Overcoming Issues of 3D Software Visualization through Immersive Augmented Reality

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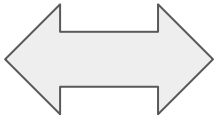
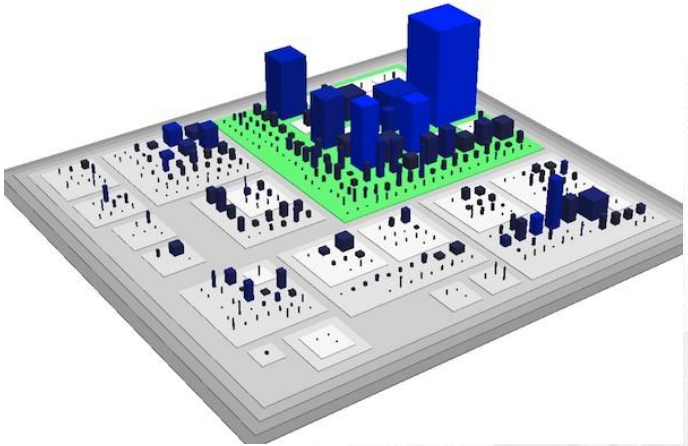
Table of Content

Software Visualization

- Software is no physical object → You cannot touch it
- 3D Visualization provides a way to represent software
  - Structure
  - Components

```java
import java.io.BufferedReader;
import java.io.IOException;
import java.io.InputStreamReader;

public class MainController {

    BufferedReader br = new BufferedReader(new InputStreamReader(System.in));

    public MainController() {

    }

    public Queen askForCoordinate(Queen queenA, int rank) {
        System.out.println("Please enter the position of the queen " + (rank+1) +".");
        try {
            String positionA = br.readLine();
            int Ax = Integer.valueOf(positionA.split(",")[0]);
            int Ay = Integer.valueOf(positionA.split(",")[1]);

            queenA = new Queen(Ax, Ay);
        } catch (IOException e) {
            // TODO Auto-generated catch block
            e.printStackTrace();
        }
        return queenA;
    }

}
```

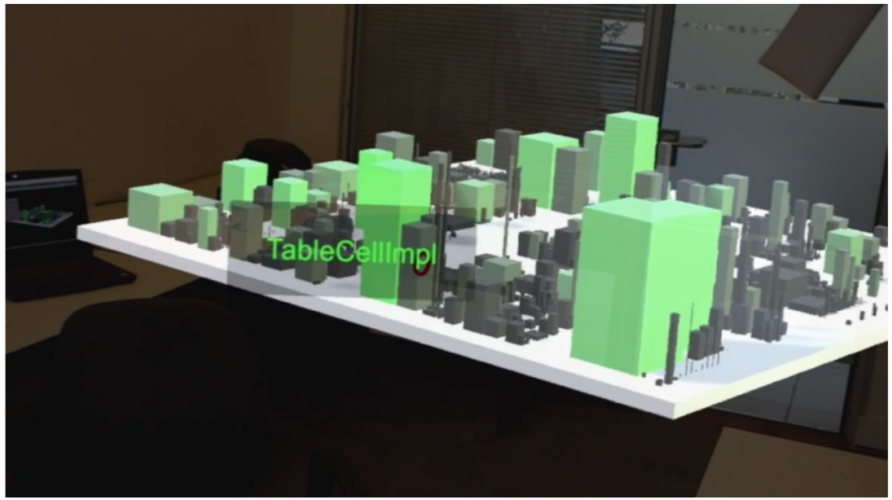




Jim Barritt (2015)

Introduction

What do you think about this 3D visualization? Are you able to see all components?



Merino et al. (2018, p. 3)

Usability Issues with 3D visualizations

Navigation
Selection
Occlusion
Text Readability

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Why is this Paper important?

Usability issues influence developer’s

- Effectiveness
- Experience

No previous research on overcoming usability issues

Why is this Paper important?

Improvement of Comprehension Tasks of Developers

Research Question

Can **Immersive Augmented Reality** help to

RQ.1 Overcome Usability Issues of general 3D Visualizations?

RQ.1.1 Navigation
RQ.1.2 Selection
RQ.1.3 Occlusion
RQ.1.4 Text Readability

RQ.2 Increase Developers Effectiveness?

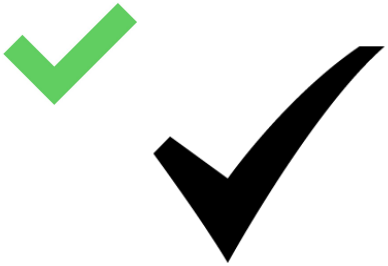
Merino et al. (2018, p. 1)

Hypothesis about Usability Issues (RQ.1)

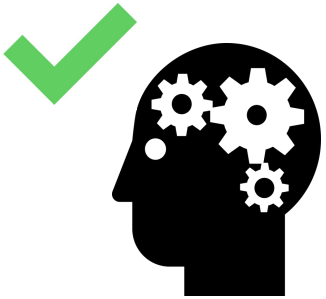
Displaying Comprehension Tasks in Immersive Augmented Reality can help to overcome usability issues of 3D visualization.

Hypothesis about Effectiveness (RQ.2)

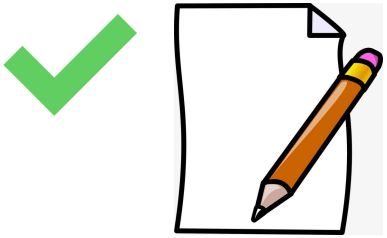
Time



Correctness



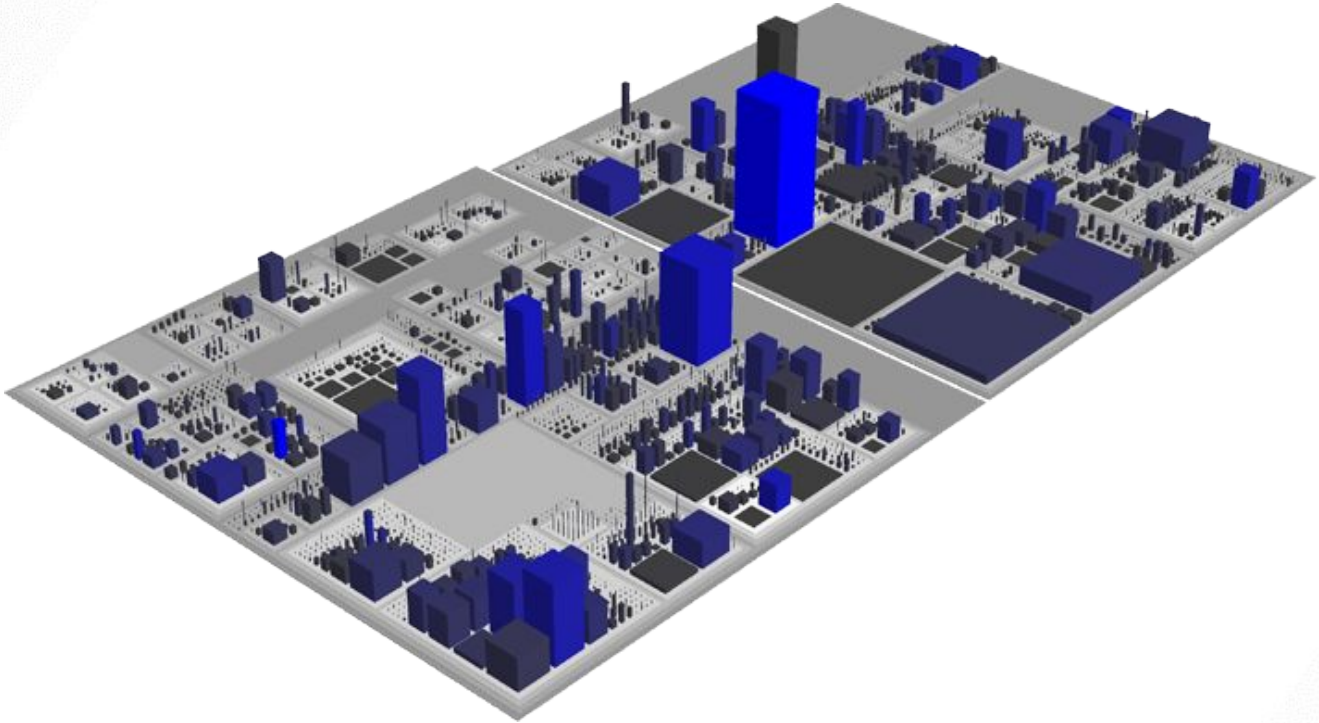
Difficulty



Recollection

Emotions

3D City Visualization

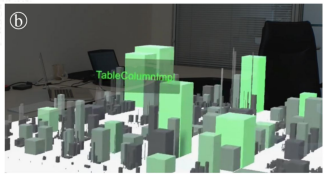


Richard Wettel (2017)

How did they proceed? Increase Developers Effectiveness?

Controlled experiment

Immersive augmented reality



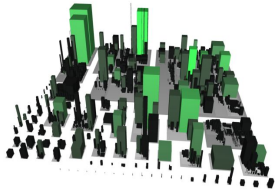
9 Participants

Training Session

Same comprehension tasks

Training Session

Computer screen



9 Participants

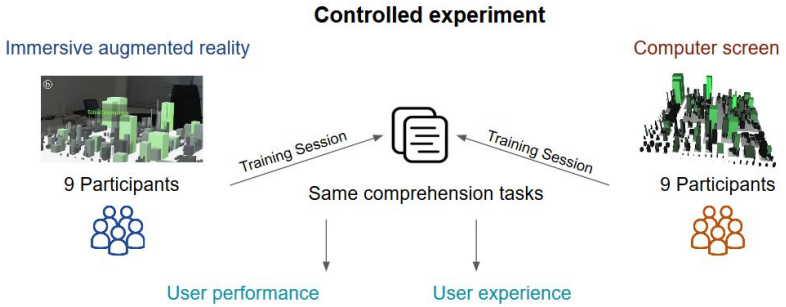
User performance

- Completion time
- Correctness
- Recollection → Drawing

User experience

- Difficulty → Likert scale
- Emotion → Cards

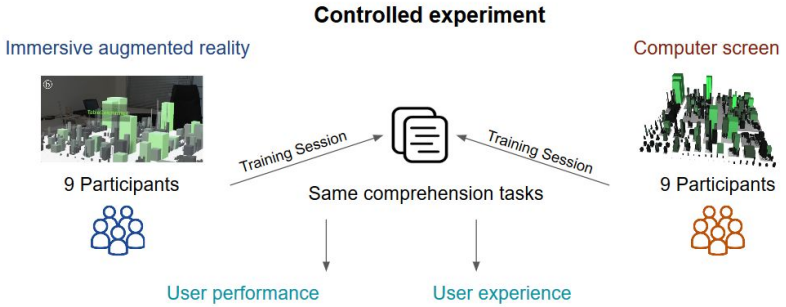
Good Parts



Construct Validity

- Same building settings

Good Parts



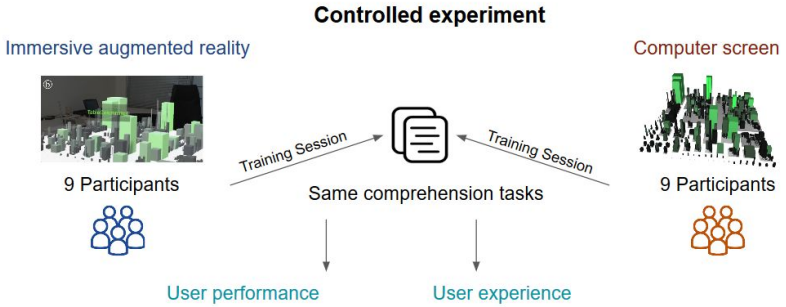
Construct Validity

- Same building settings

Internal Validity

- Same building settings
- Similar groups
- Similar experiment rooms
- Identical procedure

Good Parts



Construct Validity

- Same building settings

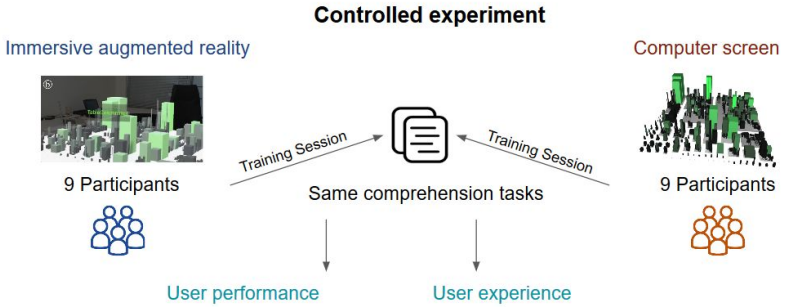
Internal Validity

- Same building settings
- Similar groups
- Similar experiment rooms
- Identical procedure

External Validity

- Training sessions
- Between-groups design: No learning effects

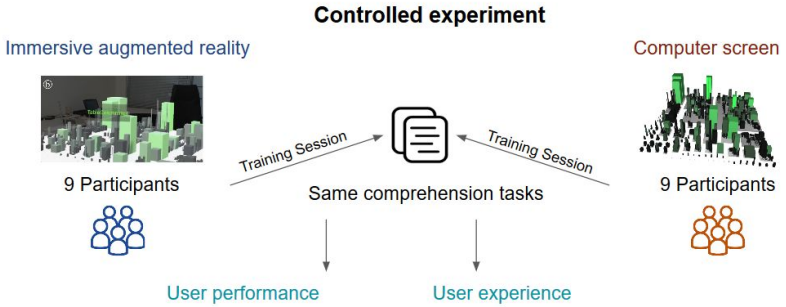
Limitations



Construct Validity

- Usability issues not completely covered
- Visualization quality
- Recollection measure

Limitations



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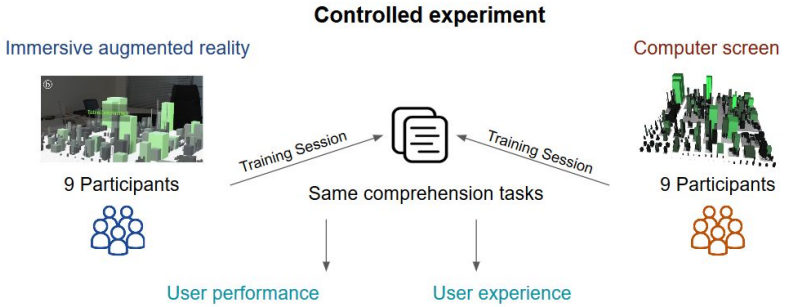
- Visualization quality
- Recollection measure

Internal Validity

- Different method of instruction

Limitations



Construct Validity

- Usability issues not completely covered
- Visualization quality
- Recollection measure

Internal Validity

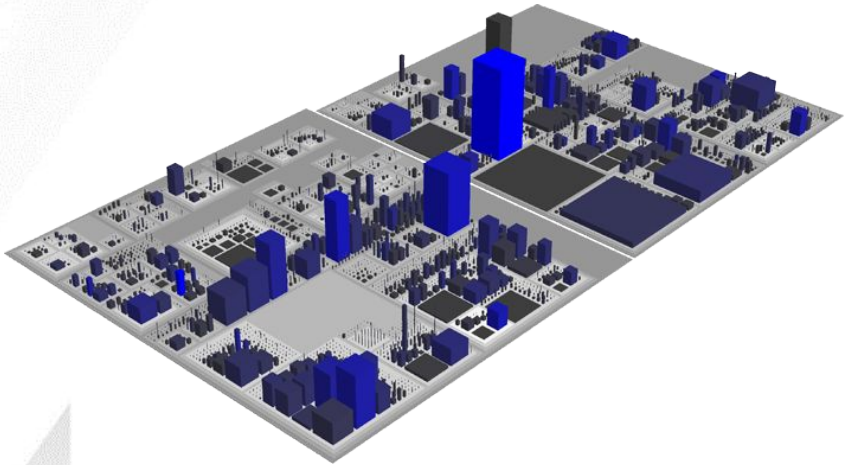
- Different method of instruction

External Validity

- Small sample
- Only one data set
- Selection bias: Students
- Participant characteristics

Types of Visualizations

3D City Visualizations



Richard Wettel (2017)

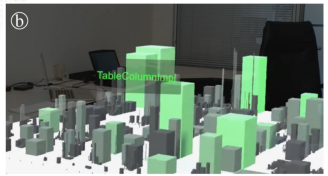
Space-Time Cube Visualizations Technique

Merino et al. (2018, p. 5)

How did they proceed? Overcome Usability Issues of 3D Visualizations?

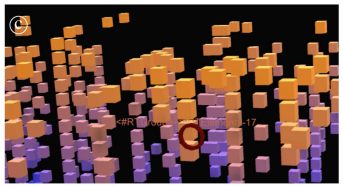
User Study

3D City Visualization



Same 9 Participants

Space-Time Cube Visualization

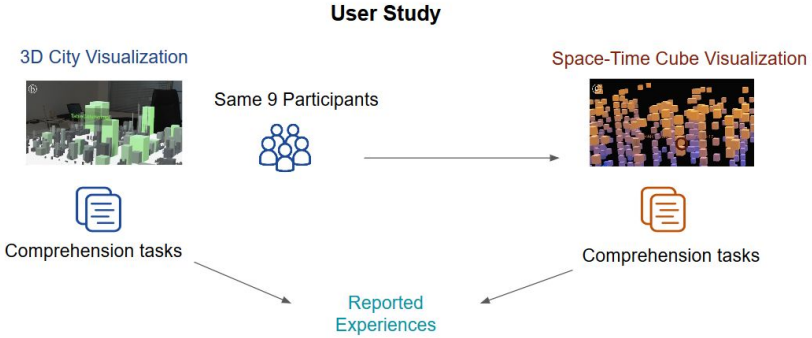


Comprehension tasks

Comprehension tasks

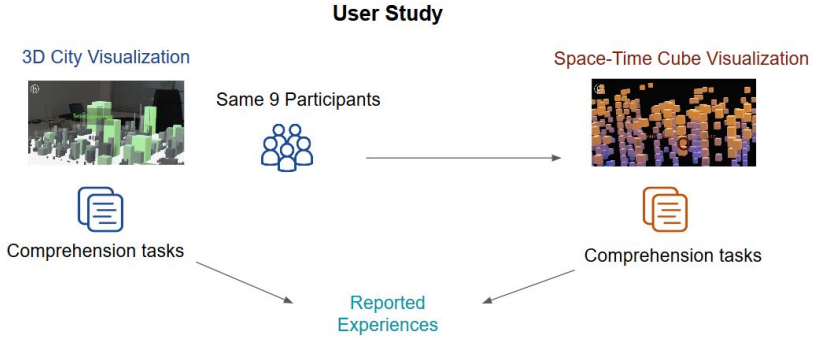
Reported Experiences

Good Parts



- Same participants → Comparison of different techniques
- Qualitative study → More detailed impressions collected
- Different tasks → Reduced learning effect

Limitations



- Unclear period of time between controlled experiment and user study
- Same data set → Learning effect
- Selection bias: Students
- Participant characteristics

Findings

RQ.1 Does Immersive Augmented Reality Help Overcoming 3D Usability Issues?

RQ.1.1 Navigation
RQ.1.2 Selection
RQ.1.3 Occlusion
RQ.1.4 Text Readability

RQ.2 Does the Usage of Immersive Augmented Reality Increase Developers Effectiveness ?

RQ.1 Usability Issues with 3D visualizations

Immersive Augmented Reality helps to overcome:

- RQ.1.1 Navigation
- RQ.1.2 Occlusion

But these aspects still remain an issue:

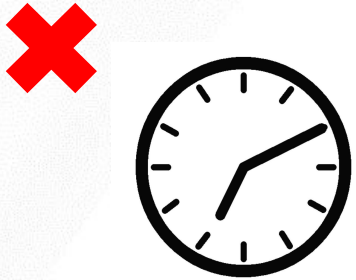
- RQ.1.3 Selection
- RQ.1.4 Text Readability

RQ.2 Effectiveness of 3D software Visualizations

- 3D visualizations in immersive augmented reality support developers in software comprehension tasks

- They increase pattern detection

RQ.2 Effectiveness of 3D software Visualizations



Time

Correctness

Difficulty

Recollection

Emotions

RQ.2 Effectiveness of 3D software Visualizations

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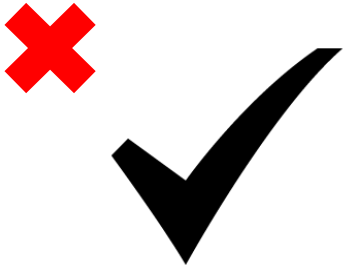

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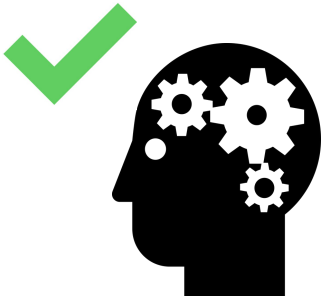

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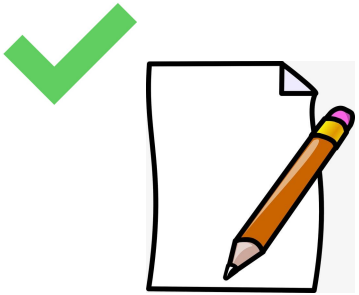

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RQ.2 Effectiveness of 3D software Visualizations

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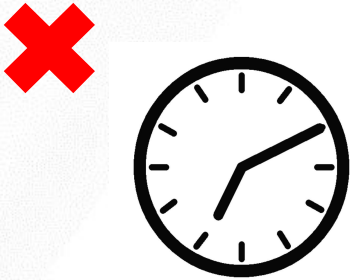
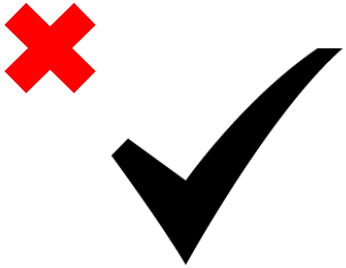
RQ.2 Effectiveness of 3D software Visualizations



Time



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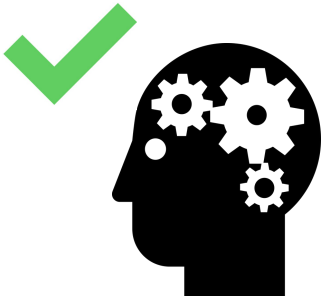

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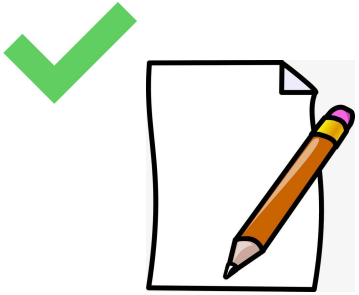
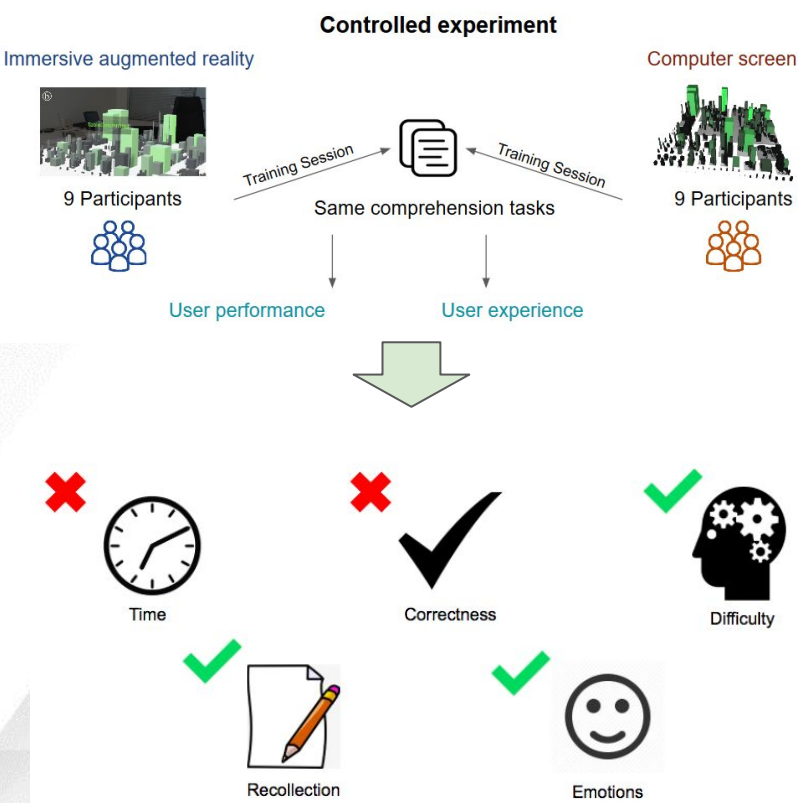
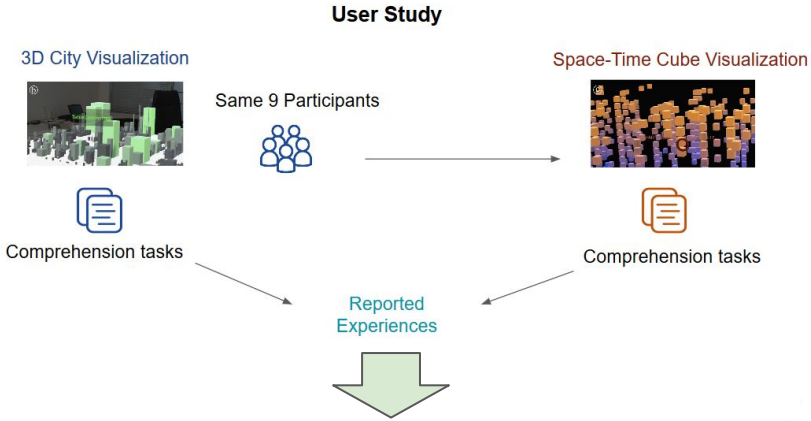


Recollection

Emotions

Summary





RQ.1.1 Navigation

RQ.1.2 Occlusion

RQ.1.3 Selection

RQ.1.4 Text Readability

Discussion

1. What are the two most surprising findings?
2. Find two ways in which the study can be improved?
3. Name two possible future researches?

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Literature

- Merino, L., Bergel, A., & Nierstrasz, O. (2018). Overcoming issues of 3D software visualization through immersive augmented reality. Proc. of VISSOFT, page in review. IEEE.
- Wettel, R. (2017). Welcome to CodeCity!. https://wettel.github.io/codecity.html. Last visited: 22.10.2018
- Barritt, J. (2015). Walk the streets of your codebase: inFusion, Code City and a MOOSE). http://jimbarritt.com/non-random/2010/10/25/walk-the-streets-of-your-codebase-infusion-code-city-and-a-moose/. Last visited: 22.10.2018