# Co-creating interactive virtual reality training environments
## Reflections on a model for a participatory design process

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*Abstract*—**This paper discusses the activities of an ongoing research project related to open science. Based on the involvement of team leaders, an interactive Virtual Reality training for social skills has been developed. Yet, the participatory and co-creative elements of the process encountered a series of limitations. Analyzing the difficulties of the case, we outline an ideal-typical model for the participatory development of socio-technical information systems.**

*virtual reality training, co-creation, participatory research, open science.*

## I. INTRODUCTION

Any IT-based design is not limited to technological issues but has also specific societal and ethical implications. Such implications can and should be addressed in co-creative processes, especially when novel technologies are developed, or new fields of potential applications emerge. Co-creative processes in this sense are value-based [1], i. e. they should include dialogue and discussion at eyelevel between developers and users on the ethical and societal aspects that are relevant for the respective design project. Since co-creation is not limited to the exchange of ideas among different stakeholders but should include methods and ways of common decision making, processes of value-based co-creation include also participatory elements.

In this paper, we present an ongoing implementation case of a co-creative design of a socio-technical information system. The research and development project Virtual Skills Lab, funded by the Austrian Research Promotion Agency, aims at developing an interactive Virtual Reality (VR) environment for the training of social skills for mid-level managers. The project was designed as a transdisciplinary process with co-creative and participatory elements. The rest of the paper is organized as follows: In section II, we describe the structure of the research process, highlighting its co-creative and participatory aspects. In section III, we present some considerations on the limitations of our case regarding co-creation. In section IV, we outline a categorization of the building blocks of the process regarding co-creation as well as participation and critically appraise the extent and intensity of co-creation in the Virtual Skills Lab. Based on this appraisal, in section V, we will outline a process design for an ideal-typical co-creative and participatory development of an interactive VR environment.

## II. VIRTUAL SKILLS LAB – A TRANSDISCPLINARY PROJECT WITH CO-CREATIVE AND PARTICIPATORY ELEMENTS

The idea of the Virtual Skills Lab was created in September 2018 in a five-day seminar structured in form of a sandpit named 'Ideas Lab' [2]. It was organized by the Austrian Research Promotion Agency. The overarching topic of the lab was the future of human-machine interaction, especially in working environments [3]. Within the seminar, a group of researchers, developers and practitioners, representatives of five organizations, was constituted around the idea of developing an interactive VR environment for social skills training. The group, later enlarged by other members of the consortium's organizations, consisted of a software developer specialized in learning technologies, a human-computer interaction researcher specialized in user experience, a psychiatrist, a sociologist specialized in the sociology of technology and a philosopher with a specialization in corporate culture and social skills training.

Together, this group worked out the proposal for the Virtual Skills Lab project, in which a VR prototype for the training of social skills should be developed. The idea was to use the interactive VR technology in combination with technologies like speech recognition and natural language processing, in order to create a learning experience for team leaders in which they find themselves in the simulation of a difficult communicative situation with a fictional collaborator.

From the beginning, the structure of the project was conceived in terms of a co-creative process. This was especially the case for the Ideas Lab, in which the project idea was born, and for the two-months of writing the full-length proposal required by the funding agency. Furthermore, co-creative elements were planned for the whole implementation period of the project, which continued to be based on a transdisciplinary approach.

On the one hand, the members of the consortium contribute to the project by separately carrying out specialized tasks and work packages. On the other hand, many of these tasks are interrelated, so that there is a lot of decentralized coordination and teamwork realized across the boundaries of disciplines and specialization.

During the requirement analysis at the beginning of the project, a series of interviews were conducted with experts from diverse backgrounds: from VR-related research and

development to business, training and trade unions. The interviewees were asked to express their views on the various stages of the project. Some of their statements were integrated into the development of the prototype and especially into the reflections on the ethical and diversity-related aspects of the work.

A special focus in terms of co-creation was given to the participation of potential users. This participatory activity consisted of a series of workshops with team leaders of an international organization, in which a storyline was developed. The development of the storyline was based on reflections of the team leaders on the everyday interaction with their team members and other colleagues in the organization. At the end of the workshop series, they decided that, among all the topics raised, "decline in an appreciative way" was the most relevant for creating an interactive scene. A scriptwriter worked out an office scene related to this topic, which was discussed together with the team leaders and further refined. At the end of this process, the scene was accepted as the basis of the prototypical interactive VR scene, in which the fictitious collaborator appears in form of a virtual non-playable character.

In a common discussion process, the members of the consortium had to take a decision on the characteristics of the virtual non-playable character. The perspectives of the sociologists, the screenplay writer, the psychologist, the user experience researchers, and the VR-developers had to be aligned. Finally, the group decided to design the virtual non-playable character as a woman aged about 30 years with a migration background. Furthermore, the decision was taken to design alternative characters according to the features of age, gender, body type, and realism for the evaluation phase of the prototype.

For the involvement of other potential users, various studies in terms of usability and user experience were planned. The research group was invited to take part in two "science meets public" events organized by the city of Vienna in 2020. Both events that would have served not only as a presentation, but also for the testing of the scene by the public, had to be cancelled due to Covid-19.

Not only gender and diversity, but also the reflection of ethical aspects was integrated into the research design. On this behalf, the sociologists have been organizing a series of workshops with experts from diverse backgrounds. In these workshops, issues such as the appearance and back story of the characters of the virtual non-playable character but also the co-creative design of the research process, are discussed and subject to critical appraisal.

## III. LIMITATIONS OF THE CO-CREATIVE APPROACH IN THE VIRTUAL SKILLS LAB

Reflecting on the co-creative and participatory character of the Virtual Skills Lab, we can state that some achievements have been accomplished, particularly concerning the implementation of the transdisciplinary approach. In addition, the openness towards external views and critical stances concerning the project have been appreciated by the experts that have taken part in the interviews and workshops dedicated to ethical issues. Still,

the research group has encountered several limitations to a fully co-creative and participative research process.

### A. Internal and external cooperation

Although the project has been realized in a very open, transdisciplinary spirit and the coordination between the different actors works well, several stages of the implementation are solely carried out by the respective specialists. There could be more interaction, reflective loops and points of intersection between the different groups.

Coordination is realized in a decentral, network-like, open and non-hierarchical form. Still, we have not explicitly set up decision-making and working methods that could have organized the development in a way to further increase the opportunities for reflecting, deciding, and implementing together.

From our perspective, we have not sufficiently involved potential users, obviously because of the pandemic, but also because the gap between in-group (research and development team) and out-group (cooperating company) of potential users has not entirely been breached. Furthermore, the motivation of the individual team leaders in the process has remained unclear. This could be also due to the limited possibility to meet the participants of the story workshops caused by the pandemic. The lack of communication with the participants and the organization's representatives has caused some misunderstandings and irritations during the process. For example, participants often assumed the position of a customer that assesses a product, instead of feeling part of the research process. In addition, their expectations towards the design of the VR scene diverged significantly from the actual outcome.

### B. Technological options

We did not involve potential users in the discussion of technological options. An interactive VR scene can be realized in three ways: either by using playable characters (i. e. as a live role play) [4, 5], or as an interaction with a non-playable character controlled by a computer [6, 7], or in the form of a 360° video. The decision to use a non-playable character was taken in advance, also due to the necessities of the research proposal. However, we could have organized workshops in order to discuss the various options in terms of technology with the participants. This would have helped anyway to create a shared understanding of the training scenario and the possibilities of the VR technology. We did not realize this in the Virtual Skills Lab because in a first step we focused on co-creating the VR content, not realizing how important is would have been to involve also potential users in technical decisions. Beside the consequences of the pandemic, we lacked of time and financial resources to ensure also the users' perspective in this stage. Up to now, the gap between the experts' specialized view on the technology and the lack of involvement and information on the side of the participants remains.

### C. Resources

For the realization of a fully participatory and co-creative research, more time and financial resources would have

been necessary. In this way, more potential users from different organizations could have been involved from the beginning. Furthermore, the involvement of users in the development of the technological solution could have been realized.

Due to the Covid-19 pandemic, organizations' priorities shifted significantly, which resulted in a lacking willingness to organize participatory events like workshops and presentations. This has severely limited the possibilities to involve potential users and stakeholders in the research.

## IV. CATEGORIZATION OF CO-CREATIVE AND PARTICIPATORY ELEMENTS

Generally, the co-creative and participatory organization of research has been practiced for a few decades. 'Open Science' and 'Open Innovation' are concepts that stand for a growing community of researchers and members of the public who carry out research projects intending to involve stakeholders from diverse backgrounds that go far beyond the academic field. Hence, Open Science aims at transparency regarding the use of data and methods applied.

Still, the intensity and extent to which a research process is opened to non-experts varies. In a report on public participation in scientific research from 2009, Bonney et al. establish three categories to differentiate between a higher or lower degree of participation in such projects [8]. They define research projects as 'contributory' if they are designed by researchers and if members of the public just contribute data. In 'collaborative' projects, researchers are still responsible for the design, but involve members of the public in the refining of the design, in data analysis and the dissemination of findings. By contrast, 'co-creative' projects are such endeavors in which researchers and members of the public cooperate in the design and in all of the implementation steps.

If we apply these categories to the Virtual Skills Lab, the project can be defined as contributory and collaborative. The project is characterized by many activities in which qualitative and quantitative data are created by potential users (in the story workshops as well as in the interviews on gender and in the evaluative user experience studies), but also by experts (in the expert interviews during the requirement analysis as well as in the workshops on ethical aspects).

According to this categorization, the Virtual Skills Lab cannot be defined as co-creative as a whole, in that members of the public have not been involved in the design. However, as we have outlined above, there are co-creative and participatory elements in the design as well as in the implementation of the project. The sandpit method of the Ideas Lab, where the project idea was first conceived, has implemented a transdisciplinary dynamic that has been provoking discussions and reflections in the research group that are well comparable to the dynamic between experts and members of the public in co-creative projects as conceived of by Bonney et al. [8]. Because of the high diversity of academic disciplines, any expert of the group is at the same time a member of the public with respect to the other disciplines.

Also, the process of creating a story for the VR scene can be defined as co-creative, in that the content was developed together with team leaders who eventually decided which topic should be worked out by the screenplay writer. In addition, the cooperation between the research group and the screenplay writer can be described as co-creative. The writer joined the research group at an early stage of the project, initially assuming the position of an external service provider. Still, during the process, she began to identify more and more with the research and eventually considered herself and her work as part of the research.

Nevertheless, as already mentioned, the consortium has not succeeded to keep the borders between the in-group of the researchers and the out-group of potential users as open as it would be required in a truly co-creative process, limiting the openness of the process to contributory and collaborative activities – except for the transdisciplinary character of the research and the development of the story.

TABLE I.

| Virtual Skills Lab | | |
|---|---|---|
| *Building block* | *Category* | *Method* |
| Conception | Co-creative | Sandpit Ideas Lab) |
| Requirement analysis | Contributory, collaborative | Qualitative interviews |
| Transdisciplinary implementation | Co-creative | De-central coordination, discussion and cooperation beyond specialized tasks |
| Target group involvement | Collaborative, co-creative | Workshops |
| Usabilty and User Experience | Contributory, collaborative | Qualitative and quantitative evaluation |
| Gender and Diversity | Collaborative, co-creative | Qualitative interviews, common decision on virtual non-playable character's characteristics |
| Ethics | Collaborative | Workshops |

## V. A MODEL FOR A CO-CREATIVE DESIGN OF INTERACTIVE VR-ENVIRONMENTS

The categorization introduced by Bonney et al. [8] considers all three types of projects as participatory and distinguishes according to the extent to which members of the public are invited to participate. It reserves the category 'co-creative' for those projects in which members of the public are involved from the stage of designing and formulating the research proposal to the various implementation and evaluation stages.

From our perspective, the term 'participatory' also refers to the various decision-making processes and methods applied during the different stages. A distinction between more or less participatory research projects could be drawn

according to the extent to which non-hierarchical decision-making methods are applied and formalized in the various phases. In this sense, not only the involvement in the design and the generation of quantitative or qualitative data should be considered, but also the way decisions are taken whenever there are diverse options or alternative ways in which the respective project can be continued. Research projects can be defined as more or less participatory according to the extent to which decisions on relevant topics of the research are taken together (in a transdisciplinary team or with members of the public), and if the decision-making methods allow for openness and a non-hierarchical dialogue.

Participatory decisions can be taken at any stage of the process, starting from the project idea and conception. In our project, the content of the interactive VR scene was developed together with members of the public. The same process could have taken place regarding the technological solution. Furthermore, the whole development process could have been organized in form of continuous participatory loops. Finally, also publication and dissemination activities could be organized involving specialized researchers as well as members of the public.

Conceiving an ideal-typical model for participatory research, we propose to introduce participatory decision-making tools right from the beginning of the process. These can be derived from the commons research [9] or from new non-hierarchical organizational models and decision tools like sociocracy or systemic consensing [10,11]. These are valuable methods and organizational forms for an effective shaping of discussion and creation processes in which specialized and non-specialized participants are involved.

TABLE II.

| Ideal-typical Model | | |
|---|---|---|
| *Building block* | *Category* | *Method* |
| Conception | Co-creative, participatory | Sandpit, Systemic consensing |
| Requirement analysis | Contributory, collaborative | Qualitative interviews |
| Transdisciplinary implementation | Co-creative, participatory | Non-hierarchical organization (e.g. sociocratic, systemic consensing) |
| Target group involvement | Co-creative, participatory | Workshops, Systemic consensing |
| Usabilty and User Experience | Contributory, collaborative | Qualitative and qualitative interviews survey |
| Gender and Diversity | Co-creative, participatory, collaborative | Qualitative interviews, co-creative design of characters, systemic consensing |
| Ethics | Collaborative | Workshops |

In this way, the co-creative and participatory potential of the design of socio-technical information systems could be further raised. Therefore, we propose to introduce decision-making instruments like systemic consensing or the sociocratic organization of discussions for the conception of the project, the whole process of transdisciplinary implementation and especially for the involvement of target and stakeholder groups. This implies that researchers should acquire the skills necessary for moderating group processes and common decision-making, in order to be able to effectively connect the openness of scientific research with the openness of participatory approaches. In our view, it is highly recommendable for researchers engaged in co-creative research to go through training in group dynamics and the moderation of non-hierarchical decision processes. Alternatively, these competencies could be provided by external professionals.

[1]     S. Spiekermann, Ethical IT Innovation. A Value-Based System Design Approach, Boca Raton: CRC Press, 2016.

[2]     K. Maxwell, P. Benneworth, "The construction of new scientific norms for solving Grand Challenges". Palgrave Commun 4, 52, 2018. https://doi.org/10.1057/s41599-018-0105-9.

[3]     https://www.ffg.at/ideenlab/ausschreibung2018

[4]     J. Fox, S. J. Ahn, J. Janssen, L. Yeykelis, K. Segovia and J. Bailenson "Avatars Versus Agents: A Meta-Analysis Quantifying the Effect of Agency on Social Influence", in Human-Computer Interaction 30 (5): pp. 401–32, 2015.

[5]     T. Allen, L. Ashmore, S. Gordon Shelley, A. Tate, L. Cook, and S. Bond Chapman, "CharismaTM: A Virtual Reality Training to Promote Social Brain Health in Adults", in Social Skills Across the Life Span: Theory, Assessment, and Intervention, D. Nangle, C. Erdley, R. Schwartz-Mette,  Eds., Waltham: Elsevier, 295–309, 2020.

[6]     D. Bombari, M. Schmid Mast, E. Canadas and M. Bachmann, "Studying Social Interactions through Immersive Virtual Environment Technology: Virtues, Pitfalls, and Future Challenges", in Frontiers in Psychology 6, 869, 2015.

[7]     M. Gillies, X. Pan "Virtual Reality for Social Skills Training", in Proceedings of the Virtual and Augmented Reality to Enhance Learning and Teaching in Higher Education Conference, J. Hudson, R, Kerton, Eds., IM Publications Open LLP, 83–92, 2018.

[8]     R. Bonney, H. Ballard, R. Jordan, E. McCallie, T. Phillips, J. Shirk and C. Wilderman, Public Participation in Scientific Research: Defining the Field and Assessing Its Potential for Informal Science Education. A CAISE Inquiry Group Report. Washington, D.C.: Center for Advancement of Informal Science Education (CAISE), 2009.

[9]     E. Ostrom, Governing the Commons, Cambridge: Cambridge University Press, 1990.

[10]     T. Rau, J. Koch-Gonzalez, Many Voices One Song. Amherst, MA: Sociocracy for all, 2018.

[11]     https://www.sk-prinzip.eu/