Collaborative Work on 3D Educational Content

Thesis
for the degree of philosophiae doctor

Mikhail Fominykh
Norwegian University of Science and Technology

24.04.2012
Trondheim, Norway
Outline

- Introduction
- Research Design
- Results
- Evaluation
- Future Work
Technology-Enhanced Learning

Technology

Learning
The Technology

Networking

Virtual Reality

3D Graphics
Collaborative Virtual Environments

- 3D CVEs
  - three dimensional, multiuser, synchronous, persistent environments, facilitated by networked computers

- Features
  - interaction
  - simulation
  - communication
  - immersion
Challenges

- Collaborative work on 3D content
  - need for learning approaches methods that exploit advantages of 3D CVEs and overcome limitations

- Tools and environments
  - need for convenient educational tools and environments that would support educational activities in 3D CVEs

- Learning communities
  - need for exploring how 3D CVEs can support learning communities
Outline

- Introduction
- Research Design
- Results
- Evaluation
- Future Work
Research Goal

- **Main goal**
  - explore collaborative work on 3D content, including its use in educational context, design of tools and environments, and support of communities

- **Main RQ**
  - How to provide learning communities with an adequate support for collaborative work on 3D educational content in a virtual campus and virtual city context?
Research Topics

1. Topic 1: Collaborative work on 3D educational content
2. Topic 2: Design of tools and environments within 3D CVEs
3. Topic 3: Support for learning communities in 3D CVEs
<table>
<thead>
<tr>
<th>RQ1</th>
<th>How can collaborative work on 3D content benefit educational activities?</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ2</td>
<td>How to design tools and environments in 3D CVEs to benefit educational activities?</td>
</tr>
<tr>
<td>RQ3</td>
<td>How to support learning communities in 3D CVEs?</td>
</tr>
</tbody>
</table>
Research Questions

RQ1  How can collaborative work on 3D content benefit educational activities?

RQ1a How to characterise 3D content and educational visualizations in CVEs?

RQ1b How to facilitate learning by means of educational visualizations in 3D CVEs?
Research Questions

RQ2  How to design tools and environments in 3D CVEs to benefit educational activities?

RQ2a  How to design tools for a virtual campus and a virtual city?

RQ2b  How to design environments of a virtual campus and a virtual city?
Research Questions

RQ3  How to support learning communities in 3D CVEs?

RQ3a  How to support learning communities by means of collaborative work on 3D content?

RQ3b  How to support learning communities in an educational virtual city?
# RQ-Interconnections Timeline

<table>
<thead>
<tr>
<th>Year</th>
<th>RQ1</th>
<th>RQ2</th>
<th>RQ3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **RQ1**:
  - **RQ1a**: C1, C2
  - **RQ1b**: C3, C4

- **RQ2**:
  - **RQ2a**: C3, C4
  - **RQ2b**: C5, C6

- **RQ3**:
  - **RQ3a**: C5
  - **RQ3b**: C6
General Research Approach

1. Planning
2. Proposal
3. Observation/empirical study
4. Data analysis/theoretical study
5. Framework
6. Analysed data
7. Requirements
8. Prototype
9. Development
General Research Approach

Planning

Proposal

Prototype

Observation/empirical study

Data

Data analysis/theoretical study

Framework

Requirements

Analysed data

Development

(x 3)

(x 4)
Methods and Data

○ Case study method
  – multiple sources of evidence and multiple cases

○ Data sources
  – direct observation
  – virtual artefacts: chat log and 3D constructions
  – user feedback: questionnaires and essays/blogs

○ Analysis
  – discourse analysis, content analysis, and constant comparison
Research Process

Theoretical studies

Virtual campus → Virtual campus and virtual city → Universcity

Empirical studies

Educational Virtual city → 3D content & visual means → Educational visualization (I)

Educational Virtual city → CVW and Virtual campus (I) → Educational visualization (II)

Educational Virtual city → CVW and Virtual campus (II) → Educational visualization (III)

Educational Virtual city → CVW and Virtual campus (I) → Educational visualization methodology

Educational Virtual city → CVW and Virtual campus (II) → Educational visualization methodology

Educational Virtual city → CVW and Virtual campus (III) → Educational visualization methodology

<table>
<thead>
<tr>
<th>time</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topic 1</td>
<td>Collaborative work on 3D content</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Topic 2</td>
<td>Tools and environments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Topic 3</td>
<td>Learning communities</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Outline

- Introduction
- Research Design
- Results
- Evaluation
- Future Work
Results

- 4 Empirical studies
  - observation, development, and evaluation
- 5 Projects
  - among them, 3 EU-funded
- 6 Contributions
- 20 Publications
  - published: 1 book chapter, 3 Journal articles, and 13 conference papers
  - under review: 3 conference papers
Contributions to Topic 1

C 1  Typology of 3D Content and Visualization Means
  – a framework for analyzing 3D educational visualizations

C 2  Methodology for learning with 3D educational visualizations
  – a sequence of well-defined phases for structuring educational process
Student projects – 3D visualizations
Contributions to Topic 2

C 3 Creative Virtual Workshop
- a framework for designing tools to support collaborative work on 3D content
- tools at the NTNU virtual campus (prototype)

C 4 Guidelines for designing virtual campuses and virtual cities
- six-dimension guidance
- Virtual City of Yoshkar-Ola (R&D)
- Travel in Europe (R&D)
- Virtual Campus of NTNU (prototype)
Virtual Cities VCYO and TiE
Virtual Campus of NTNU
Contributions to Topic 3

C 5 Virtual Research Arena
- a framework for creating awareness about educational and research activities
- Virtual Science Fair (prototype)

C 6 Universcity
- a framework for designing educational virtual cities
- integration of culture, society, education, and entertainment
Virtual Science Fair
Virtual Science Fair
Research Papers

Paper 1
Virtual City: a place for learning and socializing
iJET 2009

Paper 2
Integration of Virtual Campus and Virtual City
JILR 2011

Paper 3
Educational visualizations in a virtual campus
G-Learn 2010

Paper 4
3D Educational content: challenges and implications
CATE 2010

Paper 5
‘Universcity’: educational Virtual City
VSMM 2010

Paper 6
Virtual Research Arena
G-Learn 2011

Paper 7
Educational visualizations: Methodology
ITSE 2012

Paper 8
3D CVEs for community building
CSCL at work

Paper 9
3D CVEs for creativity support
E-Learn 2011

Topic 1: Collaborative work on 3D content
Topic 2: Tools and environments
Topic 3: Learning communities

JP Journal paper
CP Conference paper
BC Book chapter
1A First authorship
Co-authorship
Aw Awarded paper
Important contribution

NTNU
Outline

- Introduction
- Research Design
- Results
- Evaluation
- Future Work
Evaluation

○ Goals achieved
  – collaborative work on 3D content explored, including its use in educational context, design of tools and environments, and support of communities
  – focus specified – context extended

○ Main RQ answered
  – six contributions
  – multidisciplinary results
Outline

- Introduction
- Research Design
- Results
- Evaluation
- Future Work
Future Work

- Collaborative work on 3D Content
  - new domains, new methods, and new platforms
- Design of tools
  - vAcademia project
- Design of environments
  - CAMO project
- Learning communities
  - international collaboration and creativity
Thank you!

Mikhail Fominykh
Norwegian University of Science and Technology, Norway
mikhail.fominykh@svt.ntnu.no
Virtual Research Arena context

- Authentic environment
- Learning & researching
- Socializing

- Social layer
- Layer of ed. and research
- Cultural layer
- Entertainment layer

- University

- Virtual Campus

- Creative Virtual Workshop

- Workplace (tools & tutorials)
  - Virtual library
  - Virtual stage
  - Virtual gallery
Research Context

- Virtual City of Yoshkar-Ola
- Travel in Europe (EU)
- Virtual Campus of NTNU and Virtual Science Fair
- TARGET (EU) summer schools
- CoCreat (EU)
Validity

- **Construct validity**
  - threat: subjective perception of the participants
    - multiple sources of evidence and user groups

- **Internal validity**
  - threat: no control over the variables
    - multiple sources of evidence and multiple cases

- **External validity**
  - threat: no representative sample
    - additional data, multiple contexts and evaluations