Finding Common Ground: Design Cards Supporting Mutual Learning in Co-design

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***Abstract*—This article explores how design cards can support mutual learning between researchers in design and non-designers in the fuzzy front end of a design process. We present a case where we created and used bespoke design cards in a co-design workshop with educators and students at a medical training center in Norway. The goal of the co-design process was to design a mixed reality training solution for simulating medical procedures. Findings suggest that the cards enabled non-designers to have a say in the design process, facilitated for mutual learning across disciplines, and broke down barriers for collaboration. The cards enabled active participation and empowered the medical educators to take a first step from consumers to designers of information and communication technology (ICT) solutions. The paper contributes to the growing body of literature on design cards, co-design and participatory design, and we discuss the potential of design cards as boundary objects that can facilitate co-realization of ICT solutions across professional boundaries.**

Keywords-design cards; co-design; participatory design; design games; mutual learning.

I. INTRODUCTION

Co-design has become an important approach in the design of ICT solutions in the past decades, and the methods and tools that can be used in the design process has grown exponentially [1]. In this strand of design, collective creativity between designers and people not trained in design practices is a core activity [2]. Designers, developers, end-users, and stakeholders come together in the various phases of a design process.

To secure active participation, Participatory Design (PD) is another design approach where users are invited in as partners equal to designers and developers throughout the different phases of design [3]. Bratteteig and Wagner [4] explain that the power to decide the scope and the shape of a technical solution needs to be shared with those who will use it. Principles like having a say, decision-making, mutual learning, and co-realization lie at the very core of PD. Having a say enables users to influence the design process by having their voices heard in the design decisions being made [5]. With mutual learning, the people involved in a design process should learn from each other's expertise, work context and practice. Bratteteig, Bødker, Dittrich, Mogensen and Simonsen [5] also explain that involvement, or co-realization, is important. Here, visualizing possible solutions is a priority as it may be difficult for different users to imagine design possibilities. While involving users as active participants in a project can lead to more conclusive design outcomes, there are several issues that can arise when researchers, designers and users collaborate. Co-design requires creative initiative from the entire collaborative team, and a lack of design expertise can make the users feel like they can't contribute meaningfully to a design process [6]. One explanation is a lack of familiarity with design processes and the terminology used by expert designers. If the users are to successfully be part of a design team they must be given the right tools. These tools must allow them to express themselves without having to adopt specialized design languages. To ensure constructive and meaningful collaboration, researchers and designers have created various methods, tools and techniques that can be brought into the design process [7]. These are used to provide inspiration to the team and to facilitate collaborative activities. They are especially valuable in early design phases where the object of design is still unknown and the design problems are still being explored.

One such tool is design cards. Design cards are used for fostering creativity in design processes, and have been designed for a variety of different purposes, contexts and domains [8][9]. Described as tools for generating ideas and new design concepts, design cards are reportedly used in domains like education, gaming, in exploring social issues and design of new ICT solutions [10]–[12]. Design cards can support design dialogues and discussions, and can structure the design process by making the process visible and less abstract [9]. Physical, tangible cards are easy to use and manipulate and can act as a common reference between participants.

The aim of the study is to investigate collaboration and creative thinking between researchers in design and non-designers in the early phases of a design process. Together with educators at a medical training center in Norway, we explore the design of a mixed reality training simulator. By mixed reality, we mean combining the physical environment with virtual elements to create immersive experiences. The center wants to implement virtual simulations that enable students and medical practitioners to train on procedures that are hard to simulate with the equipment already available at the center. To facilitate for active participation and meaningful design dialogues, the researchers created the MixED design cards and used them in a co-design workshop with participants from the medical center. The MixED card set contains 46 bespoke cards divided into five categories

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tailored to the specific context of medical practice and virtual simulations supporting that practice. The goal of using these cards in a co-design workshop was to investigate how the cards could 1) enable non-designers to contribute meaningfully to a design process, and 2) facilitate for collaboration and mutual understanding of the design problem. Based on this, we ask:

RQ: why do a deck of bespoke design cards support researchers in design and non-designers in finding common ground?

The paper is structured as follows: Section II provides an overview of design cards as a tool for co-creativity. In Section III, we explore important principles in co-design and PD. Section IV shed light on the theoretical concept of boundary objects. In Section V, we describe the methods used in this study, and Section VI gives a detailed account of the co-design workshop. Findings from the study are summarized in Section VII. In Section VIII, we discuss what our findings mean for the design community. Lastly, Section IX will summarize and conclude the study with future works.

II. DESIGN CARDS SUPPORTING CO-CREATIVITY

Researchers have created various tools and techniques to successfully bring future users into the design process, including probes, mock-ups, prototypes, design games and toolkits [1][7][13][14]. Design games are promising approaches that can structure design activities [14]. Toolkits have been created for PD activities and are considered appropriate for engaging and inspiring non-designers [1]. In the front end of design, toolkits and design games are used to facilitate collaborative activities and support non-designers in expressing ideas about how they want to live, work and play. In reviewing analogue ideation tools, Peters, Loke and Ahmadpour [13] found that card-based tools, like card decks and card games, have become popular in collaborative ideation with future users. Design cards are accessible, analogue and tangible. They are instantly recognizable and can therefore serve as shared references between groups of diverse people [15]. Previous studies illustrate how design cards have been used in many contexts and domains, including exertion game design [16], tangible designs [17], and for playful experiences [18]. By presenting keywords, pictures and questions the cards facilitate for creativity by acting as a source of inspiration [17][19]. Cards with these types of cues (keywords, pictures, and questions) can lead to a more tangible and applicable transformation of theory [17][20]. Through these cues, design cards can provoke new contextual perspectives that extend beyond personal experiences [19]. Additionally, their tangibility can support integration with objects such as notes and sketches [21]. According to Bornoe, Bruun and Stage [8], design cards can be used to 'rephrase abstract frameworks into something more operational' [ibid, p. 2]. Design cards can help identify design opportunities prior to designing the product or service in the early phase of design and can either be general or tailored to specific contexts and use cases.

As an endeavor to classify design cards, several reviews of design cards have been made [9][13][22]. Reviewing 18 design cards, Wölfel and Merritt [9] divide the cards into three categories constituted by purpose and scope: general (used for open-ended inspiration), Participatory Design (used to facilitate collaboration) and context specific or agenda driven. Of the 18 decks, six of them were used in PD, but with varying degree of customization and rules of use. A newer classification was made by Roy and Warren [22]. In analyzing 155 design cards they propose six main (but overlapping) categories: 1) creative thinking and problem solving, 2) domain-specific design, 3) human-centered design, 4) systematic design methods and procedures, 5) team building and collaborative work, and 6) future thinking. The latter three is proportionally smaller than the first three. After a validation of the classification, only four decks were presented in the category 'team building and collaborative work', including the Group Works, Totem cards, SILK, and Bootleg Method Cards. Further, they explain that within participation and collaboration, three subcategories were found: 1) direct end-user participation (15,5%), 2) help designers identify user's abilities, needs, and wants (11,6%), and 3) facilitate collaboration between professionals and experts (34,8%).

In our search, we have found that design cards are used for co-realization and visualizing future design possibilities. According to Myers, Piccolo and Collins [10], design cards can also democratize knowledge, support collaborative design, and can enable more engaging design experiences and results. They do, however, report limited studies presenting methodologies for collaborative design cards. Studies exploring why design cards can facilitate for collaboration in early design phases of ICT solutions are scarce, especially regarding mutual learning and collaboration across professional boundaries.

III. SECURING PARTICIPATION AND CREATIVE INITIATIVE

Over the last decades, commercial businesses and design and research communities have recognized the importance of the user's needs [6]. User-centric design approaches have been applied in design processes to involve future users in the design of, e.g., ICT solutions. Two strands of user-oriented approaches that involve users in a larger degree is co-design and PD.

In co-design, future users are given room to inform, ideate and conceptualize design solutions, bringing their domain expertise into the design process. Here, researchers, designers and non-designers come together, letting collective creativity influences the design process. These collaborative endeavors are increasingly undertaken early in a design process, in what Sanders and Stappers [6] refer to as the 'fuzzy' front end of design due to the '[…] ambiguity and chaotic nature that characterise it' (ibid, page 4). As illustrate in Figure 1, the design outcome is here often unknown and can be informed and explored alongside future users.

PD evolved as a design approach in Scandinavia in the 70's, and centered around joint-decision making in the workplace empowering resource weak stakeholders (usually local trade unions) [6][23].

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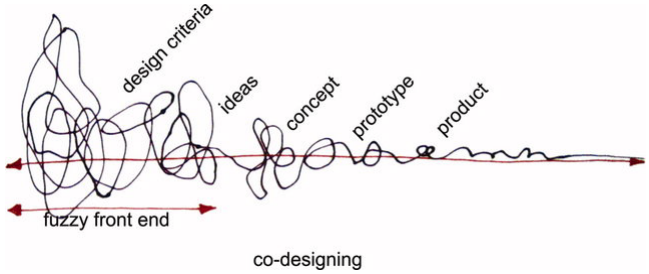

Figure 1. Sanders and Stappers [6] illustrating the co-desing process.

Researchers engaged in PD want to ensure that future users are given more influence and initiative in the design and are seen as 'partner' in the process. The motivation for choosing PD as a design approach varies from being a political position, where users have the right to influence a design solution, to a more pragmatic view where allowing users to inform and participate in the creation of design makes it easier to create suitable design outcomes [3]. Over the decades, the research community has elevated several core principles important for a successful PD process. At the heart of PD lies a premise that those affected by a design solution should 'have a say' in the design process [5][23]. This has consequences for how the process is organized and which methods and tools are made available to the user partaking in the process. Design is about decision-making, and the choices we make during a PD process are shared with future users [4]. PD opens up for collaborative decision-making which Bratteteig and Wagner [4] explain are the exercise of shared power. This shared power, alongside a shared and mutual understanding, regulate the decision-making process. Mutual learning is another guiding principle in PD. Here, mutual respect between two collaborative partners is achieved by letting them learn about each other's mindsets and work practices [5]. Researchers and designers need to learn about the domain and activities of the participants and non-designers in the project, and vice versa. The partners need to build trust and share knowledge across fields of practice. Through mutual learning and interdisciplinary knowledge sharing, the collaborative team can generate ideas and visions about new design solutions and practices. Another principle in PD is co-realization. Here, prototypes, tool and techniques play an important role in visualizing possible design solutions [5]. Tangle artifacts are used to help the team make appropriate decisions.

Bringing together stakeholders with potentially diverging perspectives can challenge participation [7]. The research communities engaged in co-design and PD have shed light on various challenges and issues that can arise in settings of collaborative decision-making [3]. Sanders and Stappers [6] present several issues regarding co-design and society's reluctance to adopt the approach. Firstly, co-design principles are in direct opposition of the power structures in many business communities; hierarchies and control are cornerstones in many manufacturing companies and asking them to give up this control have been met with reluctance. Secondly, in adopting co-design perspectives one must believe that all people are creative. Many people find it difficult to think of themselves as creative and are therefore reluctant to take a more active role as a co-designer in a design project. A successful co-design process requires creative initiative from the entire team and the participants must fully commit to the role.

Securing participation and creative initiative through design artifacts that can support future users in visualizing possible design solutions is therefore important. Enabling future users to communicate and discuss design problems and outcomes through, e.g., mock-ups and prototypes has been important from the very beginning of PD. These design tools lessen the need for users to adopt the specialized and technical language of designers [3].

IV. THEORETICAL CONCEPT

Due to divergent perspectives among stakeholders, maintaining coherence across different practices can be difficult. In studying these differences, Star and Greisemer [24] propose the concept of boundary objects as a key for enabling cross-disciplinary collaboration. Boundary objects are objects or artifacts that serve as a means of communication and translation between interdisciplinary groups. They describe boundary objects as

> …objects which are both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across site (ibid, p. 8).

Boundary objects can be both abstract or concrete and can have different meaning depending on the social world observing or using them. Their structure should, however, be common enough to be recognized by multiple worlds. They are external *representations* of reality which simplifies an issue so that it more easily can be communicated [25]. In their work on boundary objects, Morris et al., [26], referring to the work of Zeitlyn [27], shed light on a three-way relationship between 1) what is being represented (reality), 2) the representation itself (the boundary object) and 3) the intentions of the maker of the object and the audience. While boundary objects are created with a specific intention, they take on a separate identity once produced. A person's interpretation of a boundary object reflects their perception of reality, and the maker of the object can not predict how the object will be used and interpretated by a user.

Dalsgaard, Halskov and Basballe [28] provide an overview of the work on boundary objects done by the research community. Here, they explain how Bertelsen [29] used the concept of boundary objects to explain how design artifacts act as mediators between groups in a design process, and how Bechky [30] introduced the concept of *transformative* boundary objects. With transformative boundary objects, knowledge is shared between professional boundaries and members of one group reaches a new understanding of a problem or topic based on the knowledge shared by the other group, altering and enriching their world view. It expands the understanding of a process or product, and this again enhances the person's understanding of his own work, shedding new light on the world.

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Jean et al., [31] explain how serious games (games intended for other purposes than entertainment, e.g., for education and training) can function as a catalyst for *boundary crossing* where stakeholders with different professions, ideologies and perspectives collaborate. Here, boundary objects, in the form of artifacts, people or even institutions, play an important role in bridging the space between actors, and act as a mean to align different perspectives. A balance must, however, be found between rigidity and flexibility so that the object can unite different interests and also encompass the many practices they seek to unite. Morris et al., [26] suggest using structured boundary objects in the form of a board game to facilitate exposing and reconciling trade-offs between stakeholders with different incentives, perspectives and values in local agri-food systems. They explain how games can both organize knowledge and produce comparable visual outputs useful for communication.

V. RESEARCH METHOD

In this Section, we give an overview of the research method, including research activities like project meetings and card-making activities. We describe the methods of data collection and analysis, as well as ethical considerations for the study.

A. Research method

In this study we use qualitative methods when inquiring into how and why design cards facilitated for interdisciplinary co-design of ICTs.

1) Data collection

Data was collected through various activities including formal project meetings, direct observation during physical simulations, an online workshop, and a pilot workshop using a first draft of the design cards. Lastly, a co-design workshop using the MixED design cards was held with medical educators and students.

a) Formal project meetings

Three formal project meetings were held between the 17th of June 2021 and 21st of March 2022 between the researchers and three stakeholders from the medical center. The stakeholders were a senior lecturer and educator (early 60s), a facilitator, student advisor and educator (late 30s), and the third was an associate professor (early 50s). The purpose of the meetings was to establish a shared understanding of the project and the fields of practice as a basis for a project plan developed by the first author. Here, note-taking were used to record ideas and discussions. In the third meeting, held online due to Covid-19, were held with the first and second author and the three representatives from the medical center. Data was collected through written notes and a screen recording which was later transcribed.

b) Observation during physical simulations

Unstructured direct observation was made of two physical simulations at the training center. Simulation #1 was a student-driven simulation held on the 1st of December 2021. This simulation included eight Bachelor students in paramedic, two students in continuing education in emergency nursing and two educators facilitating the simulation. The first author followed the group of students for two hours during three different medical scenarios. Data was recorded through field notes, and from informal conversations with the facilitators and three students. The notes were written into the researcher's field diary. A follow-up, semi-structured formal discussion between the first author and one of the facilitators were also held.

Unstructured direct observation was also performed during simulation #2 on the 10th of March 2022. Here, the first and second author observed a full-scale emergency drill involving educators at the medical center, around 100 paramedic and specialist nurse students, medical workers from a Norwegian hospital, emergency services in the municipality and Red Cross. The researchers followed the drill for two hours, and recorded data in the form of individual note-taking and conversations between the researchers documented in a memo by the first author.

The primary goal of observing these activities was to understand how the physical simulations were conducted and their desired learning outcomes.

c) Card-making activities

The design cards were made in an iterative design process using collaborative brainstorming between the first and second author. The brainstorming was based on several activities including 1) project meetings with the three stakeholders in the project, 2) direct observations of physical simulations, 3) e-mail correspondence were stakeholders expressed what type of scenarios they found suitable for a mixed reality simulation, and 4) informal conversations and discussions with the participants. The first and second author held six design workshops lasting between 1 to 4,5 hours. In total, 19 hours were spent designing the cards. In addition to the information from the activities, the researchers took inspiration from previous research on design cards, like the PLEX-cards and the Ideation Decks [18][32], and a similar study undertaken by the third author in another research context. In total, 46 cards divided into five categories were created. The categories, as illustrated in Table 1, include 1) simulation, 2) medium, 3) interaction, 4) learning outcomes and 5) challenges. As illustrated in Figure 2, the layout of the cards is simple: each card has a written label and an abstract or figurative image meant to spark inspiration and individual interpretation. The images were downloaded from royalty free services like Unsplash. The researchers also created rules for the design cards stipulating how the cards should be used in a workshop. These are further explained in Section VI.

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TABLE I. CATEGORIES AND LABELS IN THE MIXED DESIGN CARDS

Category	Cards and labels
Scenario	Traffic accident, drowning accident, fire accident, home nursing, psychiatry, accident site, prison, falling accident, inside the body, overdose, heart attack.
Medium	2D images (slideshow), 2D video, 3D video, 360-video, Augment Reality (AR), Virtual Reality (VR), Mixed Reality (MR).
Interaction	Speech, gesticulating, holding objects, movement, looking, feeling, buttons
Learning outcomes	Empathy, time management, stress management, collaboration, multitasking, communication, physical skills, technical skill, confidence, focus, problem-solving, critical thinking, adaptivity, leadership
Challenges	How to perform this individually? How to perform in a group? How does an instructor fit in? There is too little time. Too small or big space. How does teamwork work? How does a marker fit in?

d) Pilot workshop

The three researchers held a pilot test of the design cards in a workshop with ICT students. The workshop was facilitated by the first and second author, with the third author joining the students in testing the cards. Here, data was collected through note-taking during the workshop and in the follow-up discussion with the students.

a) Co-design workshop with desig cards

A two-hour co-design workshop with five educators and facilitators from the medical training center, three bachelor students and the researchers was held on the 1st of March 2022. Data was collected through audio recordings, pictures, note-taking, follow-up conversations with participants, and the design outcomes from each group in the form of Post-it notes and paper sketches. The workshop is further described in Section VI. The primary goal of this activity was to use the design cards as a generative tool to 1) ideate and conceptualize content for a mixed reality training room and 2) to facilitate collaboration between educators, students, and researchers.

Figure 2. Layout of the design cards.

2) Data analysis

Data from the observations, project meetings and workshops were analyzed by the first and second author. The first author used data from memos, the research diary and audio and video recordings to categorize important findings that would later be made into the cards.

The second author used thematic analysis when transcribing and analyzing the data. Thematic analysis is a method used for analyzing qualitative data by sorting and coding the data, and create relevant themes across datasets [33]. The process of analysis is illustrated in Table 2 and includes 1) organizing and preparing the data for analysis, transcribing the audio and video recording, 2) coding the datasets, 3) winnowing the data, 4) reviewing categories, 5) generating themes. Themes are data that correlated to each other from multiple sources, like a participant's statements and actions in the workshop. This inductive process ensured the finding of relevant and related information across multiple datasets.

TABLE II. THE PROCESS OF ANALYZING DATA

Steps	Activities	Codes and themes
Preparing data	Transcribing audio and video recordings.	
Code	Color-coding all the data with wider categories.	Codes: working together, explanation, annoyed or angry, creative, impressed, struggling, amused, decisive, personal experience
Winnowing	Winnowing the already color-coded data two times. Narrowing and choosing important finings.	
Reviewing categories	Defining and renaming categories, combining categories,	Positive experience: amused, intrigues/curious, engaged, impressed. Negative experience: confused, having difficulties, annoyed. Collaboration and group dynamic: working together, creativity, decisive. Previous experiences: own experiences, working together, engagement.
Generating themes	Themes emerged for further analyzing the categories	Creative collaboration, own experience, stakeholder experience, technology domain knowledge, health domain knowledge, use of domain-specific terms, understanding the rules [in the workshop], feedback.

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B. *Research ethics*

This study was conducted following institutional guidelines for research ethics from Østfold University College and the Norwegian Center for Research Data (NSD). Data management and consent forms used in the project were approved by NSD (NSD number 788872). Participants partaking in activities where images, video and audio recordings were used for data collection were informed of the purpose of the study and how the data would be used. Participants gave written approval regarding data collection and analysis, permitting information to be used in scientific publications and other dissemination work. To ensure the confidentiality and privacy of the participants, the data collected during the workshops and meetings was stored in a secure location not accessible to the public. Only the three researchers involved in the study has access to the data, and participants were anonymized in the analysis.

Direct observation of the physical simulations took place without informed consent from participants. The purpose of this observation was to gain insight into the everyday life of medical educators, students, and other partitioners. Data collected during these activities are in the form of written notes and memos, and no personal or identifiable data were collected.

VI. USING DESIGN CARDS IN A CO-DESIGN WORKSHOP AT THE MEDICAL TRAINING CENTER

This study aims to explore the design of an immersive and virtual training simulator for the medical training center. The center is currently equipped with manikins, physical simulators, welfare technology, and medical equipment. Personnel at the center want to investigate how a now empty room can function as a virtual training simulator for students and medical practitioners. The goal of the project is to explore how the training simulator can be designed to support learning opportunities by allowing users to practice different sequences of medical events in a safe environment. Together with medical educators and facilitators at the centers, we explore design solutions for this virtual training simulator. The MixED design cards and rules for the co-design workshop were created based on several project meetings between participants and researchers, direct observation of physical simulations, and collaborative brainstorming between the first and second author. The card deck consists of 46 cards divided into five categories. Each card has a written label and an abstract or figurative image meant to spark inspiration and interpretation.

In this two-hour co-design workshop, nine participants were divided into three smaller teams. Two of the teams had two medical educators or facilitators (age mid-30s to early 60s) and one student (in their 20s). In the last group, the third author partook as the third member to get equal groups. The first author facilitated the workshop, beginning with a 15-minute introduction to the design cards and the rules of the co-design activity. The workshop was divided into four phases: individual assignment, group assignment 1, group assignment 2, and presentation of scenarios.

In the individual assignment, each team member selected one random card from each category (except a challenge card which were introduced later). As illustrated in Figure 3, Post-it notes and paper sheets were used to write down ideas about possible medical scenarios in a rapid idea generation activity. This activity lasted five minutes and was repeated three times.

In the second and third phase, the team got together and discussed their ideas, selecting and possible merging the ideas into one scenario. In phase three, we introduced the challenge cards. The participants first picked one challenge-card and repeated the processes three times over the course of 15 minutes. This challenged them to discuss organizational issues with the scenario they were currently working on.

As illustrated in Figure 4, each team presented their scenario in front of the other groups at the end of the workshop, prompting a discussion among the different teams.

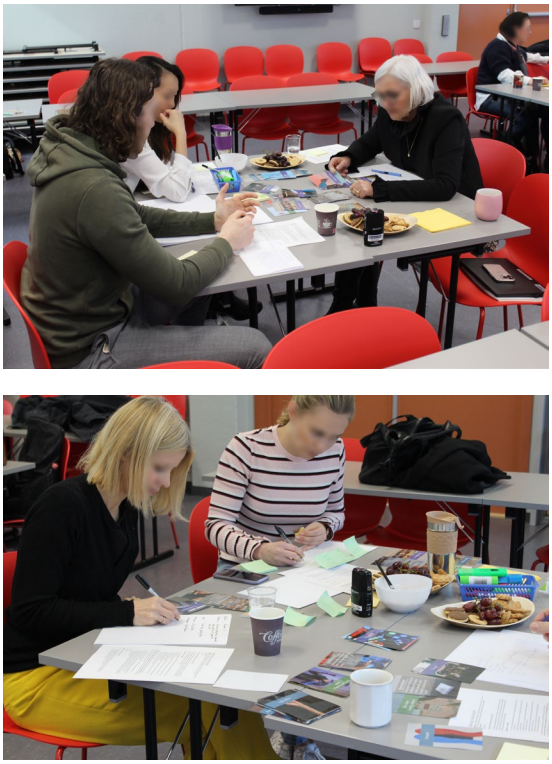

Figure 3. Participants discussing and generating ideas with design cards in the workshop.

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Figure 4. Participant presenting the scenario.

VII. FINDINGS

The findings are presented in two parts. First, we cover the insights gained from the initial design phase leading up to the creation of the design cards. Here, we identify misunderstandings and design opportunities from the fuzzy front end of the design process. We then present the findings from the co-design workshop using the design cards.

A. The fuzzy front end

One of the more evident discoveries from the early design phase was the language barriers that divided the two different practices. We spent a lot of time trying to explain different domain-specific concepts. Concepts that we had already covered in previous meetings were brought up again in the second and third project meeting. One of the participants expressed a lack of understanding and confusions around terminology in the project plan. There were concepts from ICT that medical practitioners found hard to understand, as well as concepts from their practice field that the researchers used incorrectly. The team strived (and failed) to establish the expectations of the collaboration early on. There was no clear consensus on what the researchers expect from the medical practitioners, and vice versa. This was an issue long into the project, where misunderstandings about practices played a large role. We failed to establish a common ground in initial project meetings. The educators at the center alternated between different ICT concepts during this early phase, discussing different technical and physical solutions and requirement. Parallel, the researchers tried to explain that they wanted the practitioners to participate in a co-design process where we explore requirements together through a series of design workshops. Later, in the online project meeting, the participants discussed two different projects that they wanted to simulate. In the first one, they wished to simulate events that are difficult to train on with the equipment they already have (e.g., a fire in a tunnel or a highway car accident) using projector technology. The other project should simulate internal bodily functions, where the student can "stand" inside the body and observe blood levels and explore what happens inside the body, e.g., during an infectious disease. While discussing these two ideas, one participant commented that the important thing was to decide what technology should be installed in the room, and what type of requirements was needed to rig and equip the room, saying:

> …What kind of projectors should we have, what kind of PC should we have. In other words, all these physical prerequisites, that is what needs to be in place first before you start thinking about different technologies. […] But in my understanding, the first thing we really have to do is figure out how to rig this room. And I'm missing that in the project plan. #1

The participant explained that they wanted the ICT solution up and running as soon as possible, and wanted the researchers to start investigating possible hardware and software applications that could be bought or developed. One researcher stressed that the technical requirements would be made clearer later in the design process, after we've held collaborative workshops as described in the project plan. The design workshops would clarify what they need this room and the training simulation to be, and then we could decide on which technology would be best suited to support this. As there were disagreements between the participants on what they wanted the room to be, the second author asked them for clarification, where one of the participants answered '[I] don't think we disagree on what we need, but from my perspective it's what we need first'. #1

As the design process progressed, we also found ample opportunities to learn from each other's different experiences and expertise. In the second project meeting, a lot of time were spent cleaning up the terminology to find common ground and a shared understanding. For example, one participant asked what the researchers meant regarding 'Mixed Reality'. Explaining and discussing this, we agreed upon a definition. Likewise, they explained terms like training modules, simulations and simulators, which the researcher had used incorrectly in regard to how these were use in the context of medical practice. Here, they also expressed wanting an adaptable ICT solution that supports continuous creation of training simulations. A platform that could evolve over time so as not to be insufficient in a year or two. During the online workshop, participants partook in brainstorming activities with the researchers regarding the content of the simulator. We already had a list of different scenarios sent in an earlier e-mail correspondence between participants and researchers (e.g., home accidents, drowning accidents, noisy environments). Early in the online meeting, they also expressed wanting state of the art immersive ICT solutions, like Augmented Reality (AR) and Virtual Reality (VR) and reflected on what medium would be best suited for different types of content. After discussing logistics and organizational challenges with these technologies, they further considered more cost-effective solutions, like using standard imagery or 360 video in a CAVE-system. We also discussed interaction types, management of large groups of students, and platform usability.

After clarifying disagreements about ICT requirements and what they wanted from this system, we (to some degree) found a common ground. Participants expressed wanting to focus on projectors with interactive sensors. They wanted to

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have scenarios that multiple students from different medical fields could use to train on situations that are hard to simulate or teach with the equipment they already have. They also wanted a solution that mixed the physical and the virtual environment. We also agreed upon the need for a user-friendly solution as the students are most likely to operate the simulation themselves.

B. Using design cards in the co-design workshop

Using the MixED design cards in the co-design workshop prompted both positive and negative feedback. Most of the participants were not familiar with design workshops using design cards to ideate and generate design solutions. Many expressed confusion early in the workshop and when we introduced the challenge-cards in the third round. It became evident that the concepts had different meanings and connotations based on the background of the participant, which led many participants to ask the facilitator for clarifications. In the audio recordings, one participant that did not understand one of the labels are heard saying 'I don't know the subject. I just have to come up with something' #3-3. Some participants expressed annoyance about improper use of labels. One example being the card suggesting using Mixed Reality as a medium. Here, the designer used the abbreviation MR, which in medical practice in Norway refers to MRI scanning. Another participant said that

> …what is the difference between [the label] and the practical skills? Yes, [the researchers] does not know the concept here. #3-1

There was confusion about the rules of the card game at the beginning of a new round, e.g., when one participant drew the same card twice. This was not specified in the rule-sheet they were given.

Although there was confusion around the labels and rules at the beginning of a new round, many participants quickly got comfortable using the cards to generate ideas. Many displayed both engagement and enjoyment when creating different scenarios. This is seen during the intended five-minute break, where all groups remained seated, continuing to discuss and create content. Multiple participants expressed that using the cards in an organized co-design workshop provided new perspectives on ICT solutions for simulating medical processes. One participant said that:

> …this is the kind [of training simulations] that we can actually get to make, isn't it?", another adding that "and what I think is very good now is that this is a very feasible scenario. #1-3

In the follow-up conversation after the workshop were finished, one participant expressed that the workshop was a great learning experience, that the design cards "forced" them to think creatively and to come up with achievable concepts.

> …[Brainstorming with design cards] makes you think new and differently, and you are influenced by how others think […] and that's how you come up with new ideas. #4

One participant with extensive experience about learning methodologies explained that the workshop showed them how to "think backwards" regarding the methods they normally would use to achieve specific learning outcomes, and that '[design cards] challenges us to think in a different way, so it was very exciting'. #3

At the end of the workshop the groups presented their ideas for the rest of the participants. They showed excitement for each other's concepts and discussed possibilities and challenges with the scenarios.

VIII. DISCUSSION

In this discussion, we shed light on how the design cards worked in supporting collaboration and finding common ground between the designers and non-designers. We discuss possible explanations for the challenges we faced early in the design process, and why the design cards helped ease the collaboration in the workshop. We also discuss the design cards in regard to the concept of boundary objects. We then discuss the role played by the cards in giving the non-designers a voice and how the cards helped co-realize design solutions across disciplines.

Myers, Piccolo and Collins [10] suggest that design cards can democratize knowledge and support co-design process by enabling more engaging and playful design experiences. We find that this also applies in our study. The layout and design of the cards, alongside the rules in the workshop, provoked new contextual perspectives regarding design problems and possible ICT solutions. This corresponds well with the discussions made by Kwiatkowska, Szóstek and Lamas [19]. The MixED design cards were suitable as a toolkit for promoting collaboration between an interdisciplinary team of researchers in design and non-designers in the fuzzy front end of a design process. As a tangible tool, it helped co-realize and visualizing possible design solutions.

According to Bratteteig, Bødker, Dittrich, Mogensen and Simonsen [5], future users should be given the power to influence the decisions made during a design process. In early projects meetings, the voice the participants had were influenced by their understanding of design and development processes. They are not accustomed to design practices of ICT solutions; the various welfare technologies at the training center are developed by companies specializing in creating and selling medical simulators. The result of this was seen in the early projects meetings; the participants disagreed on what they needed this simulator to be and divided much attention to what technology to buy, how the room should be rigged and how quickly we could get the simulator running. This is discussed by Bratteteig and Wagner [3] as a challenge when dealing with 'wicked' and 'ill-defined' design problems, explain that 'most design processes are open-ended, often exploratory, and highly complex' (ibid, p. 5). It is important to make design decisions that support the ability to remake design choices and closing in on a design solution too early in the process puts

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unwanted restrictions on the possible design outcome. What is interesting, is that although the participants expressed wanting a solution that where 'open' enough to evolve over time (which were not possible in the welfare technologies they usually bought), they wanted to hasten the design process by jumping straight to buying state of the art ICTs. We understand this contradiction as their unfamiliarity with the practice of design and our role as design researchers (and not developers). Explaining what we wanted to accomplish when inviting them to partake in the project as co-designers, trying to convince them to take a step back from technology specifications and be a part of a design process, was passed over multiple times. This is a common issue with co-design and participatory design. Different practices, unclear roles and diverging perspectives often lead to misunderstandings and tensions within the design team [3].

When introducing the design cards in the workshop we found that many of these tensions and misunderstanding were eased. The educators were given a tool they could use to express design decisions and a voice they didn't know they needed. It allowed them to discuss the problem space and reflect on what ICT solutions were appropriate to implement without being restricted by formal design or development languages. These language barriers are one of the issues when inviting non-designers into a co-design process, and the design cards lessened the need for the users to adopt a specialized design language [3]. As we understand, the workshop broke down their misconceptions about who can design and be creative. As discussed by Sanders and Stappers [6], people find it difficult to believe themselves creative and is therefore reluctant to take an active role in a design team. The cards worked as a tool enabling them to make meaningful decisions about design.

Before introducing the design cards in the workshop, we used the project plan created by the first author as our primary artifact to convey and discuss important aspect of the project and used it to try finding a shared understanding between participants. Looking back, this plan did not adequately help us establish the common ground that was needed to guide the project forward. But in many ways, the workshop did. What, then, was it about the workshop that did that the plan could not?

By taking another glance at the concept of boundary objects, Star and Greisemer [24] explain that these objects need to be plastic enough to adapt to local needs yet 'robust enough to maintain its identity across sites'. Jean et al., [31] further explain how there must be a balance between rigidity and flexibility if these objects are to unite different interests and practices. In the light of this, the project plan that we relied on in the project meetings was not suitable for establishing a shared understanding of the project. It was too rigid and not plastic enough to adapt to our needs. It does, however, seem that we found this balance in the design cards and the rules of the design game. The cards abstracted the specific language from both the medical and the ICT domain. The cards were plastic and flexible enough to adapt to local needs and encompassed the practices they sought to unite. And in combination with the rules and the context of the workshop, they were also rigid enough to unite the different interests in the project.

In their study, Jean et al., [31] also explain how serious game simulations have been 'isolated as a potential boundary object' to bring different stakeholders together. In our experience, however, the boundary object (in their case the simulations and in ours the design cards) should not be seen as an isolated object. It is how the artifact and the context of using the artifact came together that determined whether the artifact could unite the parties in their endeavor to collaborate. We can exemplify this by looking at the last activity in the workshop. Here, the different groups presented their design ideas and concept using a A3 paper sheet and Post-it notes. Using these tangible objects, the groups visualized and communicated possible scenarios and facilitated a discussion between the different groups. According to Morris et al., [26], boundary object can be visual representation of reality, like props, concept maps and mental models, for catalyzing discussions that can lead to a comprehensive exploration of the issues which are understood differently or incompletely by different actors. These can help reach a common level of understanding. However, it was the context of the workshop, the use of design cards and the rules of play, that made this discussion possible and meaningful.

The combination of the design cards and rules in the workshop also enabled the participants to think like designers. The design game expanded the world view of the participants, enriching their understanding of a design process and the terminology used by the different experts, which lies close to the concept of transformative boundary objects introduce by Bechky [30]. We observed that the design game helped the team challenge previous conceptions about each other's practice fields and found common ground regarding possible design solutions. We believe that the design cards in themselves did not give us that shared understanding; they are what Pennington [25] referred to as *representations* of reality, and they exist independently of collaboration and has different meanings for the different people using them. But as a design game, were the cards and the rules of play came together, they facilitated for interpretation and enabled negotiations. This is illustrated in the misunderstandings with the MR-card, where the designer's intent was 'Mixed Reality' and the participant's interpretation was MRI-scanning. If the researchers hadn't been there to clarify, the participant would have created a scenario about using MRI-scanning machines. Which is just as relevant for medical practice, it's just not what the designers had in mind when they created the card.

Facilitating for mutual learning by creating a space where designers can learn from non-designers, and vice versa, is important in a co-design process. As mentioned, we spent a lot of time explaining concepts across disciplines (e.g., cleaning up the project plan). The researchers tried to project the correct medical terminology explained to us by the practitioners onto the cards, but even then we didn't quite get it right; during the workshop, participants express frustration about the labels on the cards – both that they didn't understand ICT terms and that we had used medical terms

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incorrectly. At the same time, however, the erroneous terminology also triggered the work to create a shared understanding. They felt the need to explain and, in this, shared their expertise with the other stakeholders, something which again helped in the creative process. Seems like this is a positive attribute with design cards – they are "official" representations of problems, terms and technologies triggering critique, opposition, discussions, and the need for clarifications – the groundwork in creating mutual learning and shared understanding across disciplines. How the world is ordered by a deck of cards can be provocation, to one, several or all the stakeholders involved. If handled well, the provocations can be a boon to the co-realization of design solutions.

IX. CONCLUSION AND FUTURE WORK

In this study, we found that bespoke design cards structured as a design game can support collaboration and in finding common ground across disciplines. The design game allowed non-designers to discuss the problem space and reflect on appropriate ICT solution without having to adopt a specialized design language. The language barrier between the different practices was an obstacle when trying to move the project forward, but it also allowed mutual learning opportunities between the stakeholders. This mutual learning was not achieved in the early design phase where we relied on a project plan to communicate shared goals and expectations. Introducing design cards in a co-design workshop triggered a more constructive exchange of knowledge across practices. Granted that the design cards are structured by a design game, space is created for the participants to express themselves. The design game acted as a mediator between the participants and researchers, and as a transformative boundary object by extending and transforming the participants understanding of the different practices. The workshop, cards and rules of play were both flexible and rigid enough to encompass and unite the different practices, facilitating a shared understanding of the problem space and project.

For future work, we suggest further analysis on how design games understood as transformative boundary objects, can support interdisciplinarity in design processes. We also suggest introducing design cards earlier in a co-design process and see what this can do for the collaborative process. This may support the collaborative parties to find common ground earlier.

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