

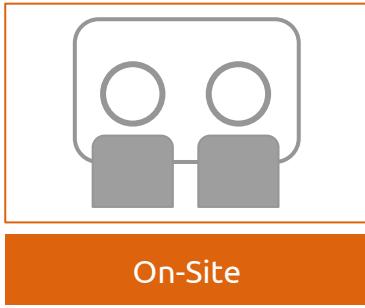


Digital Collaboration with a Whiteboard in Virtual Reality

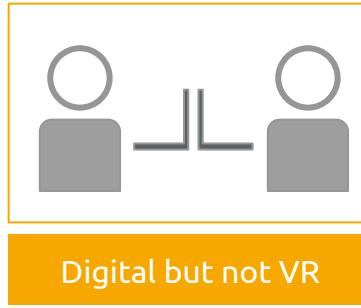
Markus Petrykowski

Improving work of a **collaborating Group** of
people at different places at the same time
using Design Thinking techniques by the
means of Virtual Reality

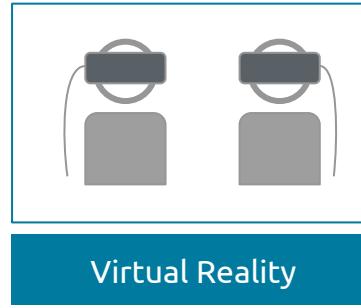
Types of Collaboration for remote teams



On-Site



Digital but not VR



Virtual Reality

Direct Communication

Video Conference

Personal Interaction
possible

Real Time
collaboration

Outcome has to be
documented
afterwards

No personal
interaction

Costly & Time
intensive

Work directly saved

?

Collaboration in Virtual Environments

Available Tools

How they can be used in virtual reality

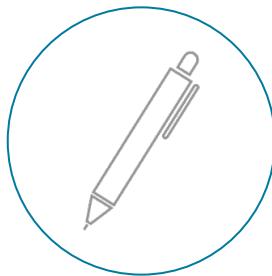
Available Tools^[6]



Sticky note tool

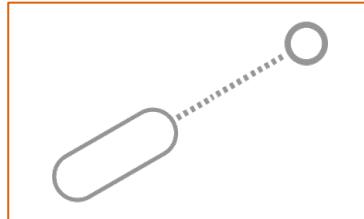


Hand tool

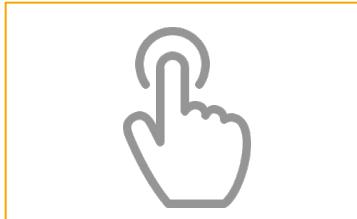


Pen tool

Interaction Methods



Pointing



Intersecting

Description

Interacting through a ray-cast with environment [1]

Actual “touching” of objects in virtual environment [3, 4]

Advantages

Interaction from a distance

Provides realistic experience

Disadvantages

Difficult for interaction with 3D Objects

Missing haptic feedback
User needs to move to object

Prototype

Requirements



Design-Thinking



Social Presence

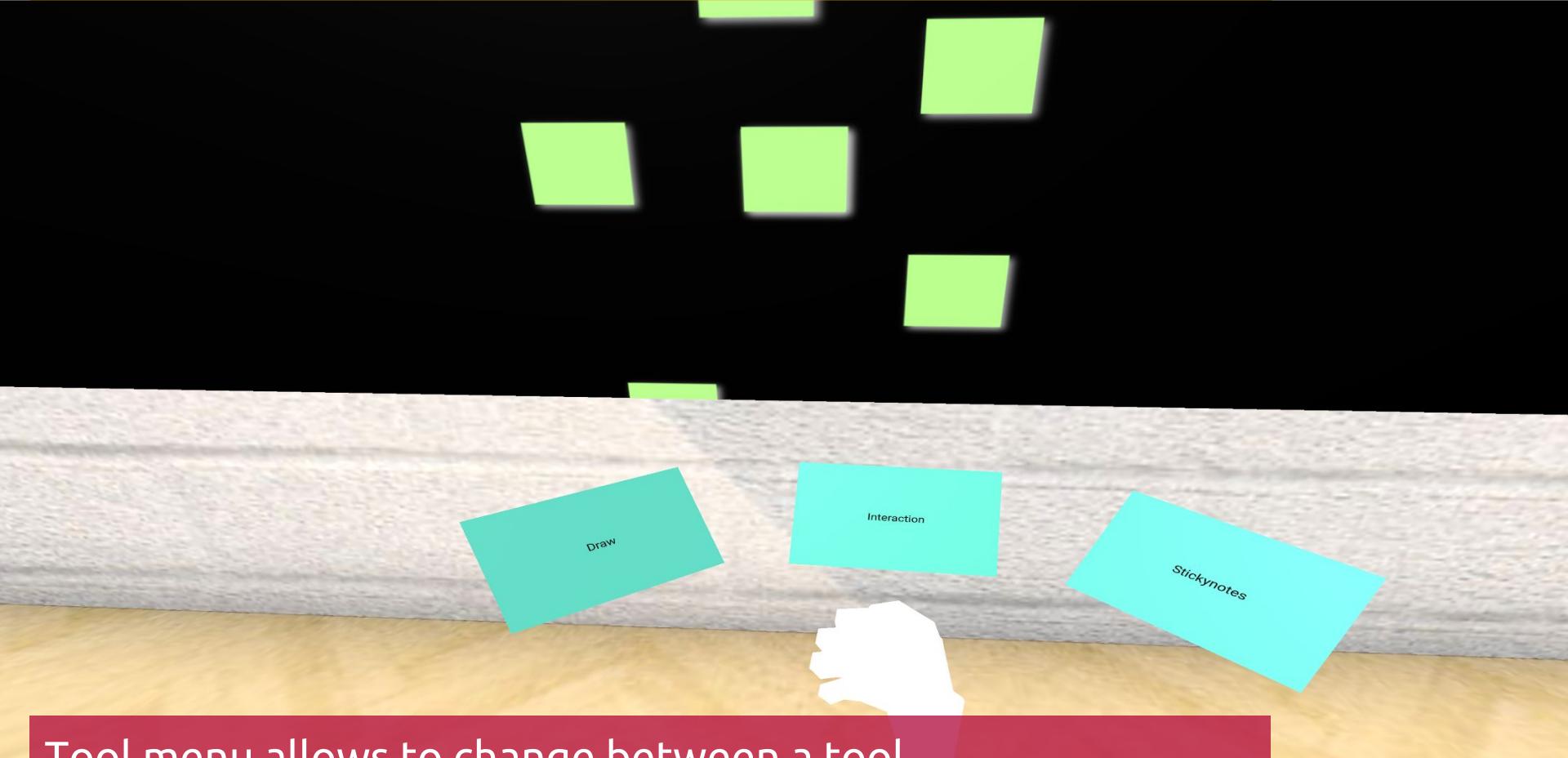


Web technologies

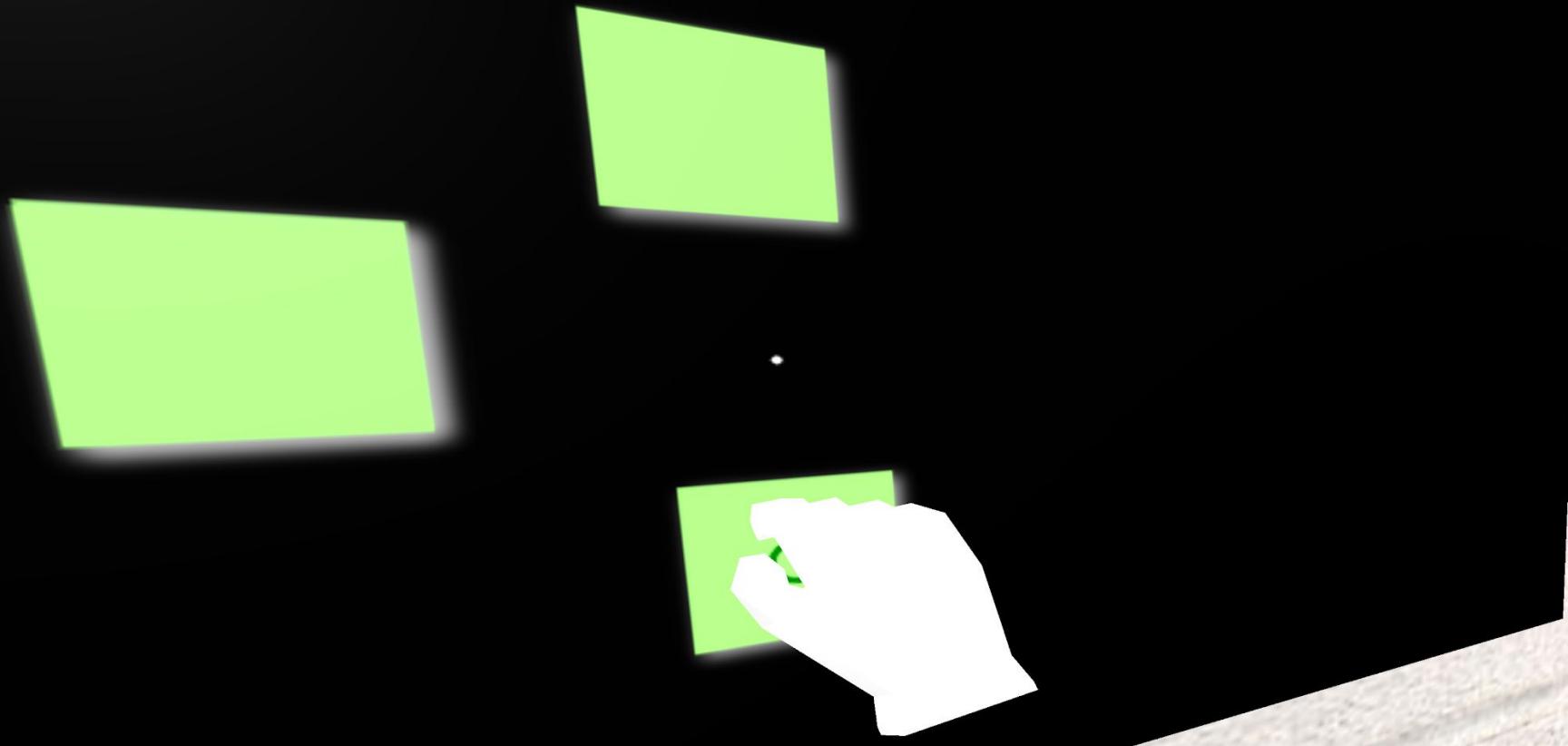
Framerate	
fps	18.02
raf	25.19
Three.js - Memory	
Textures	26
Programs	5
Geometries	128
Three.js - Render	
Vertices	3389340
Points	0
Faces	1129780
Calls	127
A-Frame	
Load Time	2427
Entities	38



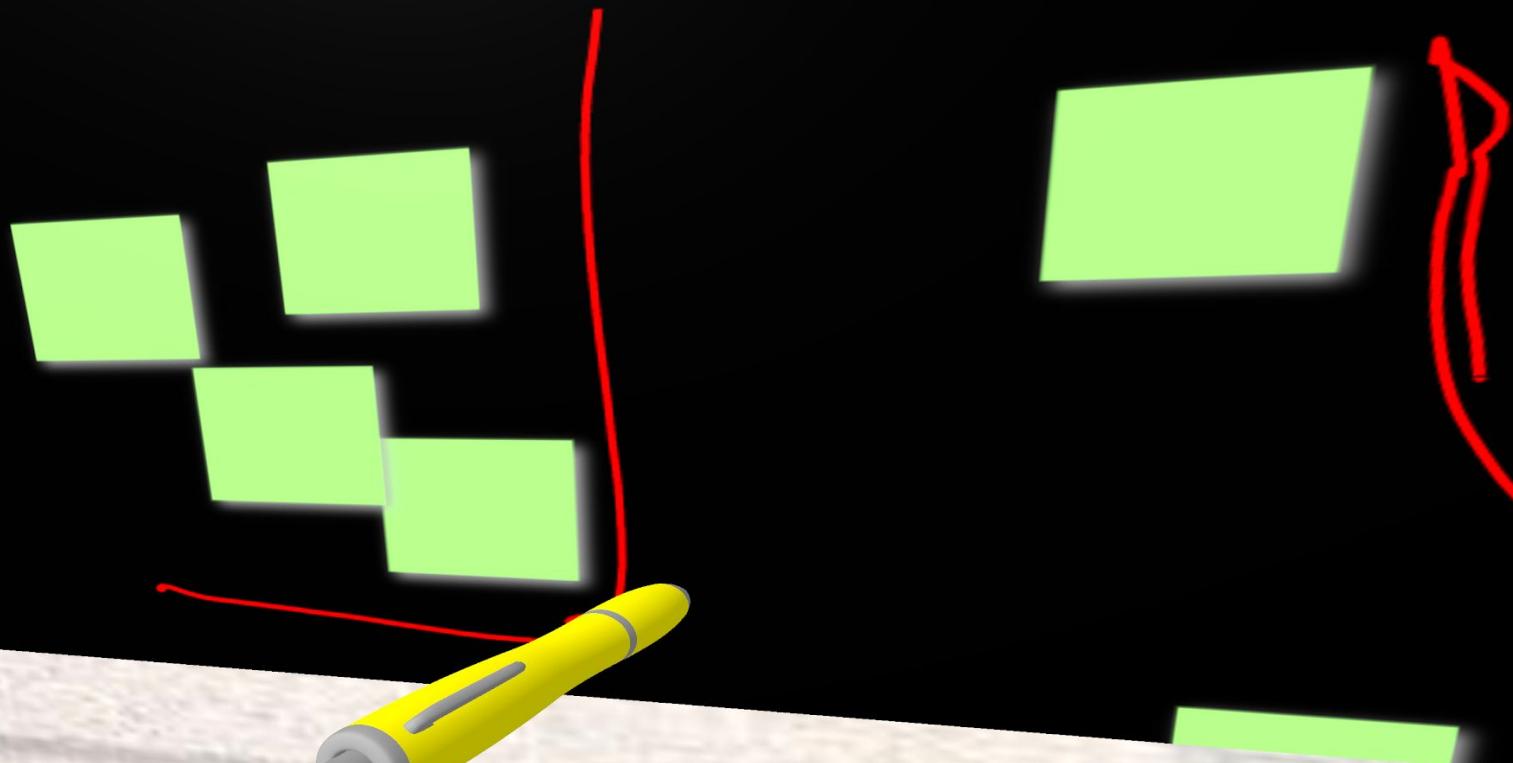
Collaborating user in virtual environment



Tool menu allows to change between a tool
Follows principle of locality



The hand tool allows to interact with sticky-notes

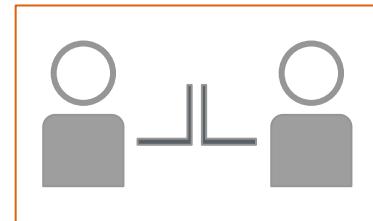


The pen tool enables the user to draw on the board

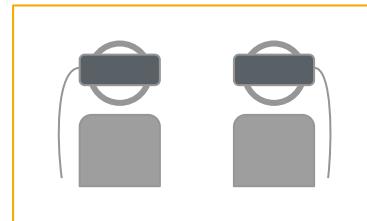
User study concept

Can we make **Design Thinking** possible over
distances by the means of **Virtual Reality**

Performance Comparison



Digital but not VR



Virtual Reality

Team member 1

Team member 2

Team member 3

Team member 4

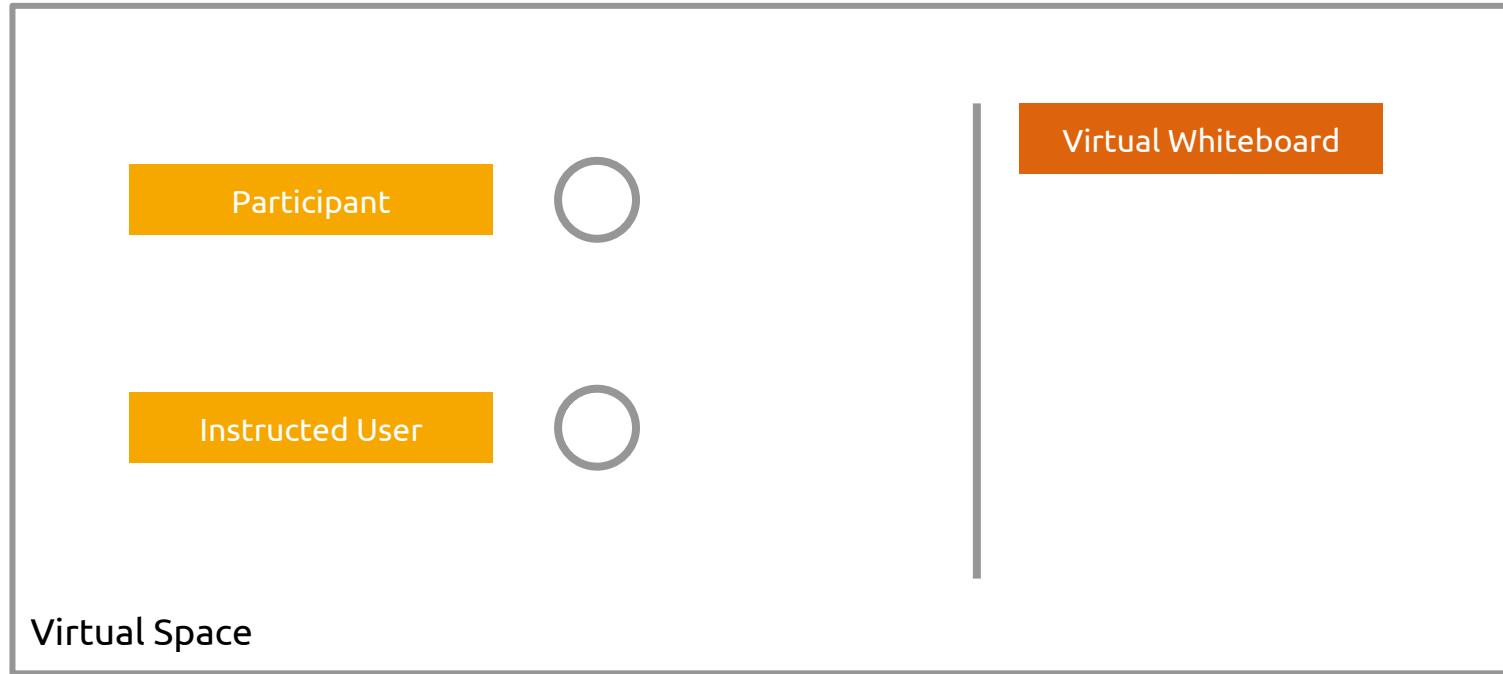
Weekly Plan

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Master Thesis Introductory Pr-esentation						
Notes		TODOs				



neXboard





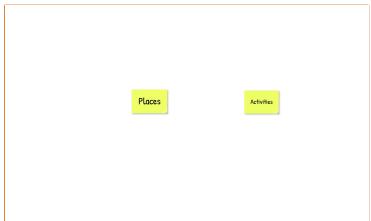
Setup of virtual environment



User study setup - Virtual Reality

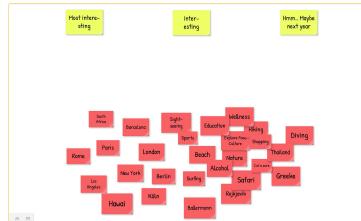
User study's setup - Design Thinking

Next mutual vacation



Task 1

Brainstorming of possible places and activities



Task 2

Prioritizing of brainstormed ideas



Task 3

Comprehension of information of a certain travel destination

Each task should:

- be solved in a reasonable amount of time around 5 minutes
 - require the users to communicate with coworkers
 - have a definition of when task is being completed

Evaluation

Study Feedback



Comparing
performance indicators

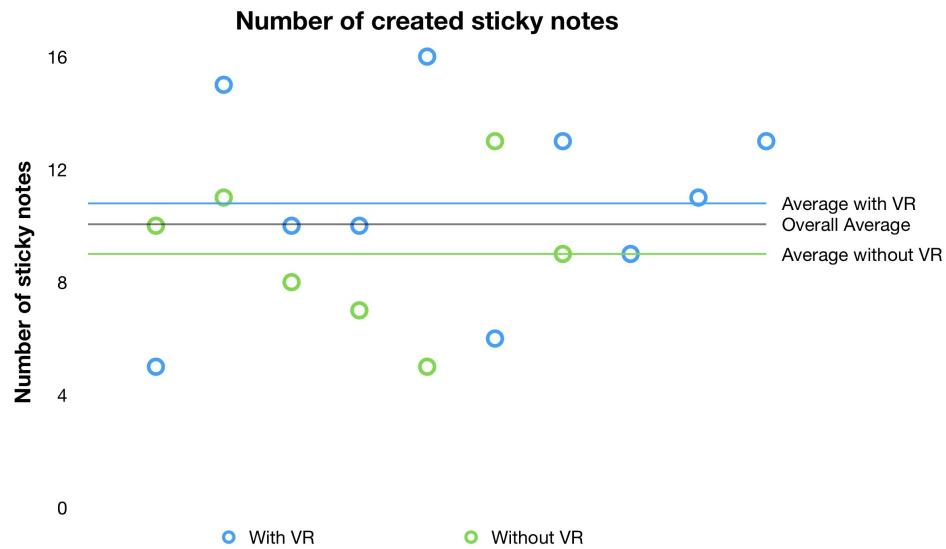


Observing user
behaviour



User's feedback
through questionnaire

Task 1 - Brainstorming



Key Outcomes

VR leads to more produced sticky-notes

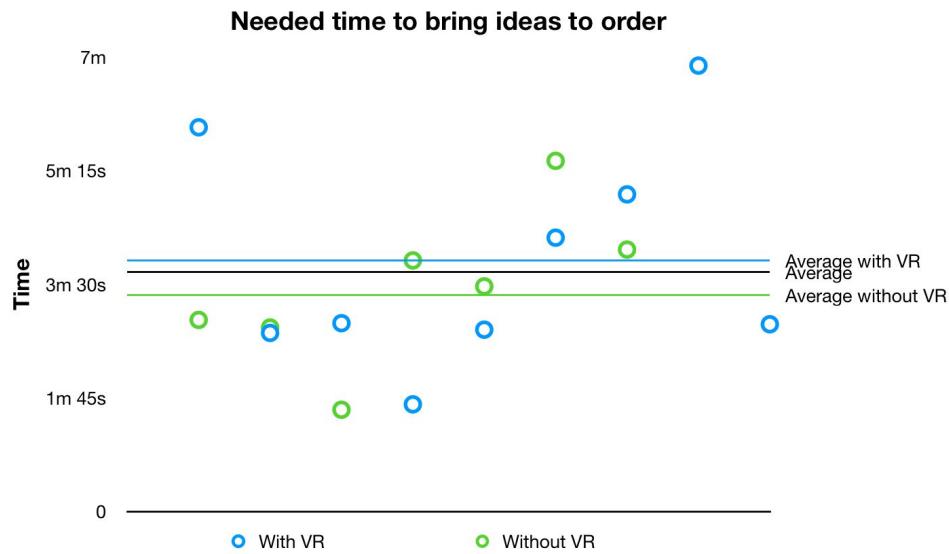
Virtual reality

Participants used the the sticky-note tool and the pointing interaction. Some started with touch.

neXboard

Participants used different colors for sticky-notes

Task 2 - Prioritization



Key Outcomes

VR leads to longer times

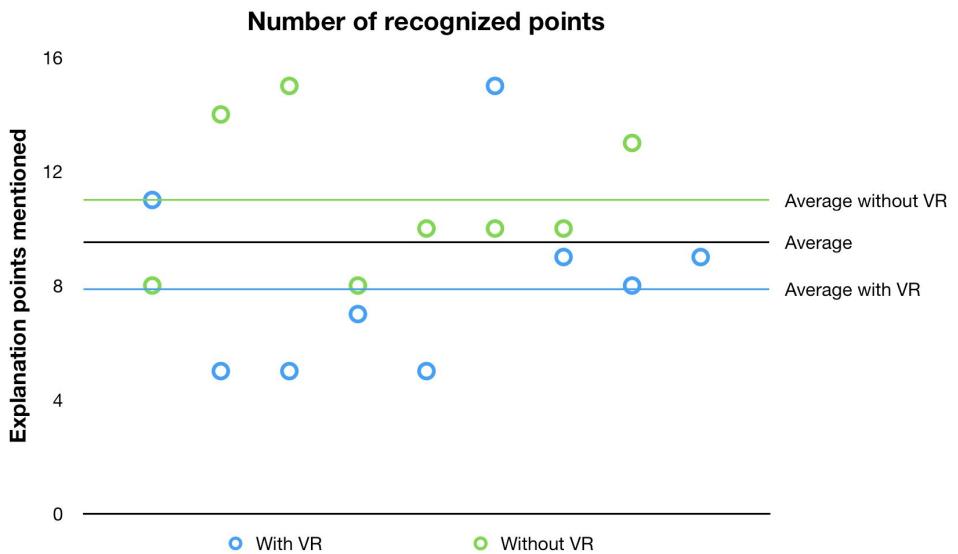
Virtual reality

Participants used pointing interaction.

Focus on whiteboard

Voice communication was most important

Task 3 - Comprehension



Key Outcomes

Users without VR could recognize more points

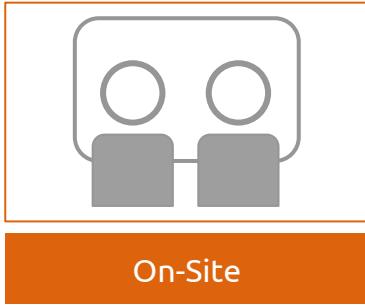
Virtual reality

User mainly interacted with the board

neXboard

Participants wrote sticky-notes to better recall information

Conclusion

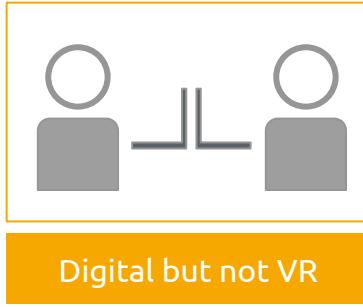


Direct Communication

Personal interaction possible

Outcome has to be documented afterwards

Costly & Time intensive

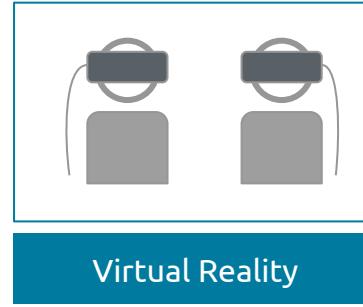


Video Conference

Real time collaboration

No personal interaction

Work directly saved



Digital Avatar conveys social presence [2]

Real time collaboration

Personal interaction [7]

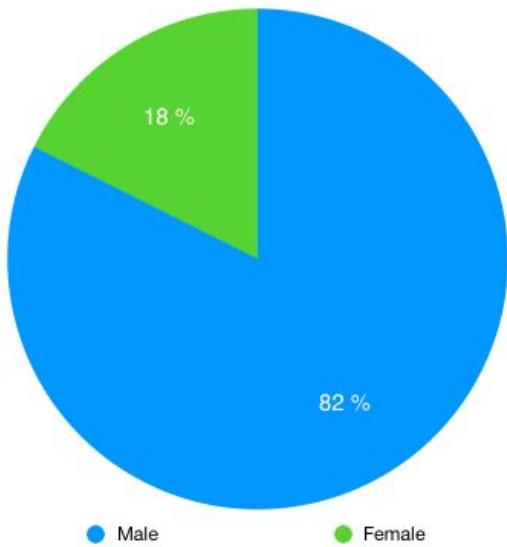
Increased focus

- [1] Carlsson, Christer, and Olof Hagsand. "DIVE A multi-user virtual reality system." *Virtual Reality Annual International Symposium*, 1993., 1993 IEEE. IEEE, 1993.
- [2] Greenwald, Scott W., Wiley Corning, and Pattie Maes. "Multi-User Framework for Collaboration and Co-Creation in Virtual Reality." 12th International Conference on Computer Supported Collaborative Learning (CSCL), 2017.
- [3] LeBlanc, André, et al. "Sculpting with the 'ball and mouse' metaphor." *Proc. Graphics Interface*. Vol. 91. 1991.
- [4] Hand, Chris. "A survey of 3D interaction techniques." *Computer graphics forum*. Vol. 16. No. 5. Blackwell Publishers, 1997.
- [5] Tang, John C., and Scott Minneman. "VideoWhiteboard: video shadows to support remote collaboration." *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, 1991.
- [6] Gumienny, Raja, et al. "Tele-board: Enabling efficient collaboration in digital design spaces." *Computer Supported Cooperative Work in Design (CSCWD)*, 2011 15th International Conference on. IEEE, 2011.
- [7] Koh, Eunyee. "Conferencing room for telepresence with remote participants." *Proceedings of the 16th ACM international conference on Supporting group work*. ACM, 2010.

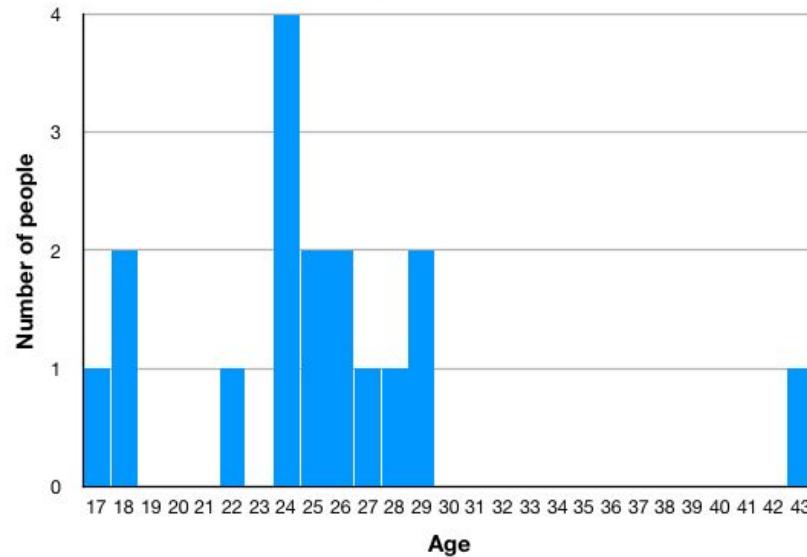
Participants

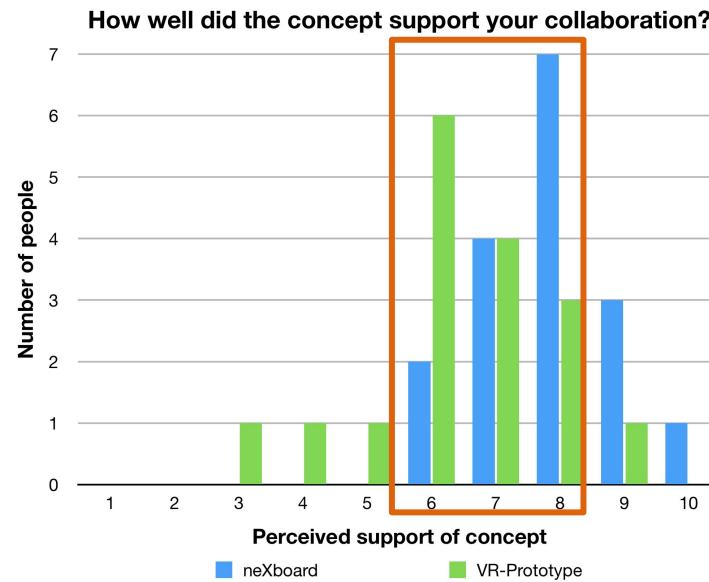
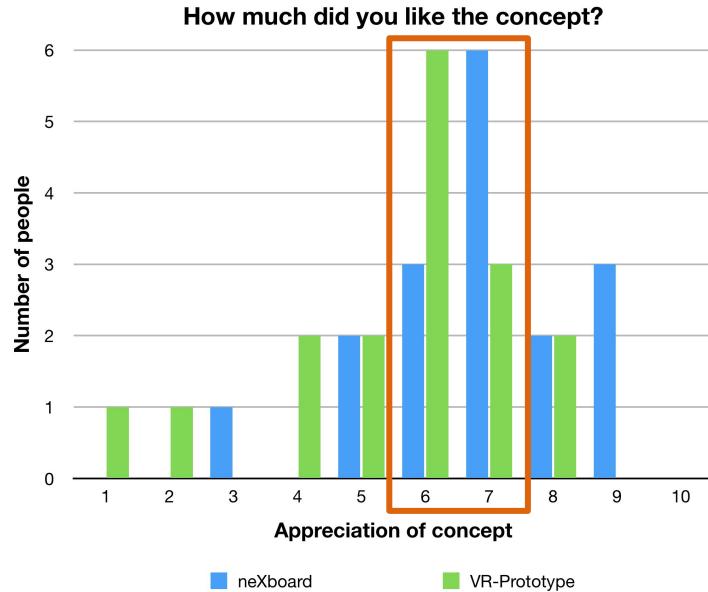


Gender



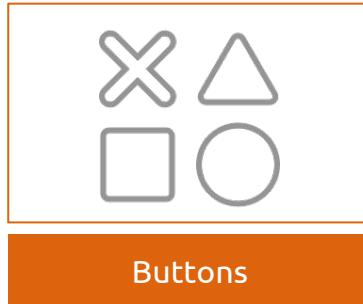
Age Distribution





The proposed approach supports the collaboration

Tool Selection



Buttons



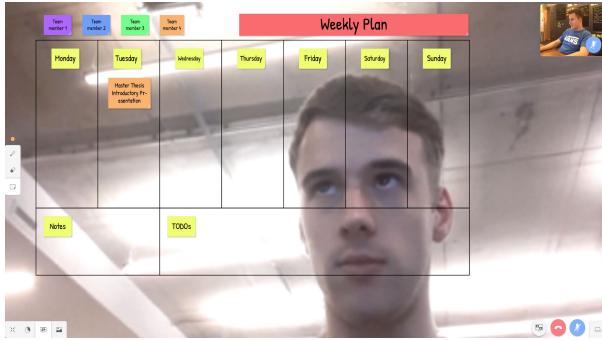
Digital Tool-Belt



Gestures

Description	Buttons correspond to a certain tool directly	Reaching down to waist level opens up a digital menu [2]	A certain gesture triggers a certain tool
Advantages	Principle of locality Easy to understand	Principle of locality Easily extendable	Principle of locality
Disadvantages	Restricted number of tools Not visible to user		Bad explorability Hard to remember many gestures

Social Presence



- Creating sense of other people's presence
- Video conferencing and virtual reality can provide this experience
- Digital Avatars can represent other people [1, 5]



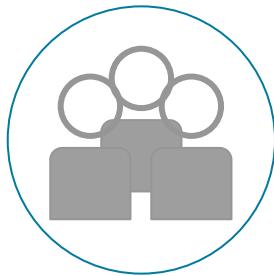
Conclusion



Design Thinking with
Virtual reality

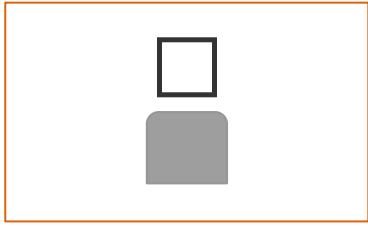


Immersiveness with
web technology



Social Presence

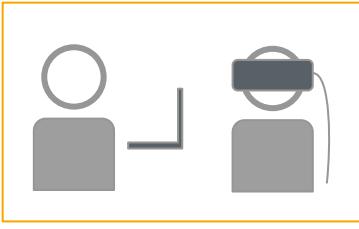
Future Work



Emotions for avatars

Facial expressions play an important part for supporting comprehension

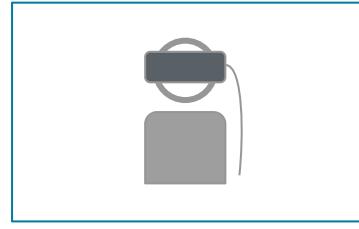
Helps to increase the social presence



Cross device

Design Thinking addresses a heterogenous group

Integration of non-VR user into the virtual environment

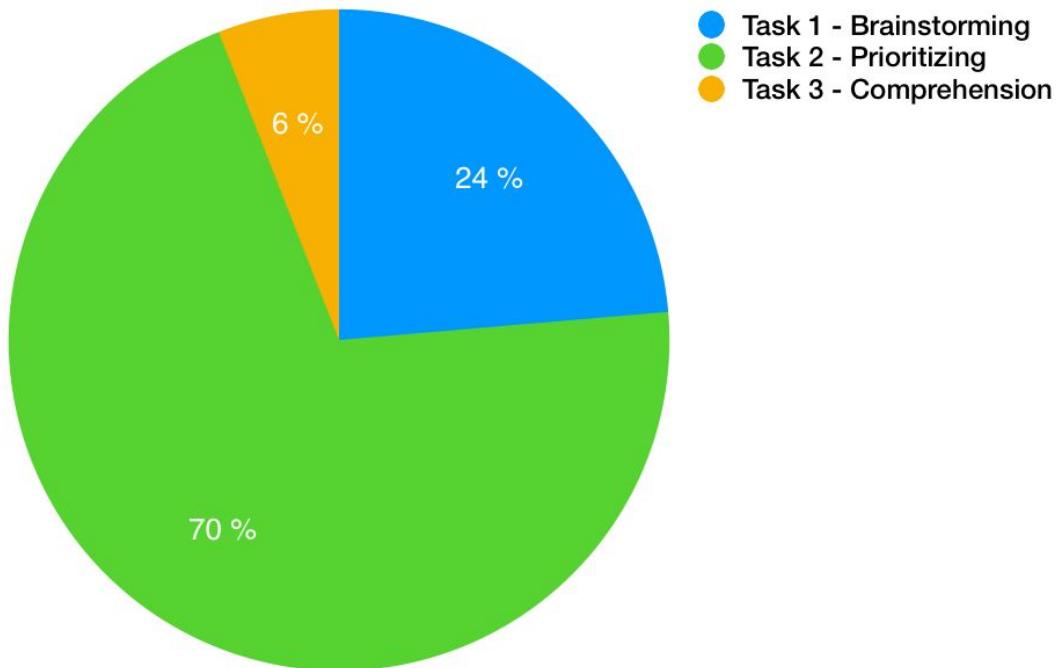


Interaction methods

Interaction was acceptable but could be improved especially text input

The better the interaction the better the immersiveness

Which task has been the easiest ?

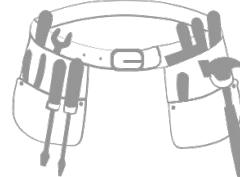


Prioritizing has been the easiest
Independent of the use of virtual reality

Tool Selection



Buttons



Digital Tool-Belt



Gestures



Dedicated Hardware

Buttons correspond to a certain tool directly

Reaching down to waist level opens up a digital menu [2]

A certain gesture triggers a certain tool

Each Tool has a dedicated hardware controller

Principle of locality
Easy to understand

Principle of locality
Easily extendable

Principle of locality

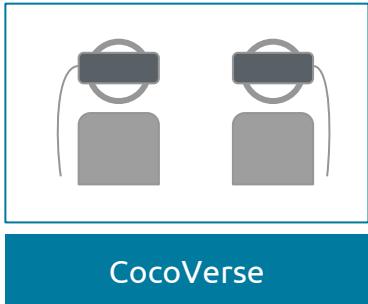
More realistic / immerse feeling

Restricted number of tools
Not visible to user

Bad explorability
Hard to remember many gestures

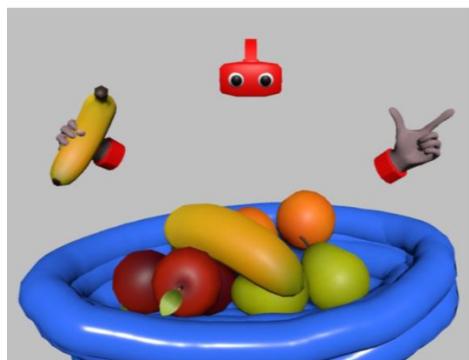
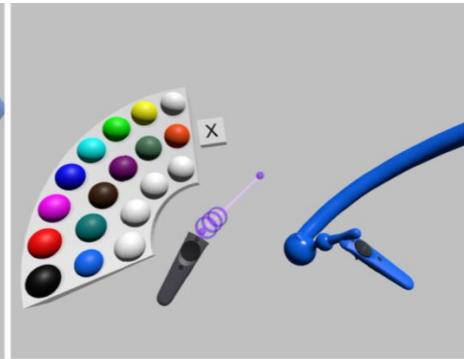
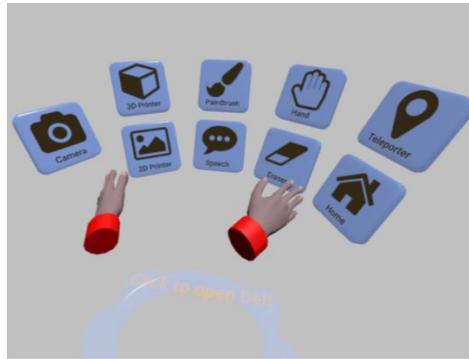
As many controller as tools
(No) principle of locality

Related Work - CocoVerse [6] (2017)



Multiuser
collaboration tool

Focus on Interaction
with application





Rezept



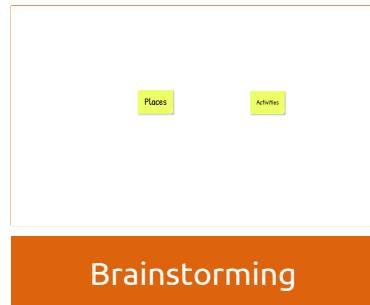
Tele-Board for digital Design Thinking



Virtual Reality introduction “First Touch”

Task 1

Brainstorming of possible places and activities



Participants think about possible spaces and activities for their next vacation

Start setup

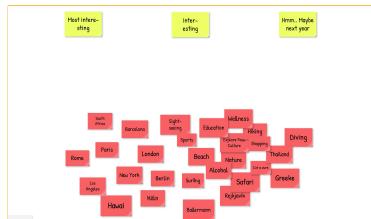
A board that contains a sticky-note for places and activities each

Performance Indicator

number of created
sticky-notes

Task 2

Prioritizing provided places and activities



Prioritizing

Performance Indicator

time needed to
order provided
sticky-notes

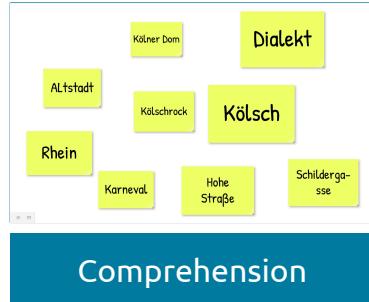
Participants prioritize existing activities and places into three categories most interesting, interesting and not interesting

Start setup

A board that contains 18 sticky-notes containing places and activities and areas on the board for the three categories

Task 3

Understanding explained information



The participant gets information about a certain vacation place

Start setup

A board that contains sticky-notes containing a rough story-line of the explained information

Performance Indicator

Amount of information that could be recalled



User study setup - neXboard