Innovations in Teaching Seminar IITS 2017

Pedagogies of learning technologies: how does technology create new possibilities for learning?

3 Oct 2017, Tuesday
Lecture Theatre 7 (NS1-02-03)
8.30am to 5.00pm

Organized by Centre for IT Services (CITS), in collaboration with Teaching, Learning & Pedagogy Division (TLPD).

Faculty Showcase
Cai Yiyu
Associate Professor,
Professor-in-charge, Computer Aided Engineering Labs
Program Director, Strategic Research Program of Virtual Reality & Soft Computing
School of Mechanical & Aerospace Engineering

Virtual & Augmented Reality Technology Enhanced Learning
Abstract

Technology enhanced learning (TEL) is rapidly coming to us in NTU. This talk will focus on the virtual & augmented reality technology enhanced learning (VARTEL). First, I will introduce the fundamentals of virtual & augmented reality technology. Second, I will discuss the challenges in developing virtual & augmented reality technology for learning applications. Third, I will share some of our work currently undergoing on VARTEL for engineering, sciences and humanity education. Last but not least, I will invite fellow colleagues to hands-on one or two VARTEL demo
1. Background
1. Background

(a) External Views of the MAE MP Workshop

(b) Internal View of the MAE MP Workshop

Fig 2.4: Machine tools

Fig 2.5: Removing unwanted materials from the original blocks to form the desired shapes with specific functions.

(a) Drilling and milling machines

(b) CNC machines

Fig 2.3: Machines in the MP Workshop
1. Background

- Large cohort vs. Limited resource
- Learning objectives vs. Cost
- Learning outcomes vs. Safety
1. Background

Aerospace

Automobile

Sciences

Humanities
2. Intended Student Learning
2. Intended Student Learning:

- **In-depth Learning** through more hands-on
- **In-depth Learning** through team work
- **In-depth Learning** in realistic environments
- **In-depth Learning** in safe ways
- **In-depth Learning** by serious gaming
- **In-depth Learning** by fun experiences/engagement
- **In-depth Learning** with low-cost & scalable solutions
- **In-depth Learning** with self-paced approaches, in and out of school
3. Pedagogical Purpose of the Technological Intervention
3. Pedagogy: TEL

Holding signal benefits the accuracy of the A/D conversion.

- Minimum sampling rate should be at least twice the highest data frequency of the analog signal.
3. Pedagogy: VARTEL

Teach Less

Learn More

Projects & Hands-on
Discussion & Presentations
Tutorials
Interaction & Contact

Lecture

Pedagogy: VARTEL teaches the balance between teaching and learning, focusing on strategies that allow students to learn more effectively with less teaching. This approach emphasizes active learning methods such as projects, hands-on activities, discussions, and tutorials, all aimed at enhancing student engagement and comprehension.
3. Pedagogy: Overview of Learning Design

Technological-pedagogical affordances from developing the VAR learning object

Design of learning activities and intended learning outcomes

Interactions in collaborative learning
3. Pedagogy: Technological-pedagogical Affordances for VARTEL

(Adapted from Wu, Lee, Chang & Liang, 2013)
3. Pedagogy: Technological-pedagogical Affordances for VARTEL
3. Pedagogy: Design of Learning Activities and Intended Learning Outcomes

**Before Class**
- Schemata building by reading up how a turbo engine works (provision of readings/videos/animations)
- Students manipulate learning object at their own time and pace.

**In Class**
1. Case-based learning in small groups
2. Detailed investigation to ascertain fault in turbo engine
3. Worksheet/within simulation scaffolds
4. Formative quizzes

**After Class**
- Review and practice
  - Students manipulate learning object at their own time and pace to answer given questions/provide solutions to more advanced applications through low cost VARTEL
3. Pedagogy: Interactions in Collaborative Learning

Inquiry-based
Conceptual clarification
Reciprocal Teaching (Palincsar and Brown, 1984)/Peer Teaching

Interactivity, Synchronicity and Negotiability (Dillenbourg, 1999)

Joint construction of knowledge
Justification of presentation and arguments
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Faculty Showcase
Randall Packer
Associate Professor
School of Art, Design & Media

The Pedagogy of Remote Teaching in the Virtual Classroom

4. Leveraging VARTEL: Development & Challenges
4. VAR Technology: Fundamentals
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4. VARTEL: Research & Development

VAR
- Immersion
- Interaction
- Fidelity Modeling/Simulation
- Realistic/Stereographic Visualization
- Real-time Interaction
- Natural User Interfacing

4. VARTEL: Research & Development

Immersion
Interaction
VAR
- Fidelity Modeling/Simulation
- Realistic/Stereographic Visualization
- Real-time Interaction
- Natural User Interfacing
4. The Challenges in Developing VARTEL Applications: Low Cost & Compatibility
4. The Challenges in Developing VARTEL Applications: Scalability

- Very low end solution
- Low end solution
- Basic solution

TR+
4. The Challenges in Developing VARTEL Applications: Systematic Solution

Y Cai (Ed.), 3D Immersive & Interactive Learning, Springer, 2013
### 4. The Challenges in Developing VARTEL Applications: Content Selection

**VARTEL**

**Immersive & Interactive Learning Ecosystem (I²LE)**

<table>
<thead>
<tr>
<th>Virtual Mechanical Engineering</th>
<th>Virtual Aerospace Engineering</th>
<th>...</th>
<th>...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Manufacturing Process Workshop</td>
<td>Virtual Turbine</td>
<td>...</td>
<td>...</td>
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</tbody>
</table>

- Virtual Welding
- Virtual Cutting
- Virtual Drilling
- Virtual Lathing
- Virtual Milling
- Virtual CNC
- Virtual Aerospace Engineering
- Virtual Turbine
5. Concluding Remarks
5. Evaluation on VARTEL: Improved Student Learning

### 3.5.2 Comparison of Pretest Results

The students in the experimental group ($M = 2.13$, $SD = 1.01$, $N = 135$) were not significantly better than those in the control group ($M = 2.20$, $SD = 0.97$, $N = 114$) with regards to the spatial visualisation skills, $F(1,247) = 0.32$, $p = .57$, as measured for spatial visualisation at the beginning of the experiment.

<table>
<thead>
<tr>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Significance</th>
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<tbody>
<tr>
<td>Between Groups</td>
<td>0.32</td>
<td>1</td>
<td>0.32</td>
<td>.32</td>
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<tr>
<td>Within Groups</td>
<td>244.12</td>
<td>247</td>
<td>0.95</td>
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<tr>
<td>Total</td>
<td>244.44</td>
<td>248</td>
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</table>

### 3.5.3 Posttest versus Pretest Results for Experimental Group

The students in the experimental group did significantly better in the posttest than the pretest in regards to the spatial visualisation measure, $F(1,268) = 6.25$, $p = .012$ (see Table 3.3). This means that the spatial visualisation skills of the students taught using the Virtual Reality Elements method was almost significantly better at the end of the experiment compared to the beginning.

I feel invigorated and enthused by the 3D animated cells and it’s indeed a very fulfilling experience for me. Now, I think I would like the Biology lessons more than ever as we dive deeper into the world of human biological cells. I would like other schools to have such special lessons too.

— Jadeline

It’s fun to see the 3D cells rather than 2D ones in photographs. The video has enhanced my understanding of cells and the lesson is engaging. Now I am keen to learn more and I hope there will be animation for other biology topics.

— Madeline

The 3D animation has really helped me gain another outlook in the structure and internal working of cells, plus illustrate effectively the units of DNA, which was very interesting, and as good, if not better than a practical lesson.

— Jian Qin

<table>
<thead>
<tr>
<th>Scale</th>
<th>No. of Items</th>
<th>Alpha Reliability</th>
<th>Mean Correlation with Other Scales</th>
<th>ANOVA (between classes)</th>
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</thead>
<tbody>
<tr>
<td>Student Cohesiveness (A)</td>
<td>6</td>
<td>.751</td>
<td>.460</td>
<td>.025</td>
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<tr>
<td>Student Involvement (B)</td>
<td>6</td>
<td>.747</td>
<td>.488</td>
<td>.046</td>
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<td>Student Investigation (C)</td>
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<td>.904</td>
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<td>Student Cooperation (D)</td>
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<td>Differentiation (E)</td>
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<td>.632</td>
<td>.490</td>
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<tr>
<td>Equity (F)</td>
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<td>.806</td>
<td>.435</td>
<td>.003</td>
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<td>Creativity (G)</td>
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<td>.815</td>
<td>.484</td>
<td>.005</td>
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<tr>
<td>3D Usage (H)</td>
<td>6</td>
<td>.800</td>
<td>.499</td>
<td>.013</td>
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</tbody>
</table>
5. Publications and Exhibitions
5. VARTEL for insightful education

Einstein could look at Maxwell's equations and marvel at what it would be like to ride alongside a light wave, and he could look at Max Planck's equations about radiation and realize that Planck's constant meant that light was a particle as well as a wave.

-Walter Isaacson

<<Einstein>>
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