Rules of Play to Balance Ideation and Decision Making in Co-design Games

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***Abstract*—Virtual simulations for medical training and learning should be designed together with expert users to ensure that the digital learning environment reflects the complexity of their practice. Practitioners and educators are often brought into the design process only to validate prototypes, which can leave the final application unfitting to the practice it is intended to support. In this paper, we explore how a generative design game can support medical educators to make meaningful decisions about design. The design game was developed to mitigate the practitioner's unfamiliarity with the technical and domain specific languages of designing virtual simulations. Reporting from the design process of creating the design game and a collaborative workshop with medical educators and students, we reflect on how a design game using design cards and specific rules can structure design activities, enable non-designers to explore design ideas together, and create concepts for feasible solutions for virtual medical simulations.**

Keywords-design game; design cards; generative tool; virtual simulation; co-design.

I. INTRODUCTION

The tools we use in design can be both influential and critical to successful design outcomes [1]. Design tools provide a range of benefits in a design process as they are "useful for catalysing interactions, building relationships, and enabling diverse communities to creatively take action and innovate" [1, p. 3]. Sanders and Stappers [2] explain how users can take part in the design process and become a part of the design team as experts of their experiences. By contributing directly to the design process, the users can become co-designers. Bringing users into the process, allowing them to be a part of the design of a solution, needs careful structuring and facilitation. Non-designers can however make feasible design decisions when given the right tool for expressing themselves. Sanders and Stappers [3] explain how methods and tools for making enable both designers and non-designers to "make 'things' that describe future objects, concerns and opportunities" [3, p. 2]. Such frameworks and generative tools are often specific to their purpose and reveal a new language of both verbal and visual components that can be combined in various meaningful ways to enable both designers and non-designers to express ideas, thoughts and feelings. Sanders [4] found that generative tools are useful for collaborative thinking, mapping, dreaming, storytelling and visioning. One type of generative tool is design games. As described by Brandt [5], design games are a form of play where we use props and specific rules to structure and organize design with users, where the "aim is to take advantage of the various skills and expertise's represented and jointly explore various design possibilities within a game setting" [5, p. 2]. With a growing number of tailored design games available, design tools like analogue design cards are reported being used in the early stages of collaborative design processes [1]. Many design cards (also referred to as 'ideation cards') have been made and deployed in various research settings, like the IDEO's Method Cards, Tiles and PLEX [1][6][7]. Design cards can be used to address specific domains, like exertion games [8], internet of things [7] and mixed reality games [9]. In the fields of domain-specific human-centered design, design cards are used in systematic design methods and procedures [10].

In this paper, we reflect on how a design game using cards and a specific ruleset in a co-design workshop with medical educators support the claim that design cards enable non-designers to make meaningful decisions about the design of information and communication technological (ICT) solutions. The design game we created focuses on virtual simulation technologies and serious games created to support training and learning on medical procedures and routines. Using virtual simulations in the training of medical practitioners are today being explored, and several commercial companies specialize in creating these types of training applications (see for example InSimu [11] and Virtual Medical Simulation [12]). There is, however, a dearth of research into how these should be designed to support everyday collaborative medical practice [13][14]. Multiple studies do recommend involving end-users in the design and development process [15][16] [17].

Collaborating with a medical training and education center at Østfold University College in Norway, we investigate how these virtual simulations should be designed as an educational learning platform with the goal of ensuring a high use value and adequate learning possibilities for medical students. To explore this, we created the MixED design game – a toolkit consisting of 47 design cards and ruleset – and used it in a co-design workshop with educators, students, and research-designers. The main rationale for creating the design game was to mitigate the practitioner's unfamiliarity with the technical and domain specific

languages of design so as to enable them in expressing feasible and fitting solutions to their educational needs.

In this paper, we will present our reflections on the lessons learned when creating and using the design game in the workshop, and we ask: how did the design game support non-designers to make meaningful design decisions?

The paper is structured as follows: in Section II, we present related research, before presenting the MixED design game in Section III. Here, we describe the design process, the cards and the rules that constitute the game. In Section IV, we retell the collaborative workshop held with stakeholders and participants. In Section V, we present the study's methodology, before summarizing the findings in Section VI. In Section VII, we discuss the lessons learned and provide insights to the design community. Section VIII summarize the study with implications for future work.

II. Related Work

Organizing participatory and co-design events often involves including people with different backgrounds, expertise, interests and professional languages [5]. These differences need to be accommodated for by the designers with the aim of allowing every participant to explore, negotiate multiple views and make decisions about design. Design is all about making decisions based on inquiries and explorations of possibilities and the process is not straight forward. Löwgren and Stolterman [18] shed light on two approaches in design thinking, namely convergent and divergent design. Where divergence is about designers expanding their thinking, and exploring possibilities and alternatives to design, convergence is about "focusing on a specific solution or a synthesis of several ideas" [18, p. 29]. The design process often ends in a convergence phase, but the early design phase is mostly driven by divergent activities where designers develop and explore several ideas instead of a singular one. This divergent thinking keeps designers from "falling in love" with one initial idea, by working with several ideas in parallel [18, p. 30].

In these early phases in design processes, non-designers are dependent on appropriate tools to help them think like designers without having extensive knowledge in the field of design. Non-designers need to be allowed to be experts in their own fields and be given tools that can help them express their expertise in an easy way. This is especially important in interdisciplinary teams where domains may collide (e.g., in the design of new ICT solutions in healthcare). With the right tools, non-designers can explore feelings, past experiences, and/or assess their understandings and insights. Using the right tool for the job is important as different tools can yield different insights in different contexts [4].

Design games are one such tool designers can create and utilize to help non-designers express themselves. Brandt [5] describes four types of exploratory design games, namely 1) games to conceptualize design, 2) the "exchange perspective"-design game, 3) the negotiation and work-flow oriented design game, and 4) the scenario-oriented design game. Common for these is that they provide a structure that is flexible and provide people with game materials (tangible game pieces and rules) that they can relate to and make meaning from. The design game helps people to explore aspects of the project and context together and to generate new insights and a common ground for "where the future design work should be headed" [5, p. 9]. Design games to trigger a creative ideation process can take many forms, including future workshops, tabletop games with game pieces and boards, and design cards.

Design cards can support designers across all stages in a design process but are most often used early on for ideation [19]. According to Tahir and Wang [20], design cards "offer an approachable way to introduce information as part of the collaborative design process, and their abstraction level has enabled researchers to successfully use them in a wide variety of fields" [20, p. 2]. Domains include emergency medical services technology [21] and mixed reality games [9]. In a recent study, Hsieh et al. [19] analyzed 161 decks of design cards and identified seven types of design knowledge supported by the decks: creative inspiration, human insight, material and domain, methods and tooling, problem definition, team building, and value in practice.

Design researchers have found various characteristics of cards that make them valuable to design practice [20]. Li et al. [22] explain how designers can leverage the modularity of the cards to address complex design problems across disciplines by letting the cards represent different categories, like domain cards and technology cards [22]. Wetzel et al. [9] reports that ideation cards are a 'viable design method utilized by professional designers' [9:4] and give examples of cards used for ideation; IDEO method cards, PLEX cards [6] and Verbs, Nouns and Adjective cards [23]. Li et al. [22] also points out how design cards can be used to support both designers and non-designers, like with their Flexi Card game. Kwaitkowska et al. [24] report how design cards or game-like cards can support ideation in co-design and participatory design processes. Wetzel et al. [9] describes how they used their ideation cards to synthesize design knowledge about mixed reality games, and how their cards "enable collaborative design in a playful manner" [9, p. 2]. They report the cards being a helpful tool for rapid idea generation and for in-depth idea development for designers of mixed reality games. In their work, they identified six properties the design decks should elicit. Design cards should 1) encapsulate domain-specific knowledge, 2) foster collaboration between teams of designers, and they should 3) avoid overwhelming designers. Further, the cards should 4) avoid making designers feel restricted, 5) support initial and rapid generation of ideas, and they should 6) support a more in-depth development of ideas.

III. MixED Design Game

In this section, we will present the MixED design game. First, we will describe the process of designing the cards, the categories and layout, before explaining the rules of the design game.

A. Designing the Cards

The cards were the result of an iterative design process involving four meetings and workshops with stakeholders,

including three educators from the medical center. These interactions supported the gradual emergence of a common language and a shared understanding of the domains. These meetings, along with observations, e-mails, informal conversations, and discussions, informed the selection of content and categories.

The research-designers conducted six design workshops (total of 54 hours), with a focus on integrating the categories and content into the card's layout. Inspiration was also drawn from established decks like PLEX, Tiles and Ideation decks [6][7][25]. As can be seen in Table 1, this resulted in a deck of 47 cards in five categories: scenario, medium, interaction, learning outcomes, and challenges.

As illustrated in Fig. 1, the layout was kept simple. Each category was color-coded and displayed a background-image representing the card's content and a keyword or single line of text. These keywords were chosen based on the labels listed in Table 1. The images were sourced from royalty-free services, like Unsplash.

TABLE I. THE CATEGORIES AND KEYWORDS IN THE DESIGN GAME

Category	Keywords
1 Scenario	Traffic accident, drowning accident, fire accident, home nursing, psychiatry, accident site, prison, falling accident, inside the body, overdose, heart attack.
2 Medium	2D images (slideshow), 2D video, 3D video, 360 video, augmented reality, virtual reality, mixed reality.
3 Interaction	Speech, button, gesticulation, holding objects, movement, looking, feeling.
4 Learning outcome	Empathy, time management, stress management, collaboration, multitasking, communication, confidence, physical skills, technical skills, focus, problem-solving, critical thinking, adaptivity, leadership.
5 Challenges	How is this performed individually? How is this performed in a group? How does the educator fit in? How does collaboration work? How does the marker fit in? Too little time. Too small or big space.

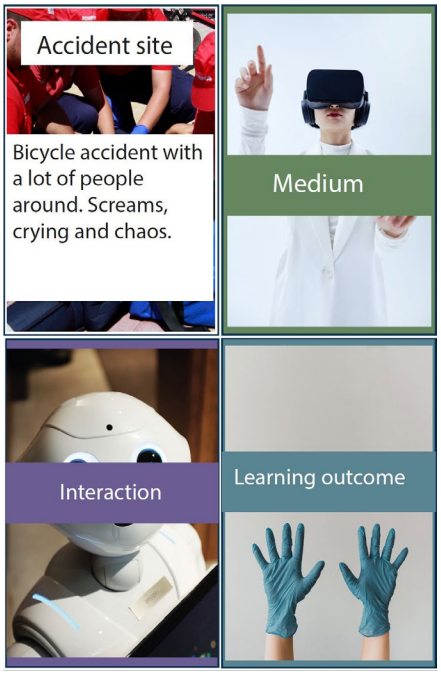

Figure 1. Layout of the cards.

B. *Rules of Play*

The workshop was divided into four phases, each with a specific time limit. We have summarized the phases in Table 2, as well as giving a longer description in Section IV. Each phase builds on the previous one, leading the non-designers through the design process. We also created a rule sheet intended for the participants during the workshop, explaining the rules and phases. Here, the colors of the text corresponded to the cards they would be drawing (i.e., green for Medium cards, blue for Learning outcome).

IV. CONCEPTS GENERATION IN A CO-DESIGN WORKSHOP

The two-hour workshop was held in a classroom at the medical center on April 1st, 2022. In total, nine participants divided into teams of three partook in the workshop. The participants were four educators and facilitators from the center, three bachelor students in production design and one design-researcher. The classroom was big enough so that the teams were able to be placed far enough from each other so that there would be no distractions or collaboration between the different teams. In addition, the workshop had two facilitators, one who led the workshop and one who observed and took notes. The nine participants were intentionally placed in mixed teams of three by the facilitators to encourage interprofessional discussions and avoid reestablishing old ideas and thinking between colleagues. Before starting the workshop, the lead facilitator gave a short presentation on the day's agenda, the cards and the rules.

TABLE II. PHASES AND TASKS IN THE DESIGN GAME

Phase	Task
Individual assignment (15 minutes)	1. Random draw: participants choose one card from category one to four. 2. Create a scenario using the selected cards and take notes. 3. Repeat this process three times using 5 minutes for each round.
Team assignment (20 minutes)	1. Participants present their individual ideas and scenarios. 2. The team decides on one scenario to work with, either from an individual segment or by combining aspects from multiple scenarios.
Team assignment with challenge cards (10 minutes)	1. The team is introduced to the challenge cards, and applies two random drawn cards from this deck to the chosen scenario from the previous phase. 2. Discuss how the challenge card impacts the scenario and make any necessary changes. 3. Repeat this process twice for 5 minutes each round.
Team assignment and presentation (50 minutes)	1. The teams finalize their scenarios and prepare presentations with freedom in how the scenario is to be expressed (e.g., roleplay, video, PowerPoint). 2. Each team have 5 minutes to present their scenario, with opening for questions from other teams. 3. All teams participate in a discussion and use a dot voting system where the participants vote on their favorite idea/scenario with stickers.

As illustrated in Fig. 2, the participants were also given a worksheet with the tasks and times as referenced during the workshop. They were also provided with materials like papers, post-it notes and pencils to document and illustrate their ideas.

In phase one, the participants picked three random cards from each category except the challenge-cards and were asked to create three scenarios. The ideas where then shared with the rest of the team members in phase two. After sharing their ideas, the participants discussed all the ideas from phase one with the goal of creating one shared scenario they would work one and develop further into a concept. They were allowed to mix and match individual ideas to create this scenario. When the second round was done and all the teams had one scenario to work with further, the challenge cards were introduced. In this third phase, the participants picked two challenge cards and were asked to improve their scenario to accommodate for these. The challenge cards sparked interesting discussions in the teams as some of their scenarios had to be completely re-designed based on the new cards. The teams finally presented their final scenario (illustrated in Fig. 3) to the rest of the participants leading to creative and open discussions regarding the feasibility of the three scenarios.

Figure 2. Participants using MixED when designing scenarios in the workshop.

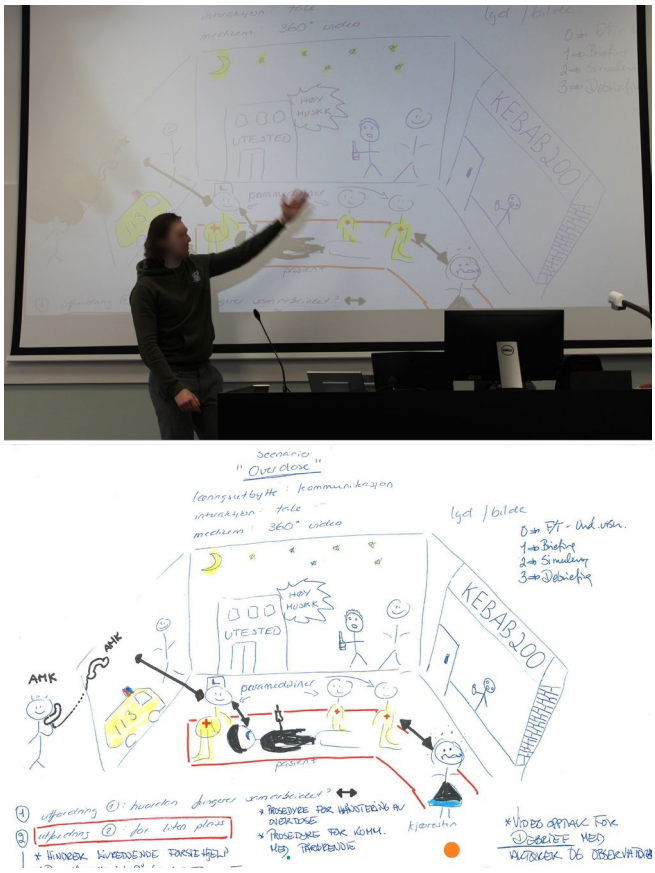

Figure 3. Participant presenting the scenario and the design outcome.

In this section, we have looked closer at the use of the design game in a co-design workshop. We will now report on the study's research method and analysis.

V. METHODOLOGY

We will here give an overview of the methods used for collecting and analyzing data both prior and during the co-design workshop.

A. Research Method

This study employs research through design (RtD) as a qualitative method to gain new insights. RtD, a method rooted in practical inquiry, involves creating and evaluating novel artifacts or systems to generate knowledge that can be applied across contexts [26]. These artifacts not only have the potential to reshape our world toward desired outcomes but also serve as benchmarks, facilitating the seamless transfer of research insights to the Human-Computer Interaction (HCI) community.

As Gaver [26] suggests, integrating design practices into specific HCI research allows researchers to discern both challenges and opportunities. Through RtD, we can delve into novel ideas, theories, or concepts, while also exploring the practical applications of newly designed artifacts within the field.

B. Data Collection

Prior to the workshop, information was gathered in the form of notes and memos from formal project meetings and an online workshop with three educators at the medical center. We also performed direct observation of physical simulation training during class at the medical center. The goal was to gain insight on how student learning is organized and facilitated for at the center. We also observed a large-scale simulation which included students and educators, medical emergency responders from the local hospital and the municipality's fire department. The data was collected through notes and images and was analyzed and used as a basis for the design cards.

We also held an initial pilot workshop with one design-researcher and four master students in applied computer science at Østfold University College, testing the preliminary version of the design game. Data gathered during the pilot were audio recordings, photos, notes, and the design output created by each team. The data lead to a revision of some of the keywords and accompanying illustrations. During the co-design workshop, data was gathered via audio recordings, photographs, note-taking, subsequent discussions with participants, and the tangible design results produced by each team, including Post-it notes and paper sketches.

C. Analysis

The data was individually analyzed by two of the design-researchers using the method thematic analysis. Thematic analysis involves organizing data and identifying recurring themes and aims to enhance comprehension of the data gathered from workshops, meetings, and observations [27]. The researchers were here able to have an open mind during the analysis, find themes and discuss their findings with each other. The audio recordings from the workshops were transcribed and analyzed iteratively in a step-by-step process. The steps included 1) line-by-line color-coding, 2) narrowing the data down, 3) creating descriptive categories, and 4) generating the themes presented in Table 3 by finding data that correlated with each other, e.g., participant's statements from different teams [27].

The study adhered to ethical guidelines set forth by Østfold University College and the Norwegian Center for Research Data (NSD). Data management and consent forms utilized in the study received approval from NSD (NSD number 788872). Participants gave written consent to the gathering and use of data from the workshop and other research activities related to the collaboration.

TABLE III. THEMES FROM THE DATA FOUND BY THE TWO RESEARCHERS.

Researcher	Themes
1	Breaking or changing the rules, management and organization, difficulties, content creation, clarification/collaboration/negotiation, engagement/motivation, technical skills and practical skills, decision making
2	Creative collaboration, own experience, stakeholder experience, technology knowledge, health knowledge, the use of terms, understanding the rules, feedback.

VI. FINDINGS

Before using the design game, the three design-researchers and three of the educators at the medical center spent a lot of time trying to agree on how we were going to proceed with design and development of a medical educational platform for the center. There was little consensus, and a lot of ideas were being exchanged back and forth with little structure to the conversation. The educators suggested solutions with a lack of regard to how a virtual simulation could be implemented at the center, or how the simulations would work in practice. In this phase, it became evident that we struggled to find common ground and bridge our respective fields [28].

Introducing the design game to the process provided structure to the conversations and opened for a more constructive negotiation of ideas and concepts. It enabled the educators to think like designers by giving them a tool that enabled reflection on not only what type of technology should be used, but how it should be used in the context of the practice of providing medical training. The different teams in the workshop grounded their ideas, they set realistic expectations regarding suitable technologies and discussed how the simulations could be implemented as an educational component in the training of many students.

From analyzing the data, the teams (referred to as G1, G2 and G3) worked very differently in the four phases of the design game. They all, however, created three feasible scenarios regarding the choice of technology, facilitation and learning outcomes. Several themes emerged from analyzing this process.

Firstly, the teams demonstrated the ability to express ideas beyond the cards. For example, G1 discussed how they could implement difficulty levels and variations in the scenarios, adding elements outside normal procedure and represent the complexity of patient treatment. They also discussed adding multiple-choice and branching scenarios, where events evolve over time based on the choices of the students.

Secondly, they demonstrated joint decision making and an ability to conceptualize scenarios together. For example, when finishing working on their presentation, G1.1 said "this is the type of things we can make. We can create videos of emergency situations, and then students can play the roles [of patient or bystanders]". When summarizing their idea into one concept, G3 quickly went through everything they had discussed up until that point, including facilitation and collaboration during training sessions, the roles of everybody involved, and technical requirements of visualizing sequences of events, exclaiming that "this is absolutely doable" #G3.3. They expressed engagement, as G3.1 says "I think this is really exiting, if we can make this happen. […] There is a lot of students that can experience enjoyment from this."

Lastly, they displayed an ability to make realistic decisions about the use of technologies by tempering their expectations. They discussed pitfalls with the different technologies and considered the utility and cost of choosing between them. When one member in G3 suggested an

advanced multimedia representation of escalating events, another said "You know… this is fun, but it will be difficult to make" #G3.1.

VII. DISCUSSION

As part of our discussion for this paper, we will first reflect on the three findings from our analysis, and why and how the design game supported the participants in creating ideas and feasible concepts. We will then discuss how divergent and convergent design thinking is equally important to facilitate for when using generative design tools.

A. The Rules of the Game

The participants demonstrated an ability to use the cards to create and express ideas beyond what was stipulated in the cards. Reflecting on this, we believe that the card's expressiveness (the categories, the keywords in each category, and the images) fostered creativity. Not only that, but the cards represented the two fields (design of ICT solution and healthcare) with just the right amount of ambiguity for non-designers to make meaning from them. It is our understanding that the groundwork we did prior to designing and using the cards contributed to the card's usefulness in the design game. The project meetings we held with the stakeholders, the simulations we observed at the center, and the e-mails and conversations we had gave us insights into the everyday work of the educators and their field. When designing the cards, this deepened understanding helped us make better choices regarding categories and keywords. It shall be said that not all the cards captured the field of medical practice well. Participants were confused about some of the cards, like the medium card 'MR'. MR is the Norwegian term for MRI and while the design-researchers intended this card to stand for 'mixed reality' it was interpreted by participants with medical backgrounds as a medical device similar to an X-ray. As design-researchers, it should fall to us to help cross boundaries and create something that makes sense across disciplines. We therefore recommend other designers and researchers working in the intersection of disciplines to use extensive time with the stakeholders to gain a good understanding of the domain the deck of cards are expected to express and represent.

During the workshop we also saw how the participants were able to create good ideas together through joint decision making. We believe this is due to the rules of the design game and how we structured the activities in the different phases. Where we previously held several unstructured meetings discussing the design choices, the rules in the design game structured collaboration in a constructive way. Rapid, individual ideation in phase one broadened their view of what this ICT solution could be, and each participant brought their unique ideas into the next phase. In phase two, they spent a lot of time negotiating and coming to an agreement on which ideas to pursue further, evaluating design decision and making design moves together.

In initial project meetings between the design-researchers and stakeholders, there seemed to be little consensus on what to design. Stakeholders often discussed unrealistic ideas about what this ICT solution should be, with little regard for how the technology would work. For example, when discussing what technology to implement, one stakeholder voiced a need for creating educational training modules using virtual reality as medium. This would require a specific setup in the room intended for the virtual simulation, and it would be difficult for 60+ students to use these efficiently. What we saw during the workshop was that the participants could use the cards to generate ideas and then evaluate those ideas in a constructive way, for example to make realistic choices regarding the choice of technologies. Phase three urged them to reflect on the limitations that space (physical room), cost and organization of the simulation would require. The cards helped them to concretize, understand and evaluate the components of the technical solution. This enabled the participants to make meaningful decisions about the creation of complex ICT systems – something which is well outside their domain of expertise.

B. Convergent Design Games

Reflecting on what took place in the design game, we seem to have found a balance between openness and preciseness in the rules of using the cards. The ideation activities in phase one and the start of phase two gave room for exploration of the categories and components of a virtual simulation for learning. By dividing the workshop into sequential phases where design activities built upon each other drove the design process forward in a natural way. This gave the workshop a constructive pace: the facilitator controlled the workshop's activities and guided the participants to the next phase. During the activities, participants were given room to openly explore ideas and be creative all the while moving forward to a more concrete and realistic design outcome.

We believe that this is a good example of the divergent and convergent design thinking processes described by Löwgren and Stolterman [18]. Where divergent design thinking is about creating choices, convergent design thinking is about which choices to pursue further. By analyzing the structure of our workshop, we see that phases one and two are clear examples of divergent design activities. Further, we see a mixture of divergent and convergent activities in phase three. Introducing the challenge cards helped narrow and focus the scenarios by putting contextual constraints on their solutions. In phase four they demonstrated their ability to discuss, negotiate and make decisions by converging their ideas into one final concept.

Brandt [5] explains how exploratory design games can 1) stage participation (organize collaboration) and 2) help open up for multiple ideas. In the literature, the terms "ideation cards" and "design cards" are used interchangeably. Ideation is the process of opening up and producing many ideas, but for anything meaningful to coming from a design process, designers and participants also need to close in and make decisions regarding the design. Therefore, it is important to balance divergent and convergent activities when creating and facilitating design games. Design cards are usually used

in the fuzzy front end of design, which by nature is messy [2]. The same can be said of interdisciplinary collaboration; before common ground is found, cooperation across disciplines can be challenging. Therefore, at the start of a design project, where people from different disciplines come together to create a product, an artefact or a solution, ideas are bounced back and forth based on each participants' expertise and experiences. In turn, this can result in nonstop divergence, with new ideas and concepts being generated but where no move is made towards the making of meaningful decisions. Using a design game with cards and a specific set of rules to support participants in understanding the problem space and giving them 'things-to-think-with' is most certainly useful. However, designers also need to provide non-designers with tools and a framework that helps them make design moves and choices when creating design concepts that have a real chance of being built. Rules that stop the generation of new ideas, help them discuss these ideas, and move from ideation to conceptualization. To facilitate for decision making through both divergent and convergent design activities.

VIII. Conclusion and Future Work

In this paper, we have reported on the creation of a generative design game for medical virtual simulations, as well as findings from a co-design workshop with medical educators. In so doing, we have shed light on the need for collaborative design approaches in the design of virtual simulations for medical training and learning. The conventional practice of involving expert users solely for prototype validation often results in digital learning environments that inadequately capture the intricacies of medical practice.

Through a collaborative workshop involving medical educators and students, we demonstrated how the design game facilitated for meaningful decision making about medical virtual simulation. Utilizing design cards and structured rules provided a framework that enabled non-designers to engage in design activities. By bridging the gap between practitioners' expertise in medical education and design of virtual simulations as learning environment, the design game empowered participants to explore innovative design ideas, and critically reflect on possibilities and limitations with ICT-solutions.

Drawing on Löwgren and Stoltermans [18] notion on divergent and convergent design thinking, this study also shed light on the importance of finding a balance between ideation and making design moves. For future work, it would be interesting to see more research on how designers and researchers can structure design activities after the principles of divergent and convergent design, and in so doing facilitate for both ideation and decision making during co-design activities.

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