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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

Faculty Showcase

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School of Mechanical & Aerospace Engineering

Virtual & Augmented Reality Technology Enhanced Learning

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

Supported by John Cheung Endowment (Social Media for Teaching and Learning)

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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

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1. Background

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

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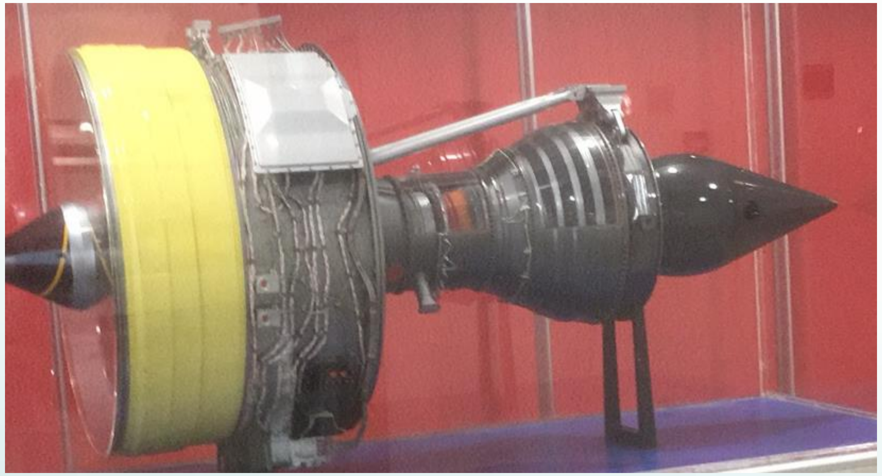
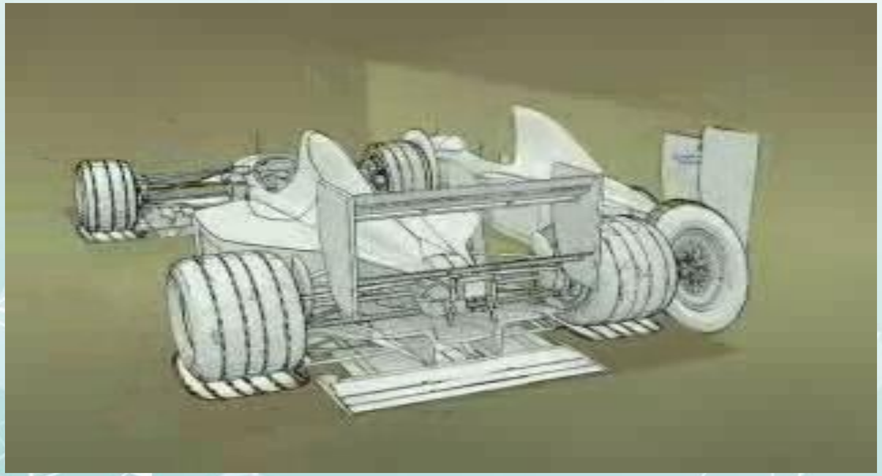
1. Background

Aerospace



Sciences

Automobile



Humanities

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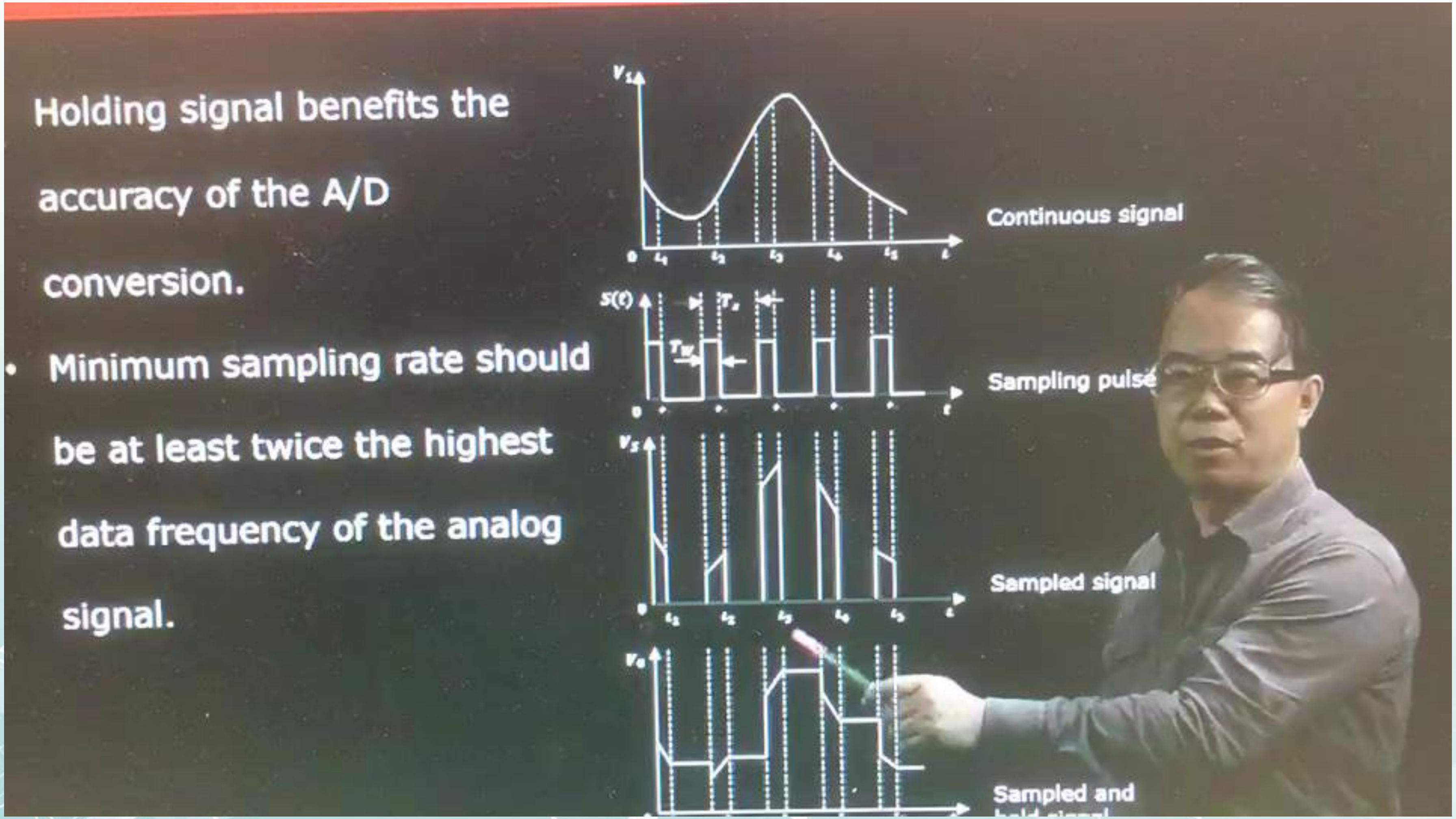
2. Intended Student Learning

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

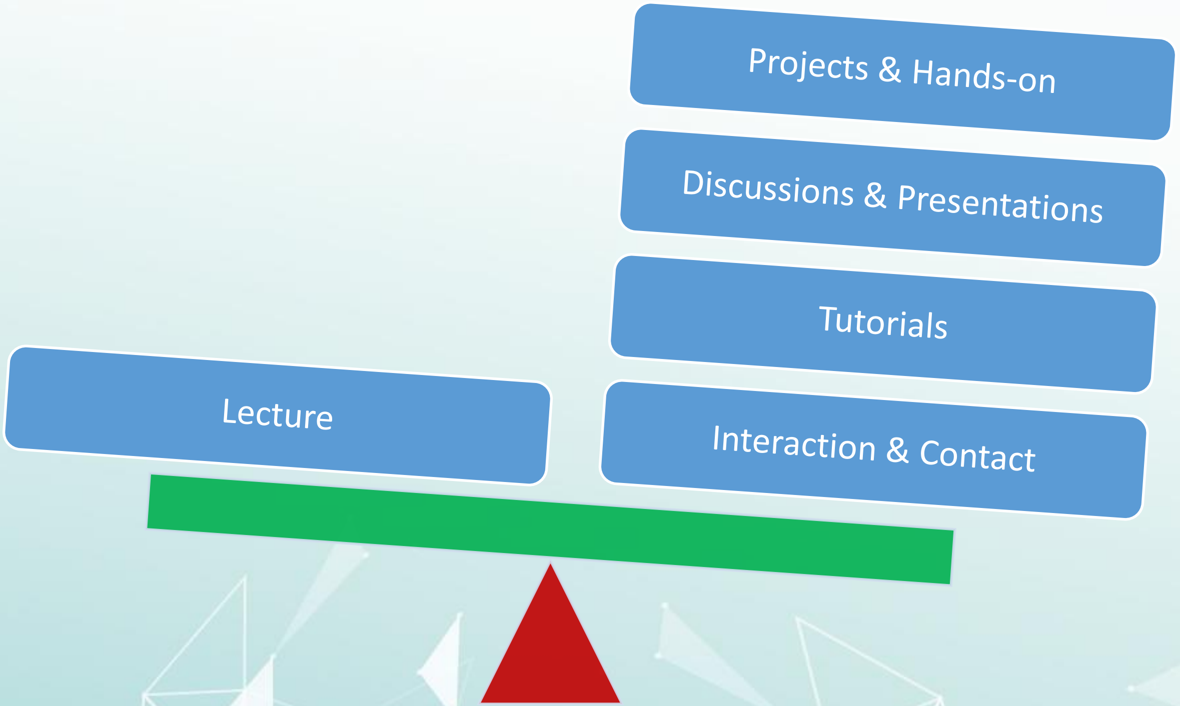
3. Pedagogical Purpose of the Technological Intervention

3. Pedagogy: TEL

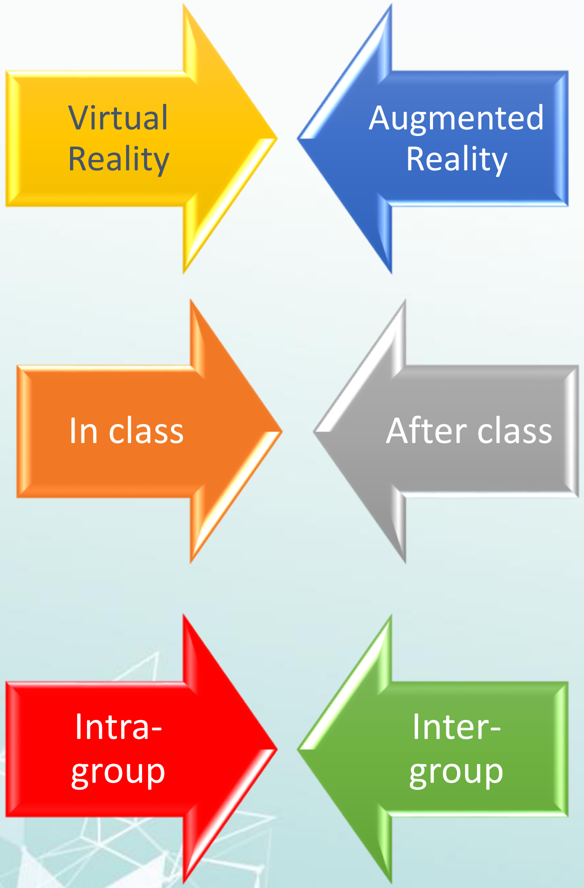


3. Pedagogy: VARTEL

Teach Less	Learn More



3. Pedagogy: Overview of Learning Design

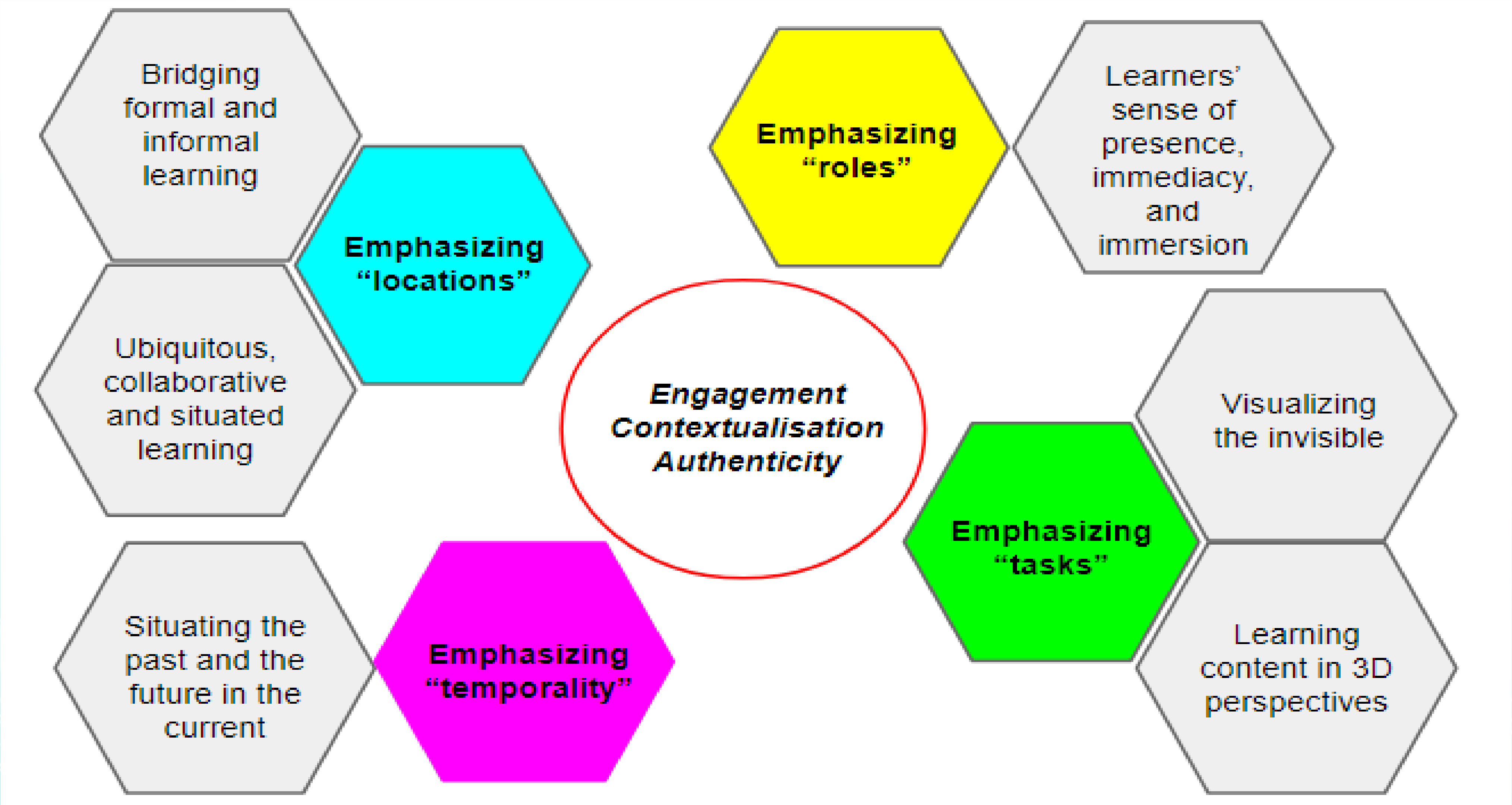


Technological-pedagogical affordances from developing the VAR learning object

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)

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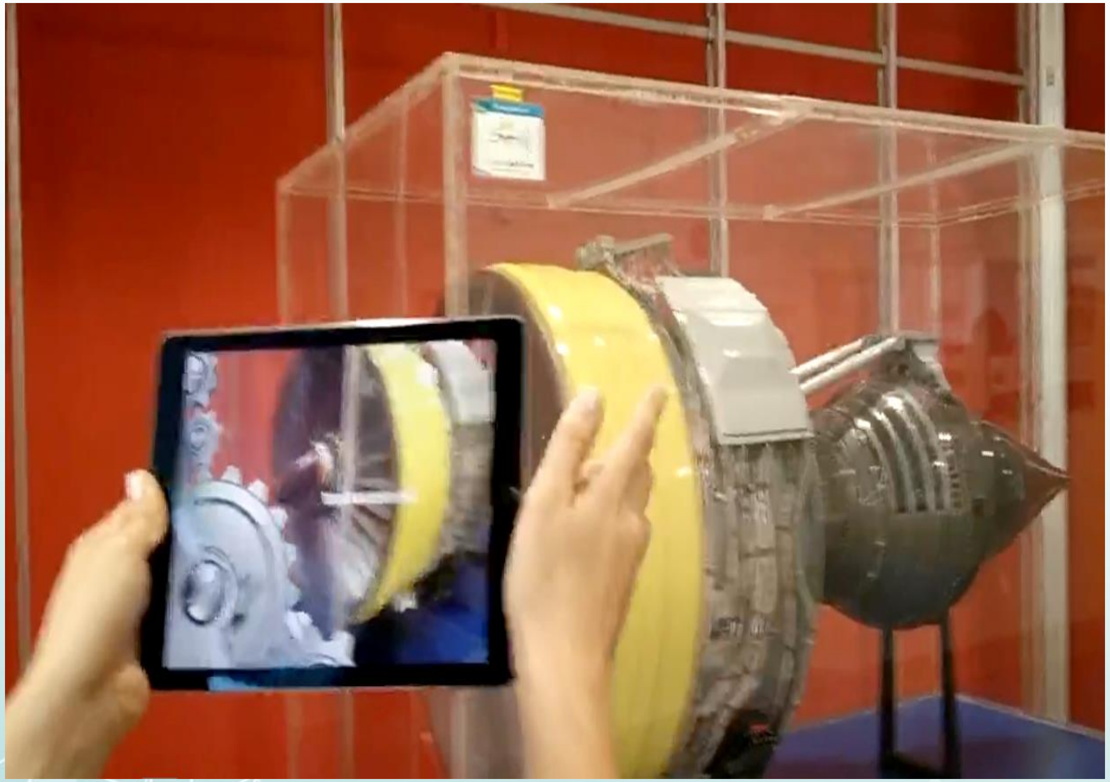
3. Pedagogy: Technological-pedagogical Affordances for VARTEL



Where

Who

Engagement
Contextualisation
Authenticity

When

What

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3. Pedagogy: Design of Learning Activities and Intended Learning Outcomes

Before Class

Schemata building by reading up how a turbo engine work (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 own time and pace to answer given questions/provide solutions to more advanced applications through low cost VARTEL

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3. Pedagogy: Interactions in Collaborative Learning

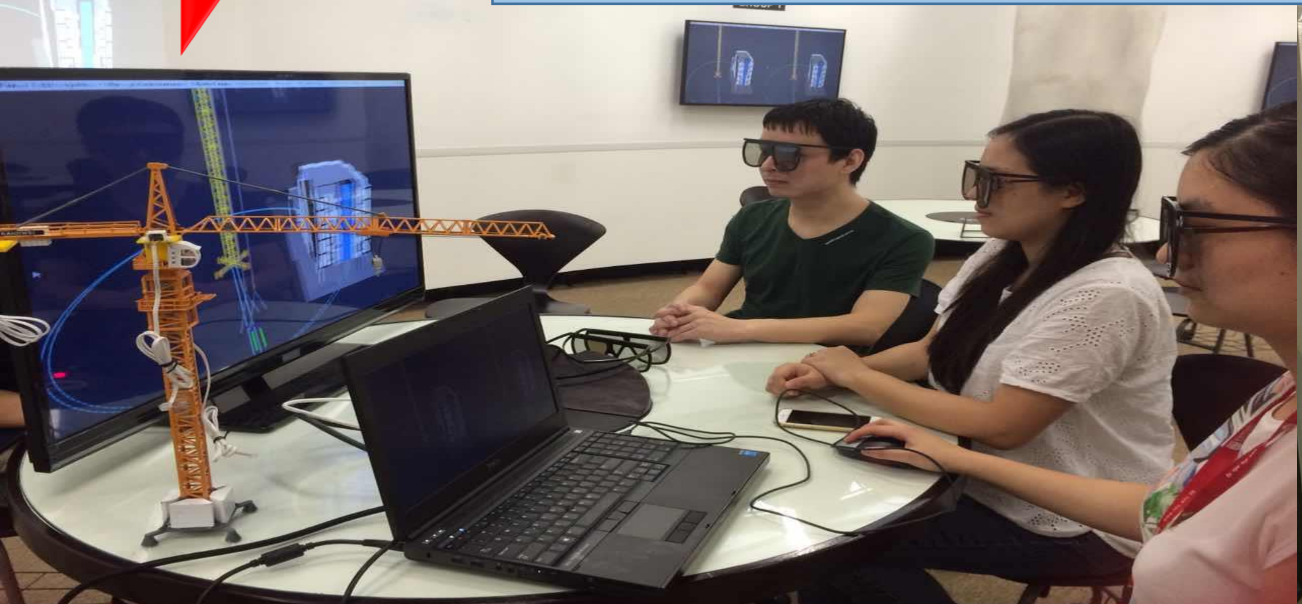
Inquiry-based
Conceptual clarification
Reciprocal Teaching (Palincsar and Brown, 1984)/Peer Teaching

Joint construction of knowledge
Justification of presentation and arguments

Intra-group

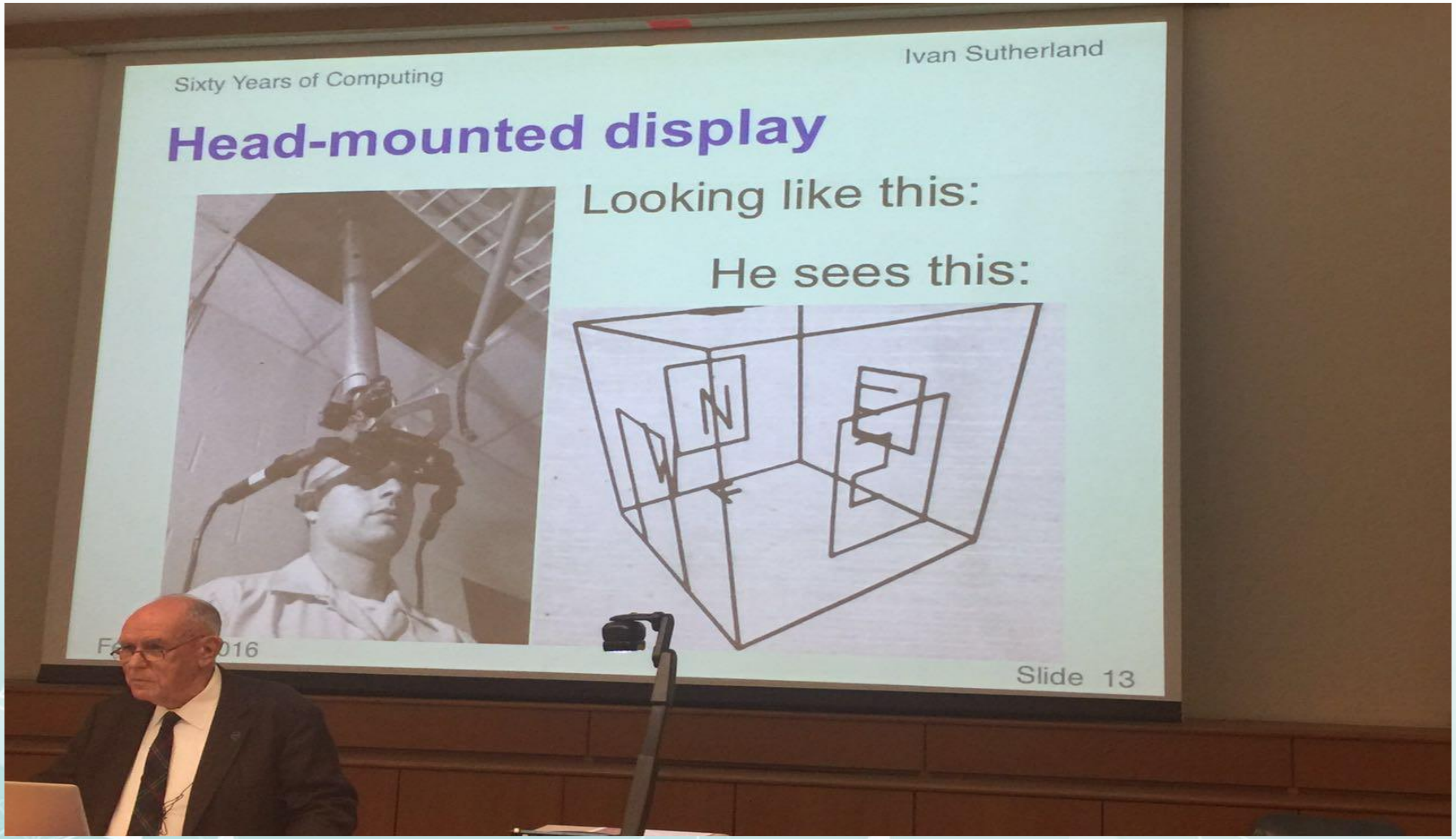
Interactivity, Synchronicity and Negotiability (Dillenbourg, 1999)

Inter-group



4. Leveraging VARTEL: Development & Challenges

4. VAR Technology: Fundamentals



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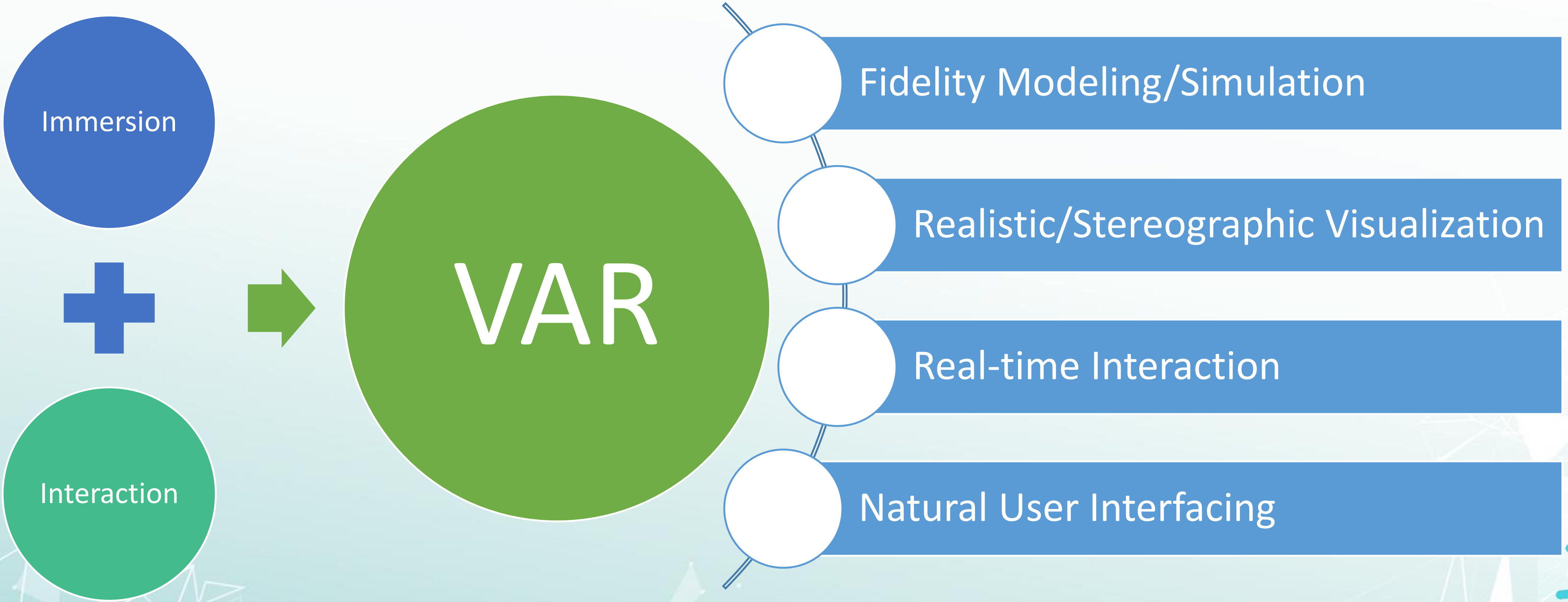
4. VARTEL: Research & Development



4. The Challenges in Developing VARTEL Applications: Low Cost & Compatibility

Very low end solution

Low end solution

Basic solution

Mid end solution

High end solution

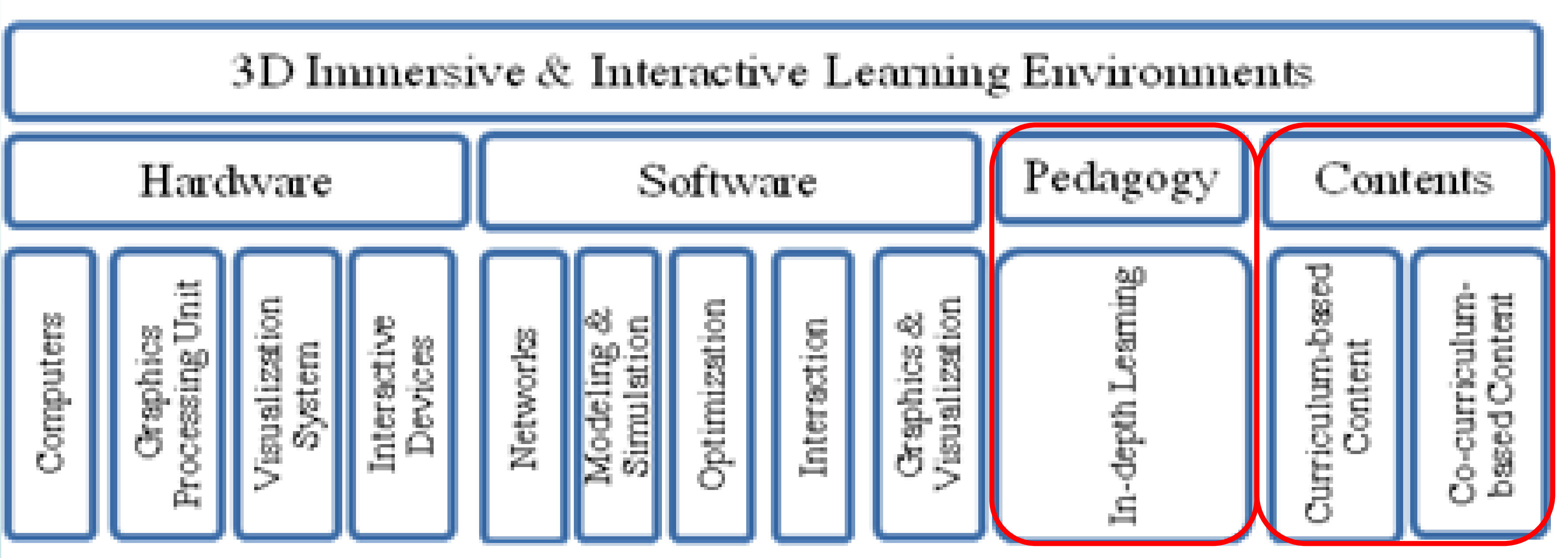
4. The Challenges in Developing VARTEL Applications: Scalability

Very low end solution

Low end solution

Basic solution

4. The Challenges in Developing VARTEL Applications: Systematic Solution



Y Cai (Ed.), 3D Immersive & Interactive Learning, Springer, 2013

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4. The Challenges in Developing VARTEL Applications: Content Selection

VARTEL

Immersive & Interactive Learning Ecosystem (I^2LE) | …

Virtual Mechanical Engineering | Virtual Aerospace Engineering | … | …

Virtual Manufacturing Process Workshop | … | Virtual Turbine | … | … | …

Virtual Welding | Virtual Cutting | Virtual Drilling | Virtual Lathing | Virtual Milling | Virtual CNC | … | … | … | … | ..

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5. Concluding Remarks

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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 3.7 Pretest Results for Purdue Spatial Visualisation Test – Rotations between Experimental Group and Control Group

	Sum of Squares	df	Mean Square	F	Significance
Between Groups	0.32	1	0.32	0.32	.57
Within Groups	244.12	247	0.99		
Total	244.44	248			

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 3.8). 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.

Table 5.3: Scale statistics for 8 modified TROFLEI scales with 49 students from two classes

CLASS 1 (26 students) and CLASS 2 (23 students)				
Scale	No. of Items	Alpha Reliability	Mean Correlation with Other Scales	ANOVA (between classes)
Students Cohesiveness (A)	6	.751	.460	.025
Student Involvement (B)	6	.747	.488	.046
Student Investigation (C)	6	.904	.426	.001
Student Cooperation (D)	6	.851	.487	.002
Differentiation (E)	6	.632	.490	.038
Equity (F)	6	.806	.435	.003
Creativity (G)	6	.815	.484	.005
3D Usage (H)	6	.800	.499	.013

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

Y Cai (Ed.), 3D Immersive & Interactive Learning, Springer, 2013

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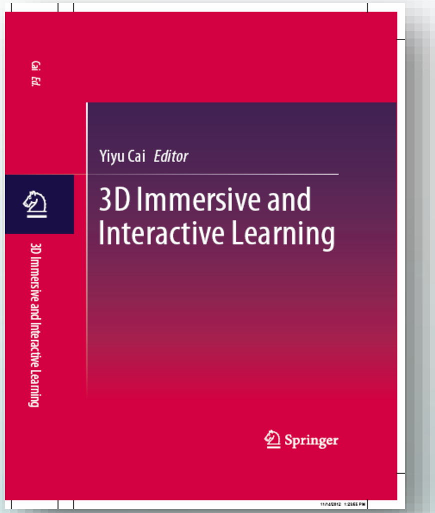
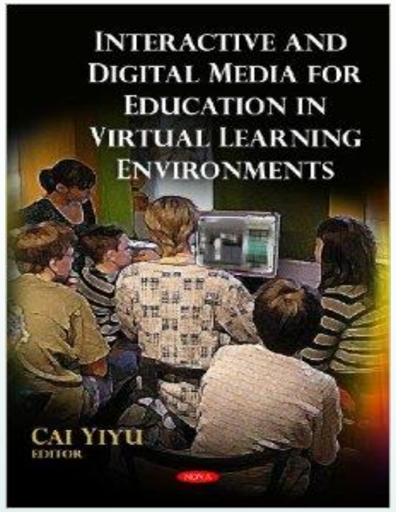
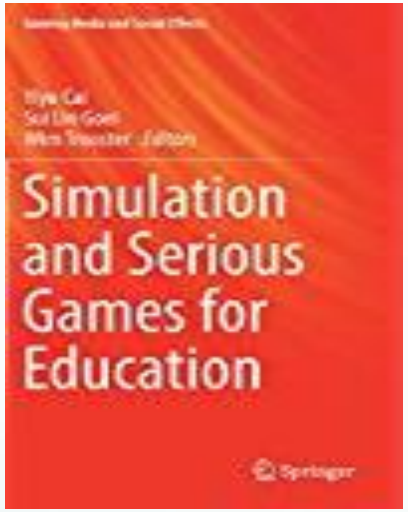
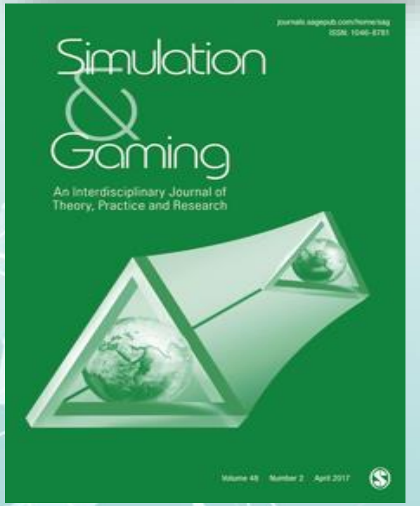
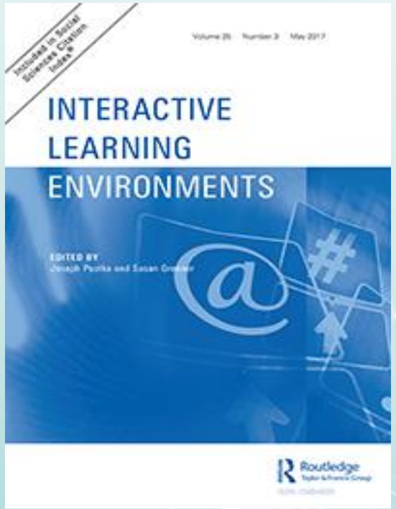
5. Publications and Exhibitions

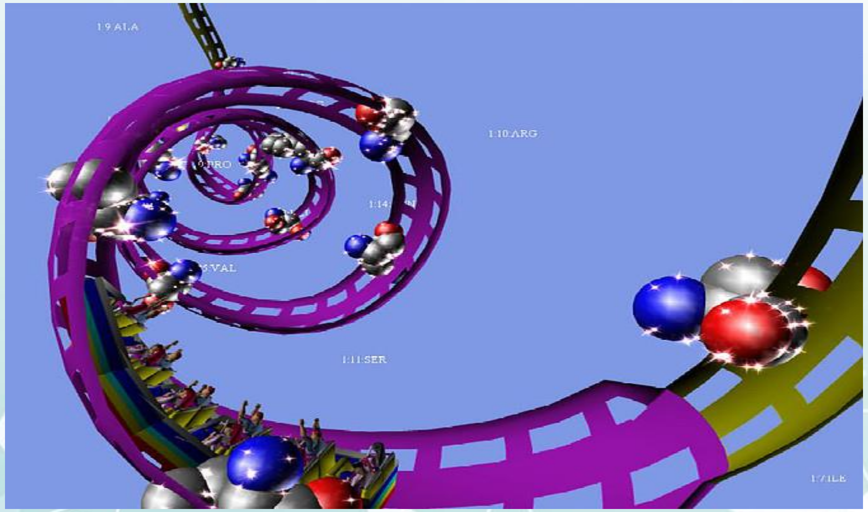




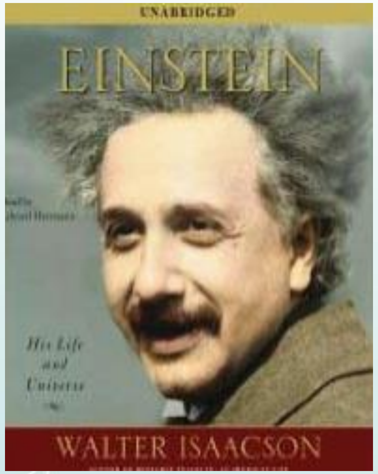








5. VARTEL for insightful education



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>>

Acknowledgements

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- Ms Tan Yee Yin (YY)
- Mr. Syed Nouffer Bin Syed Aqil