With or Without U(sers): A Journey to Integrate UX Activities in Cybersecurity

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Abstract. Integrating human factors into cybersecurity system development is crucial if users are to make these technologies their own. This case study reports our introduction of UX activities in a cybersecurity project focused on creating cyber range scenarios. Research objectives include assessing non-UX stakeholders' UX literacy, examining the impact of user involvement on non-UX stakeholders' UX literacy, and identifying barriers and opportunities for UX integration. Data was collected at three key points, using a mixed method approach of survey, interview and observation. The findings reveal that although introducing UX methods progressively did not uniformly improve UX literacy, it reduced barriers to UX integration and increased confidence in conducting UX activities. Further, it facilitated effective communication within a multidisciplinary team, fostering consensus on development priorities.

Keywords: user experience · cybersecurity · UX literacy · UX integration

1 Introduction

As contemporary users are prone to reject systems that offer an inadequate UX, organizations must adopt human-centered design (HCD) to design technologies capable of competing successfully in a saturated global market [14]. Despite an abundance of related literature [18], the integration of software development and user experience (UX) remains challenging to practitioners and organizations attempting it [11,12,39]. There are several barriers to UX integration [4,6]: lack of understanding of UX return on investment (ROI); mistaken belief that performing UX requires no UX expertise or that UX can be performed informally; contentious attitudes toward users, UX practitioners and UX activities; and mistaking UX for aesthetics or user interface. Moreover, low UX literacy manifests

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itself in insufficient understanding of HCD and UX, insufficient awareness of UX return on investment (ROI), and contentious attitude toward users [4]. In turn, low UX maturity is characterized by a lack of resources for UX and difficulty in fully committing to UX design from the onset of the project [9].

Integrating human factors into cybersecurity systems and infrastructure development is crucial if users are to make these technologies their own. Further, creating CRS tailored to users is key for effective learning. Failure to meet user needs may result in disengagement from the system [8,24], reduced relevance and practical application [16,34], inability or disinterest in completing the training when tasks do not match trainees' capabilities (too easy or too difficult) [42].

This case study reports how we introduced and conducted UX activities in a cybersecurity project (2022-2025) aiming at supporting the creation of cyber range scenarios (CRS). The system is intended for CRS designers, trainers and trainees [37]. Trainers need a usable graphical user interface (GUI) to create CRS and monitor trainees' progress during the execution of the CRS, whereas trainees need the GUI to follow the CRS and complete their training. The project involves three stakeholders: a university (UNI), a center of excellence (COE), and an industrial partner (IND). The mission of UNI is to implement the HCD process as software development model, design a GUI, model, and implement an approach to generate and guide CRS; COE implements and integrates the GUI of the CR; and IND provides the cyber range (CR). We opted for UX methods without users to execute understanding, specifying, and producing HCD processes, as recommended by [19] when resources such as budget and time are limited. Moreover, we opted for a strategy without users due to their involvement being a pain point for technology-driven stakeholders, unlike stakeholders with a human-centered mindset [4]. Thus, we first conducted an expert review to improve the GUI of CR, which allowed us to get familiar with the existing system and domain. We then conducted prototyping workshops to design a GUI for CRS creation.

This case study objective is to explore the progressive integration of UX activities, first without, then with users, to promote an HCD-oriented mindset within a cybersecurity project. In particular, we aim to answer the following research questions (RQs):

- What are project stakeholders' perceptions of UX, specifically their UX literacy? (RQ1)
- How does involvement or lack of involvement of users in UX activities affect project stakeholders UX literacy? (RQ2)
- What are the barriers and opportunities to UX integration? (RQ3)

The contribution of this paper is to uncover and discuss ways to facilitate UX integration in a cybersecurity project. This case study presents a preliminary account of the gradual involvement of users into project development lifecycle to reduce the amount of friction between project stakeholders and UX staff. We believe that UX methods without users have increased stakeholders' UX literacy, which paved the way to further improve stakeholders' attitude toward users.

2 Background

2.1 UX and Cybersecurity

Integrating UX into cyber range development enhances the effectiveness of cybersecurity training by prioritizing software usability and improving user acceptance. The UX design process, rooted in HCD, is guided by user needs and requirements to create systems that are not only functional but also provide user satisfaction and performance [33]. By focusing on understanding the context of use and specifying user requirements from the outset [20], UX helps aligning training content with trainees' competences, responsibilities and real-world environment. Integrating UX could help address the challenges related to cyber range scenario relevance and effectiveness highlighted in [8,16,34], ensuring a more seamless and engaging learning experience for trainees.

Conversely, lack of UX considerations engenders a disregard for user needs and poses challenges to the goal of improving trainees' competences. This oversight results in potential misalignments between cyber range's training content and the actual responsibilities of trainees. Moreover, the failure to incorporate context-driven and relatable scenarios may induce disengagement, as trainees struggle to bridge the gap between theoretical knowledge and practical application [8,16]. Engagement is also affected by misaligning trainees' abilities and the difficulty level of training scenarios [41,42], which diminishes training relevance and restricts the application of acquired knowledge in the real-world [16,34].

2.2 UX Integration

Organizations and project stakeholders struggle with UX integration and prioritization during software development [17]. To integrate UX activities, UX practitioners must build trust with project stakeholders, who are more inclined to trust UX practitioners before trusting the field of UX [35]. However, gaining trust and support from colleagues remains a challenge [32]. Ingrained beliefs tend to prevail in the face of uncertainty, such as individual-level risk aversion [4,35].

The inherent disparities between software development and UX stakeholders' rationales, priorities, and practices present considerable challenges to UX integration and create multiple friction points [30]. Developers' inability or unwillingness to adopt a user-centric mindset together with developers' focus and interest in the functionality and efficiency of the code rather than on usability [2,5] constitute one such challenge. Lack of mutual understanding between UX designers and developers leads to ineffective communication [3,21], further exacerbating the issue [23]. Moreover, senior managers' focus on safeguarding developers' time contributes to the prioritization of coding over UX, reinforcing the notion UX holds lower value, as it is dispensable unless insights are gained and thus lowers the expectations for UX quality [35].

Another challenge arises from insufficient prioritization and resources for UX. The neglect in UX implementation and resource allocation manifests through disorganized and erratic UX management, resulting in a product vision deficit and introducing uncertainty: e.g. lack of UX leadership, lack of UX representation at strategic levels, and lack of consistency in implementing UX activities across projects [35]. Lack of resources leads to in high workloads for UX designers [22], imposing limitations on productivity and creating bottlenecks [32].

2.3 UX Literacy

We contend that a lack of or limited UX literacy leads to numerous challenges to UX integration described in scientific literature. For instance, developers' tendency to expedite UX activities or resist accommodating UX outcomes, rooted in prior internal decisions or perceived lateness in the process, culminating in a hurried approach [35]. Another challenge is the misconception that UX is resource-intensive, indicating a limited knowledge about existing UX methods [5] and discount alternatives [38]. Additional challenges include conflating UX with aesthetics or visual design [4,15] and believing users are unable to express their needs and provide insights during evaluation [2]. Further, the absence of colleagues with UX literacy poses a challenge, as a certain level of UX literacy is necessary to effectively execute UX activities [28], which leaves UX practitioners feeling isolated and struggling to make their voices heard [32].

Yet, UX literacy is valuable when integrating UX into software development, where comprehension of UX ROI correlates with frequent UX evaluations and higher UX maturity [40]. Barriers also stem from a lack of UX literacy among the system commissioners, leading to the absence of UX requirements [2,37], as they undervalue UX and resist investing in UX [4,5]. This resistance in investing in UX is also prevalent in organisations' senior management [38].

2.4 UX Methods

There are two classes of UX methods [25,26]: knowledge elicitation methods and artifact-mediated communication methods, also referred to as UX design methods (Fig. 1). Knowledge elicitation methods include those not involving users and those involving users. Methods without users (e.g. expert review or heuristic evaluation) aim to predict the use of a system based on the opinion or expertise of an expert, without involving user data collection. Conversely, methods with users collect user data to incorporate the user's perspective into software development. There are three types of methods with users: (1) attitudinal methods focused on collecting self-reported data about users' feelings (e.g. interview); (2) behavioral methods focused on collecting and measuring data about actions of users and/or their physiologic state (e.g. observation); (3) the combination of both attitudinal and behavioral methods (e.g. contextual inquiry). Artifact-mediated communication methods rely on UX artifacts as means of communication means for helping/improving/organizing communication and collaboration for both internal and external parties, and should be available throughout the project for involved stakeholders [7]. There are two types of artifacts: those concerning stakeholders needs (e.g. UX goals) and those concerning communicating designs (e.g. wireframes).

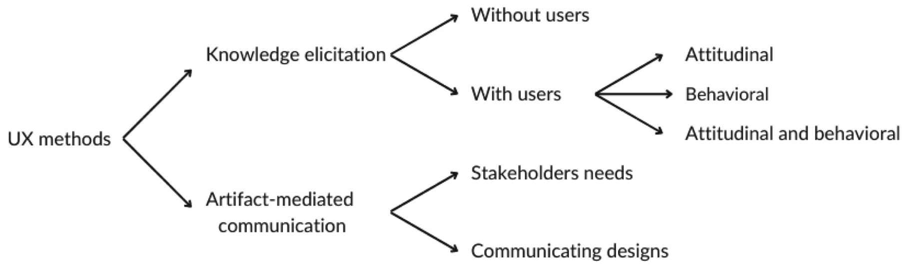

Fig. 1. Description of UX methods (variation of [26]).

3 Conducting UX Activities

The project involved UX methods with and without users (Figure 2). First, we used UX methods without users (i.e., expert review, prototyping workshops, and UX goals); detailed descriptions of expert reviews and prototyping workshops conducted until June 2023 can be found in [37]. The literature recommends using UX methods without users when resources (e.g., budget, time) are limited [19] and in case non-UX stakeholders exhibit contentious attitudes toward users and misunderstand the UX ROI [4,6]. Further, offering a venue for stakeholders to share their ideas and opinions helps minimize the risk of non-UX stakeholders acting independently in sessions with users that they themselves moderate [35].

Then, we interviewed a stakeholder from IND with over ten years' experience as a trainer and CRS designer. This experience makes them both an expert in teaching and a user of the intended system. Therefore, we consider this interview to straddle both classes of UX methods (Figure 2). The interview allowed us to gather information regarding the context of use of the intended system from both a trainer and trainee's perspective.

Finally, we used UX methods with users by conducting user testing. System evaluation generates the most enthusiasm from non-UX stakeholders [9], making user testing the most opportune UX activity to introduce methods with users.

3.1 UX Activities Without Users

Expert Review. A UX researcher (UNI) and a CR expert (IND) conducted an expert review of the GUI of a CRS creation tool, evaluating it against usability guidelines proposed by [31]. Initially, each reviewer independently assessed the relevance of every guideline for the review, evaluated the GUI's compliance with each relevant guideline, and assigned a confidence rating to their assessments. Subsequently, the two experts convened online to consolidate their evaluations of the 209 guidelines, suggesting redesign solutions in cases where they agreed on noncompliance with a given guideline. Disagreements on three guidelines prompted the collection of user feedback through a survey. As a result, 132 guidelines were deemed relevant, with 102 fully satisfied, 14 partially satisfied, and 16 not satisfied.

Prototyping Workshops. Two UX researchers (UNI) conducted 16 prototyping workshops with project stakeholders in total, five until June 2023 [37] and 11 until December 2023. The design team involved two information and communication technology (ICT) experts from UNI, two from COE, and the two UX researchers. The goal was twofold: (1) to design a GUI that would enhance trainees' learning experiences and offer valuable insights to trainers, and (2) to involve project stakeholders in HCD processes. Utilizing lo-fi prototyping facilitated rapid iterative design [19], triggering discussions on user requirements [25], and GUI layouts [27]. The team broke down the system into design chunks, hosting in-person or hybrid workshops for sketching and real-time visualization, and online sessions to refine data models. This multidisciplinary approach successfully addressed UX and functional requirements, identifying essential features for optimal CRS creation.

Definition of UX Goals. Two UX researchers (UNI) and the prototyping team defined the UX goals for trainees and trainers after consolidating the GUI design during prototyping workshops. The prototyping team defined the UX goals using the list of design sprints proposed in [29]. Setting UX goals helps establish clear expectations, prevent misunderstandings [6,23], ease decision-making, and prioritize fixes [39].

3.2 UX Activities with Users

User Tests. Two UX researchers (UNI) conducted and recorded online user tests for two me-fi prototypes, engaging with two distinct types of users. ICT and CR experts from COE and UNI observed one session for each prototype, either synchronously (in online sessions) or asynchronously (via recordings), and documented their observations using an analysis grid provided by the UX researchers.

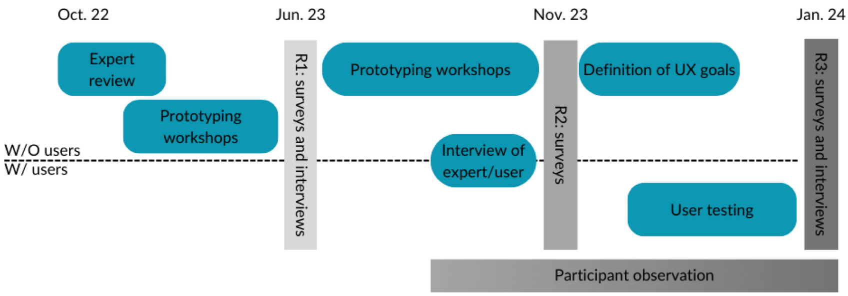

Fig. 2. Timeline of UX activities (blue rectangles) and data collection (grey rectangles) in the project. R1 refers to round 1, R2 to round 2, R3 to round 3. (Color figure online)

4 Methodology

4.1 Objectives and Approach

This case study aims to enhance the integration of UX activities in a cybersecurity project, first through UX methods without users and then with users. The specific objectives of the research include assessing stakeholders' UX literacy (RQ1), examining the impact of user involvement on stakeholders' UX literacy (RQ2), and identifying barriers and opportunities for UX integration (RQ3). We conducted an exploratory case study since data on perception of UX is scarce and contextual conditions relevant to the RQs cannot be controlled [36]. The case study is not intended for generalizing findings but rather to provide insights into strategies for improving UX integration in cybersecurity projects, as well as a set of methods for repeating the case study in other projects. Earlier findings [37] suggest that even without direct user involvement, UX methods improve stakeholders' UX literacy and collaboration, and advocate phased user inclusion.

4.2 Data Collection Methods

To answer the RQs, we carried out three rounds of data collection (Figure 2): round 1 (R1) took place after conducting exclusively UX methods without users, while round 2 (R2) and round 3 (R3) took place after the introduction of UX methods with users. In each round, we used the survey presented in [4] to measure project stakeholders' UX literacy, specifically the UX dimensions: understanding of HCD (HCD), understanding of UX (UUX), attitude toward users (ATU), awareness of UX ROI (ROI), perceived opportunities (OPP) for and barriers (BAR) to UX integration. To operate the survey, project stakeholders indicated their level of agreement with statements on a 5-point Likert scale. In R1 and R3, we conducted a follow-up interview to collect additional insights into stakeholders' current beliefs regarding UX based on the set of questions presented in [37] addressing UX integration into the software development model, impact on their roles, considerations for future projects, and desired UX-related information for decision-making. As can be seen from Fig. 2, we also used participant observation to collect observational data on non-UX stakeholders behaviors during UX activities (i.e. interview, prototyping workshops, definition of UX goals, and user testing).

The combination of survey, interview and participant observation data enables us to answer the RQs by cross-analyzing data and cross-checking findings:

- Collecting survey data on UX dimensions allows us to measure the UX literacy of each participant (RQ1)
- Collecting survey and interview data at each rounds allows us to compare participants' UX literacy before and after using methods with users (RQ2)
- Collecting interview and participant observation data allows us to identify barriers and opportunities to UX integration and analyze the demand for implementation of UX activities (RQ3).

All parties entered into a memorandum of understanding, authorizing observation data collection between parties. Prior to survey and interview, non-UX stakeholders were required to read and sign a consent form. We recorded interviews via an online video conference tool.

4.3 Participants

In R1, a total of 11 participants took part in the survey, and 6 participants in interviews [37]. As this case study focuses on UX activities using UX methods with and without users, we sampled participants from project stakeholders who took part in UX activities without and with users: two participants from UNI and two participants from COE. Participants are all males aged between 30 and 49, with a solid experience in ICT, cybersecurity, or both. Table 1 presents the involvement of each participant in rounds of data collection.

Table 1. Participant sampling. Experience expressed in years. x indicates participation in rounds of data collection (S: survey; I: interview).

Participant	Stakeholder	Experience	R1-S	R1-I	R2-S	R3-S	R3-I
P1	UNI	8	x		x	x	x
P2	UNI	7	x	x	x	x	x
P3	COE	18	x	x	x	x	x
P4	COE	13	x		x	x	x

5 Results

This section is dedicated to presenting raw results per method for data collection, namely first survey, then interview, and finally participant observation. Data cross-analysis and findings cross-checking are discussed in Sect. 6.

5.1 Survey

Table 2 displays survey mean scores assessing UX literacy per round of data collection on a normalized scale ranging from 1 (poor answer) to 5 (good answer). We reversed scores for survey statements using a negative form. Table 3 displays the UX literacy scores (median and standard deviation) per survey statement.

Overall Tendencies. Participants perceive UX differently between rounds, both positively and negatively (Table 2). All participants scored better in BAR, meaning they beliefs present a reduced barriers to UX integration. In contrast, all participants scores decreased in OPP and to a lesser extend in ATU, meaning respectively they perceive fewer opportunities to UX integration and display a negative attitude toward users.

Table 2. Participants' mean scores per round of data collection. Green depicts an increase in score between R1 and R3, red depicts a decrease between R1 and R3.

Participant	Round	HCD	UUX	ATU	ROI	BAR	OPP
P1	R1	4.25	3.67	3.75	3.75	3.75	3.75
	R2	4.50	4.17	4.50	4.00	4.75	2.75
	R3	4.75	3.67	3.75	4.00	4.25	2.50
P2	R1	4.75	3.67	4.00	3.00	4.50	4.50
	R2	5.00	4.17	4.75	4.00	4.50	2.50
	R3	5.00	4.50	3.75	3.00	5.00	1.75
P3	R1	5.00	4.50	3.00	4.00	2.50	4.25
	R2	5.00	3.00	3.00	3.50	3.75	2.75
	R3	4.00	4.00	3.00	4.00	3.75	2.50
P4	R1	4.50	3.83	3.75	3.75	2.50	3.25
	R2	4.25	3.67	3.25	3.50	3.50	3.00
	R3	4.00	3.67	3.50	3.50	3.75	2.75

Table 3. Survey statement median for each round. * indicates the scale was reversed due to negative statement.

Survey statement	R1	R2	R3
Understanding of human-centered design (HCD)			
Grounded in-depth understanding of users, tasks and environments should be a focus at the start of development	4.50	5.00	4.00
UX research is a "blocker" to the real development work*	4.00	5.00	4.50
UX research is an optional add-on*	5.00	4.50	4.50
Design should be driven by user tasks, goals and evaluation	5.00	5.00	4.50
Understanding of user experience (UUX)			
Graphic design and UX design are the same and therefore are performed by the same person*	4.00	4.00	4.00
UX is subjective and therefore cannot be measured*	4.50	3.50	4.00
UX awareness is all you need to design good user interfaces or good user experience*	3.50	3.50	4.00
Non-utilitarian concepts (e.g., joy, stimulation, aesthetics) are part of UX	3.50	4.00	4.00
Utilitarian concepts (e.g., efficiency, effectiveness, satisfaction) are part of UX	4.50	4.50	4.00
UX is essential for acceptation, adoption and trust in a product	4.00	4.50	4.00
Attitude toward users (ATU)			
Users do not need a good UX, they just need training*	5.00	4.50	4.50
Users are able to express what they want	2.50	3.50	3.00
User expectations are difficult to manage*	2.50	3.50	2.00
Users should be at the centre of product development, not just have a supporting role	4.50	4.00	4.50
Awareness of UX return on investment (ROI)			
UX activities increase product attractiveness	4.00	4.00	4.00
UX activities reduce sales and revenues*	4.00	4.50	4.00
UX activities help reduce users' need for training and technical support	4.50	4.00	4.00
UX activities increase development costs and time*	2.50	2.50	3.00
Barriers to UX integration (BAR)			
We have enough resources (time, budget, staff) for UX	3.00	3.00	4.50
We have enough skills to conduct UX activities	2.00	4.50	4.00
UX conflicts with our current software development model*	2.00	4.00	4.00
Our projects are too small to incorporate UX into our software development model*	2.00	4.50	4.00
Opportunities for UX integration (OPP)			
Some of our projects or products fail because of poor UX design*	4.00	3.50	3.00
User needs for training and technical support are important*	4.00	2.00	2.00
The overall net loss in user productivity from UX issues is insignificant	4.00	3.00	1.50
The overall net loss in late design changes from UX issues is insignificant	3.50	3.00	3.00

HCD. Overall, P1 and P2 improved their scores, whereas P3 and P4 experienced a decline. In R1, both P1 and P2 recognized that UX research does not hinder development efforts. In contrast, in R2, P4 showed an improved understanding of HCD by emphasizing the importance of understanding users, tasks, and environments at the project's outset. However, P4 exhibited reduced conviction in the indispensability of UX research and the significance of user tasks, goals, and evaluation in guiding design. In R3, P1 strongly agreed that UX research is essential, while P3's scores declined across all statements.

UUX. Following R1, P1 and P2 recognized the inadequacy of relying solely on UX awareness for designing effective UI. Initially, P4 scored poorly for the statement "UX as subjective and therefore cannot be measured", but improved by R3. In R2, P3's scores declined regarding the inclusion of non-utilitarian (e.g. stimulation, aesthetics) and utilitarian (e.g. efficiency, effectiveness) concepts in UX, and the significance of UX for product acceptance. In R3, P1 and P3 demonstrated a reduced understanding of UX by misconstruing graphic design and UX as synonymous. P4's comprehension of non-utilitarian elements in UX decreased in R3, contrasting with an improved understanding of the importance of utilitarian elements after R1.

ATU. Participants displayed a negative attitude toward users. In particular, they perceived user expectations as challenging to manage. During R2, both P1 and P2's scores improved, but declined during R3. Between R1 and R3, both P1 and P3 scores regarding users' ability to express what they want improved, while P2's score declined. Despite an improvement, this statement still received a low score from participants. Moreover, although participants generally believed that training does not substitute for the need for good UX, P4's perception on this matter declined. Overall, participants believed users should be at the center of development. During R2, P3 and P4's scores decreased to a neutral stance on this statement, and in R3, P4's scores increased.

ROI. P2's awareness of UX ROI underwent an overall improvement in R2, but this positive trajectory reversed significantly in R3. In R2, P2's score improved concerning the recognition of UX activities in reducing users' need for training and technical support. Concurrently, P3 and P4's score declined for this particular statement. However, in R3, P2's score declined for the mentioned statement, while P4's score increased. In R2, P4's score for the statement "UX activities increase development costs and time" decreased, whereas P1's score increased. In R3, P3 score for this statement increased.

BAR. P1, P2 and P3 consistently perceived fewer barriers to UX integration between R1 and R3. Only P4's scores indicated a diminished view of sufficient UX resources, contrasting with the increased belief among all other participants in the availability of adequate resources for UX. Following R1, all participants gained confidence in the design team's skills for UX activities and expressed a decreased conflict between UX and their current software development model.

Furthermore, except for P3, who already held a high score, all participants increasingly believed that their projects are not too small for UX integration.

OPP. Across rounds, participants' scores declined, reflecting diminished opportunities for UX integration within the project. Participants' scores suggest a diminishing perception of the substantial nature of user needs for training and technical support. A shared perspective emerged, except for P4, indicating a consensus that projects are not at high risk of failure due to poor UX design, and the overall decrease in user productivity from UX issues is considered minor. Additionally, P2 and P3 expressed heightened confidence in the insignificance of the overall net loss in late design changes resulting from UX issues.

5.2 Interview

Participants consistently stressed that HCD is key to understanding user needs and ensuring a positive user experience. They highlighted the importance of prototyping workshops and user testing for identifying and preventing potential usability issues. In R1, P2 and P3 emphasized initiating UX activities early to prevent the development of non-usable systems. In R2, participants advocated for the early engagement of UX experts to design features aligned with user needs, emphasizing the ongoing necessity of UX activities throughout development to build successful and user-friendly systems.

Understanding HCD and UX value led participants to desire UX integration in other projects. P1 highlighted the proximity of UX experts to users as crucial for effective design, while P4 stressed their role in bridging the gap between users and developers. P3 and P4 found UX has value when the project's technology readiness level reaches a stage involving a GUI and users. Further, P2 emphasized the contribution of UX in building relevant systems and reducing both time and development costs.

Despite stating that UX activities are time-consuming, participants, particularly P2, stressed their indispensable role in understanding user needs, thus preventing "building features that do not align with user expectations". On the other hand, P1 noted that developers might become less engaged during the design phase due to a lack of clear features to code. P3 found conducting UX and functional activities in parallel challenging, as UX and system architecture influence each other. To address time constraints, P1 suggested parallelizing activities, and P2 proposed reducing iteration size to gather frequent user feedback and commence development based on validated insights.

Conducting UX activities prompted participants to prioritize understanding users and designing for their needs over coding features. Introducing UX activities triggered a shift in perspective within software development since users "view efficiency from a different perspective" that diverges from the developers' focus on code (P1). P3 perceived translating user needs into specifications as part of their job. Meanwhile, P4 viewed UX activities as an additional task within an already diverse portfolio, considering it without negativity.

Participants derived crucial insights from UX activities to guide decision-making. Wireframes aid in understanding and meeting user requirements (P2, R1), designing workflows (P1), and ensuring a streamlined and user-friendly system (P4). Visual representations help developers better understand what needs to be implemented and should be done "before starting development" (P3, R1). Moreover, P3 articulated a desire for UX guidelines, best practices, and style guides to facilitate development. Both P3 and P4 explicitly expressed the need for ongoing user feedback to enhance and refine the system.

Ultimately, active participation in a project integrating UX has provided P1 and P2 with firsthand experiences, reinforcing their conviction regarding the value of UX. P1 noted that "I already knew that UX would be useful for the development, but during the testing phase, I was mind blown". On the other hand, P3 and P4 maintained that their perspectives on UX have remained consistent. However, during R1, P3 specifically highlighted that UX activities, particularly wireframe prototyping, aided in effectively communicating the design solution to developers. This minimizes iterations and ensures unanimous agreement on project objectives (P3, R1).

5.3 Observation

UX activities not only facilitated the design of a system aligned with user needs and requirements but also contributed to facilitated communication among team members and elevated morale. In contrast with other development activities, UX activities established an environment conducive to consensus-building among team members following the exchange of opinions (Table 4). User testing was delayed as the design team was uncertain about what aspects to test and had reservations about collecting user feedback before implementing features closely resembling the final system. Further, toward the conclusion of the prototyping workshops, participants experienced growing frustration with the substantial time invested in designing the system, attributing blame to diverging objectives.

Table 4. Summary of UX activities (Sept.-Dec. 2023) with related goals and observation of non-UX stakeholders. UX activities displayed in chronological order for methods with and without users.

UX activity	Goal(s)	Observation(s)
Interview (2x)	Gather contextual information on CRS design and execution	Team displayed high level of interest, posed insightful questions, and patiently awaited their turn during the interview
Methods without users		
Prototyping workshop	Validate design solution proposed by UX team	UNI and COE sought active participation in the design process, expressing discontent over exclusion. COE consistently opposed proposed design solutions
Prototyping workshop	Redesign solutions proposed by UX team	Team collectively shaped proposed solution. COE showed significant support and friendliness, compared to previous meeting
Prototyping workshop	Consolidation of wireframes and discussion over design chunk	Sketches hanged on whiteboard, promoting visibility and fostering discussions on common themes. Session started with major and tense discussion between UNI and COE, consuming almost all allocated time and heightening formality in conversations
Prototyping workshop	Brainstorm ideas and design a solution for a design chunk	Discussion and sketching, COE absent initially, joining later. Initial half progressed smoothly with collaborative discussions on solutions. COE's arrival prompted revisiting and clarifying the methodology, causing frustration among engaged participants
Prototyping workshop	Brainstorm ideas and design a solution for a design chunk	Presenting individual design sketches sparked discussions, creating a respectful environment that valued each team member's input.
UX goals	Agree on workflow and UI design, select UX goals and measures for user testing	Shift from one key user to another, due to disagreement within team. Tension arose from past UNI and COE frictions over project technicalities
UX goals	Agree on workflow and UI design, select UX goals and measures for user testing	Team showed signs of disengagement, needing prompts for active involvement. Some individuals seemed preoccupied with unrelated matters. Observable tension emerged between UNI and COE, stemming from past disputes initiated in meetings without UX team, later affecting UX-driven sessions
Methods with users		
User testing	Test design solutions with users	Team actively took notes and demonstrated a keen interest in user feedback, recognizing its value and significance

6 Discussion

6.1 UX Literacy

Introducing UX methods without users and then UX methods with users did not consistently improve UX literacy. The design team's perception of UX activities was influenced by factors like the need to start development and meet project milestones. P3 and P4, both responsible for software development, experienced a decline in their HCD scores. Statements emphasizing the importance of understanding user tasks and the environment at the project's onset declined, with both individuals believing that UX research hindered actual development work. During interviews, participants recognized the importance of understanding user needs. However, they also raised the challenges related to conducting UX activities concurrently with development. Participants stressed the importance of allocating enough time for software development and running UX activities in parallel. However, the absence of a clear link between UX activities and developers' responsibilities, such as coding features, presented a challenge and reduced engagement in UX activities. For instance, the lack of a clear connection between defining UX goals and subsequent development phases resulted in decreased engagement, requiring interventions to prompt active participation. Conversely, UX activities with a clear link to feature building (e.g. interviews) or issue identification (e.g. user testing) led to heightened participant engagement.

The non-linear nature of learning also hindered consistent UX literacy improvement. For instance, in R2, P1 and P2 scored high for the statement indicating that managing user expectations is easy (ATU), after participating in a UX activity in which a user from IND effectively conveyed the challenges of their job and suggested potential improvements. However, during R3, user testing uncovered unexpected design flaws and, during a follow-up interview, users occasionally made statements that contradicted their actions during user testing. This experience might have reinforced the widespread belief among developers that involving users is time-consuming because users are unable to express their needs or provide valuable insights during evaluations, as documented in [2] and aligns with the results of the survey statements. Our findings suggest that these experiences may have prompted P1 and P2 to recognize that designing good systems entails more than just thinking about users during the design phase and asking them direct questions. Consequently, managing user expectations became challenging, as indicated by the decline in P1 and P2's scores for that statement. The same experience might have led P4 to conclude in R3 that good design alone may not be sufficient, and users may require training (ATU).

The prevailing negative attitude towards users is concerning, considering users' role in shaping effective interactive systems [30]. Further, the challenges encountered in systematically testing and validating requirements with users, as evidenced by our extended timeline (Figure 2), align with observations in [13]. The extended period of upfront design becomes a collaboration challenge [21], leading non-UX stakeholders to perceive UX as challenging due to its resource demands [35] and leading to tensions within the team regarding the amount of time dedicated to UX activities. Yet, participants demonstrated a pronounced enthusiasm for user feedback to improve the system. Survey findings underscore participants' strong belief that users should be a primary focus in the development process and that users need good UX, not just training. During interviews, participants mentioned wanting user feedback to inform decision-making, refine system design, and validate ideas in real-world settings. The design team's active engagement during the user testing phase underscores their commitment to valuing and incorporating user feedback throughout the development lifecycle.

6.2 UX Integration

Although integrating UX methods without and then with users did not uniformly improve UX literacy, it contributed to reduced barriers and increased confidence in the team's ability to conduct UX activities. Prototyping workshops encouraging discussions with developers helped participants to see the value of UX [2]. During the interview, P4 expressed appreciation for the prototyping workshops' methodology, highlighting how sharing ideas and consolidating design solutions collaboratively helped achieve consensus and ensured consideration of all ICT and UX requirements and constraints. Our findings, similar to [35], highlight the importance of fostering a safe environment for non-UX stakeholders. This environment encourages experimentation with UX methods with minimal barriers, gradually incorporating user-centric approaches. Observation notes indicate a more harmonious and cooperative atmosphere during UX activities, positively contributing to results and project progression when compared to activities without UX involvement. The engagement of developers during prototyping workshops facilitated the transition toward a human-centered mindset.

Participants' growing confidence in their ability to leverage UX within the current development framework reflects a positive attitude toward UX integration, which is further supported by the diminishing opportunities for UX Integration (OPP) scores observed across rounds. The perceived significance of user needs for training and technical support diminished, alongside apprehension about project failure or substantial decreases in user productivity due to UX issues. The decrease in OPP scores appears to be linked to the project's robust UX integration and suggests a plateau in the incidence of potential UX integration opportunities. Prototyping workshops played a pivotal role in gradually introducing UX practices and principles. However, the efficacy of conducting such UX activities hinges on participants' sufficient UX literacy, as observed in [28]. During the interviews, participants noted the project's immediate integration of UX activities deviates from their usual practices, expressing appreciation for this approach. Despite acknowledging potential cost and time implications (ROI), participants deemed UX activities key to project success. The presence of UX practitioners as intermediaries fostered confidence in system development alignment with user needs. In interviews, both P1 and P2 expressed pre-existing belief in the potential of UX. However, the project served as a practical demonstration, highlighting the feasibility and desirability of seamlessly integrating UX into the development process.

From R1, participants recognized the importance of understanding user needs and creating relevant systems. In interviews, participants explicitly stated that UX activities are indispensable; without them, there would be a lack of clarity on what constitutes user requirements and therefore on what needs to be developed. Additionally, participants acknowledged that developers often prioritize technical aspects, neglecting user concerns. This aligns with previous research [2], which notes that developers, even when recognizing the importance of usability, may maintain a "developer mindset", prioritizing programming aspects, technical challenges, and product functionality over UX considerations. The continual involvement of UX experts throughout development was crucial in steering the design team away from this mindset, which is supported by HCD high scores, particularly for statements emphasizing the vital role of UX research and advocating for development guided by user tasks, goals, and evaluation.

Conducting UX activities facilitated effective communication within a multidisciplinary team with diverse objectives, fostering consensus on development priorities. In line with [1], our research underscores the necessity of open, inclusive, and reflective discussions with developers to integrate UX successfully. UX cannot operate in isolation but must be collaboratively built with developers [1]. Our study aligns with [39], indicating that involving developers in design solutions, integrating them into user requirements, and sharing UX artifacts contribute to a shared understanding of the design vision. This collaborative approach helps address the common challenge outlined in [21], where a lack of regular communication between developers and UX designers results in a perceived misalignment between development and UX work. Contrastingly, participants emphasized the importance of understanding user needs and requirements in building and supporting design solutions. The interviews underscored the importance of user feedback, particularly through user testing. In R1, participants primarily highlighted the significance of gathering user feedback to inform the design process, whereas in R3, they further emphasized the crucial role of user testing in identifying design flaws, understanding overlooked aspects, and providing a reality check.

6.3 Limitations and Strengths

The study exhibited characteristics inherent to exploratory case studies and qualitative research, including a lack of control over the setting, a limited sample size, a reliance on narrative data, and a lack of intent to statistically generalize findings or demonstrate cause-and-effect relationships [36]. Moreover, the authors' active involvement in all study aspects, coupled with a year-long engagement with participants, may introduce bias. Potential biases were mitigated by employing the same survey and interview guide throughout the study [10]. Further, the authors maintained their role as UX practitioners throughout the mission.

This study's strength lies in its practical mixed-method approach, blending observational data with surveys and interviews to reduce bias. Cross-checking findings, maintaining a longitudinal approach, and focusing on a single group enables a thorough exploration of phenomena and identification of evolving patterns. The presence of all participants in all rounds ensures a representative sample and facilitates tracking perception changes and attitudes toward UX.

7 Conclusion

This exploratory case study focused on integration of UX methods with and without users into a cybersecurity project aimed at creating a graphical user interface for cyber range scenarios. We studied how non-UX stakeholders perceive UX after using UX methods without users and then UX methods with users. We tracked the changes in their perception of UX by collecting data through surveys, interviews, and observations at three key points: after using UX methods without users, after an interview with an expert, and after introducing UX methods with users. Our findings indicate participants perceived the added value of UX integration, as it helped understanding user needs, reducing development costs and time, facilitating decision-making, and improving communication of design decisions. Additionally, UX contributed to improved team communication and morale, as evidenced by [19]. Introducing UX at the project outset, first through methods without users and then through methods with users, aids non-UX stakeholders to progress toward a human-centered mindset, also observed in [1,35].

Future work in the project includes collecting data using the same methods at different intervals to track the changes in UX perception among non-UX stakeholders within and throughout the same project. Additionally, data collection efforts will extend to non-UX stakeholders who have limited involvement in UX activities. Other future work includes the replication of our protocol across multiple projects and teams. The aims are to (1) validate the data collection methods and (2) determine if introducing UX methods first without users and then with users helps non-UX stakeholders adopt a more human-centered mindset. A similar multiple case study approach will enable identification and pattern analysis from both similar and contradictory results, providing insights for the development of a theory for seamless UX integration.

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