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Vandekerckhove, Pieter; Timmermans, Job; de Bont, Antoinette; de Mul, Marleen

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Pieter Vandekerckhove, Job Timmermans, Antoinette de Bont, Marleen de Mul

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Pieter Vandekerckhove[1] MSc; Job Timmermans[2] PhD, IR; Antoinette de Bont[3] PhD; Marleen de Mul[1] PhD

[1]Erasmus School of Health Policy & Management Erasmus University Rotterdam Rotterdam NL
[2]Netherlands Defense Academy Breda NL
[3]Tilburg School of Social & Behavioral Sciences Tilburg University Tilburg NL

Corresponding Author:
Pieter Vandekerckhove MSc
Erasmus School of Health Policy & Management
Erasmus University Rotterdam
Burgemeester Oudlaan 50
Rotterdam
NL

Abstract

Background: The involvement of stakeholders such as patients, care professionals and care managers is considered to play an important role in developing digital health. To this end generative co-design (GCD) is widely used to develop digital health. Yet, even though active stakeholder involvement is key in GCD, the justification to involve specific stakeholders is lacking in GCD research to develop digital health. Therefore a generative co-design methodology (GCDM) based on theory has previously been developed to improve the scientific rigor regarding stakeholder involvement.

Objective: In this study, we implement the GCDM recommendations concerning stakeholder involvement in a GCD project to develop a serious game for cancer patients. Here, the stakeholder involvement recommendations are further operationalised as a stakeholder selection procedure.

Methods: Snowball sampling was used to identify potential stakeholders, and short interviews involving eight criteria were used to assess their relevant knowledge and abilities. On this basis, those deemed most appropriate as participants in GCD were allocated to Group 1 and those with fewer of the desired skills to Group 2. Both groups participated in identical GCD workshops. The influences of the implemented stakeholder selection procedure and the resulting allocations were qualitatively assessed by comparing the knowledge output and the related knowledge processing in the two workshops.

Results: We found that the interaction quantities in the two workshops were broadly similar but the Group 1 stakeholders had a stronger and more positive influence on the diversity and density of knowledge processing, which resulted in a better quality of knowledge output than from Group 2. In terms of further developing the theory about the role of stakeholders in the GCDM, we would encourage researchers to explore the role given to abduction-2 inference in the selection procedure, and the role of facilitation with abduction-2 and contextual certainties in the GCD process.

Conclusions: We encourage the further validation of our stakeholder selection process in GCD. Ultimately, this will help GCD researchers come to more methodologically sound findings and to further refine the methodological recommendations to involve robust decisions and then report them in a sound way, both of which will improve the scientific rigor of GCD science for digital health.

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Title: Diversity in stakeholder groups in generative co-design for digital health: assembly procedure and preliminary assessment

Background: Diverse knowledge and ways of thinking are claimed to be important when involving stakeholders such as patients, care professionals and care managers in generative co-design (GCD). However, this claim is rather general and has not been operationalized and therefore the influence of various stakeholders on a GCD process has not been empirically tested.
Objective: This study aims to take the first step in assessing stakeholder diversity by formulating a procedure to assemble a group of diverse stakeholders and test its influence in a GCD process.
Methods: To test the procedure and assess the influence on the GCD process, a case was selected involving a foundation that planned to develop a serious game to help people with cancer get back to work. The procedure for assembling a stakeholder group involved snowball sampling and individual interviews leading to the formation of two groups of stakeholders. Thirteen people were identified through snowball sampling and they were briefly interviewed with criteria to assess their knowledge, inference experience and communication skills. Two diverse stakeholder groups were formed, one more potent than the other. The influence of both stakeholder groups on the GCD process was qualitatively assessed by comparing the knowledge output and the related knowledge processing in two identical GCD workshops.
Results: Our hypothesis on diverse stakeholders was confirmed although it also appeared that merely assessing the professional background of stakeholders was not sufficient to reach the full potential of a GCD process. The more potent diverse group had a stronger influence on the knowledge output and knowledge processing, resulting in a more comprehensive problem definition and in more precisely described solutions. In the less potent diverse group, none of the stakeholders had experience with abduction-2 inferencing, and this did not emerge in the GCD process, suggesting that at least one stakeholder should have previous abduction-2 experience.
Conclusions: A procedure to assemble a stakeholder group with specific criteria to assess diversity of knowledge, ways of thinking and communication can improve the potential of the GCD process and improve the resulting digital health.

Key terms: Collaborative design, design methodology, stakeholder involvement, participatory design, digital health

1. Introduction

Stakeholders such as patients, care professionals and care managers are considered to play an important role in designing and creating digital health [1–4]. A widely used form of co-design that can involve a group of people to develop a digital health product is generative co-design (GCD) [5,6]. GCD is characterized by a collective creative process whereby knowledge is shared by stakeholders to develop a product or service, such as digital health [7–12]. In a GCD process, stakeholders are more actively involved in the creative design process than they would be in a more classical design process [10].

A wide variety of people who do not necessarily have a design background, such as patients, care professionals and health policymakers, can be GCD stakeholders in a digital health project. For instance, content experts such as patients (often referred to as 'users') may improve the uptake of the output as their needs regarding user guidance, specific reminders and personal tracking will likely be better addressed [13]. Health policy experts may also contribute to digital health development. For instance, it has been suggested that their involvement during the Covid-19 pandemic led to improved alignment between payers and care professionals, which may have contributed to the rapid uptake of digital health [14,15].

There are both theoretical and practical issues when involving different stakeholders in GCD. From a theoretical standpoint, GCD scholars hypothesize that the more that diverse stakeholders are involved in a group in terms of diverse knowledge and ways of thinking, the better the GCD process [10]. However, this claim is not clearly explicated, which may be due to the conceptual challenges present, such as the lack of consensus on the definition of 'stakeholder' and 'involvement' [16]. For instance, how one defines involvement depends on how one views stakeholder representation, the time involved in the project and whether the scope focuses on the project or a wider cultural change [16–18]. In addition, GCD is part of a larger research field known as participatory design (PD) [10]. In PD, specific values are upheld including democracy, equalizing power relations, mutual learning and situation-based action [16,19]. However, these values are not currently applied explicitly in the GCD stakeholder selection procedure. For instance, adhering to a democratic principle could mean that not only a hospital manager but also current and future users should be involved in the development process of digital health. However, criteria have not been proposed to justify who would be ideal participants.

From a practical point of view, assembling a diverse stakeholder group to design digital technology in the healthcare field may require more thought than in other sectors because the

interests of the diverse stakeholders may not be aligned. This may lead to practical challenges for stakeholders in gaining trust, challenges in managing multiple stakeholders and time pressure when involving patients and physicians [20–25]. However, design practice manuals do not address how to overcome these additional challenges when using GCD to develop digital health [11,26,27].

When tackling these theoretical and practical issues and involving stakeholders in a GCD process to develop digital health there is little scientific guidance to help select the best stakeholders. There are no studies reported where the performance of different stakeholder groups was evaluated in using GCD to develop digital health. A meta-review, albeit limited to the development of serious games, has highlighted the need for this research as the effect of involving some users as stakeholders in participatory design studies was unclear [28].

To provide further scientific guidance on the involvement of stakeholders, we set out to test the hypothesis that stakeholders with more diverse knowledge and more diverse ways of thinking would improve the GCD process. To satisfy this aim, we operationalized the hypothesis through a procedure to assemble distinct stakeholder groups and assess their influence on the GCD process and output. As such, the research question is: *Do stakeholders with diverse knowledge and diverse ways of thinking improve the GCD process for digital health?* The study's goal is to conduct a preliminary assessment of diverse stakeholder groups assembled through a prescribed procedure in the early stages of a GCD process of a digital health project. This assessment will hopefully provide deeper insights that other researchers and practitioners can consider when deciding who is most appropriate to involve in their GCD project. In time, this could lead to a validated GCD stakeholder involvement procedure for digital health.

2. Procedure to assemble diverse stakeholder groups

The stakeholder group assembly procedure amounts to an operationalization of the Sanders and Stappers [10] hypothesis that stakeholders with more diverse knowledge and more diverse ways of thinking could improve the GCD process. To involve stakeholders who meet these requirements in a GCD process, a procedure containing three steps was followed: snowball sampling, interviews and assembling stakeholders (Figure 1).

First, to recruit people, one needs to identify people who are committed to addressing the problem at hand. It can be useful to sample stakeholders through a relevant organization, association or event [25,29]. This should help ensure their commitment to solving problems as

these people have directly or indirectly been exposed to the problems and are logically more motivated to develop a solution.

Second, individual interviews can be held to qualitatively assess the diversity of knowledge and ways of thinking of the potential members. To operationalize the term 'knowledge' we define three types of knowledge (Table 1) based on the work of Batens [30–32]. One key form of knowledge that is also defined in GCD research is the deeper-lying tacit knowledge [10], which we measure here as contextual certainties. Alongside this type, there are methodological instructions and relevant statements. Each of these three types of knowledge was assessed during an interview on a scale from 0 to 3 (Table 2). Stakeholders with extensive knowledge regarding the relevant statements and the contextual certainties will be given the maximum score (3), in doubt given a 2, and if the stakeholder seemed to have little knowledge (1), or if relevant information was not provided in the interview, they receive the lowest score (0).

To operationalize the other component, 'thinking', we define four types of inferences: induction, deduction, abduction-1 and abduction-2 (Table 1), as categorized initially by Peirce [33–35]. In particular abduction-2 inferencing is expected to play an important role in the design process [33,35], and is typically attributed to how designers think. Previous experience with these types of inferences can be assessed during an interview by counting the amount of times an inference is used (Table 2). Abduction-1 can be scored as the number of methodological instructions formulated as concrete solutions (e.g. having an overview of one's energy capacity after cancer treatment to continue work). Abduction-2 can be scored by looking at the use of generative heuristics as analogies or metaphors.

In addition, one can assess communication skills to find out whether potential stakeholders can effectively communicate their ideas to others in a group. For instance, whether a patient has the appropriate content expert background with various relevant statements that they feel confident to share during a GCD process with other stakeholders. This can be assessed by asking the respondent for a self-evaluation.

Third, after conducting the interviews and scoring the responses, a diverse stakeholder group can be assembled based on three criteria. One can start by putting people with different professional backgrounds together. Next, one can ensure that those stakeholders with the highest knowledge scores are included as they have more knowledge. In other words, if there are two stakeholders with the same professional background, then the one with the highest score is included. Finally, one can assess the diversity of inferencing experience. Here one

should ensure that a stakeholder group covers all inference types. Once one is satisfied that the stakeholder group covers all inference types, one can seek out the stakeholders with the greatest inference experience. For instance, if there are two stakeholders with abduction-2 experience, the one with the most experience (highest score) can be chosen.

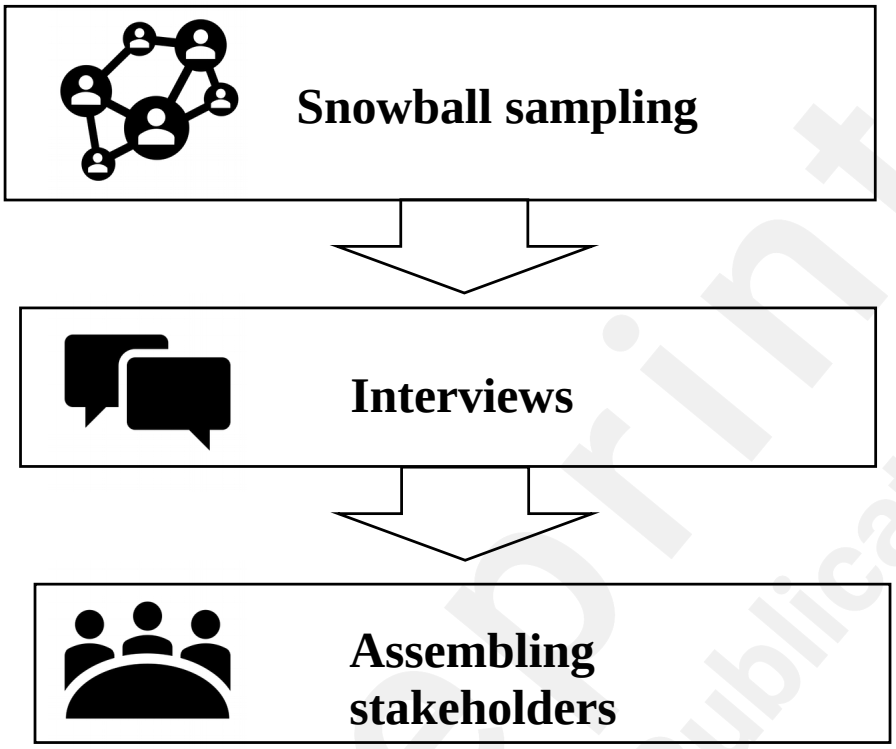


Table 1: Working definitions of knowledge and inference types used for assessment

Knowledge types	Contextual certainties	Knowledge containing a deeper lying perspective or philosophical principle
	Methodological instructions	An approach to solve a (sub-)problem such as a procedure for operations, instruments or tools
	Relevant statements	Factual knowledge about the problem or the solution
Inference types	Induction	A sequence of reasoning steps leading to a generalization, whereby several similar utterances are grouped under a new term or name, often in the form

		of a remark or conclusion following the utterances of others [33]
	Deduction	A sequence of reasoning steps leading to a conclusion based on several previous utterances [33]
	Abduction-1	A sequence of reasoning steps leading to the suggestion of a solution in the form of a methodological instruction
	Abduction-2	A sequence of reasoning steps leading to the suggestion of a solution in the form of a methodological instruction whereby induction, deduction, abduction-1 and generative heuristics can be used e.g. a metaphor [36,37] or analogy [38]

Table 1: Criteria used for stakeholder selection

Assessment aim	Criterion	Example interview questions and assessment
Assess knowledge diversity and depth	Professional background	What is your job?
	Relevant statements	What, in your view, is the core of the problem about cancer and work? (0-3 score)
	Contextual certainties	Why is this an important problem? (0-3 score)
Assess inference experience	Induction	How did you come upon this problem, through direct or indirect experience? (0-3 score)
	Deduction	Have you previously tested solutions regarding work and cancer? (0-3 score)
	Abduction-1 (methodological instructions)	What inspiring solutions arise in your mind to address the work and cancer challenge? (count number of occurrences)
	Abduction-2	Abduction-1 with generative heuristics as analogies or metaphors (count number of occurrences)
Assess communication abilities	Self-assessment	Choice between three suggested answers: “OK, but sometimes challenging”, “good”, or “very good”

3. Method

To assess the stakeholder group assembly procedure, an action research approach [39] was used to guide the practitioners of a GCD project while adding the stakeholder group assembly procedure to simultaneously gain research insights.

3.1. Hypothesis to test

The aim was to test how a stakeholder group, assembled using the stakeholder group assembly procedure described above, would influence the GCD process. We expected this stakeholder group assembly procedure to produce a group with diverse knowledge and diverse ways, and that this would have a positive influence on the GCD process and output. We also expected that, in such a group, the 'contextual certainties' knowledge type would be expressed more often by all stakeholders and the 'abduction-2' inference type would be more often used specifically by the stakeholders with design expertise than in our less experienced comparison group.

3.2. Digital health project

A digital health development project was sought in which multiple stakeholders could be involved in a GCD process, where we could test the stakeholder assembly procedure to see if it could make the GCD process more methodologically sound. Given the expertise of the first author (PV) with problems facing cancer patients, a related project was identified initiated by a Dutch cancer foundation, called oPuce (The Foundation). The Foundation aims to create awareness of the stigmatization of cancer and supports initiatives to help people with cancer continue working during and after their illness and promote the return to paid work [40]. The foundation had plans to start the development of a serious game to help people with cancer address their work-related needs. Although the actual development process had not yet started, The Foundation was interested in using a co-design process to develop the serious game. Since The Foundation had a large network of people who could potentially be involved as stakeholders in the design process to develop the serious game, we chose to add the stakeholder group assembly procedure as a first step in this process and help them with the first GCD activity.

3.3. Assembled stakeholder group

The stakeholder group assembly procedure described above was followed. Ethical approval was granted by Erasmus Medical Centre's Ethics Committee, no. MEC-2021-0231. The research data were solely managed by the first author (PV). The stakeholders received no financial compensation for taking part in this research.

Here we describe how the snowball sampling, interviews and group assembly were carried out. The first author initiated the snowball sampling [41] by approaching people at The Foundation via email and phone to identify stakeholders. At the end of this process, 13 potential stakeholders were identified (Table 3) who had been involved in the initial conversations over developing a serious game.

Table 3: Number of potential stakeholders identified through snowball sampling per professional background

Background	**Number**
Game developer/ designer	1
Employer (employing people with cancer)	3
Employer network	2
Employed cancer survivor	1
Occupational physician	1
Researcher	3
Network coordinator/ex-cancer patient	1
IT manager	1
TOTAL	**13**

The 13 potential stakeholders were each assessed through 45-minute interviews, except for the Network coordinator who was suffering from Covid-19. Prior to the interviews, they were told about the research and asked for their informed consent. The online, audio and video, recorded interviews were carried out by PV and facilitated by creative exercises on Miro's online collaborative whiteboard platform (Miro) (Appendix 1). The creative exercises helped the interviewees gain a visual understanding of their ideas and become accustomed with the online creative software they would use during the GCD workshop.

Given that there were multiple stakeholders with similar backgrounds but who scored differently in terms of knowledge and inference, they could be divided into two groups (Tables 3 and 4). A more potent stakeholder group was formed of stakeholders with diverse backgrounds who scored highly on the knowledge and inference criteria. These stakeholders

scored highly in terms of providing more relevant statements and contextual certainties. This group had experience with all the inference types. A less potent stakeholder group was formed of the remaining stakeholders who still met the desired range of diverse backgrounds but scored less highly on the knowledge and inference criteria by showing less extensive knowledge and less inferencing experience during the interviews. Notably, none of the stakeholders in this group had experience with abduction-2 inferencing.

The stakeholders in both groups were unaware of this selection procedure, or why they were placed in which group, and also the detailed aims of the study.

Table 2: Scores of stakeholders in the more potent diverse group

Background	**Score**
Game developer/designer	11
Employer (employing people with cancer in company A)/ facilitator	11
Employer (employing people with cancer in company B)	9
Employer network	9
Employed cancer survivor	9.5
Occupational physician	10
Researcher	11.5
Average score per stakeholder	10

Table 3: Sores of stakeholders in the less potent diverse group

Background	**Score**
Researcher 1	5
Researcher 2	3.5
IT manager	2.5
Employer network	3.5
Employer/facilitator	6
Network coordinator/cancer survivor*	10
Ecosystem expert**	-
Average score per stakeholder	4.5

* No formal interview, information was gathered through informal conversations
**No interview was conducted as this stakeholder only joined as an observer at the start of the GCD workshop

3.4. Data collection

Data were collected during the individual interviews as part of the stakeholder assessment procedure. In addition, data were collected in two identical parallel workshops that were part

of a larger online event organized by The Foundation about the working of their organization. Prior to the workshops, all the stakeholders were given information about the aim of the identical parallel running workshops and a link was provided to familiarize themselves with the online Miro platform. GCD workshops are social activities where stakeholders can share knowledge and work with creative exercises towards achieving the purpose of the design project [10,42,43]. Online workshops were considered the best option given Covid-19 pandemic restrictions. The thirty-minute online GCD workshops were audio and video recorded.

To provide a focus for the assessments, the GCD workshops were somewhat artificially divided into two phases: the problem phase with the aim to understand the issues to formulate a problem definition and the solution phase to create ideas for a solution. The materials used in the two parallel running GCD workshops were identical and organized specifically to focus on the interactions among stakeholders concerning the both phases. Both groups received five identical instructions with a hexagon template delineating both the problem and solution phases and sticky notes were provided (Appendix 1).

In terms of roles, PV similarly facilitated both workshops and switched between them to ensure the instructions were clear while consciously avoiding steering the content development process. Each stakeholder participated in their respective workshop as a co-designer. In addition, prior to the workshops, two stakeholders were asked if they would take on a double role of participant and assistant facilitator. All participants including the assistant facilitators were blind to the hypotheses and aims of the study.

3.5. Qualitative analysis

The data from the interviews and workshops were iteratively coded and analyzed using ATLAS.ti (Mac Version 22.1.0, Scientific Software Development GmbH). The influences of the two diverse stakeholder groups on the GCD process were assessed in terms of knowledge changes (knowledge output) and how the stakeholders processed the knowledge (the use of inferences). Given this focus, the changes in knowledge were assessed by comparing the knowledge displayed during the initial interviews with that developed during the workshop within both groups.

To compare the two workshops, we coded each set of interactions between stakeholders in the problem and solution phase about a certain topic as a sequence in each workshop. In

each sequence, we used the deductive and inductive codes described below in order to be able to compare the knowledge processing of both stakeholder groups in each sequence and phase. We separately compared the sequences of both groups in the problem and the solution phases as the knowledge outputs in the problem phase (the problem statement) and the solution phase (forms of methodological instructions) were different.

Thematic and inductive codes were used to assess changes in knowledge from that revealed in the interviews to that in the workshops. Thematic codes were based on the definitions in Table 1, using three types of knowledge and four inference types to assess the knowledge processing and output (Table 3). Using the same definitions of the assessment criteria during the stakeholder group assembly procedure and the workshop analysis ensured that we could compare at the level of knowledge and inference types. The interview data can show that an individual stakeholder mentioned a certain fact (relevant statement type) or a certain approach to finding a solution (methodological instruction type) before joining the GCD process. To evaluate changes in knowledge between the interview and the workshop we used codes such as 'repetition from interview' if the knowledge generated in a workshop had already been mentioned by one of its members in their interviews. If the knowledge did change during the workshop, we assessed how it had changed in a particular sequence of interactions between stakeholders.

The thematic inference type codes were used to code group interactions during the GCD workshops. We followed a similar coding approach to Cramer-Petersen et al.[33] whereby inferences were coded and analyzed in an empirical design setting. As such, utterances which bore similarities to the logical inference forms were coded according to the appropriate inference type (Table 3).

To further qualify the knowledge processing and knowledge output identified with the above-described deductive codes, seventeen inductive codes (Appendix 2) were used to identify stakeholder behaviors (e.g. coming up with a new idea or a reformulation) (Table 5). These were used to understand why certain knowledge or inference types were used in each sequence.

To assess the knowledge output in a sequence during the solution phase, four inductive codes were used to code the knowledge changes through stakeholder interactions: concrete specific (e.g. proposing to use a coach), concrete general (e.g. proposing to use artificial intelligence), abstract specific (e.g. a virtual angel - a specific object or artefact) and abstract general (e.g. an empowering journey - a general image that may contain several specific

solutions).

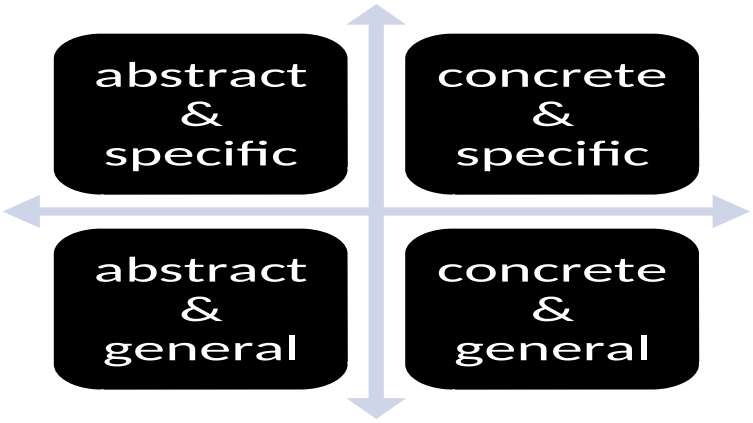


Figure 2: Inductive codes to code the knowledge changes: on x-axis from abstract to concrete and on y-axis from general to specific

Table 4: Examples of inductive code names and definitions to assess changes of knowledge within the workshops (see Appendix 2 for complete list)

Code name	**Definition**
Introduce	Utterance whereby a new idea is proposed
Reformulate	Utterance whereby a previous idea is expressed using different words
Add	Utterance whereby aspects are added to a new idea

4. Results

4.1. Main findings

Our hypothesis on diverse stakeholders was confirmed as the more potent of the two stakeholder groups had a relatively larger influence on the GCD workshop process and output in the problem phase (see 4.2) and solution phase (see 4.3) compared to the less potent group (Table 6). Regarding the problem phase, in terms of influence on the *process*, the more potent stakeholders built on each other's relevant statements, some of which had already been mentioned in the interviews prior to the workshop. Here we noticed a dual movement. On the one hand, there was an expansive movement of diverse knowledge as the varied stakeholders shared their knowledge about the problem and, on the other hand, there was a narrowing integrative movement where the content of ideas changed, and this changed the course of the discussion. In terms of *output* the more potent group developed a more comprehensive problem definition.

Regarding the solution phase, in terms of influence on the *process*, the more potent group used more abduction-2 inferences, which led to a greater variety of methodological instructions (Table 6). In addition, the more potent diverse stakeholder group, like in the problem phase, developed each other's methodological instructions. This made the solutions more concrete and specific. Therefore, in terms of GCD *output* in the solution phase, the more potent stakeholder had a bigger influence as this group produced more precisely described solutions.

The other two sub-hypotheses were not supported. Only once, and only implicitly, contextual certainties were identified in the GCD workshop (Table 6). This was only among the more potent group of stakeholders. As such, there seems to have been no significant difference between the two groups in terms of explicitly sharing more tacit deeper-lying knowledge. Further, while we had expected abduction-2 type inferencing to be applied by stakeholders with a design background, it was not used by the game developer who was the only participant with this background in the more potent diverse stakeholder group. Rather, abduction-2 inferences were made by the non-designers in this group, which is contrary to our

expectations. .

Table 5: Frequency of codes in interactions in the more potent and less potent stakeholder groups (key differences highlighted in bold)

Code group	Code	Frequency in more potent group		Frequency in less potent group	
		Problem phase	Solution phase	Problem phase	Solution phase
Inference type	**Induction**	**10**	0	**0**	2
	Deduction	**9**	6	**4**	5
	Abduction-1	0	2	0	5
	Abduction-2	0	**13**	0	**0**
Knowledge type	**Relevant statements**	**14**	4	**10**	6
	Methodological instructions	0	**24**	0	**8**
	Contextual certainties	1	0	0	0

4.2. The greater processing of relevant statements increased knowledge about the problem

In terms of interactions about the problem, the stakeholders in the more potent group shared a greater diversity of relevant statements (14 versus 10), which were processed using more induction (10 versus 0) and deduction inferences (9 versus 4), than the less potent diverse stakeholder group (Table 6). Further, the stakeholders in the first group built on each other's relevant statements, some of which had already been mentioned in the interviews before the workshop. These interactions were related to focusing the discussion, asking questions, explaining ideas, introducing new ideas and reformulating old ones, which was happening more frequently in the more potent group.

Table 7: Sequence with codes from more potent diverse stakeholder group (translated into English for reporting purposes)

Stake holder	Sequence of utterances (order of conversation)	Behavior code(s)	Inference-type code	Knowledge-type code	Repetition code
Employer	(1) It feels to me that a user-centered bespoke solution is very general. I mean, doesn't that apply to any situation?	Focus	Deduction		
Employer/ Facilitator	(2) How would you make it more concrete?	Focus, ask	Deduction		

Employer	(3) For example, coming back to what was said previously, how can we facilitate self-management? How can we avoid creating a victim role? Because we want to make something bespoke. For example, how can you contribute to the resilience of the candidates looking for work or those who want to maintain work? It's in line with self-management, but a bit more.	Introduce Explain Reformulate	 Deduction Induction	Relevant statement	From interview
Employer/ Facilitator	(4) How can you connect that to a serious game? It's obviously also a general problem. How do you maintain self-management? How do you prevent the victim role? Then you are in the development process of the serious game.	Ask Reformulate	Deduction Induction		
Game developer/ designer	(5) But more content, the didactics behind it.	Introduce	Induction	Relevant statement, contextual certainty	From interview
Employer	(6) The content	Reformulate	Induction		
Game developer/ designer	(7) Yes, indeed	Agree			
Employed cancer survivor	(8) If there would be a victim role?	Ask		Relevant statement	
Employer/ facilitator	(9) I am thinking about the last point of (employer) and from (researcher) to keep it concrete and small and still also connect it with the piece on implementation. Then we arrive again at the point of how do we make sure that the serious game offers added value for individual employees with cancer, but then we still remain with a big problem.	Focus Reformulate	Induce Deduce		

Table 8: Sequence with codes from less potent diverse stakeholder group (translated into English for reporting purposes)

Stake holder	**Sequence of utterances (order of conversation)**	**Behavior code(s)**	**Inference-type code**	**Knowledge-type code**	**Repetition code**
Researcher 1	(1) If I am now looking. I am focusing on the serious game. That seems to be the starting point. Then, I think a central problem is that we see that	Introduce	Deduction	Relevant statement	From interview

	the current ways of people getting back to work are not successful. And we want to improve that. Improve self-management. Well, let's continue here, I am sure you can add to this.				
Employer/ facilitator	(2) Does everyone agree?	Ask			
Network coordinator/ cancer survivor	(3) I think also, how can you improve the collaboration? How can you, with each other? Perhaps inter-company or inter-academic? Perhaps, this has nothing to do with…	Introduce, ask			
Ecosystem expert	(4) What I thought is that solution-oriented thinking is more on the outside of the hexagon [exercise template]. I think that the word removing barriers to resume work, that is for example a problem related to the content. I don't know how others are looking at this?	Introduce; reformulate, ask			
Researcher 2	(5) I agree with that.	Agree			
Network coordinator/ Cancer survivor	(6) This is about keeping your work?	Ask, reformulate	Deduction		
Ecosystem expert	(7) Keeping your work.	Agree			

How stakeholders in the more potent stakeholder group developed each other's knowledge about the problem is clearly demonstrated in the examples of the more potent group (Table 7). The employer expanded the discussion concerning self-management of cancer survivors and added that one should consider the resilience of these people and avoid putting them into a victim role. Although he had already mentioned the need for a bespoke resilient solution in the individual interview, this was not in relation to considering the victim role of a patient or in relation to self-management. The employer/facilitator reformulated these points slightly and responded that this comment was related to developing the content of the serious game, rather than its implementation. The game developer specified (relevant statement) that these aspects concern the content and the didactics behind the content of the serious game. This probably follows from a more abstract principle that the game designers believe in, that "the content of a serious game always has a didactic aim behind it." (contextual certainty). The employed cancer

survivor returned to what the employer had mentioned earlier, and he questioned whether there was a victim role at all. Finally, the employer/facilitator tried to integrate the different points and reformulate this as a new question.

Thus, in the more potent group, the stakeholders as employers and a patient share their views on the problem by asking questions, reformulating points and trying to draw connections. They shared their different ways of viewing self-management for people with cancer looking for work. Having a game developer as a stakeholder because of his technological background enabled him to quickly point out how this could be accommodated in a serious game: through the underlying didactics. This shows how each of the different stakeholders in the GCD process can rapidly interject with useful information to define the problem based on the actual needs while conforming to what is technically needed and possible.

The interaction between stakeholders in the less potent group (Table 8), was more a group conversation without people building on each other's knowledge (relevant statements). This led to less integration of the knowledge that is being shared. Even though they seem to make a start to focus on an aspect of the problem as 'the barriers preventing people with cancer to resume work' they did not ask each other what that means nor attempt to define the barriers. In the more potent stakeholder group, we observed a more concentrated attention on the content of the problem, which led to more integration of knowledge about the problem e.g. the concepts of self-management, the victim role and serious game development were rapidly connected towards a problem definition.

Over time, the interactions about the problem in the GCD workshop with the more potent stakeholders showed a dual movement that was not present in the less potent group. On the one hand, there was an expansive movement of diverse knowledge as the stakeholders shared more knowledge about the problem and, on the other hand, there was a narrowing integration movement whereby the content of ideas changed, which changed the course of the discussion. For example, initially there was an expansive diverse knowledge movement as various stakeholders discussed the broad theme of user-centeredness. Then there was a narrowing integration discussion about the definition of the user, whereby the question was raised whether one should focus on development or implementation aspects. Some aspects were considered together as it was mentioned that self-management was important for the user. Here, the initial ideas changed as this was rephrased to make clear that some aspects are relevant during the development phase of the serious game and others during its

implementation. Other elements that were discussed concerned resilience and the victim roles to be considered (Table 8) although these were not integrated in the problem definition. This dual movement may have contributed to the more potent diverse stakeholder group having a more comprehensive problem definition (Table 9) than the less potent group. In the problem definition phase, the less potent stakeholder group seemed to have brought together ideas in an expansive movement, but there was no subsequent integration or changing of the content that formed the problem definition. The more potent group's more elaborate problem definition seems to have provided a better-founded basis on which to develop solutions.

Table 9: Problem definitions

Problem definition of more potent diverse stakeholder group	**Problem definition of less potent diverse stakeholder group**
How do we realize a bespoke approach and self-management during the implementation of the serious game (whilst taking this into account during development of the serious game)?	Maintaining work during and after cancer

4.3. Greater use of abduction-2 inferencing improves the concreteness and specificity of solutions

In the solution phase, the more potent group of diverse stakeholders used many more abduction-2 inferences (13 versus 0), which led to a greater variety of methodological instructions (24 versus 8) than seen in the less potent group (Table 6). In addition, similar to what the stakeholders did in the problem phase, the more potent diverse stakeholder group developed each other's methodological instructions in the solution phase. This resulted in solutions that were more concrete and more specific. Further, abduction-2 inferencing was used by non-designers, which was less anticipated since inferencing is typically attributed to designers.

Table 10: Example sequence utterances from the more potent diverse stakeholder group in the GCD workshop with codes (translated into English for reporting purposes)

Stakeholder	**Sequence of utterances (order of conversation) (order of visual images in superscript)**	**Behavior code(s)**	**Inference-type code**	**Knowledge-type code**	**Repetition code**
Researcher	(1) You are not as an individual... because in such a game you are addressed as an individual, so how do we keep the social element and	Introduce	Abduction-2	Methodological instruction	From interview

	your environment? As an image I have The Borg[1], that's from Star Trek, and you are being assimilated in a very large network of other individuals.				
Game developer/ designer	(2) I didn't know you were a Trekkie.	Joke			
Researcher	(3) Wait until you see my costume, ha-ha.	Laugh			
Occupational physician	(4) I am thinking about a sort of buddy system[2], rather than peers with similar experience, use buddy's to play together.	Introduce	Abduction -2	Methodological instruction	
Researcher	(5) Yes, and maybe we can therefore also connect that with a Tinder app[3], because which buddy would you like?	Introduce	Abduction -2	Methodological instruction	
Occupational physician	(6) Ha-ha.	Laugh			
Employer/ facilitator	(7) And, there, the artificial intelligence rises to the surface again? So that you can see on the basis of your use of the game with who you have the best connection[4]?	Introduce	Deduction Abduction -2	Methodological instruction	
Occupational physician	(8) Exactly.	Agree			
Employer/ facilitator	(9) That you are not only swiping, but also get a suggestion, like Hi, this person could fit with you.	explain			

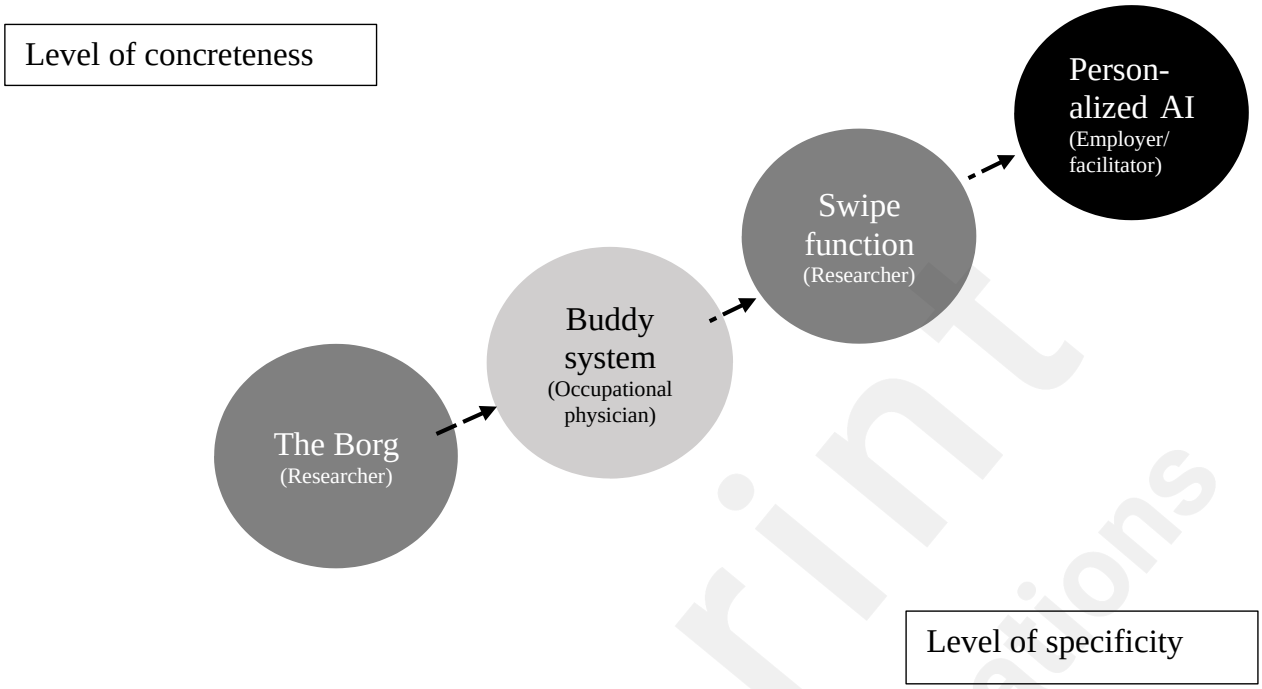
Table 11: Example sequence utterances from the less potent diverse stakeholder group in the GCD workshop with codes (translated into English for reporting purposes)

Stake holder	**Sequence of utterances (order of conversation)**	**Behavior code(s)**	**Inference-type code**	**Knowledge-type code**	**Repetition code**
Employer network	(1) I am still thinking about an approach including skills, how that would enable people. I put it left under [in Miro], I lost it…	Introduce	Abduction -1	Methodological instruction, Relevant statement	From interview
Network Coordinator / Cancer survivor	(2) No, but skills are really important. Here, you have to do something completely different, and you are looking at work differently.	Agree, add		Relevant statement	
Ecosystem expert	(3) But I think that next to the work environment also, if you assume that that was the work environment where you were, the other one could then call a different work environment. Then	Add	Deduction		

	those skills arise again, because you can perhaps get the possibilities to develop yourself differently.				
Employer network	(4) Yes, and when one conquers cancer, for example you have certain perseverance, that you are resilient. And when you focus on that, your employer can you help you realise this.	Add	Conclude	Relevant statement	

How stakeholders developed based on each other's methodological instructions and how this made the solution more concrete and precise is clearly demonstrated in the example of the more potent group (Table 10). The researcher suggested a solution using a Star Trek metaphor by referring to The Borg, which he explained as being a tool for a social network. This is an abstract solution, characterized by a metaphor, yet specific enough as it is further described as a social network. Next, other suggestions, each using a different metaphor, were used as analogies to highlight different features or aspects of the social network. In this way, the solution became more concrete and more specific. The occupational physician suggested a buddy system, the researcher suggested a similar swipe function as in a Tinder app and the employer/facilitator suggested offering personal suggestions based on an artificial intelligence algorithm. The metaphors used seem to have come from popular culture or daily use, which may have made them immediately clear to all stakeholders. As such, the solution-related knowledge of the various stakeholders started on an abstract-specific level and moved towards a more concrete and specific level (Figure 3). Overall, the more potent diverse stakeholder group had a strong influence on the quality of the knowledge output regarding the solution.

The interaction in the less potent group was more on the level of sharing relevant statements about a solution, e.g. for example, improving the skills of people with cancer (Table 11). They did not discuss in more detail how that skills training could be implemented with for instance visual images (abduction-2). Therefore, the solutions did not change from abstract to concrete, instead they stayed relatively the same on a concrete level.



5. Discussion

5.1. Principal findings

The aim of this study was to answer the following research question: *Do stakeholders with diverse knowledge and diverse ways of thinking improve the GCD process for digital health?* As a first step in attempting to answer this research question we assessed how a diverse stakeholder group, put together using a proposed stakeholder group assembly procedure, would influence a GCD process. We also established a second stakeholder group consisting of individuals who scored less well in the preliminary interviews held to assess the required competences.

Our preliminary findings confirm the main hypothesis of Sanders and Stappers that a group of stakeholders with diverse knowledge and ways of thinking has a positive influence on GCD. The more potent of the two diverse stakeholder groups had a relatively larger influence

on the GCD workshop process and output. The stakeholders in the more potent group built more on each other's knowledge which led to a more comprehensive problem definition and more precisely described solutions. In the problem phase, the stakeholders in the more potent group shared a greater diversity of relevant statements (14 versus 10), which were processed using more induction (10 versus 0) and deduction inferences (9 versus 4), than the less potent diverse stakeholder group. Further, the stakeholders in the first group built on each other's relevant statements, some of which had already been mentioned in the interviews before the workshop. This resulted through a dual movement in a more comprehensive problem definition. In the solution phase, the more potent group of diverse stakeholders used many more abduction-2 inferences (13 versus 0), which led to a greater variety of methodological instructions (24 versus 8) than seen in the less potent group. In addition, similar to what the stakeholders did in the problem phase, the more potent diverse stakeholder group developed each other's methodological instructions in the solution phase. This resulted in solutions which were developed from a more abstract and general towards a more concrete and specific level.

The other two sub-hypotheses were not supported. First, there was no significant difference between the two groups in terms of explicitly sharing deeper-lying knowledge (contextual certainties). One contextual certainty was used implicitly in the more potent group. Second, abduction-2 inferences were used 13 times by the non-designers in the more potent group, whereas not by the game designer in the more potent group. This was contrary to our expectations.

Using a person's professional background as the sole criterion in group member selection as for example done by Trischler et al. [47] may not deliver the full potential of a GCD session. Rather, it is the combination of stakeholders with diverse and complementary knowledge in terms of three knowledge types (relevant statements, methodological instructions and contextual certainties) and the most diverse and complementary inference experience in terms of four complimentary inference skills (deduction, induction, abduction-1 and abduction-2) that enhances the GCD process and its output. Moreover, abduction-2 inferencing did not occur spontaneously in our study in the less potent diverse stakeholder group. Therefore, the involvement of at least one stakeholder with abduction-2 experience (not limited to professional designers) could be critical when using GCD in hierarchical hospital settings [25] with stakeholders who are naturally not very involved in creative activities.

Further, the speed brought about by the dual movement of divergence and convergence

[49] in the problem phase could be due to the diversity of knowledge and thinking among the stakeholders, as each one has the potential to convergence or diverge. Here, each has knowledge that the others lack, and cannot think in ways that others can. In the problem phase, the example provided was about an idea that was rapidly considered from a patient experience and from employer and technical development perspectives. This led to reformulations and the raising of new questions, which steered the process in a new direction. This could be viewed as a change of frame, or perspective, brought about through the interaction of different stakeholders. Even though there is extensive literature about the framing process [50–53], the interactions of diverse stakeholders in the framing process have not yet been explicitly described. The example we provided from the solution phase suggest that framing involving diverse stakeholders can be viewed as a knowledge process that looks for a solution from different knowledge contexts that provide different perspectives when looking at a possible solution. During this process, we observed an implicit negotiation process, something that has been mentioned by other researchers [51,54], in the sense that the stakeholders' responses to proposed solutions varied. On some occasions, stakeholders laughed, which may signify acceptance of a solution. This was surprising and unexpected given that it did not relate to their own knowledge context. As such, a stakeholder group with diverse knowledge and ways of thinking may be most effective when it can reframe ideas rapidly.

The framing process may be quickened when stakeholders share more contextual certainties. However, we only observed one event in the problem phase that demonstrated how a contextual certainty can rapidly bring a new perspective to a discussion, in this case a didactic perspective which is essential when developing serious games [55,56]. This emphasizes the need to share deeper-lying knowledge in GCD [10] and the need to explicate how they are used by different stakeholders in design theory more broadly [57]. The limited expression of contextual certainties in our study may due to the lack of priming exercises [8] ahead of our workshops, coupled with the time pressure and the workloads of participants. This may have suppressed the participants' awareness of deeper-lying ideas. This suggests that there is maybe a minimum critical time before people can share such deeper-lying knowledge that our workshops failed to exceed.

5.2. Implications

Finally, we reflect on our stakeholder group assembly procedure in the light of the normative

values present in GCD that originate in the PD field [10]. In PD, broadly defined values are upheld such as democracy, equalizing power relations, mutual learning and situation-based action [16,19]. Given the lack of a theoretical consensus, there is no solid normative grounds on which to judge our stakeholder selection procedure. For instance, the democratic principle, maybe implies that one should involve people who are affected by the design decisions made or the end product [19]. In addition, it is emphasized that power relations should be equalized by giving voice to those who may be invisible or weaker [16]. In the situation of digital health, this could imply that one should involve patients and informal caregivers. As these are often hard to get involved in a healthcare setting [21], we considered the use of a snowball sampling method. This is potentially more inclusive and faster than a widely advertised recruitment strategy, which may not attract vulnerable groups. As such, in the protocol we tried to cast a wide net of possible participants through snowball sampling to include people and other vulnerable populations. However, to participate and contribute to the GCD process, individuals should be able to bring new or complementary knowledge and inferencing experience to the stakeholder group. On the basis that they lacked these assets, we did not include a cancer survivor in the more potent diverse stakeholder group even though they were in a vulnerable position. Further, it is argued that democracy requires educated and engaged people acting in their own interests and in the interest of the common good [58,59]. Kensing and Greenbaum [59] state that where necessary this should involve educating people in terms of the required technical jargon and engaging them in the process, an aspect related to the principle of mutual learning [16,19,59]. In this respect, Kleinsmann argues that, in collaborative activities, there should be a minimal shared understanding [60]. In our protocol, we tried to ensure this by looking for people with a basic interest in the topic through snowball sampling and then using self-assessment to evaluate group communication abilities. In this sense, we believe that the stakeholder group assembly procedure we used can serve as an example of how these values can be respected while improving the GCD process and output.

5.3. Limitations

The designed stakeholder group assembly procedure was operationalized in a minimal viable form to meet the aim and scope of this study. Although the assessment process was intended to accurately score the knowledge, inference skills and communication skills of potential group members, there may be a built-in bias in the questions. Although we attempted to limit this by

discussing the formation of the groups within the research team, there may still be some errors in allocating individuals to one of the two groups.

Indeed, not all the criteria were sufficiently sensitive to differentiate between the experiences of some stakeholders to ensure a robust selection. For instance, all the stakeholders scored similarly on the criteria addressing induction and deduction inference types and communication abilities. This could be due to the snowball sampling that pre-selected stakeholders who were already part of the Foundation's network with a certain level of educational training and communication abilities. Even though all the stakeholders showed a similar ability to use induction and deduction inference types in their interviews, the stakeholders in the less potent group used these less often during their workshop, which affected the knowledge output and knowledge processing. It could be that the stakeholders in this group were less inclined to use these inference types due to a lack of interaction.

The case was selected based on the background of the lead researcher and the fact that it was a project that had momentum, was about to start and had a good potential to involve various stakeholders. However, the selected case also raised concerns as it took longer than expected to gain approval to start the stakeholder selection procedure from the project manager. One reason for this could be that GCD is often employed as an informal design practice rather than as a formal scientific approach with formal stakeholder selection.

We would caution readers against drawing any causal relationships based on our study about the influence of the stakeholder groups on the GCD process. To maintain a focus in our analysis, back-and-forth interactions between problem and solution phases, that might occur when addressing a real issue were not considered. Further, given the exploratory purpose of this study, various variables were ignored including content related facilitation, interpersonal relationships [61], the creative environment [62], mutual learning over time and the higher-level strategy of the project and host organization [60,63]. Nevertheless, even without these aspects, this study was still able to provide initial insights into the role of diversity of stakeholders in GCD. To ensure this occurred, reflection meetings were organized between the lead researcher and the co-authors to identify and avoid any potential biases in the study design and in the interpretation of the results.

5.4. Further research

We would recommend further exploring how to strike a balance between the time and resources spent on snowball sampling and the number of stakeholder assessment criteria (knowledge, inference experience, communication abilities) used. One option would be to ignore induction and deduction and focus on abduction-1 and abduction-2 inference experience. One could also ignore communication abilities if the organization under consideration is a hospital that already requires interdisciplinary collaboration and focus instead on visual communication skills and open-mindedness as an indication of creative thinking. Next, to further assess the influence of the selected stakeholders on the knowledge processing component, the role of metaphors (in abduction-2 inferencing) and contextual certainties could be explored. For instance, one could link the dual-processing theory of reasoning, which involves deeper unconscious knowledge processing based on intuition and experience, and the more conscious deliberated processing with different knowledge and inference types [64]. Finally, the knowledge processing and the knowledge output could, over time, be further assessed in the GCD process, where the expression of contextual certainties is taken into account alongside stakeholders' learning processes.

6. Conclusions

A procedure to assess diversity of knowledge, diversity of ways of thinking and communication skills in assembling a stakeholder group that meets specific criteria may improve the potential of the GCD process and the resulting digital health. We would encourage the validation of our preliminary findings. Ultimately, this will help researchers to make methodologically more robust decisions about stakeholder involvement and report them in an appropriate way, which will improve the scientific rigor of GCD science for digital health.

Declaration of competing interests

None

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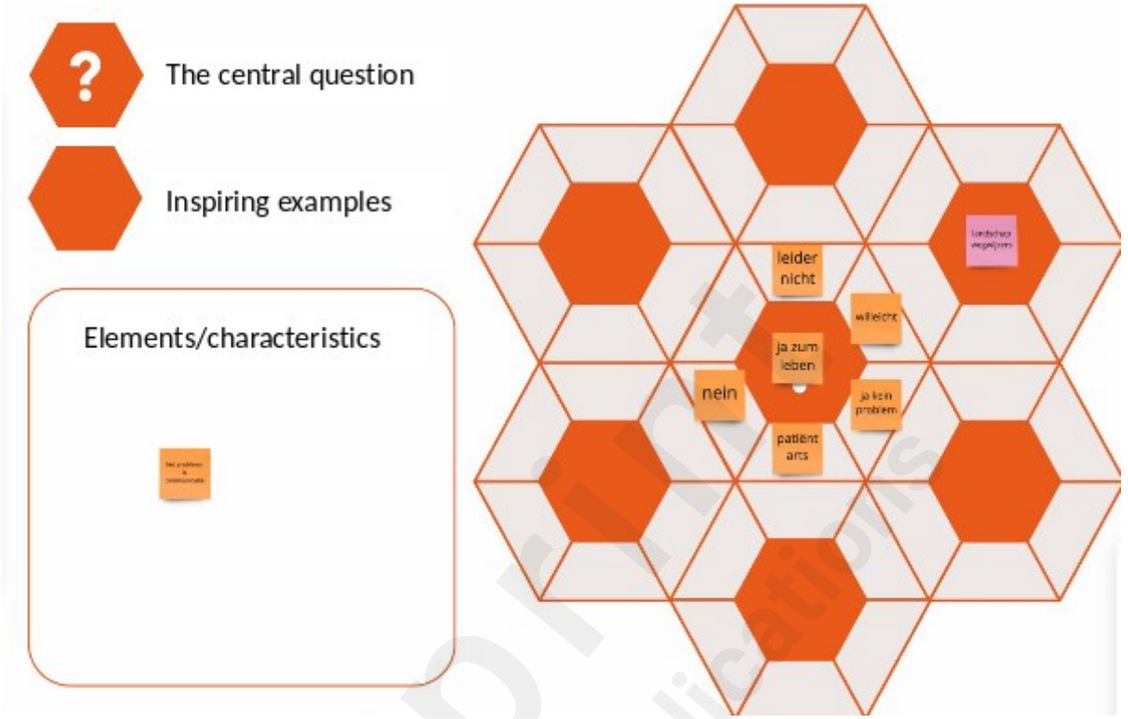
Appendix 1: Miro board interview and workshop template



Appendix 2: Inductive code list

Introduce
Agree
Explain
Add
Reformulate
Ask question
Disagree
Choose
Joke
Close discussion
Focus
Clarify
Laugh
Understand
Make options
Misunderstand
Repeat
Total

Supplementary Files

Figures

Stakeholder group assembly procedure.

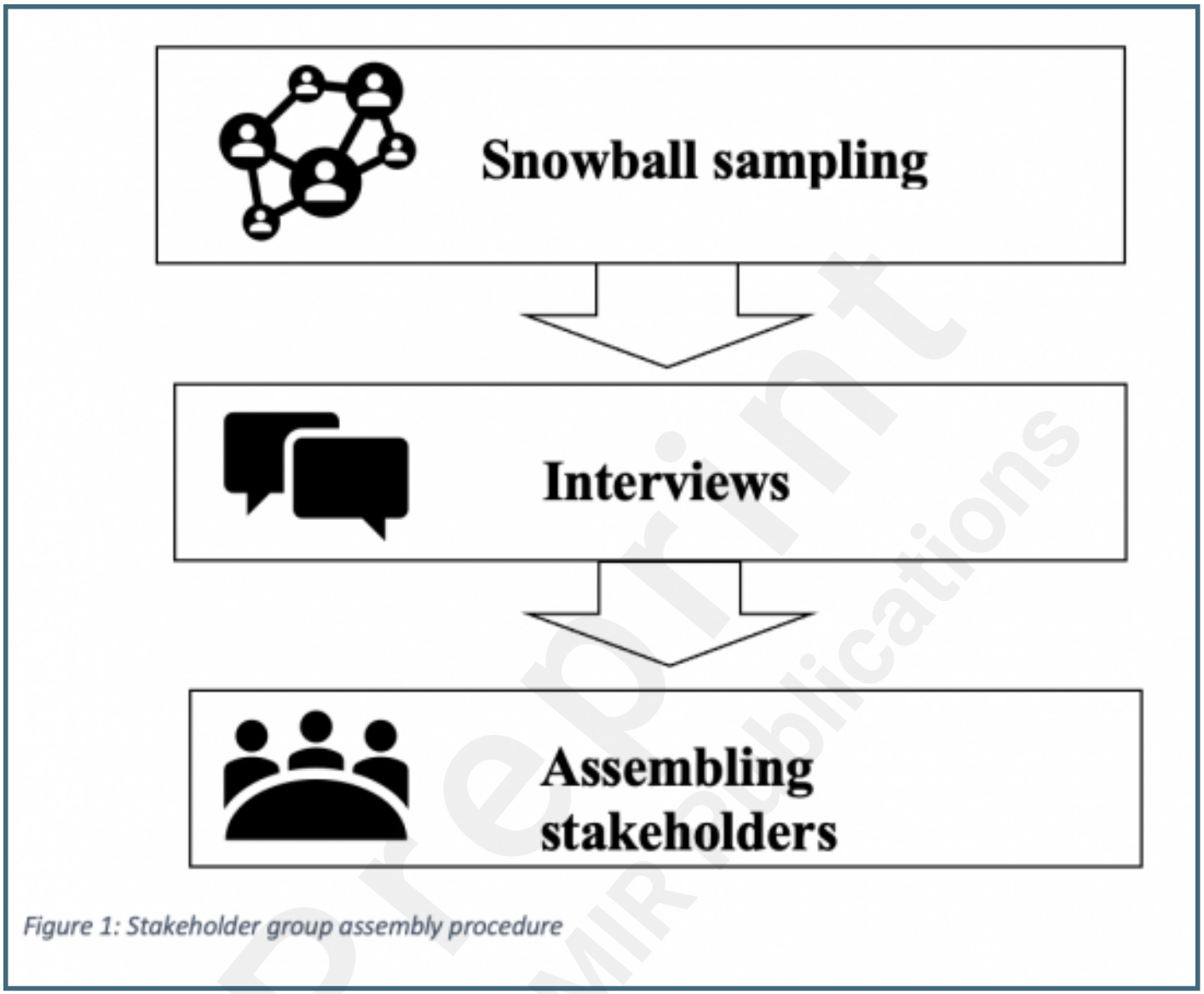


Figure 1: Stakeholder group assembly procedure

Inductive codes to code the knowledge changes: on x-axis from abstract to concrete and on y-axis from general to specific.

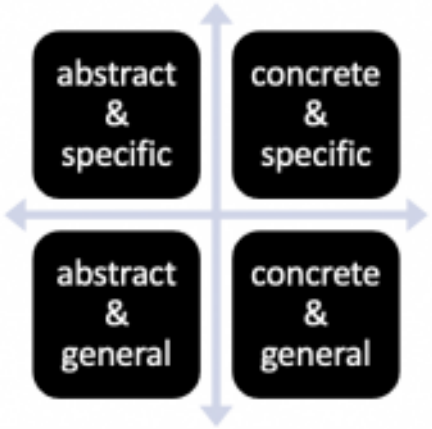
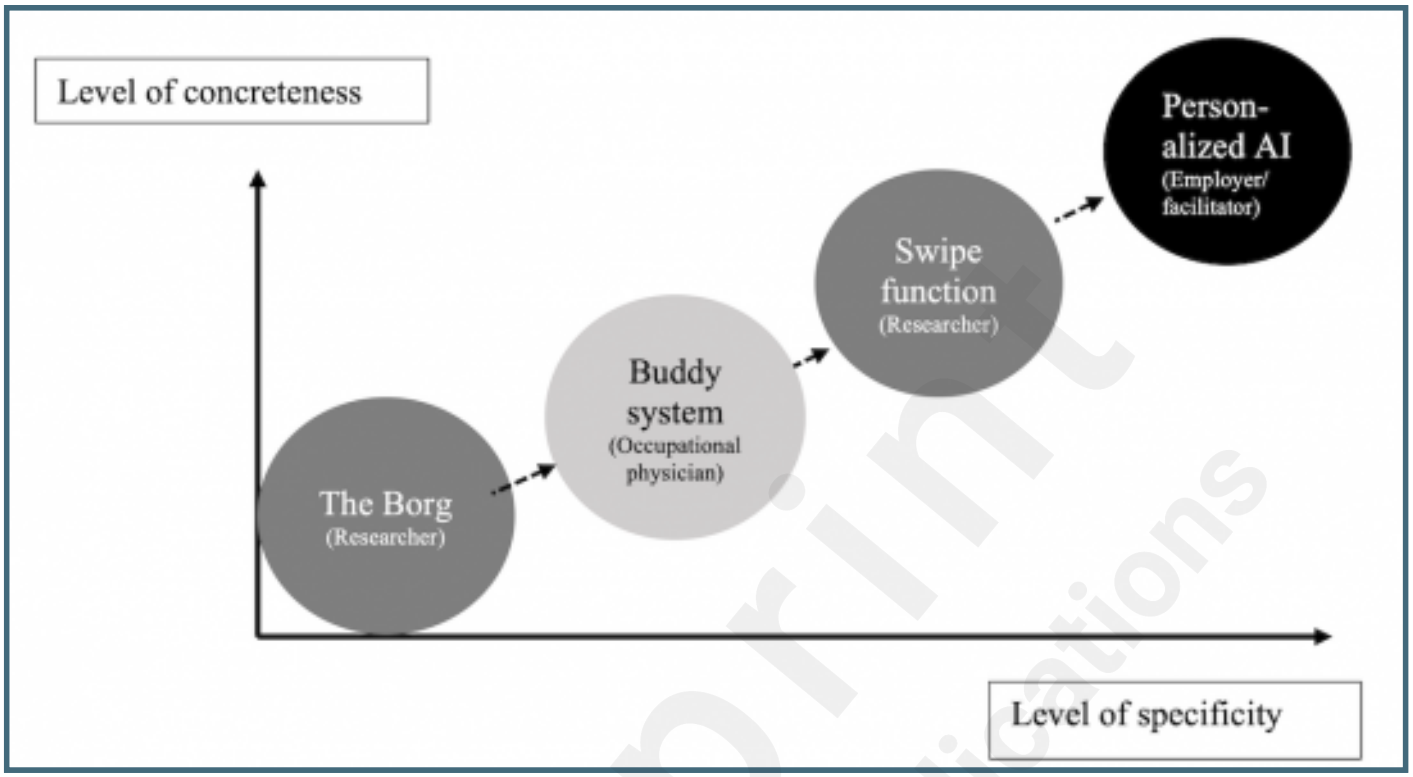


Figure 2: Inductive codes to code the knowledge changes: on x-axis from abstract to concrete and on y-axis from general to specific

Visualization of iteration of solutions (bubbles) suggested by different stakeholders in terms of specificity and concreteness (different shading for each stakeholder).



Multimedia Appendixes

Interview and workshop template used on online Miro platform.
URL: http://asset.jmir.pub/assets/8f7e60bb5b06c6c849a84a46a58fd3ed.png

Inductive code list.
URL: http://asset.jmir.pub/assets/003db355897a1292c1e4f1adeb255367.docx

Related publication(s) - for reviewers eyes onlies

Cover letter.
URL: http://asset.jmir.pub/assets/4120f27f11c91d82ebd16eb317dc7a77.pdf