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THE VALUE OF VISUAL CO-ANALYSIS MODELS FOR AN INCLUSIVE CITIZEN SCIENCE APPROACH

ACADEMIC MANUSCRIPT

INSPIRED BY CO-CREATION METHODS FROM DESIGN THINKING

CATHARINA VAN DEN DRIESCHE AND SARAH KERKLAAN

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ABSTRACT

Citizen science entails the collaboration of citizens and scientists. The process of this collaboration can take on many forms: identifying a research question, collecting data, analysing data to support or refute a hypothesis, monitoring environmental or health conditions for management or policy development. Citizen science propagates the inclusion of citizens not only as participants engaged in the design research process but also involved in designing the research process itself. In order to address issues of a citizen science approach, it is important that potentially everyone can contribute. Therefore, methodologies need to be fine-tuned to improve the involvement of non-professional researchers in the research process. Co-creation methods may be an effective methodology for doing so and bring different types of knowledge (e.g., insights, experiences, data, information) to the 'table of science' and, ultimately, improve the constructive exchange and evaluation of this knowledge.

This article describes the process of a pilot where professional researchers, informal caregivers, and human resource advisors use visual co-analysis to create a research plan. For the framing of this research a theme was proposed which focused on the possibility of technological support for work-related challenges experienced by informal caregivers working in healthcare. Five semi-structured interviews were conducted by researchers with informal caregiver in the first phase of 'Empathize' within design thinking (i.e., human centred approach). The goal of the interviews was to understand and relate to the caregiver's perception of their current informal care situation (e.g., balance, bottlenecks, opportunities, well-being). Quotes selected from theses interviews were the input for a bottom-up methodology for citizen science using the KJ Method (i.e., affinity diagramming) as a form of visual analysis model. The (co-)analysis was done by the team of caregivers, HR advisors and researchers using the online tool Miro.

This article aims to describe how the use of visual analysis models as a group consensus technique can facilitate the involvement of non-professional researchers and thereby support the establishment of inclusiveness of a citizen science approach. In other words, to obtain equal collaboration, an inclusive citizen science approach must allow communication about, and analysis of data by all participants, instead of non-professional researchers merely being presented with the finalized results of the analysis phase within research. An inclusive citizen science approach might lead to a period of uncertainty where problem definitions, research questions or predefined categories posed early on are (re-)assessed. However, this bottom-up approach will ultimately lead to a positive impact in finding the root problem for innovative scientific outcomes. Together, the pilot study and descriptive review offer guidance for understanding visual co-analysis models as the starting point for an inclusive citizen science approach.

1. INTRODUCTION

Citizen Science is an evolving approach in science moving from engagement with citizens to involvement in the research process by citizens (Bonney et al. 2009). It is in this recent development of collaborative partnerschip that design research, as an iterative and participatory process, is attracting increasing interest as an enabling factor for citizens to be involved in designing the research process. To enable citizens involvement in the design of the research process there is a need to go beyond the contributory approach to achieve equal collaboration using different types of knowledge. Therefore, communication about data implies being able to (co-)analyse data instead of only being informed (Vaughn & Jacquez 2020) in an inclusive citizen science approach.

The collaborative nature of citizen science especially challenges the initial phase in the design research process. Since different stakeholders coming together have probably already experienced and obtained knowledge for the issue at hand. Hence, to accomplish inclusiveness in citizen science, the exchange of experiences, knowledge, questions, and insights must happen in a way that permits communication about this data for (re-)formulation of the problem. This communication about data is a critical factor when addressing increasing complex problems that are in need of a scientific solution. Therefore, the collaborative partnership of an inclusive citizen science approach needs new insights on 'stretching' existing (design) methods for the production of knowledge (Hecker 2019).

In a pilot on informal caregiving, an onboarding process (i.e., becoming and staying involved in the research process) was developed to conduct citizen science in a way that meets the previous noted considerations. The first condition for onboarding in an inclusive citizen science approach is to (co-)create open and dynamic entry points during every phase of the research process. The second condition is to share

knowledge, information, or insights from all participants at the start of the onboarding process for evaluation and collaboration purposes. Third, to support working together in a way suited for and agreed upon by all participants towards collaboration on an equal basis. An important factor for these three conditions is being able to decide on what role to take on. These roles vary from being informed, consultant, partnership, collaborator, or role of empowerment in leading the research (Vaughn & Jacquez 2020).

For the support of onboarding the research study described in this paper questioned if and how visual analytic models (VAM), imbedded in a co-creation process, can inform the design of the research question, and the research process itself (i.e., inclusiveness in citizen science). Because the use of VAM improves knowledge and insights (Keim et al. 2008) and therefore stimulates the valuable evaluation, selection, and transparent development of the design research process. The KJ Method (i.e., affinity diagramming) developed by Jira Kawakita (Sugiyama & Meyer 2008) was chosen as a visual analysis model imbedded in a co-creation set-up to define the research problem.

Together, the KJ Method theory and the descriptive review of the pilot offers guidance for understanding the value of VAM for the starting conditions of a citizen science approach on two levels: the co-creation of knowledge by interacting with an affinity diagram and the 'on-going' learning process about the research process itself. Although citizen science allows for multiple roles for non-professional researchers, in this article the focus is on the 'empower level' of participation (Vaughn & Jacquez 2020) in which non-professional researchers and professional researchers share decision making in each stage of a research process.

2. BACKGROUND ON VISUAL ANALYTIC MODELS

In the early nineties designers adopted qualitative methods from anthropology to validate design decisions using data mostly from observing and interviewing users or customers. These qualitative methods are used in design approaches (e.g., contextual inquiry (Beyer & Holtzblatt 1998), service design (Stickdorn & Schneider 2014) and design thinking (Dorst 2011)), which give designers insights into (long-term) user or customer experiences. By visually mapping the user or customer experiences into models and seeing how these experiences are connected give designers the tools and techniques to validate design decisions. Additionally, in the design process itself an effect was noticeable of an increasing emphasis and time placed on finding the root problem due to visually accessible data for all stakeholders. Another effect of mapping user data into visual models is the support of conversations amongst designers, users, and clients.

A shift in VAM development came about when visualized models were adopted into co-creation processes using VAM as so-called work models (Beyer & Holtzblatt 1998). During co-creation sessions of categorization of data in a bottom-up way, participants were guided by the models in 'seeing' ideas for innovative solutions. Interacting with visual models created a 'visualized knowledge process' (i.e., inquire knowledge), enabling people from different backgrounds to speak and learn about data (Keim et al. 2008). It is this visualized knowledge process of sharing and structuring data into comprehensive understanding (i.e., awareness) that provides the foundation for synergy of knowledge (Kastner et al. 2012).

In this article it will be argued that the KJ Method (i.e., affinity diagramming) developed by Kawakita in 1975 (Sugiyama 2008) supports an inclusive citizen science approach. The KJ Method is a bottom-up approach for the exchange of data and evaluation of knowledge as a visualized knowledge process as well as a knowledge synthesis method (Kastner et al. 2012). The overall goal of this method is to synthesize experiences, information, and (scientific) knowledge to obtain valuable insights into solving complex problems. To allow a deeper insight into the KJ Method, the research approach will be placed in visual analytic research (Keim et al. 2008) and set up from the perspective of visualization research as a scientific discipline (van Wijk 2006).

To support finding the problem statement two design processes were integrated : the double diamond design process (Norman 2013) in combination with the design thinking phases of Understand, Empathize, Define, Prototype, and Validate (Dorst 2011) (Figure 2).

2.1 KJ METHOD: EXCHANGE OF DATA FOR FORMULATION OF THE PROBLEM

The design research process traditionally starts with an exploration phase where inquiry into the context of a problem is iteratively defined. In the basic scientific approach of Kawakita's W-shaped model (Scupin 1997 p. 235), understanding a problem occurs at two levels: experience and thought (Figure 1).

For the formulation of the problem, point C to D in the model, Kawakita created an analytic mapping tool to combine different types of knowledge based on experience and thought. In design research this analytic mapping tool is also known as an affinity diagram (Scupin 1997). This method is based on bottom-up and intuitive (i.e., not learned) labelling of different kind of data (e.g., interview quotes, observation notes, photographs) by multiple stakeholder groups. Kawakita defines four steps for affinity diagramming: (1) Label making, (2) Label grouping and title making, (3) Special arrangement and chart making, and (4) Verbal or written explanation. Affinity diagramming was developed to connect unorganized data for the purpose of universal applicability of interpretation, as Kawakita states:

> *"... the practice of the KJ Method has given a great number of people a new lease on life and rejuvenescence of their energies, generating at the same time true personal contact and creative consensus among people who practiced the method together"* (1977:97). He [Kawakita] emphasizes that the KJ Method enables people to free themselves from a priori assumptions, preconceived notions, rigid formalisms and dogmas, or unrealistic hopes or utopianism. Kawakita claims that the KJ Method assures scientific treatment of qualitative data, resulting in realistic, objective conclusions (1991:15). (Kawakita 1977, as cited in Scupin 1997)

Although Kawakita's idea of universal applicability (i.e., group harmony or consensus) is rooted in the Japanese culture of "decentralization of decision-making as a quality control method" (Scupin 1997), in citizen science it can uphold inclusiveness for 'low entry onboarding'. First, by being able to 'see' ideas in VAM, the decision to be involved in citizen science can be validated early on. In other words, VAM supports the discovery of the value of collaboration. Second, participants can then

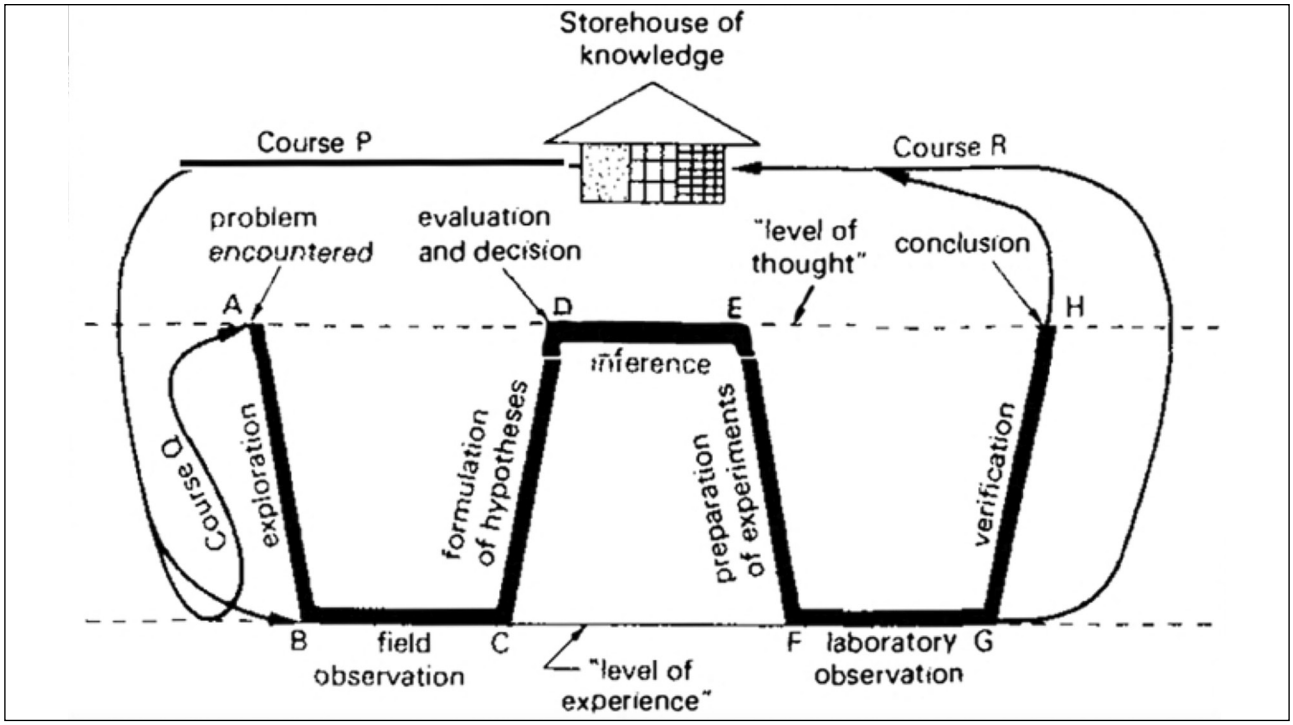

Fig.1: Kawakita's W-shaped model (Kawakita 1977, reproduced from' Scupin 1997) (p. 235)

decide on their role for (co-)designing the research process, starting with (re-)defining the problem. Third, by sharing of VAM citizens can stay informed or be involved again without experiencing a disadvantage. In this way the value of visual models in facilitating collaboration on an equal basis has a double effect: it transforms knowledge about data to the level of thought and evaluations of the design research process itself (Keim et al. 2008).

2.2 CREATIVE ABDUCTION FOR EVALUATION OF DATA TOWARDS PROBLEM FINDING

The foundation of the KJ Method as Kawakita developed it, is Charles Peirce's concept of creative abduction (Anderson 1986). Creative abductive reasoning is based on the combination of intuition and analytic interpretation of data. This creative search strategy (Schurz 2020) func-

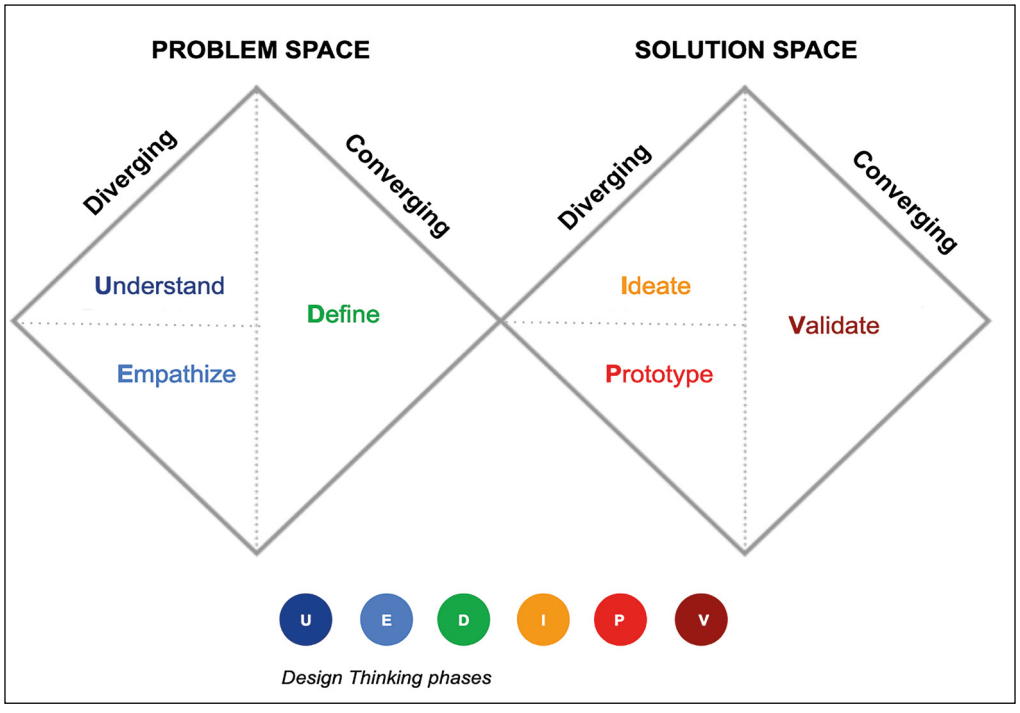

Fig.2: Double Diamond using the Design Thinking phases. Adopted from Norman, 2013 (p. 220)

tions as an intuitive non-logical thinking process or as "a meta-scientific form of reasoning" (Scupin 1997) which conforms logical reasoning from observations (i.e., what makes sense based on what we see) to select the most likely hypothesis. In citizen science projects initiated by professional researchers the research plan might already be defined before citizen are approached (i.e., problem definitions posed early on). Hence, the deployment of an inclusive citizen science approach might lead to a period of uncertainty wherein research plans are re-assessed.

An abductive reasoning as a creative search strategy (Schurz 2020) can provide direction for the 'chaos' of redefining the research plan in citizen science. Abductive reasoning is part of the first cycle of the double diamond design process (Norman 2013) of problem finding (i.e., process of diverging) (Figure 2). This process of diverging and converging supports the re-opening of the problem statement towards evaluation of quality and value for a scientific hypothesis. During the second cycle in the problem space (i.e., process of converging) the 'proof of problem' takes place by embedding measurements (e.g., empirical testing, case studies, scenarios, role play, sets of small experiments, online analytics) for the definition of a hypothesis.

Abductive reasoning supported by affinity diagramming creates an evaluative explanation of data through collaborative structuring that forces change or improvement of pre-defined problem definition or research question. The downside is that in abductive reasoning, in contrast to induction, there are no consistent results, making it almost impossible to detect an 'error' before the last phase of Validate in the design process. To avoid this problem an iterative testing in all phases would be necessary.

In the fourth step of the KJ Method (i.e., verbal, or written explanation) the provisional problem statement can be discussed using the affinity diagram. The explanation will differentiate between descriptions (i.e., visualized arrangement) and interpretations (Scupin 1997) that create new knowledge for understanding the root of the problem. Using an affinity diagram in iterative loops makes it possible to go back to the visualized arrangement during discussions for finding a problem statement to ultimately (co-)design the research plan.

To further explore whether using VAM within a co-creation process facilitates an open process structure in an inclusive citizen science approach an affinity diagram was used in the pilot on caregiving. The pilot focused on informal caregivers working in health care balancing tasks in their personal life and work situation. In this pilot two components of the onboarding conditions of citizen science were integrated: 1) working on an equal basis for collaboration with professional and non-professional researchers and 2) using VAM for (co-)analysis of five semi-structured interviews held by professional researchers with informal caregivers who were also participants in the (co-)analysis sessions.

3. METHODOLOGY

One of the pilots of the project TOPFIT Citizenlab[1] focuses on the theme of informal caregiving. The first research goal of this pilot was to create a technological innovation to pre-emptively improve the sustainable employment of informal caregivers working in health care. To lay the groundwork for an equal collaboration the research process was based on the phases in design thinking (i.e., human centred approach) (Dorst 2011). The second research goal was to explore an inclusive citizen science approach using the ten principles of citizen science according to the European Citizen Science Association (ECSA) (Hecker et al. 2018). The two research goals are ideally accomplished by co-creating the research plan in an equal collaboration between all participants of the pilot. The team existed of three groups:

1) Four [4] Citizenlab researchers, with a background in design research, physiotherapy/healthcare, wellbeing at the workplace and valorisation.
2) Six [6] informal caregivers working as professionals in healthcare while at the same time taking care of their partner, family member, or friend.
3) HR group of six [6] people existing of five [5] Human Research managers and one [1] Informal Care Advisor.

The caregivers pilot started in 2020 with an online questionnaire and five semi-structured interviews conducted by researchers with informal caregivers. The overall question for the interviews was centred on how caregivers experience daily life and work. The pilot is ongoing and will continue until December 2022 with some options for continuation. To be able to demonstrate whether VAM can function as an open process structure in an inclusive citizen science approach this article will focus mainly on the second session of analysing interviews using affinity diagramming (Figure 3).

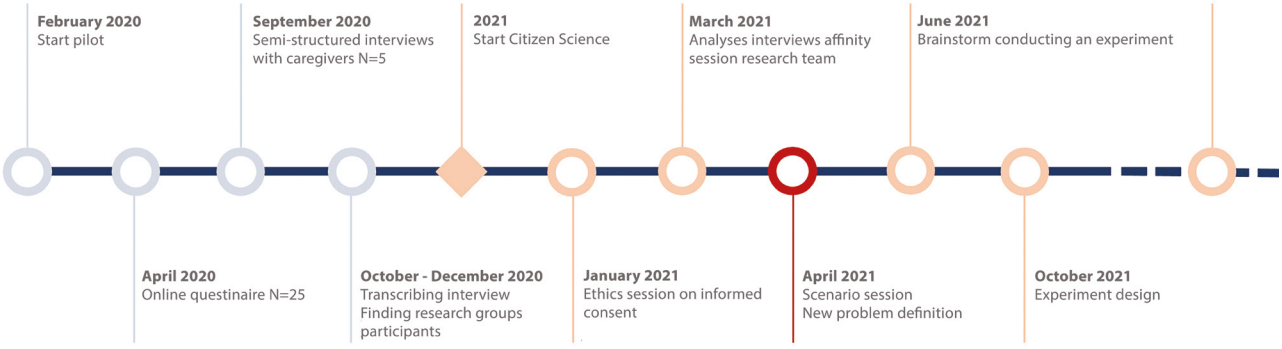

Fig.3: Overview of the process of the Citizen Science approach. The pilot will run until December 2022 with some options for continuation.

1 TOPFIT Citizenlab 2020-2023. TOPFIT Citizenlab is a three-year research and innovation programme based in Twente in which citizens, healthcare professionals and companies join forces with researchers to develop and implement technological innovation for health and healthcare. The educational institutions that are involved are University of Twente, Saxion University of Applied Sciences and ROC Twente, the Netherlands.

As mentioned, an affinity diagram is a visualization model of any kind of data as a purely bottom- up approach (Beyer & Holtzblatt 1998). In design research it is mostly used for categorizing quotes from qualitative interviews (Scupin 1997). The initial reasons and goals for using the affinity diagramming for (co-)analysis in the pilot were:

1) Sharing existing knowledge and experiences (bottom-up) of informal caregivers through scalable visualization.
2) Learning 'on the go' of research skills and how to work together using co-creation methodologies.
3) A broader insight into knowledge and experiences on caregiving in general that will give caregivers the tools to come up with solutions for challenges in the daily lives of other caregivers.
4) Gaining insights for agreements about the next step in the research process.

3.1 APPROACH

An explorative approach was taken on towards learning about a citizen science process by discussing every step in the process by the research team. The activity of affinity diagramming differed from the conventional KJ method in mainly two ways: first, the reviewing by interviewees of their own quotes and second, in the creation of three diagrams by each group in stead of one (Table 1). The three diagrams were used for comparison and discussion of different and overlapping perspectives on experiences, root of the problem and ideas for solutions.

KJ Method/Affinity	Affinity diagram in Citizen Science approach
(1) Label making. (2) Label grouping and title making. (3) Special arrangement and chart making. (4) Verbal or written explanation.	(1) Review of quotes by interviewees who were also part of the pilot research team. (2) Label making. (3) Label grouping and title making. (4) Comparison and discussion of the three diagrams.

Table 1: Overview of the steps of the conventional KJ Method and steps used in the Citizen Science approach for the pilot on caregiving.

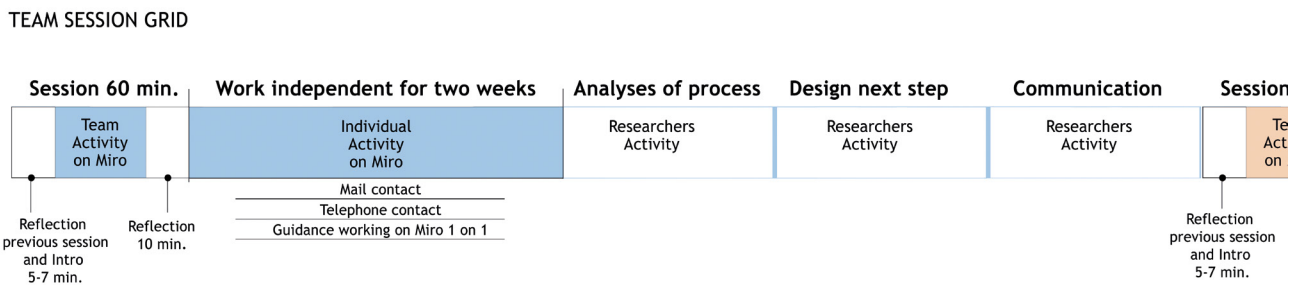

Fig. 4: Team Session Grid. The team exists of informal caregivers, HR advisors and researchers.

The Team Session Grid (Figure 4) shows an overview of the general set up of a team session based on proximately a year of working together in the pilot. The three Researchers Activities took about 4 to 6 weeks to complete.

The analysis of the process was discussed as a team in the Reflection parts, at the beginning and end of the session. During these reflections everybody talked about the approach and methods (e.g., time, working in Miro, content/quotes, observations, roles, alternative methods) used in the session. The outcome of these reflections made it tangible to understand what support everybody needed to (co-)create a framework for staying involved. The researchers remained facilitators of all the sessions because the caregivers and HR groups preferred it that way, mainly because of lack of time. All reflections were noted by the researchers and shared via e-mail. The planning of the next co-creation session was either discussed at the end of the session or by using an online date selection tool.

3.1.1 CODING INTERVIEWS FOR AFFINITY DIAGRAMMING

For the coding of the interviews the categorization of the mental model approach by Indi Young (Young 2008) was used. This mental model approach (Young 2008) provides three categorizations that focus on how people are currently handling certain challenges in daily life: Emotions, Behaviour, and Philosophy (i.e., how people ideally want to handle their challenges). The focus of the semi-structured interviews was based on the question what caregivers experience in daily life taking care of others and working in health care (i.e., being a professional trained health caregiver and extend these skills into personal life). After researchers coded and anonymized the interview data, the coding process was explained to the interviewees. Every interviewee was given the opportunity to refuse privacy-sensitive quotes in the context of the GDPR and from an ethical point of view. They were also encouraged to add quotes that

weren't included by the researchers. None of the interviewees added or refused quotes. For the informal caregivers who were interviewed an additional consent for usage of the selected quotes in the co-creation sessions was added.

3.1.2. ANALYSES USING AFFINITY DIAGRAMMING

Learning about each other's perspectives is a key component of onboarding and equal collaboration towards collaborative partnership. To ensure that every group could share their perspective from personal experience and knowledge each group created an affinity diagram. The researchers created their affinity diagram after the affinity session so they could assist working with Miro during the session. An affinity diagram template (Figure 5 and 6) was set up in Miro that remained available for two weeks after the one-hour online session. The total of 295 quotes of the five interviews were placed on Miro sticky notes and shuffled for each group. Next, the quotes were randomly divided amongst the participants of each group. Each participant was given about 60-73 quotes, depending on the groups size, which were placed underneath their name.

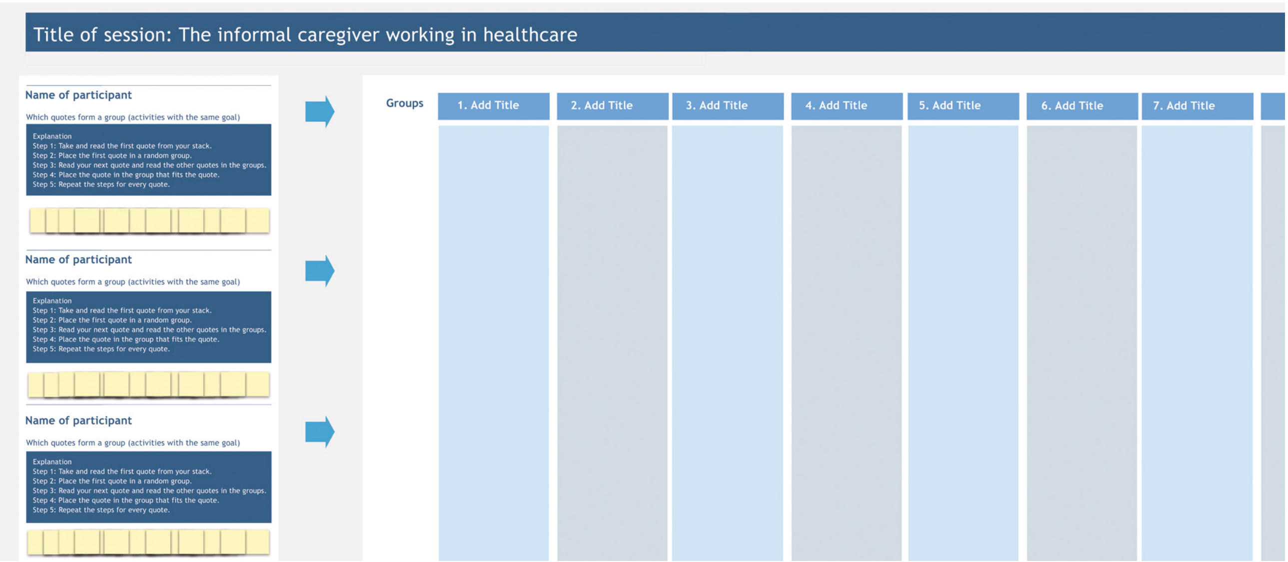

Fig. 5: Miro setup of the affinity diagram for informal caregivers, HR advisors and researchers. Moving quotes into groups and labelling the groups.

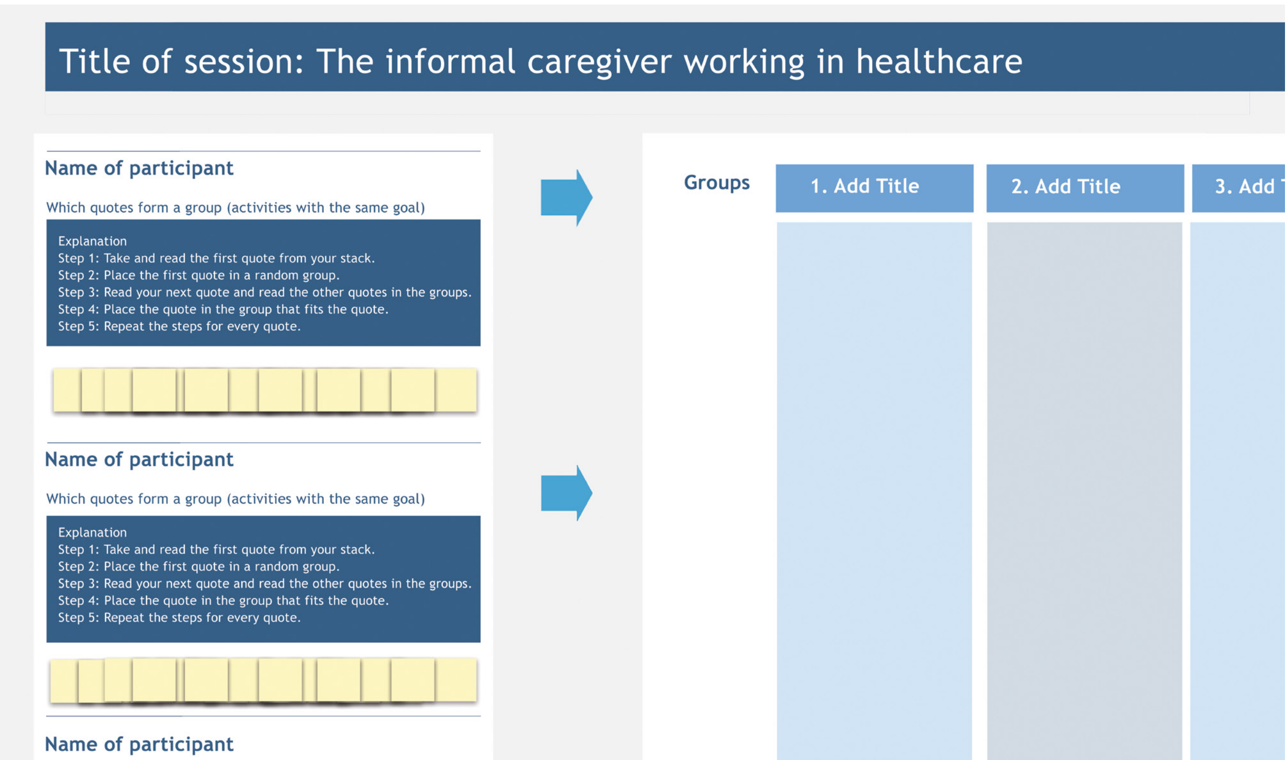

Fig. 6: Miro setup of the affinity diagram for informal caregivers, HR advisors and researchers. Moving quotes into groups and labelling the groups.

At the beginning of the affinity session the model was explained during the introduction part using Microsoft Teams. The creation of the affinity diagram happened in five steps (Figure 6):

1) Take and read the first quote from your stack.
2) Place the first quote in a random group.
3) Read your next quote and read the other quotes in the group.
4) Place the quote in the group that fits the quote.
5) Repeat the steps for every quote.

To clarification on intuitive grouping was as follows: 'Which quotes form a group (activities with the same goal)' (Figure 6). Creating the affinity diagram happened in silence because some people are verbally stronger than others, therefore preventing an imbalance in working together.

At the end of the session there was a reflection on the method of affinity diagramming and the next steps were discussed. The researchers, as facilitators, asked who was planning to use the Miro template of the affinity diagram in the next two weeks after the co-creation session and who wanted support. Most of the participants used the Miro template after the session. Two of the participants asked for support and researchers provided a one-on-one session for both.

Fig. 7: Affinity diagram by informal caregivers (anonymized screenshot of the Miro board).

3. 1. 3 NEXT STEP IN THE PROCESS: SCENARIO SESSION

After creating and discussing the affinity diagrams every group selected the three most important categories (i.e., group labels) in the next online session (Table 2). Some of the categories were merged because they were considered inseparable.

	Caregivers	HR advisors	Researchers
Categories Top 3	1. Collaborate and communicate 2. Setting Boundaries/ Relaxing 3. Work (job)/Organize	1. Clarify need 2. Communication with all involved 3. Taking care of yourself/Personal development	1. Forget about yourself / Just carry on / Stress from caregiver 2. Support by care organization/ Municipality/ Employer 3. Participation control by informal caregiver and relative / Loss of autonomy

Table 2: Selection of Top 3 categories (i.e., group labels) by each group.

By selecting the most important categories in the diagram new insights were gained for finding the root of the problem. The three categories of one group were given to another group (i.e., Round Robin technique) to create a context scenario. In this scenario the context of the categories is described obtaining the root of the problem, actors, possible support, needs and roadblocks. After discussing the three scenarios the whole team created one shared context scenario that would be the blueprint for defining the problem statement.

Scenario Session, after the affinity diagramming session.
1. Selection of three categories in need of (technical) support. 2. Round Robin technique: each group created a scenario that would support the categories selected by another group. 3. Discussing the three scenarios. 4. Creating one shared scenario as a team.

Table 3: Overview of the steps in the Scenario Session.

Following the scenario session all participants were asked to fill out a small questionnaire (Table 4 and 5). This questionnaire consisted of three questions about the experiences of the approach: motivation during the meetings, increase in knowledge (content and approach), and motivation for future meetings. Answering the questions involved selecting an option of the Likert: none-low-middle-high-very high. The questionnaire ended with an open field for improvements and positive feedback.

Overall results	
Motivation	middle-high
Knowledge increase	middle
Future motivation	middle-high

Table 4: Overall results of the whole team

Improvements	Positive feedback
Having face to face meetings.	Respect for each other's experiences in the conversations. Curious what may come out in the end because everyone experiences informal care in their own way.
Groups are too small.	Learning to work with the method and working with different disciplines.
Insufficient depth due to too short meetings.	Clear meetings, clear what is expected of you.

Table 5: Aggregated outcomes of the whole team for Improvements and Positive feedback.

3.3 SUMMARY OF THE MAIN FINDINGS

All findings are based upon the notes taken during the online 60-minute sessions, the notes of communication between online sessions (e.g., telephone and e-mail) and the questionnaire shared after the scenario session (Table 4 and 5).

Co-analysis of data in a co-creation setting created awareness of the context from multiple perspectives while working with different disciplines (i.e., transdisciplinary) (Wright et al. 2015) toward defining a problem statement and ultimately a research plan. Some team members shared negative experiences on having cooperated in research projects before and being left with a feeling of "…but nothing changed for me". Hence, although affinity diagramming was new to the participants, the idea of defining the research question and creating the research plan gave them a feeling of being actively involved in the research (i.e., empowered). Being and feeling involved in a citizen science approach assisted an active communicating of expectations for doing research activities together.

The grouping of the quotes happened in a smooth way without any informal training. Several participants worked independently with the Miro template during breaks at their job, the only moment they had spare time. Although working online was a steep learning curve in the beginning, it turned out to be crucial for the participants to stay involved. Mostly valued in the affinity diagramming was the ability to learn about each other's perspectives and still be able to visualize and value individual perspectives. Affinity diagramming made it possible to get started on analysing the data during the first session keeping the period of uncertainty of problem finding to a minimum.

As for professional researchers and for human resource advisors, setting up an affinity diagram gave insights into the 'other' (i.e., the informal caregiver). On the other hand, for the individual informal caregiver, labelling data from interviews triggered conscious thoughts about dealing with daily life that had become second nature for them. As well as this, it created an overview of many experiences and perspectives of how to deal with being a caregiver, taking a step back from a personal point of view to an overall perspective (i.e., moving from one too many). Within a short time span the affinity diagramming guided the evaluation of all the knowledge and insights from the interviews. This guidance through VAM supported staying close to the data for identifying the assumptions by separating descriptions from interpretations. For several participants, this led to a new position towards the problem situation without losing sight of personal needs and wishes.

Learning analytic research via VAM in a co-creation setting showed that seeing what others do prevents non-professional researchers from feeling embarrassed and uncomfortable (Cooper 1999). Furthermore, to work in silence during affinity diagramming was much appreciated. One participant mentioned dreading ongoing discussions about the different perspectives, leading to endless talking and no consensus or solution. Comparing the affinity diagrams by selecting the top three of most important categories supported a bottom-up way of researching challenges in informal caregiving. During the discussions about the categorization of the quotes and the selection of a top three, a mutual understanding of root pitfalls for solutions emerged. Hence, the interaction with an affinity diagram facilitated common grounds for collaborative partnership towards problem solving and decision making. In other words, the bottom-up approach of VAM enabled a movement from inclusiveness to sustainable collaboration in citizen science.

VAM added significant value to an inclusive citizen science approach in essential communication through the data. Communication through the data not only succeeded in reaching a common understanding for equal collaboration (i.e., the research process) but also an agreement on the problem statement towards a research question for finding an innovative solution. Consequently, VAM simultaneously created knowledge about the theme of informal caregiving as well as the research process itself and therefore it can uphold inclusiveness as 'low entry onboarding'.

4. CONCLUDING REMARKS

As mentioned before, the challenge of inclusiveness in citizen science lays in supporting onboarding, collaboration on an equal basis, and synergy of knowledge. The result and value of an inclusive citizen science approach stems from creative ways to stay involved. Especially because non-professional researchers aren't always able to or want to be involved. The use of affinity diagramming not only supports evaluation of data for (re)defining the research problem, but also supports an effective involvement during different phases of the process. And in doing so gaining new insights through co-creation methodology without any informal training.

Visual analytic research within a co-creation process supported an accessible way to synthesize different perspectives. During the caregivers pilot the participants: informal caregivers, HR advisors, and researchers, experienced improvement of empowerment through involvement in the research activities. The exchange of experiences with others, in the research project and in daily life or at work, created a mindset for thinking about the process. This approach for inclusion in citizen science takes more time, but trust, equal collaboration, and reciprocity lies in openness, transparency, and critical reflection of decisions made during the research process. The fluidness of this way of co-creative partnership showed an intrinsically circular knowledges process because it expands the context of research activities regarding new availability of research resources (e.g., skills, knowledge, tools) in society.

Nevertheless, more research needs to be done on VAM for an inclusive citizen science approach (e.g., comparisons of different citizens science projects, the influence of doing online research, issues in different domains, professional researchers onboarding in citizens research activities, citizens as facilitators) to validate that research outcomes are more successful in an inclusive citizen science approach. Therefore, inclusive methods like diagramming need to be fine-tuned for an inclusive citizen science approach. In other words, how conscious creation of knowledge about the collaboration process itself can be integrated into the research process. All in all, this indicates a need indicates a need to further enhance an understanding of a citizen science approach by using visual analysis models as an inclusive method for the co-creations of research questions and plans.

The caregivers pilot research team is still strongly motivated to stay involved and gradually new participants are added to the team.

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AUTHORS

CATHARINA VAN DEN DRIESCHE, C.J.H.M.
University of Twente EEMCS Faculty - DesignLab
Buildings Zilverling and Carré Faculty Office, Zilverling room 1070
Drienerlolaan 5, 7522 NB Enschede, The Netherlands
E: c.j.h.m.vandendriesche@utwente.nl
ORCID 0000-0003-0759-7973

SARAH KERKLAAN, S.
Saxion University of Applied Sciences
Faculty Healthcare – Smart Health
Enschede , The Netherlands

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