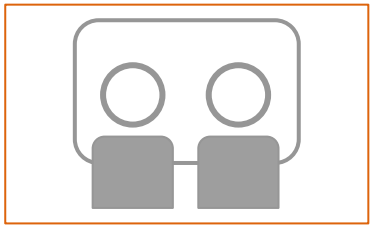
Digital Collaboration with a Whiteboard in Virtual Reality

Markus Petrykowski

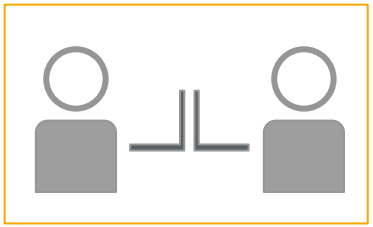
Improving work of a collaborating Group of people at different places at the same time using Design Thinking techniques by the means of Virtual Reality

Types of Collaboration for remote teams



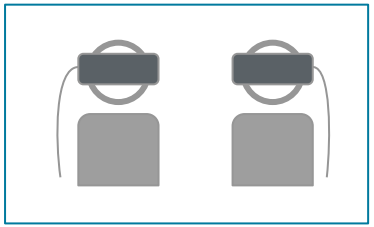
On-Site

- Direct Communication
- Personal Interaction possible
- Outcome has to be documented afterwards
- Costly & Time intensive



Digital but not VR

- Video Conference
- Real Time collaboration
- No personal interaction
- Work directly saved



Virtual Reality

?

Collaboration in Virtual Environments

Available Tools

How they can be used in virtual reality

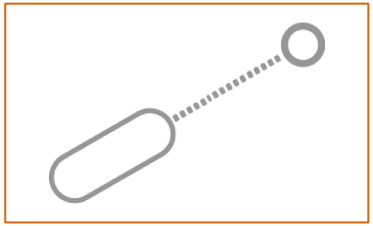
Available Tools[6]

Sticky note tool

Hand tool

Pen tool

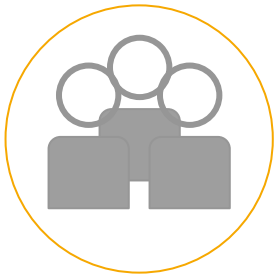
Interaction Methods

	 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



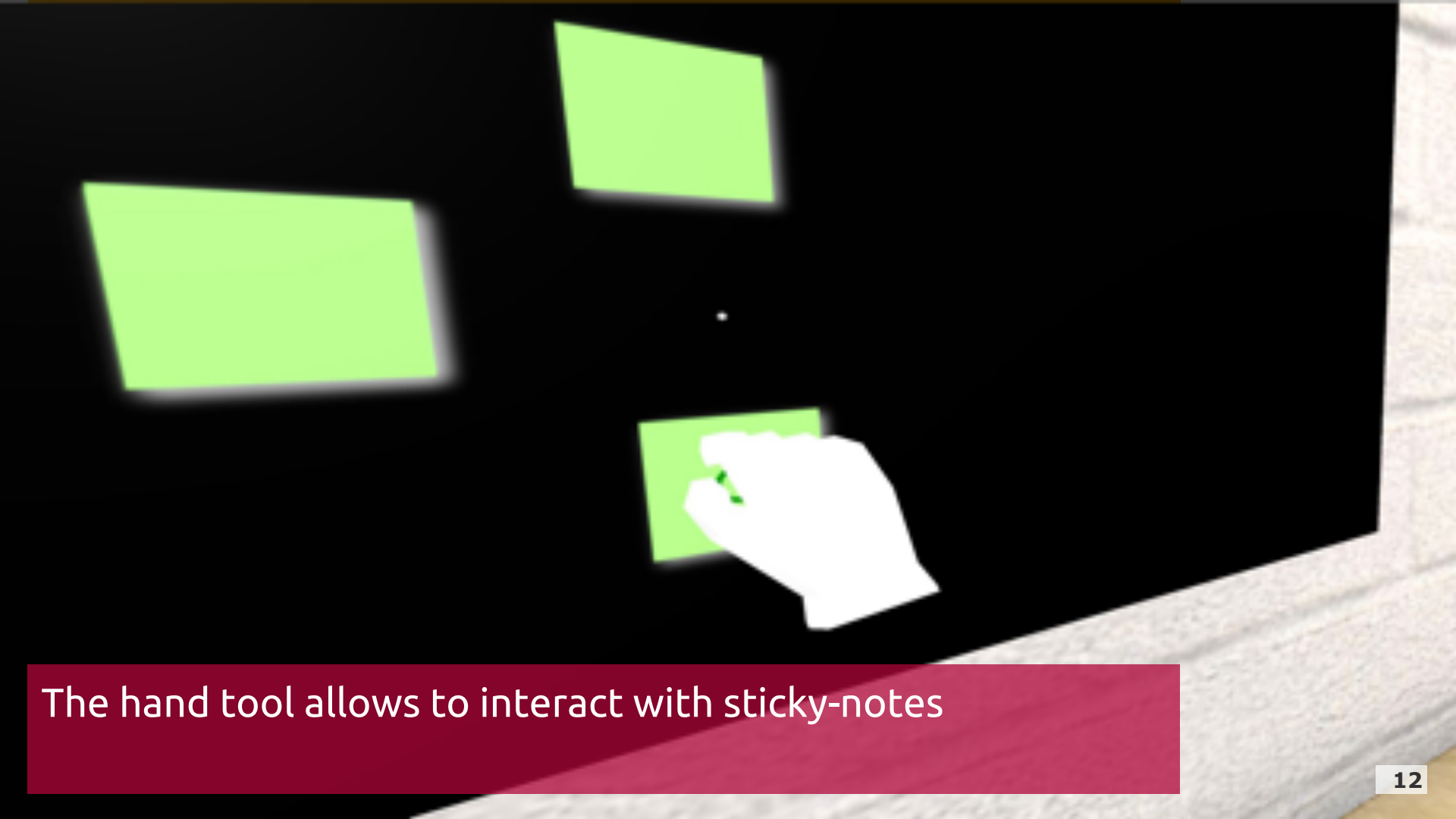
Social Presence

Web technologies

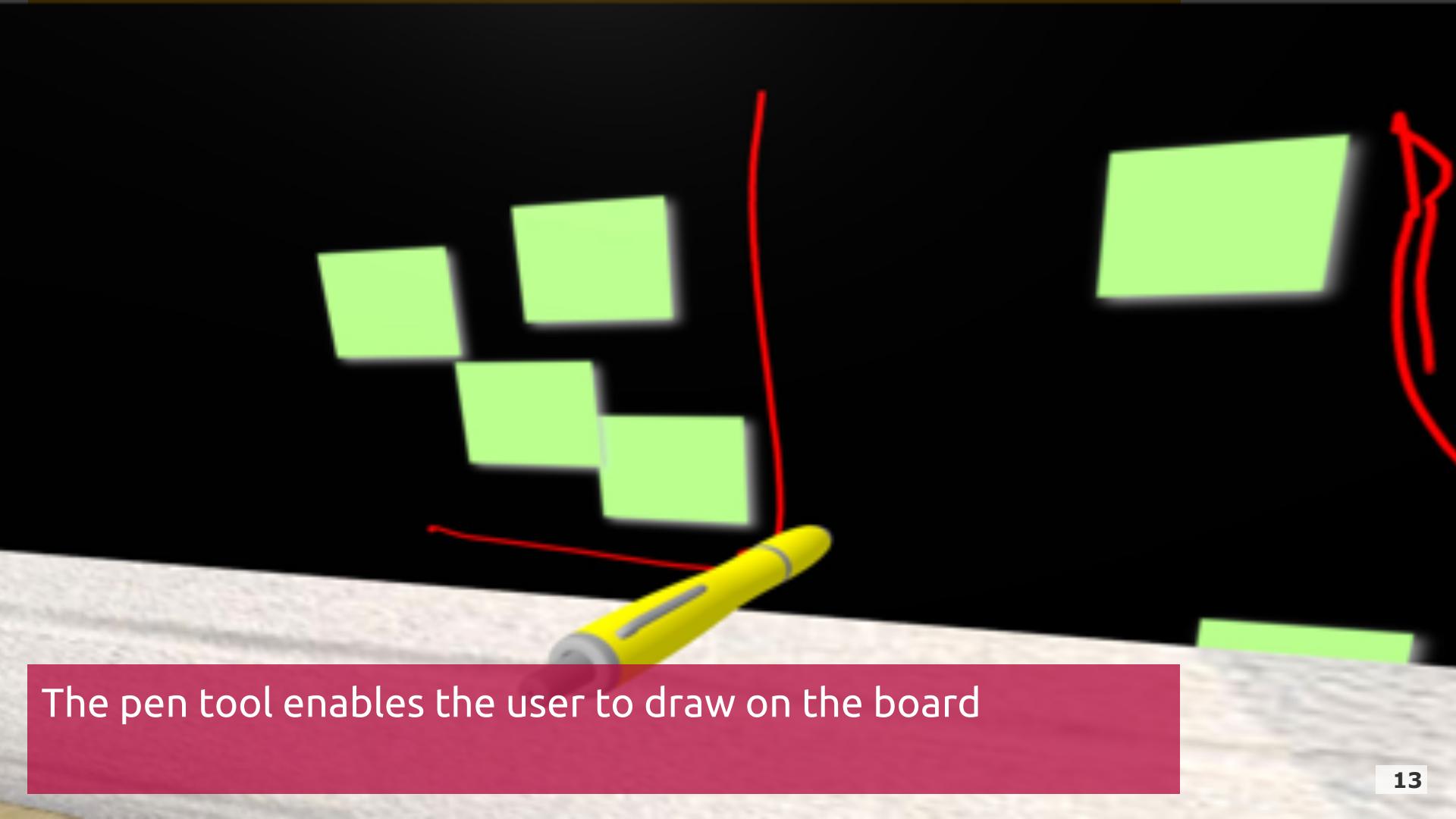
Collaborating user in virtual environment

Tool menu allows to change between a tool

Follows principle of locality



The hand tool allows to interact with sticky-notes

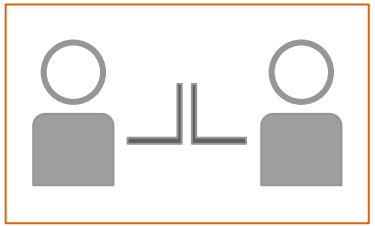


The pen tool enables the user to draw on the board

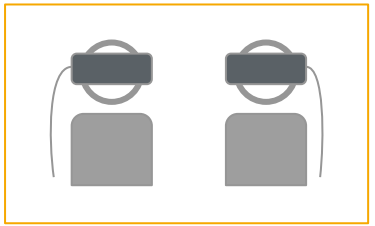
User study concept

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

Performance Comparison



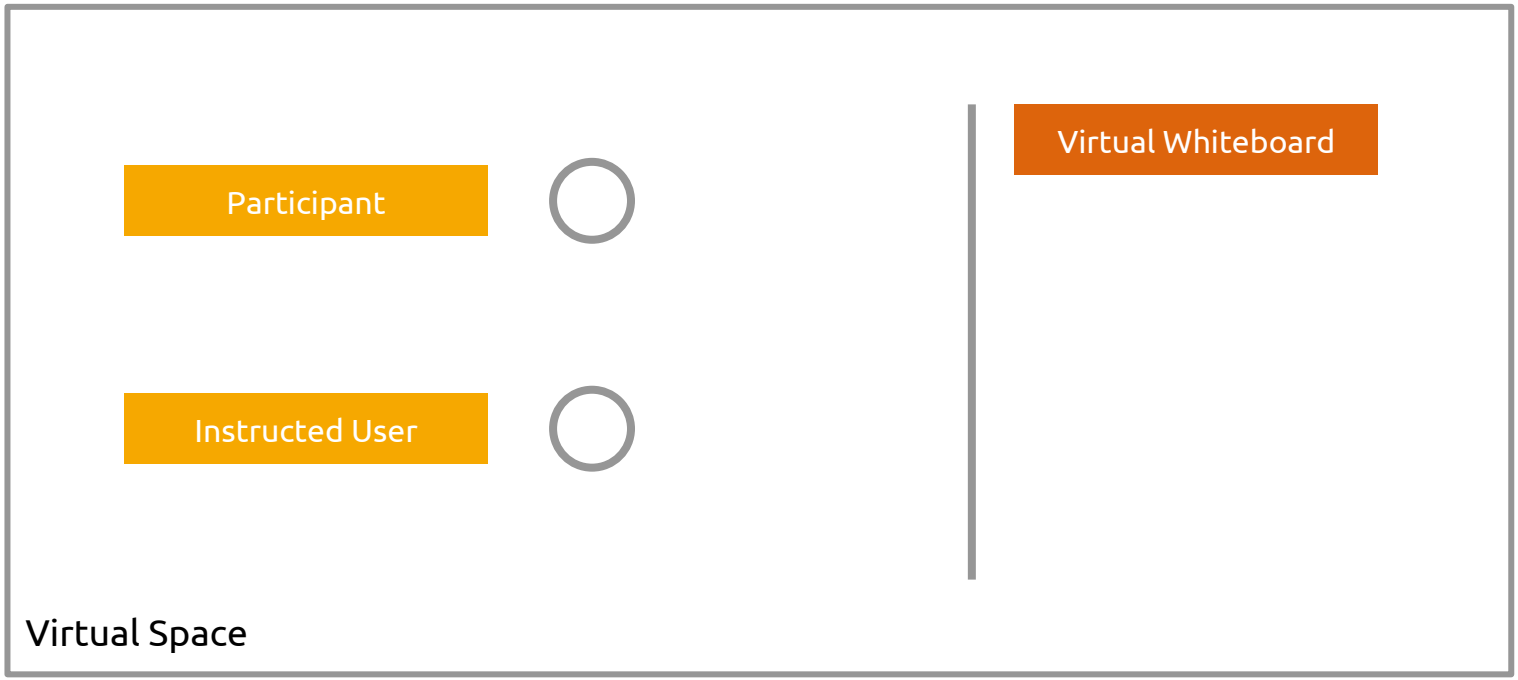
Digital but not VR



Virtual Reality


Weekly Plan
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Sunday
Notes
TODOs

neXboard

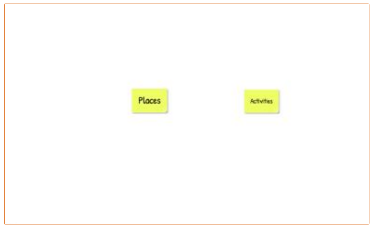


Setup of virtual environment

User study setup - Virtual Reality

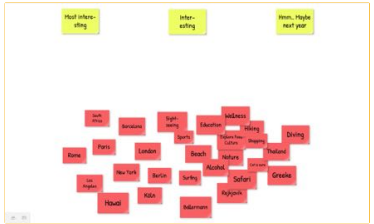
User study's setup - Design Thinking

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

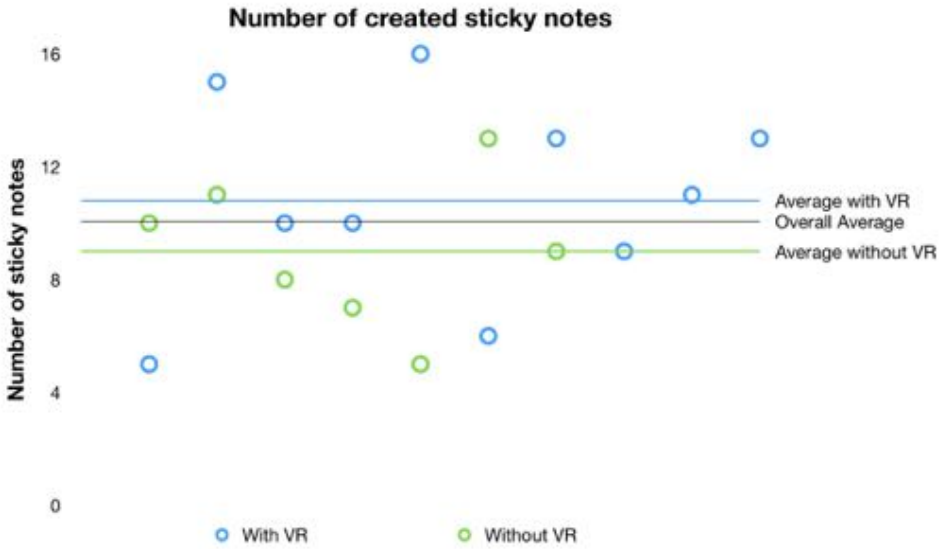
Study Feedback

Comparing performance indicators

Observing user behaviour

User's feedback through questionnaire

Task 1 - Brainstorming



Key Outcomes

VR leads to more produced sticky-notes

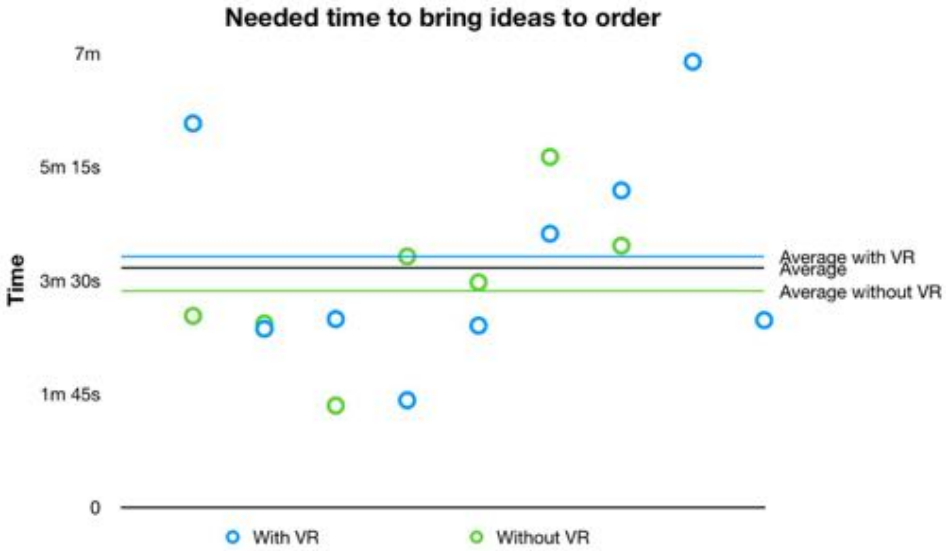
Virtual reality

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

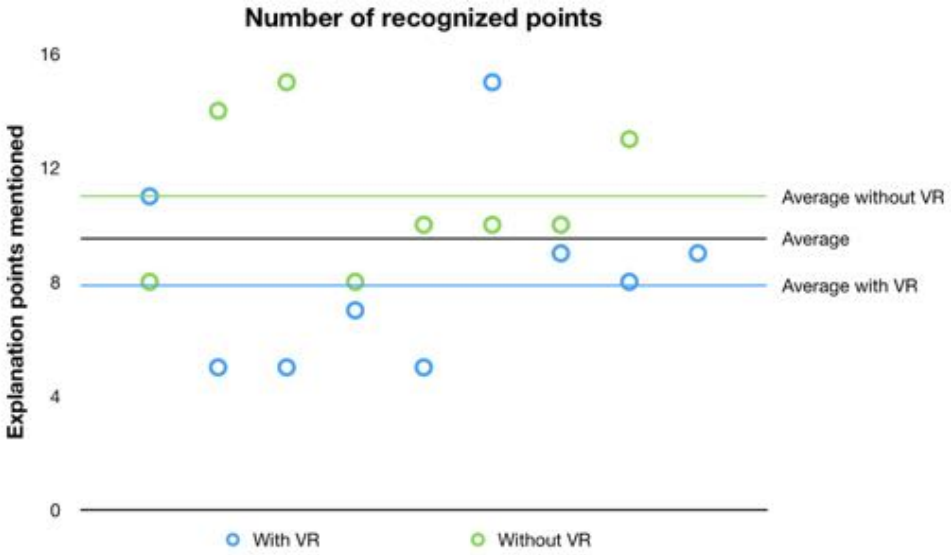
Virtual reality

Participants used pointing interaction.

Focus on whiteboard

Voice communication was most important

Task 3 - Comprehension



Key Outcomes

Users without VR could recognize more points

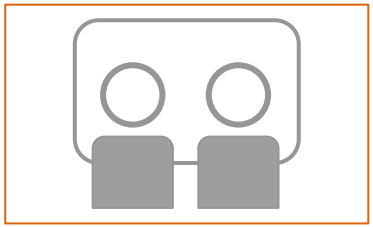
Virtual reality

User mainly interacted with the board

neXboard

Participants wrote sticky-notes to better recall information

Conclusion



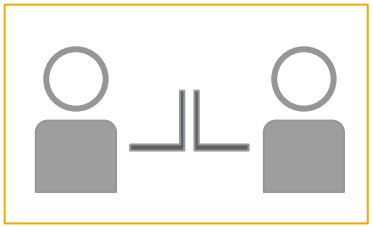
On-Site

Direct Communication

Personal interaction possible

Outcome has to be documented afterwards

Costly & Time intensive



Digital but not VR

Video Conference

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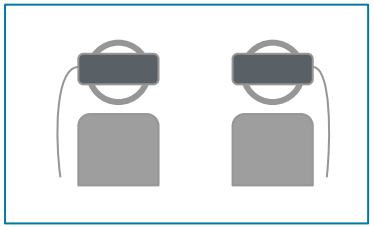


Virtual Reality

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.

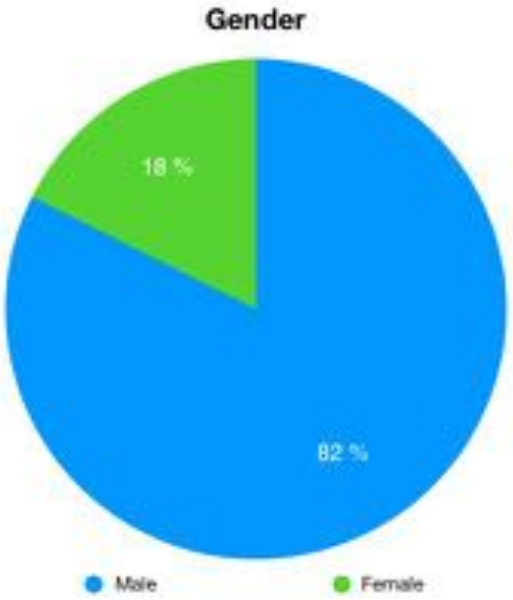
[4] Hand, Chris. "A survey of 3D interaction techniques." *Computer graphics forum*. Vol. 16. No. 5. Blackwell Publishers, 1997.

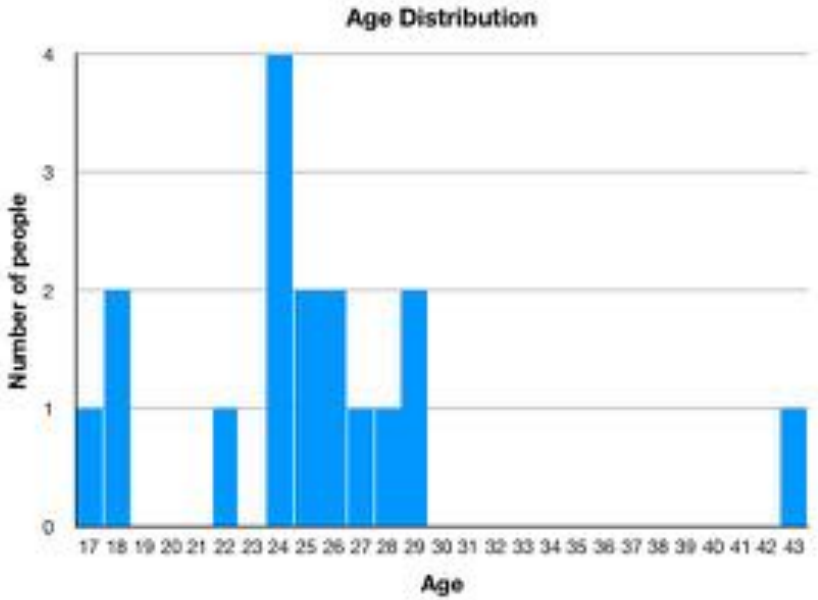
[5] Tang, John C., and Scott Minneman. "VideoWhiteboard: video shadows to support remote collaboration." *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, 1991.

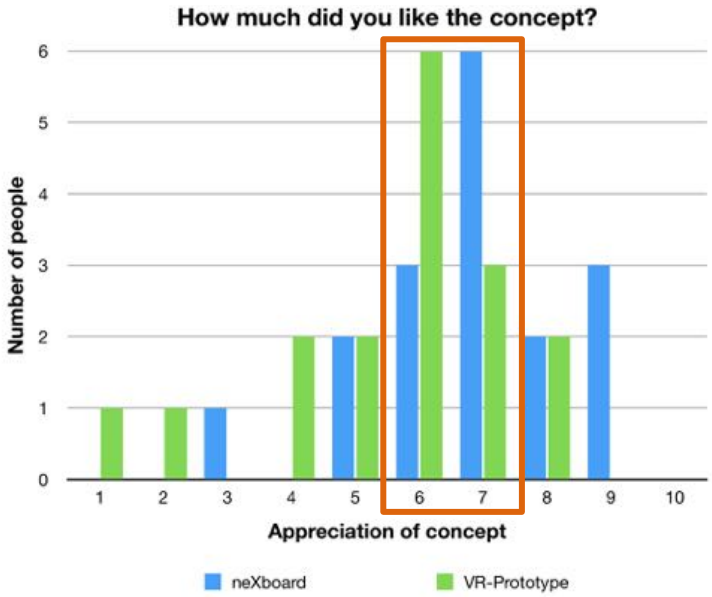
[6]Gumienny, Raja, et al. "Tele-board: Enabling efficient collaboration in digital design spaces." *Computer Supported Cooperative Work in Design (CSCWD), 2011 15th International Conference on*. IEEE, 2011.

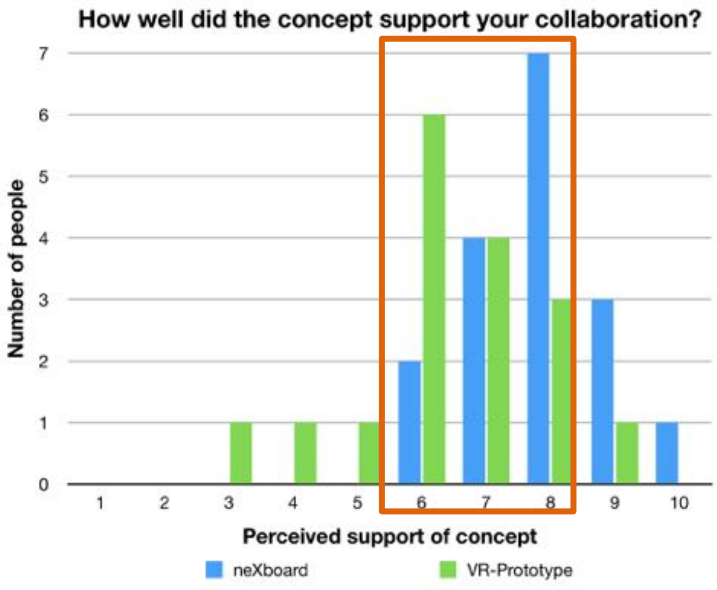
[7] Koh, Eunyee. "Conferencing room for telepresence with remote participants." *Proceedings of the 16th ACM international conference on Supporting group work*. ACM, 2010.

Participants



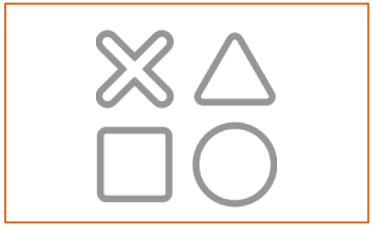
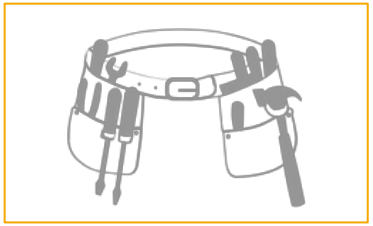
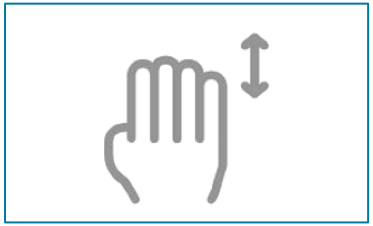




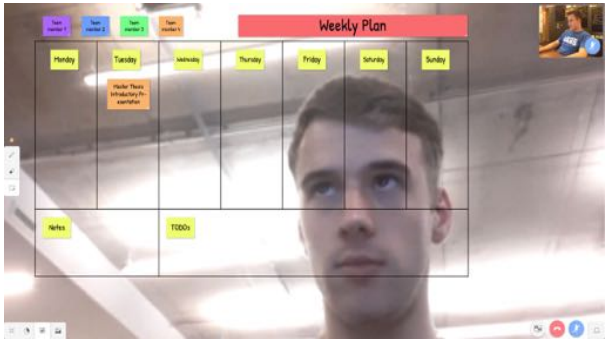


The proposed approach supports the collaboration

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]**

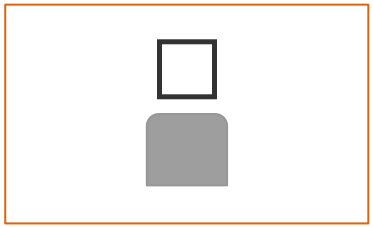
Conclusion

Design Thinking with Virtual reality

Immersiveness with web technology

Social Presence

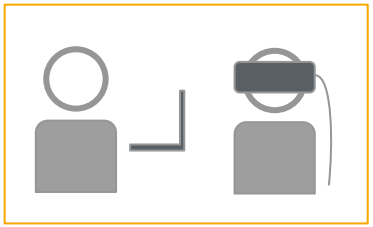
Future Work



Emotions for avatars

Facial expressions play an important part for supporting comprehension

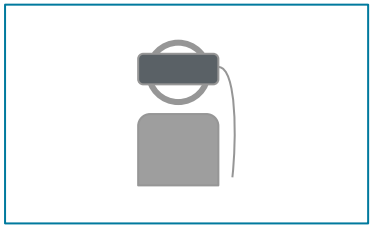
Helps to increase the social presence



Cross device

Design Thinking addresses a heterogenous group

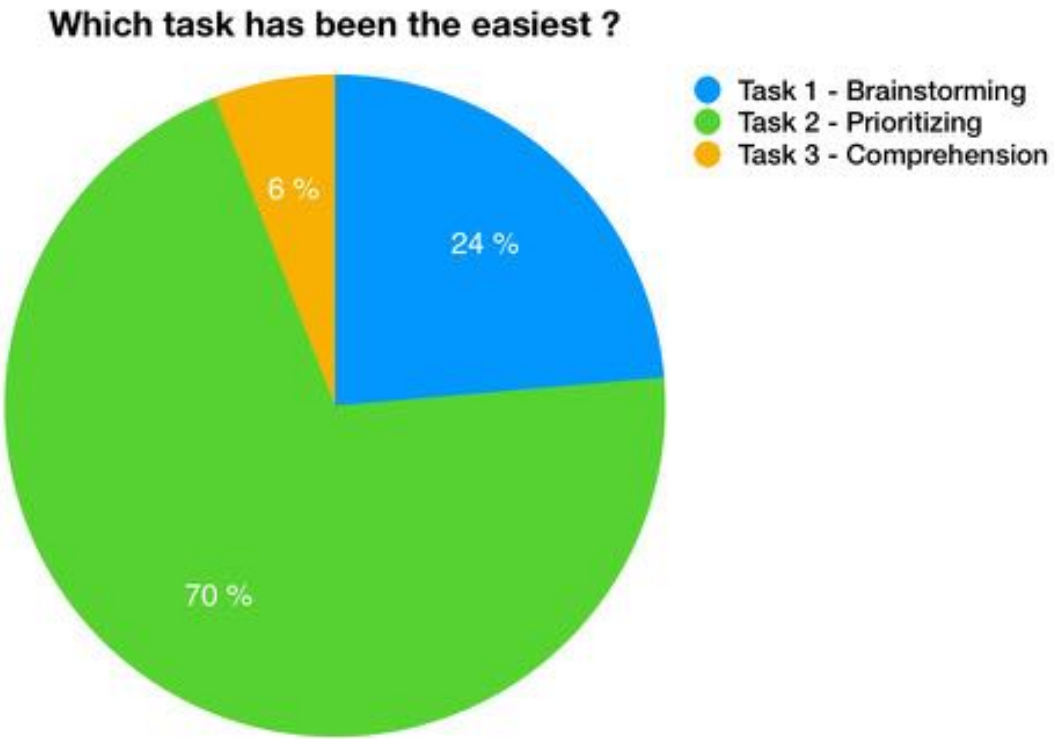
Integration of non-VR user into the virtual environment



Interaction methods

Interaction was acceptable but could be improved especially text input

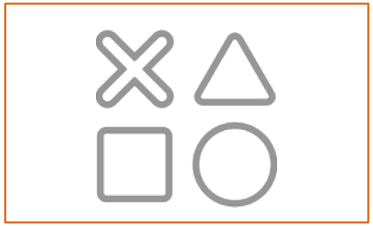
The better the interaction the better the immersiveness



Prioritizing has been the easiest

Independent of the use of virtual reality

Tool Selection



Buttons

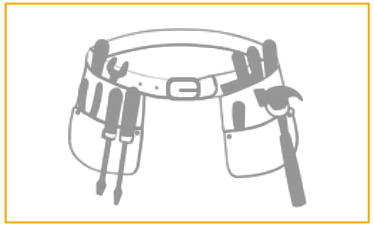
Buttons correspond to a certain tool directly

Principle of locality

Easy to understand

Restricted number of tools

Not visible to user

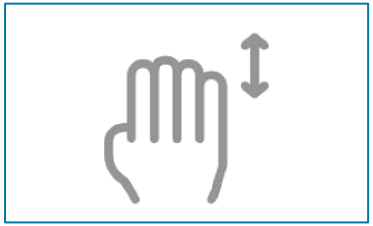


Digital Tool-Belt

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

Principle of locality

Easily extendable



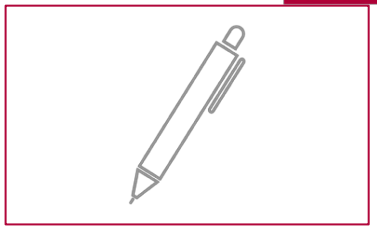
Gestures

A certain gesture triggers a certain tool

Principle of locality

Bad explorability

Hard to remember many gestures



Dedicated Hardware

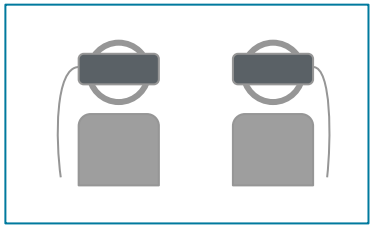
Each Tool has a dedicated hardware controller

More realistic / immerse feeling

As many controller as tools

(No) principle of locality

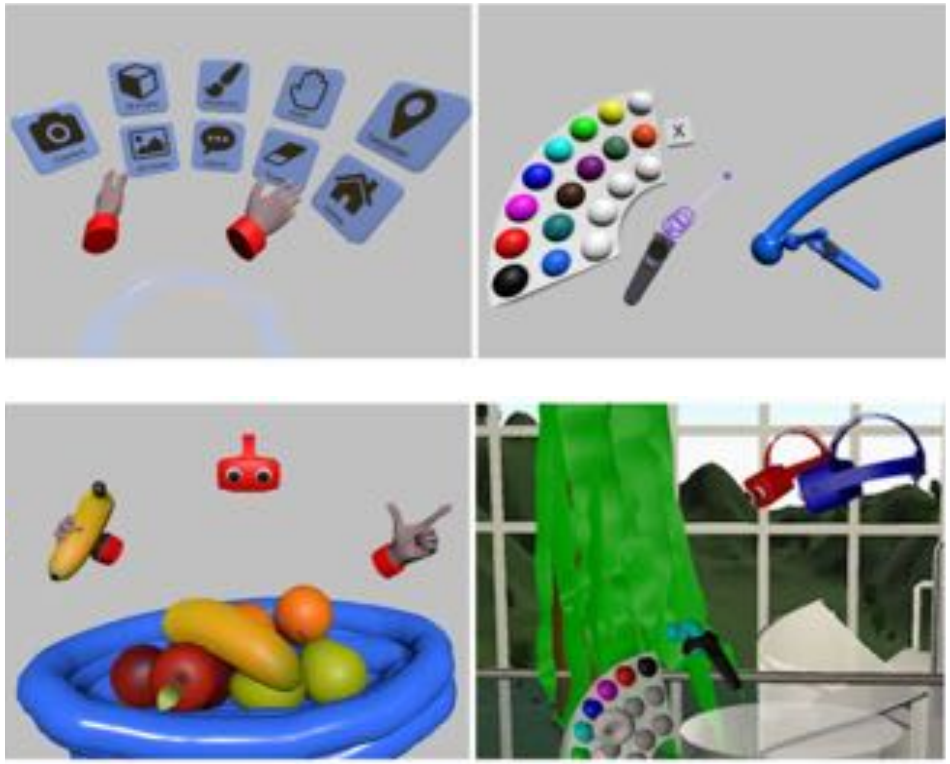
Related Work - CocoVerse [6] (2017)

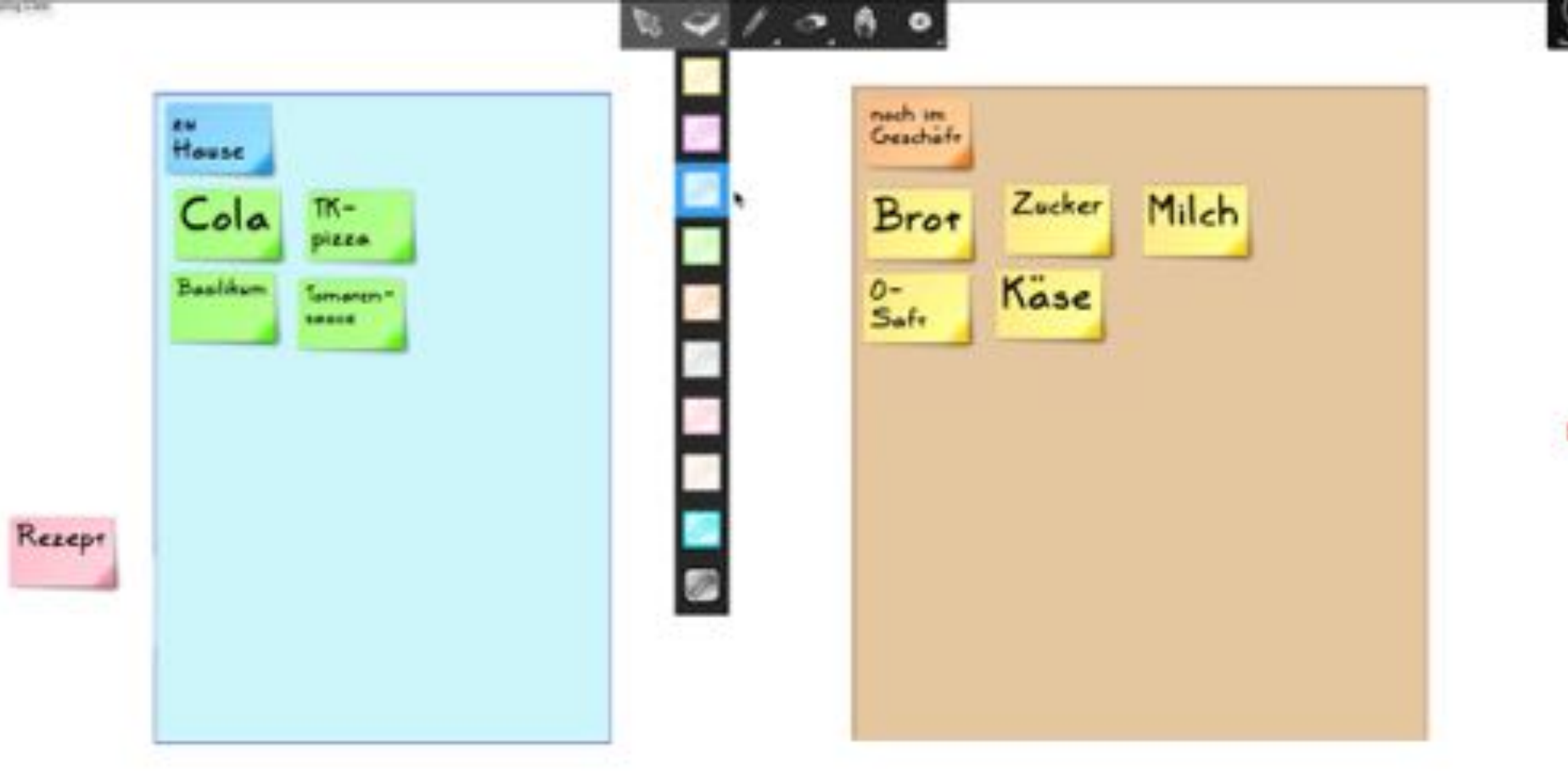


CocoVerse

Multiuser collaboration tool

Focus on Interaction with application



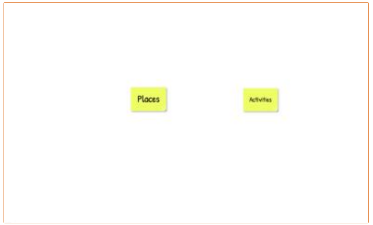


Tele-Board for digital Design Thinking

Virtual Reality introduction “First Touch”

Task 1

Brainstorming of possible places and activities



Brainstorming

Performance Indicator

number of created sticky-notes

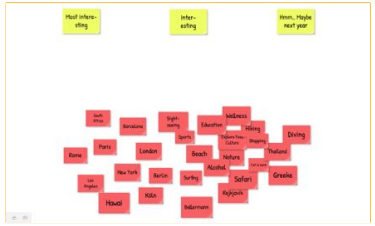
Participants think about possible spaces and activities for their next vacation

Start setup

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

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

Comprehension

Performance Indicator

Amount of information that could be recalled

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

User study setup - neXboard