learning, Playing, Cultural, and Cross-Cultural User Experience*, David Hutchison, Takeo Kanade, Josef Kittler, Jon M. Kleinberg, Friedemann Mattern, John C. Mitchell, Moni Naor, Oscar Nierstrasz, C. Pandu Rangan, Bernhard Steffen, Madhu Sudan, Demetri Terzopoulos, Doug Tygar, Moshe Y. Vardi, Gerhard Weikum, and Aaron Marcus (Eds.). Vol. 8013. Springer Berlin Heidelberg, Berlin, Heidelberg, 528–537. doi:10.1007/978-3-642-39241-2_58 Series Title: Lecture Notes in Computer Science.

[31] Marta Larusdottir, Virpi Roto, Jan Stage, Andrés Lucero, and Ilja Šmorgun. 2019. Balance Talking and Doing! Using Google Design Sprint to Enhance an Intensive UCD Course. In *Human-Computer Interaction – INTERACT 2019*, David Lamas, Fernando Loizides, Lennart Nacke, Helen Petrie, Marco Winckler, and Panayiotis Zaphiris (Eds.). Springer International Publishing, Cham, 95–113. doi:10.1007/978-3-030-29384-0_6

[32] Marta K. Larusdottir, Rosa Lanzilotti, Antonio Piccinno, Ioana Visescu, and Maria Francesca Costabile. 2024. UCD Sprint: A Fast Process to Involve Users in the Design Practices of Software Companies. *International Journal of Human–Computer Interaction* 40, 23 (Dec. 2024), 8360–8377. doi:10.1080/10447318.2023.2279816 Publisher: Taylor & Francis.

[33] James R. Lewis. 2021. Measuring User Experience With 3, 5, 7, or 11 Points: Does It Matter? *Human Factors* 63, 6 (Sept. 2021), 999–1011. doi:10.1177/0018720819881312 Publisher: SAGE Publications Inc.

[34] James R. Lewis, Brian S. Utesch, and Deborah E. Maher. 2013. UMUX-LITE: when there's no time for the SUS. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '13)*. Association for Computing Machinery, New York, NY, USA, 2099–2102. doi:10.1145/2470654.2481287

[35] Kristina Loderer, Reinhard Pekrun, and Jan Plass. 2019. Emotional foundations of game-based learning. In *Handbook of Game-Based Learning* (1 ed.). The MIT Press, Cambridge, MA.

[36] Hennig-Thurau Thorsten Marchand André. 2013. Value Creation in the Video Game Industry: Industry Economics, Consumer Benefits, and Research Opportunities. *Journal of Interactive Marketing* 27, 3 (Aug 2013), 141–157. doi:10.1016/j.intmar.2013.05.001

[37] Raoni Marqs. 2020. *Como Escrever Histórias*. Bendaora Editora. https://www.bendaora.com/product-page/ebookcomoescrever

[38] Nicola Marsden and Karen Holtzblatt. 2018. How Do HCI Professionals Perceive Their Work Experience?: Insights from the Comparison with Other Job Roles in IT. In *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems*. ACM, Montreal QC Canada, 1–6.

doi:10.1145/3170427.3188501

[39] Edwin McRae. 2018. *Narrative Design for Indies: Getting Started.* Fiction Engine.

[40] Javier Melero, Davinia Hernández-Leo, and Josep Blat. 2011. A review of scaffolding approaches in gamebased learning environments. In *Proceedings of the 5th European Conference on Games Based Learning*. 20–21.

[41] Michael Minkov and Anneli Kaasa. 2022. Do dimensions of culture exist objectively? A validation of the revised Minkov-Hofstede model of culture with World Values Survey items and scores for 102 countries. *Journal of International Management* 28, 4 (Dec. 2022). doi:10.1016/j.intman.2022.100971

[42] Frans Mäyrä. 2008. *An Introduction to Game Studies.* SAGE. Google-Books-ID: XonWQB1vHDMC.

[43] Gabriel C. Natucci and Marcos A. F. Borges. 2021. The Experience, Dynamics and Artifacts Framework: Towards a Holistic Model for Designing Serious and Entertainment Games. In *2021 IEEE Conference on Games (CoG).* 1–8. doi:10.1109/CoG52621.2021.9619144 ISSN: 2325-4289.

[44] Gabriel C. Natucci and Marcos A. F. Borges. 2023. Balancing Game Elements, Learning, and Emotions in Game Design. In *Grand Research Challenges in Games and Entertainment Computing in Brazil - GranDGamesBR 2020–2030*, Rodrigo Pereira dos Santos and Marcelo da Silva Hounsell (Eds.). Springer Nature Switzerland, Cham, 89–112. doi:10.1007/978-3-031-27639-2_5

[45] Laura K. Nelson. 2020. Computational Grounded Theory: A Methodological Framework. *Sociological Methods & Research* 49, 1 (Feb. 2020), 3–42. doi:10.1177/0049124117729703 Publisher: SAGE Publications Inc.

[46] Nurul Izzah Othman, Nor Azan, and Hazura Mohamed. 2020. Play-Centric Designing of a Serious Game Prototype for Low Vision Children. *International Journal of Advanced Computer Science and Applications* 11, 5 (2020). doi:10.14569/IJACSA.2020.0110528

[47] Martin Pichlmair and Mads Johansen. 2021. Designing Game Feel. A Survey. *IEEE Transactions on Games* (2021), 1–1. doi:10.1109/TG.2021.3072241 arXiv: 2011.09201.

[48] Jan L. Plass, Bruce D. Homer, and Charles K. Kinzer. 2015. Foundations of Game-Based Learning. *Educational Psychologist* 50, 4 (2015), 258–283. doi:10.1080/00461520.2015.1122533

[49] Cristiano Politowski, Fabio Petrillo, Gabriel C. Ullmann, and Yann-Gaël Guéhéneuc. 2021. Game industry problems: An extensive analysis of the gray literature. *Information and Software Technology* 134 (June 2021), 106538. doi:10.1016/j.infsof.2021.106538

[50] Andrew J. Reagan, Lewis Mitchell, Dilan Kiley, Christopher M. Danforth, and Peter Sheridan Dodds. 2016. The emotional arcs of stories are dominated by six basic shapes. *EPJ Data Science* 5, 1 (Dec. 2016), 31. doi:10.1140/epjds/s13688-016-0093-1 arXiv: 1606.07772.

[51] Virpi Roto, Marta Larusdottir, Andrés Lucero, Jan Stage, and Ilja Šmorgun. 2021. Focus, Structure, Reflection! Integrating User-Centred Design and Design Sprint. In *Human-Computer Interaction – INTERACT 2021*, Carmelo Ardito, Rosa Lanzilotti, Alessio Malizia, Helen Petrie, Antonio Piccinno, Giuseppe Desolda, and Kori Inkpen (Eds.). Springer International Publishing, Cham, 239–258. doi:10.1007/978-3-030-85616-8_15

[52] Jesse Schell. 2008. *The art of game design: a book of lenses.* Elsevier/Morgan Kaufmann, Amsterdam ; Boston.

[53] Klaus R. Scherer. 2005. Appraisal Theory. In *Handbook of Cognition and Emotion.* John Wiley & Sons, Ltd, Chichester, UK, 637–663. doi:10.1002/0470013494.ch30

[54] Tiago Silva da Silva, Angela Martin, Frank Maurer, and Milene Silveira. 2011. User-Centered Design and Agile Methods: A Systematic Review. In *2011 Agile Conference.* 77–86. doi:10.1109/AGILE.2011.24

[55] Ting Song and Kurt Becker. 2014. Expert vs. novice: Problem decomposition/recomposition in engineering design. In *2014 International Conference on Interactive Collaborative Learning (ICL).* 181–190. doi:10.1109/ICL.2014.7017768

[56] Olli Sotamaa. 2007. Perceptions of Player in Game Design Literature. In *DiGRA Conference.* https://api.semanticscholar.org/CorpusID:15186284

[57] UCD Sprint. [n. d.]. UCD Sprint. https://ucdsprint.com/

[58] Wim Strijbosch, Ondrej Mitas, Marnix van Gisbergen, Miruna Doicaru, John Gelissen, and Marcel Bastiaansen. 2019. From Experience to Memory: On the Robustness of the Peak-and-End-Rule for Complex, Heterogeneous Experiences. *Frontiers in Psychology* 10 (July 2019). doi:10.3389/fpsyg.2019.01705 Publisher: Frontiers.

[59] Jonathan Sykes and Melissa Federoff. 2006. Player-centred game design. In *CHI '06 Extended Abstracts on Human Factors in Computing Systems (CHI EA '06).* Association for Computing Machinery, New York, NY, USA, 1731–1734. doi:10.1145/1125451.1125774

[60] Jonathan Sykes and Melissa Federoff. 2006. Player-centred game design. In *CHI '06 Extended Abstracts on Human Factors in Computing Systems.* doi:10.1145/1125451.1125774

[61] Sevasti Theodosiou and Ilias Karasavvidis. 2015. Serious games design: A mapping of the problems novice game designers experience in designing games. *Journal of E-Learning and Knowledge Society* 11, 3 (Sep 2015). doi:10.20368/1971-8829/1071

[62] Ioana Visescu, Marta Larusdottir, and Anna Sigridur Islind. 2023. Supporting Active Learning in STEM Higher Education Through the User-Centred Design Sprint. In *2023 IEEE Frontiers in Education Conference (FIE).* 1–10. doi:10.1109/FIE58773.2023.10342978 ISSN: 2377-634X.

[63] Ioana Visescu, Marta Lárusdóttir, and Won Choi. 2024. Exploration of UCD Practice Limitations. *Interacting with Computers* (Oct. 2024), iwae046. doi:10.1093/iwc/iwae046

[64] Wolfgang Walk, Daniel Görlich, and Mark Barrett. 2017. Design, Dynamics, Experience (DDE): An Advancement of the MDA Framework for Game Design. In *Game Dynamics: Best Practices in Procedural and Dynamic Game Content Generation*, Oliver Korn and Newton Lee (Eds.). Springer International Publishing, Cham, 27–45. doi:10.1007/978-3-319-53088-8_3

[65] David Wood, Jerome S. Bruner, and Gail Ross. 1976. THE ROLE OF TUTORING IN PROBLEM SOLVING*. *Journal of Child Psychology and Psychiatry* 17, 2 (April 1976), 89–100. doi:10.1111/j.1469-7610.1976.tb00381.x

[66] Robert Yang. 2024. The Level Design Book. https://book.leveldesignbook.com

[67] Nick Yee. [n. d.]. Quantic Foundry. https://quanticfoundry.com/
[68] Robert Zubek. 2020. *Elements of game design.* MIT Press.

A Player Sheet

The Player sheet is a one-page description of the player groups' socioeconomic and cultural background, as well as its associated expected wants and needs regarding gameplay. This document aims to describe the entirety of EDA's Experience component in a clear and useful way for creating a game that will evoke the desired impression in the player. It is divided into 3 sections: (1) Describing the player's Persona context, which answers questions like "What is this Persona's name?" "What are the age range, gender, and education level?" "When, where, and how often does this Persona play games?". These questions are also heavily inspired by the User-group detailed template proposed in the UCD Sprint [57]; (2) Describing the player's expected behaviours and motivation when playing a game. To assess such behavioural traits, the PDDP is loosely based on the Quantic Foundry's Gamer Motivation Profile [67], which draws upon over 1.65 million of gamer interviews and divides player motivation into 6 types of motivations, each of those characterised by 2 traits, and shown by Table 3. In the Player Sheet, the designer has to score each one of those traits by using a 5-point Likert scale, thus identifying the most important traits for the intended Persona, and how to direct the game's mechanics and dynamics to 'wow' the player throughout the game and maximise its experience. These evaluations can be reviewed later on by the designer after conducting some player interviews. (3) Documenting the results of player interviews and their suggestions, used during the "interviewing players" step of the EDGD process. This section documents the number of interviews that have been done, what are the "must-haves" (i.e. experiences, dynamics and mechanics the player thinks are essential to be included in the game), the "nice to haves" (i.e. elements that could be included in the game for an improved experience, but are not necessarily needed or essential to evoke the desired experience), suggested games (similar games that the player tried before that evoke a similar experience to the one aimed by the designer), and finally, general notes (a place to write about any new discovery or fact during any interview). The suggested games are precisely the ones that should be explored by the designer during the "Explored games suggested by the players" step in the EDGD process. (4) Describing the player's cultural and societal influences.

Common Behaviour	Motivation Profile	Trait
Immediacy and Adrenaline rushes	Action	destruction (e. g. explosives, guns)
	Social	competitive (e. g. duels, team-vs-team, leaderboards)
Long-term goals, slower pacing	Mastery	challenge (e.g. mechanics that rely heavily on skill and ability, and reward players for persistence)
	Achievement	completion (i. e. finish everything the game has to offer, and collect all items)
Testing boundaries of the game, expressing oneself within the game	Immersion	fantasy (i.e. enjoy the sense of becoming someone else, somewhere else)
	Creativity	discovery (e. g. discover and explore different locations, and come up with creative ways to play the game)

Table 3. Quantic Foundry's Gamer Motivation Profiles

According to the EDA, culture is also an important contextual factor in designing a game. Even though the concept of culture is elusive, with various conflicting definitions [26], in this work it can be defined as a collective system of meaning [42], in which communication takes place [14]. Communication in this case can refer to any sort of art form, including games themselves. Given this definition, it is important for the designer to understand the cultural background of the player, since it helps the designer improve the game's experience by either reinforcing or subverting existing cultural elements that sound familiar to the player. For example, if a designer knows that the cultural context of its player is one that values individualism and competition, they might want to subvert it by introducing a collaboration element in the gameplay. Assessing one's culture is also important to seize particular moments in history to create games that are closely associated with current sociopolitical events. For example, the game "Punhos de Repúdio" [9] was a Brazilian 2D game created amidst the worldwide Covid-19 pandemic that gained national attention because of its theme: given that a significant portion of the population was skeptical about the Covid-19's vaccine and reluctant to take it, the game was developed as a way to "blow off steam" by the ones who took the vaccine, and its proposal was to simply rough up several non-vaccinated people as the player goes through several phases filled with popular and controversial figures of the Brazilian political landscape. In the UCD Sprint (and the Player sheet), the designer has to identify the micro and macro culture of the player's Persona. Micro culture is here defined as the historical and economical events that happen within that particular group (for example, the bubbled-up tension between vaccinated and unvaccinated people in Brazil). This also includes elements that are described as belonging to popular culture (famous people, artists, landmarks and so on). Macro culture, on the other hand, is related to how a particular group of people operates on a more fundamental level.

In the EDGD process, we adopt the Revised Minkov-Hofstede Model of Culture [41] which describes culture in terms of 2 axes representing antagonistic ideals. The first axis is the individualism-collectivism (IDV-COLL), measuring the

Minkov cultural axis	Player Statement
IDV-COLL	We respect tradition
IDV-COLL	Friends + Family > Everyone
IDV-COLL	We seek fame and success
FLX-MON	We are a proud group
FLX-MON	Our values are strong
FLX-MON	We are friendly

Table 4. Culture Evaluation in the EDGD process inspired by Revised Minkovb-Hofstede Model of Culture

degree to which people in a society are integrated into groups [22]; a person in an individualistic society is expected to take care only about himself/herself, and its immediate family, whereas a collective society would value and respect extended families and even strangers. Additionally, the collectivism dimension is also closely related to respecting society's traditions, whereas an individualistic one teaches the freedom to act according to one's own desires. The second axis is the multifaceted flexibility-monumentalism (FLX-MON), where flexibility refers to a society where individuals are associated with modest self-esteem, high self-sufficiency/control and typically delay their own gratification in order to achieve a particular goal. Monumentalism, on the other hand, has individuals who value self-indulgence, expression of all their feelings, high self-esteem and a more laid-back approach to life in general. Additionally, monumental societies also value generosity and the overall exchange amongst their peers, relying more on help from others [22]. In the EDGD process context, the designer can identify these axes by evaluating how high the player group they intend to focus on as an audience agrees with a set of six statements using a 5-point Likert Scale, as detailed in the Table 4. Higher values in questions associated with the FLX-MON axis mean that the user group is more identified with the monumentalism macro culture. In contrast, higher values in the IDV-COLL related statements mean a more collectivistic user group. Given the complex and even conflicting nature of both axes, we opted for providing three statements from each axis that capture their different facets. A full image of the Player Sheet is shown in Figure 9.

B Discovery Canvas

The Discovery Canvas is a one-page canvas that fully describes all the main elements of the game and its EDA elements, including a small summary of the Player Sheet (Player section). The main affective experience the designer is striving for in his process is also clearly summarised and stated in the Experience section. While some of the EDA subcomponents have a more direct corresponding field in the Discovery Canvas (e. g. the Medium subcomponent from Artifact has a corresponding section with the same name), others have been split into multiple sections or even merged into one section to make it easier for the designer to think about the game as a whole. For example, the engagement subcomponent from the Experience is split into three different sections to facilitate the design: (1) the Goals section, describing what are the ingame goals of the player to keep him entertained; (2) the Rewards section, i. e. what does the player acquire after completing a goal or coming closer to it? (3) the Punishment section, i.e. what happens when a player fails to do something that is required during the game? The Rewards/Punishment sections can be thought of as incentive systems such as badges, scores, and power ups, being one of the pillars of games and game-based learning [48]. Additionally, they can also include auditory and visual feedback to reward/punish certain actions, being more closely related to the game feel, or the act of designing moment-to-moment player interactions [47]. The embedded narrative and narrative

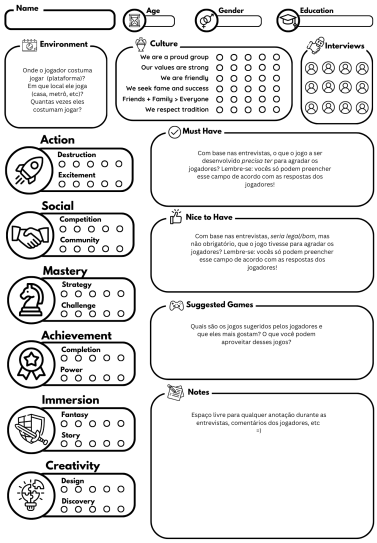

Fig. 9. Structure of the Player Sheet.

mechanics from Artifacts have been grouped into the Story section of the Discovery Canvas. The Story section combines quintessential elements from narrative, such as the Hero's Journey [11] in a more palatable way. Particularly, the design has to describe the story's *logline* [37], which is a short description of the history involving four elements: (1) concept, or where the story takes place; (2) hero/protagonist, i. e. the main character of the story (which is not necessarily the player); (3) intention/goal, or what the protagonist wants; and d) obstacles, or what is preventing the protagonist from reaching its goals.

Additionally, it needs to decide on how to tell this story from an emotional perspective, by selecting one of the 6 universal emotional arcs of a story [50], and finally decide what mechanics will be used to tell this story in the game. Common narrative mechanics can be either direct (e. g. cutscenes, narrator, monologues, dialogues, ingame books/text) or indirect. Indirect narrative mechanics are defined by as story glyphs, and are divided into tomes (small pieces of text that can be read in moments of peace during the game), flavour text (small descriptions of game items), and environmental (e.g. blood stains on the floor, symbols on the walls, background music) [39]. Scaffolding/pacing and mechanics associated with learning were translated to the Discovery Canvas as a Learning section, where the designer has to decide what the player has to learn in the game (either how to play it or some other educational goal). Inspired by previous works [4, 40], learning mechanics include textual explanations, audio explanations, tutorials, hints, NPC explanations, feedback (visual, textual, auditory), demonstrations/simulations. Pacing is also included in the Obstacles/Progress sections of the Discovery Canvas, which also cover the Challenge subcomponent of the EDA's Dynamics. In order to facilitate the design of the game, Player-Driven Design Process (PDDP) provides a list of common obstacles/challenges faced during gameplay based on common obstacles found in game design literature [8, 16, 17]:

(1) cognitive challenges, like problem-solving, spatial/logical reasoning, and to a minor degree, social challenges which can be solved by interacting with other players and/or NPCs; (2) physical challenges, which involves player's speed and reaction times, precision and accuracy; (3) and finally emotional challenges, usually evoked through narrative and the presence of strong characters. Thus emotional challenges are highly related to the story and its corresponding emotional arc. Finally, in order to further facilitate the game design, the Discovery Canvas includes a section to describe the core loop of the game, defined as the smallest sequence of activities that are going to be meaningful and enjoyable for the player [68], which also evoke the desired experience. According to this notion, the Discovery Canvas encourages the designer to think about the game from a bottom-up fashion, starting with the core loop and then evolving the game dynamics through complementary loops and/or more complicated variations of the core loop. To further highlight this design perspective, the Discovery Canvas splits EDA Artifact's game mechanics into two: (1) core game mechanics, which are present in the core loop; (2) satellite mechanics, which expand the core loop in any way.

The full Discovery Canvas is illustrated in Figure 10.

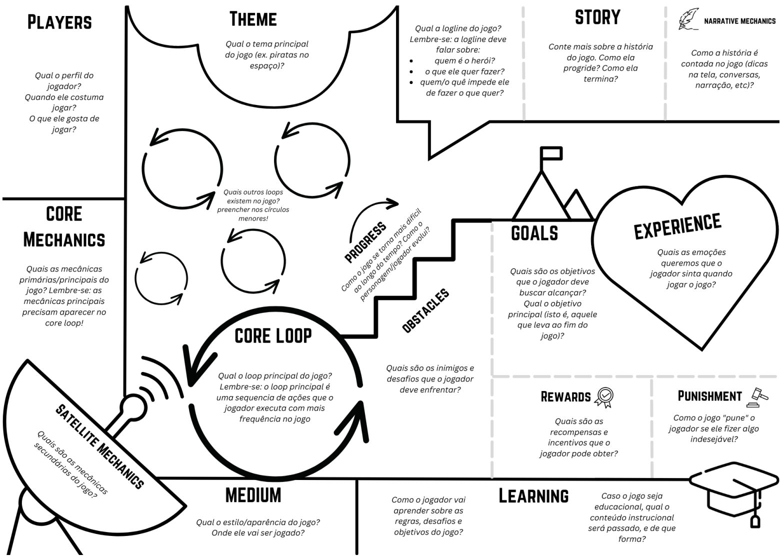

Fig. 10. Structure of the Discovery Canvas.