Strategies to Evaluate Virtual Systems in Dental Education: How Reliable is the Evidence?

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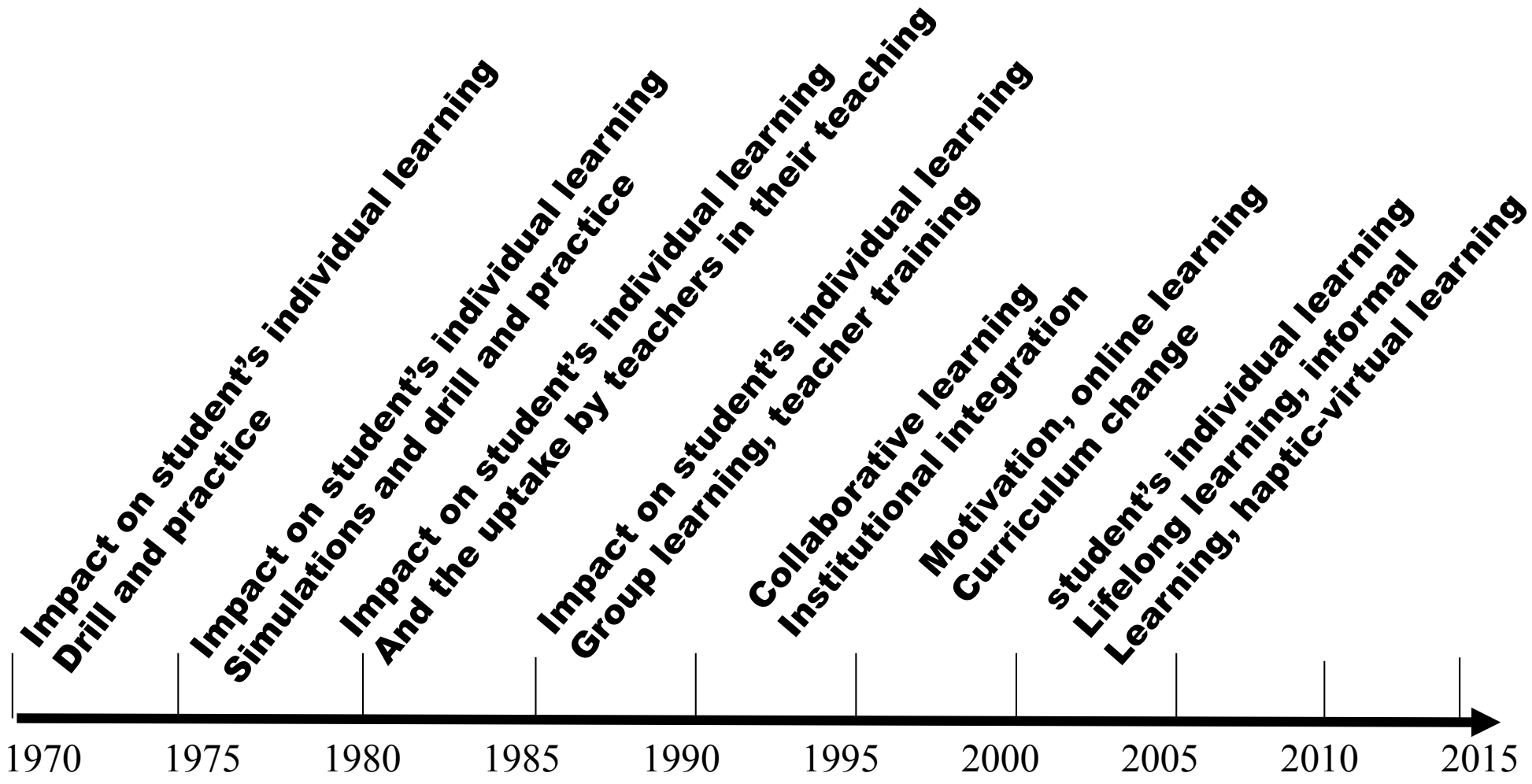
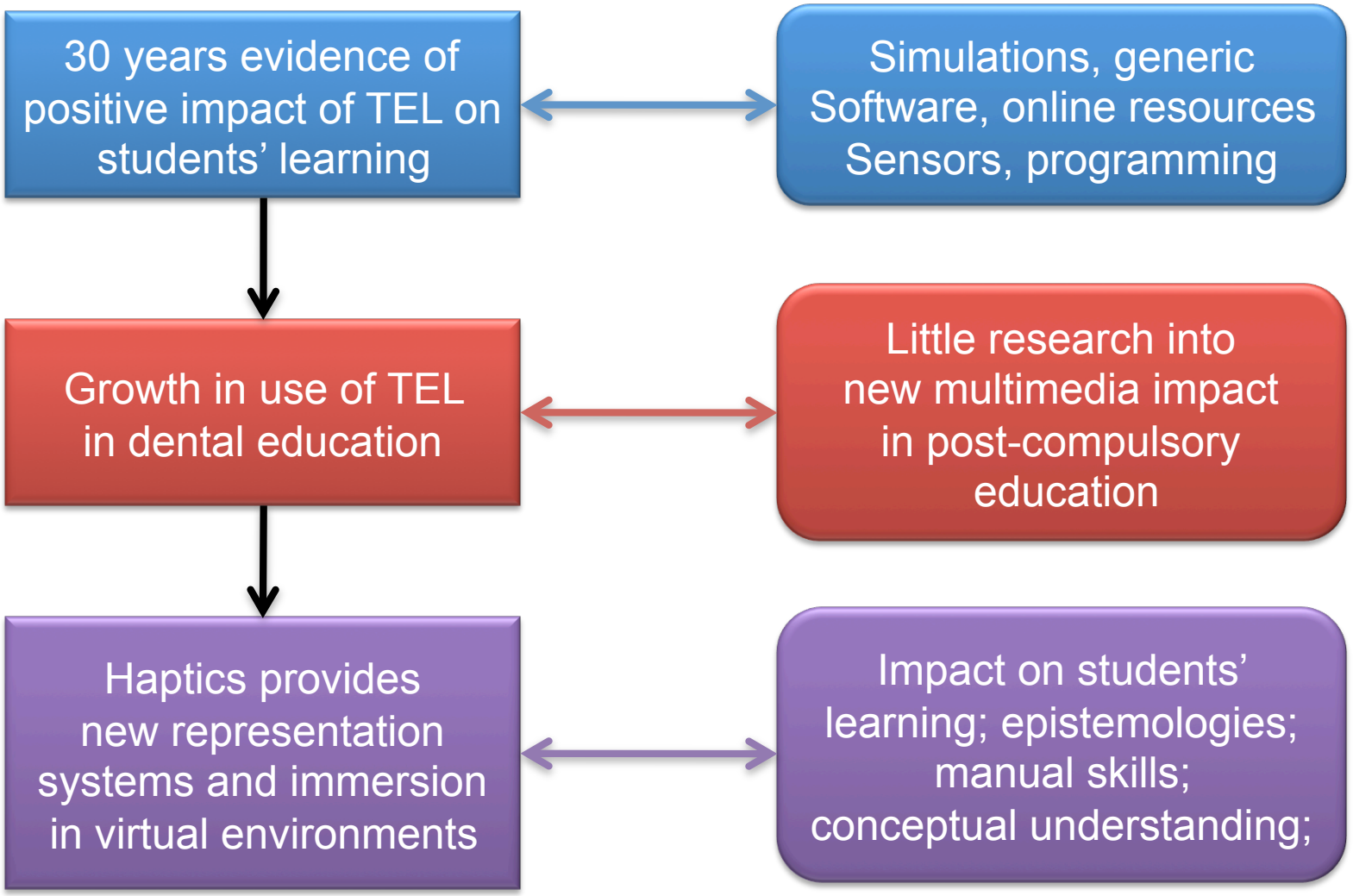
Outline of the Presentation

- Background to Research into Virtual Reality in Education
- Factors which may influence the impact on learning
  - Theories based on meta-analyses
  - Variables which confound the results
- Limitations and confounders
- Strategies to minimise the assumptions
- An interdisciplinary experience - hapTEL
- Lessons from the past
- Evaluation instruments to achieve more rigorous results

History of TEL and educational focus



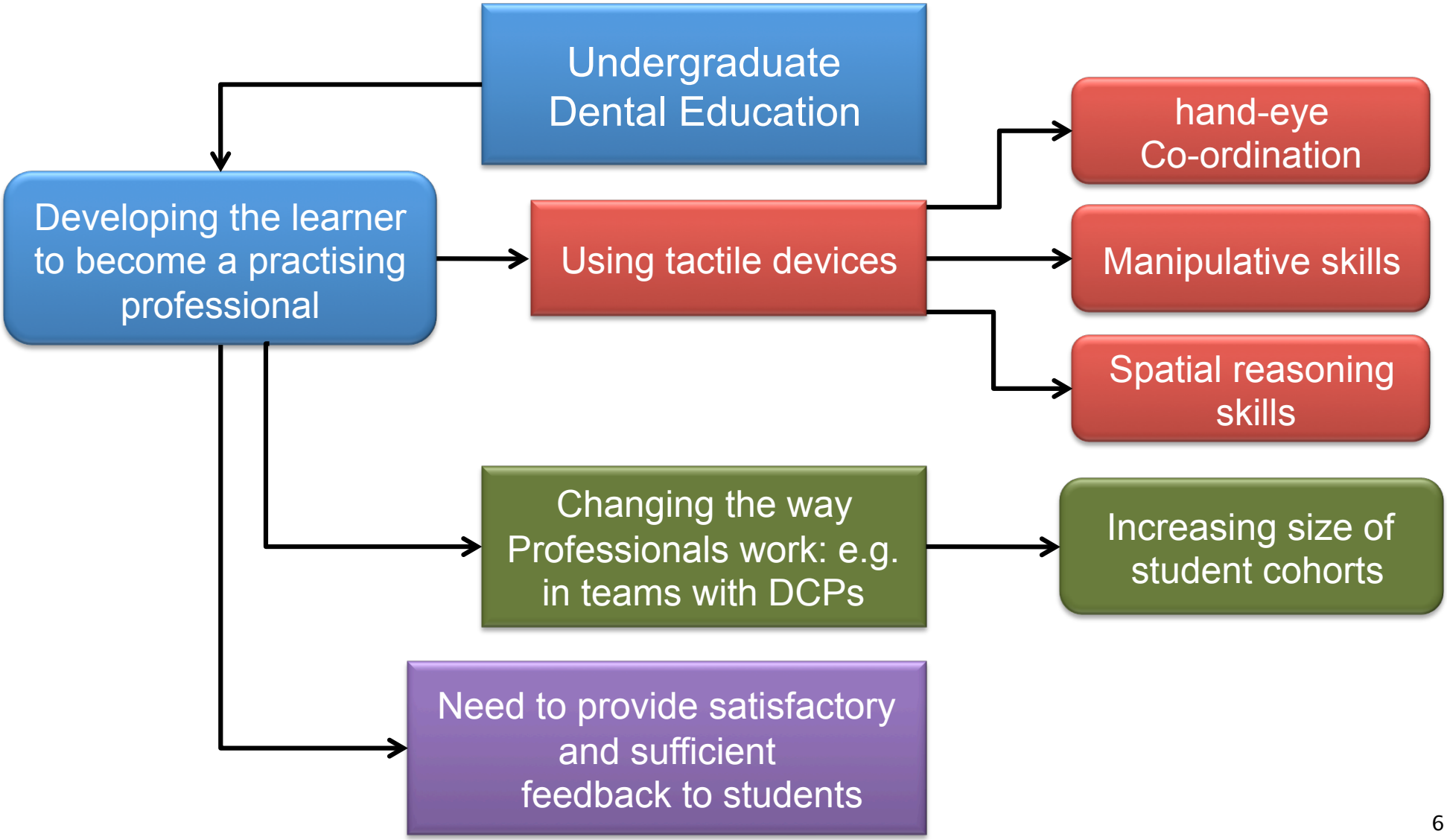
Past Evidence of TEL in Education



Limitations and confounders of previous studies (Quinn)

- Too short time span of using the innovation
- Innovation as a supplementary learning experience
- Unequal time spent on innovation compared with the traditional learning activity
- Using student volunteers instead of randomly assigned groups
- Different conceptual demands between innovation and traditional task
- Mismatch of method to potential of learning outcomes
- Not integrated into the curriculum
- Affordances of VR system different to the traditional system

Goals and issues for Dental Education



E E F
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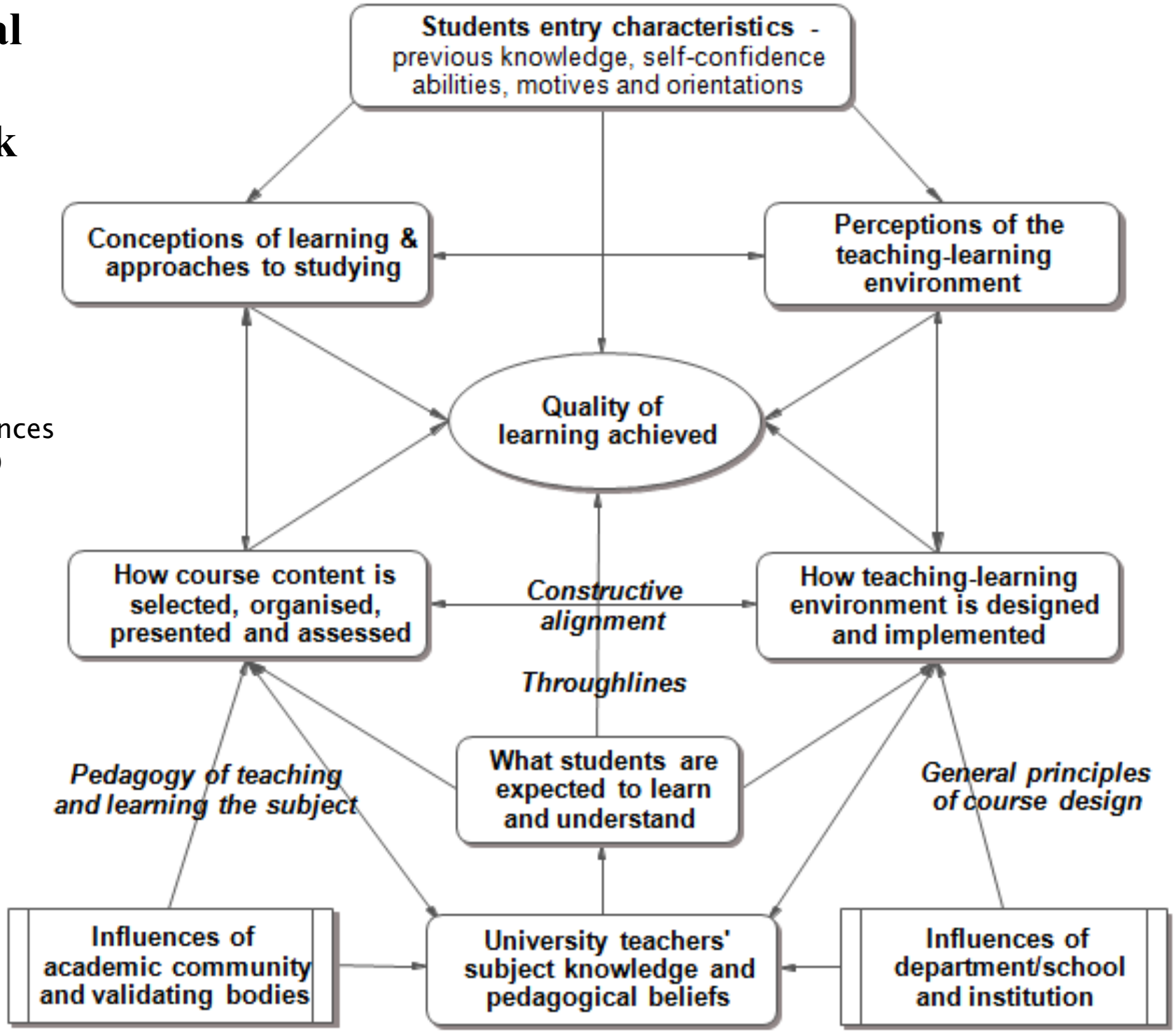
Factors affecting learning experience (Entwhistle)

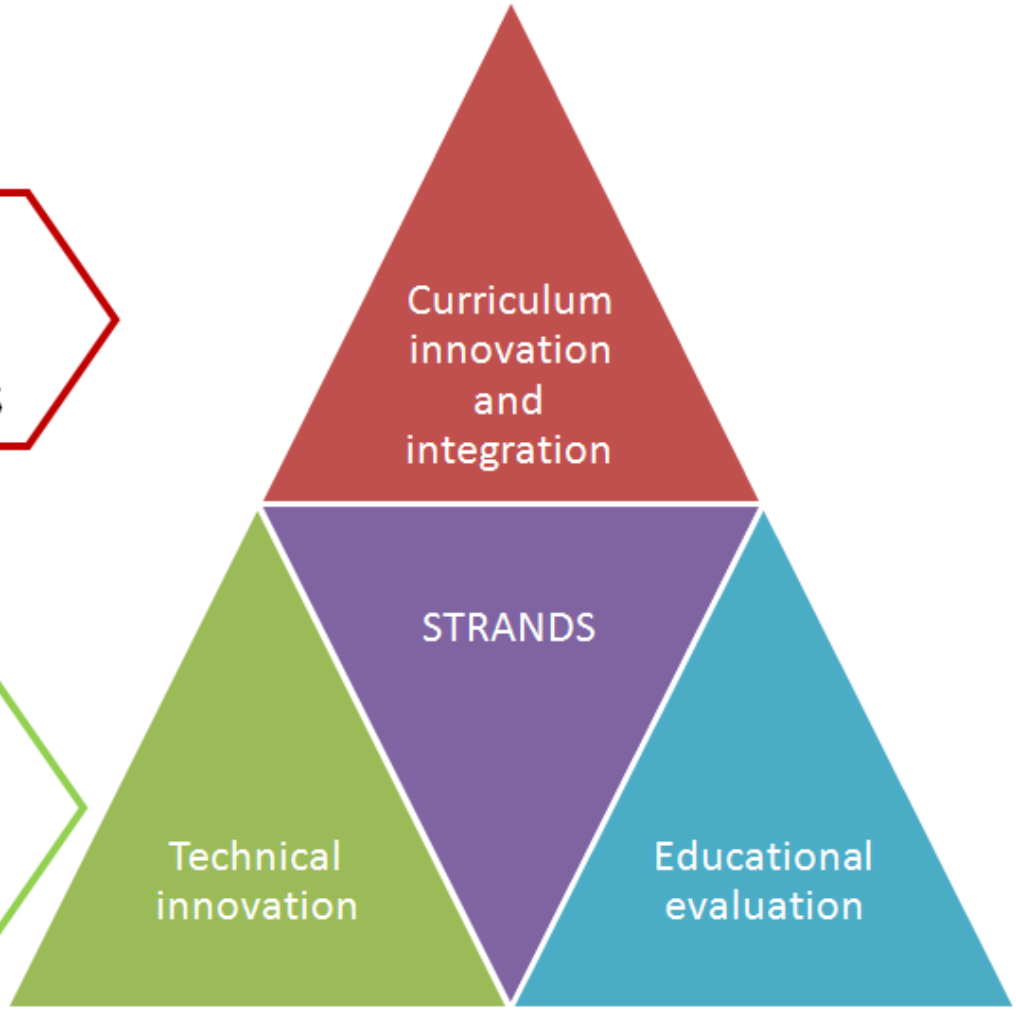
Educational Evaluation Framework

Factors affecting learning experiences (Entwistle, 1987)



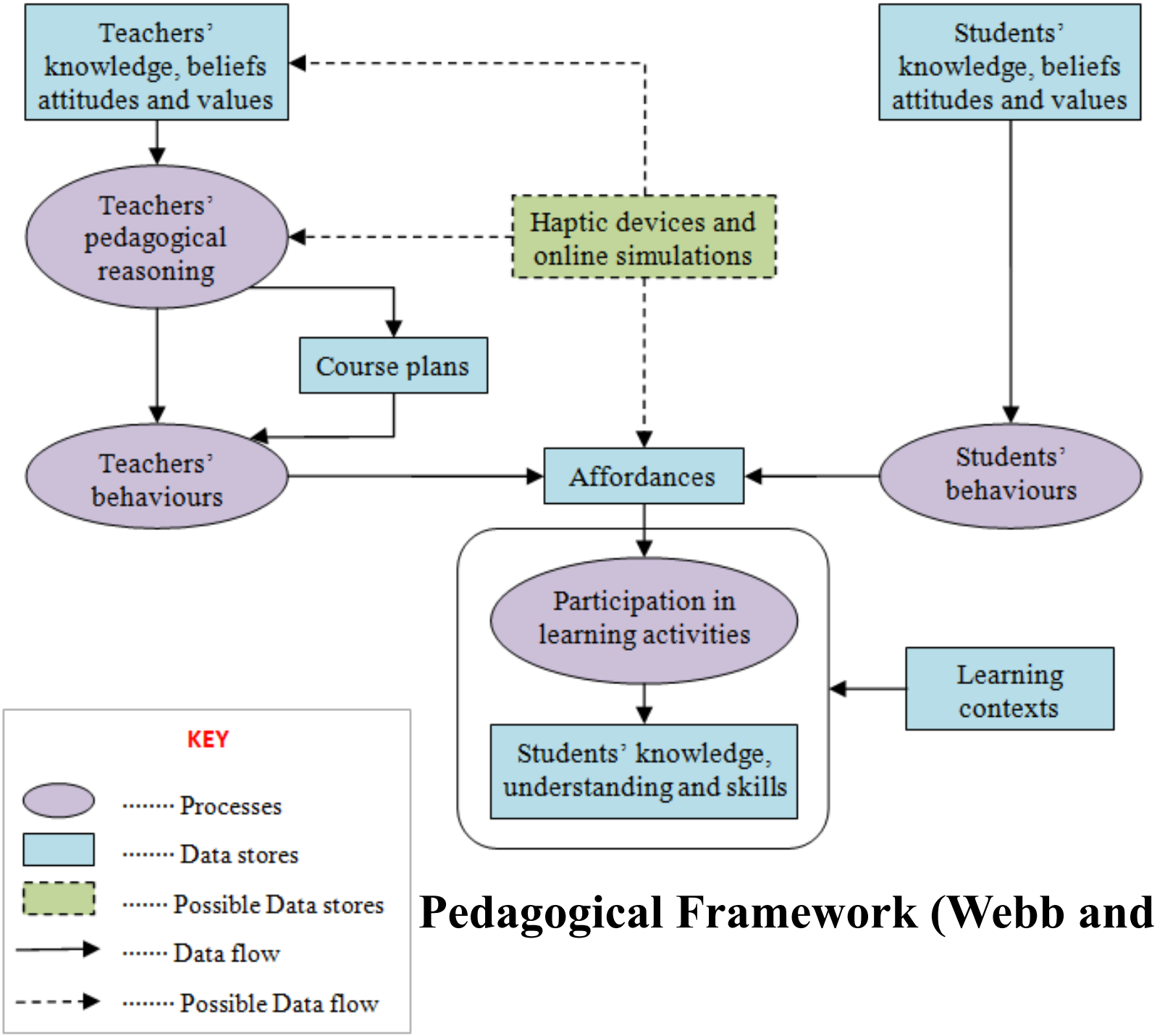
Pedagogical frameworks
Teachers' practices
Teacher-learner interactions

Multimodal sensory (haptic)
Representations/Visualisations
Data capture and logging systems



Students' attitudes
Learner-computer interactions
Cognition, learning, and psychomotor skills

EVALUATION FRAMEWORK



Pedagogical Framework (Webb and Cox, 2004)

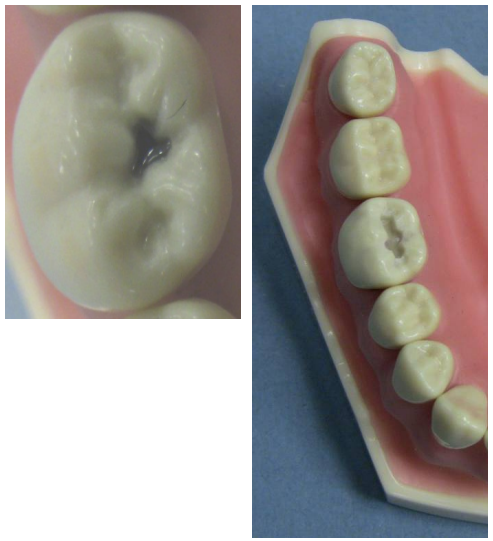
Research into developing virtual dental systems

- Physical Layout (Ergonomics, collocation, workspace)
- Physical interface (inclusion of rubber cheeks, synthetic tissues)
- Touch (Collision detection, DoF, workspace, etc.)
- Vision (3D or 2D, tissue models, colour changes, magnification, graphic scene changes)
- Audio (mono/stereo/3D, variants of feedback)
- Others (data logs and visualisation, motion representation, smell)

hapTEL Workstation
(Curriculum Version)

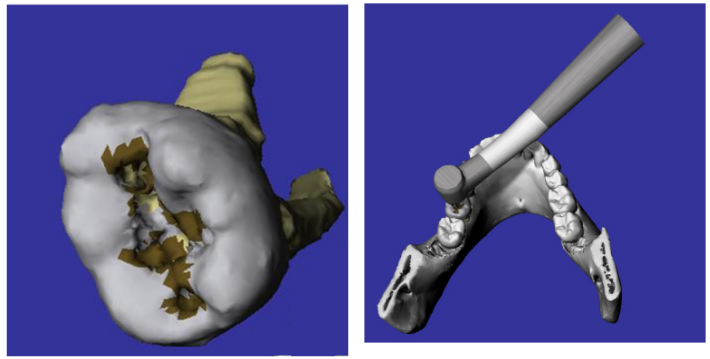
Traditional

- Removal of artificial decayed material on a plastic tooth
  - Three sessions: Two attempts per session



hapTEL

- Removal of virtual decayed material on a virtual tooth located in a jaw
  - Three sessions: as many attempts as they wish within a given time per session

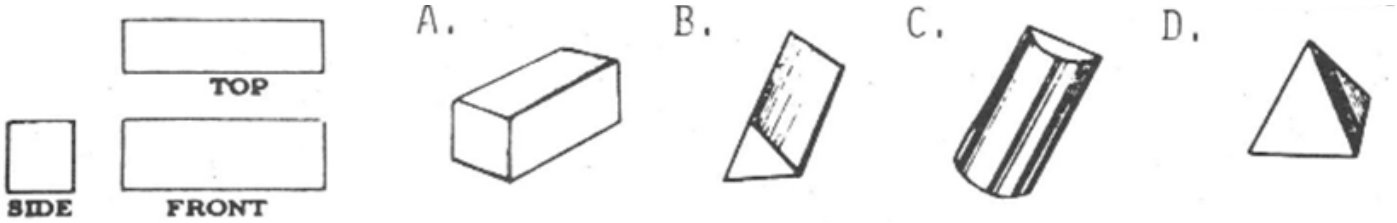


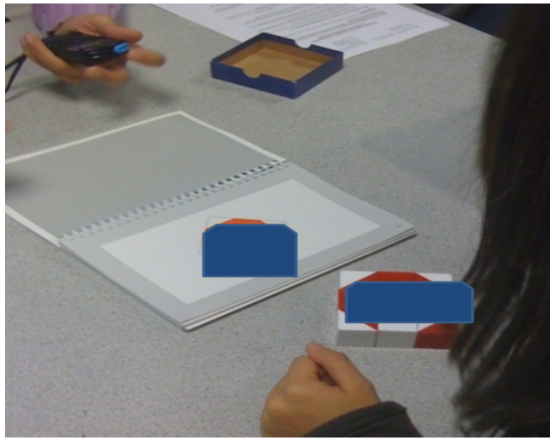
Strand 3 - Research design and methods to measure students‘ learning

- Pre and post tests
  - Spatial reasoning; fine motor skills; 3-D perceptions
  - Attitudes towards ICT and haptics
- Video observations of students’ practices in the laboratories
- Task performance in traditional and hapTEL laboratories
- Final caries removal task
- Post-lab self assessment task

Examples of assessment techniques

	1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Using haptic devices to practice preparing a cavity will take up more time than using a mannequin	◯	◯	◯	◯	◯	◯	◯
It will be hard for me to gain access to haptic devices in order to practice preparing a cavity	◯	◯	◯	◯	◯	◯	◯





Study Design (Large scale trials)

1/3

Pre-test

144 Year 1 Students

Pre-test

2/3

Post-test

Post-test

Worksheet Panel

Your task is to answer a set of post hands-on questions about your reflections on the task and overall experience of using the hapTEL Virtual Dental workstation. **Please be as detailed as you can.**

Describe any effective or ineffective strategies/techniques that you carried out.

(Type your answer here)

CLICK TO CONTINUE

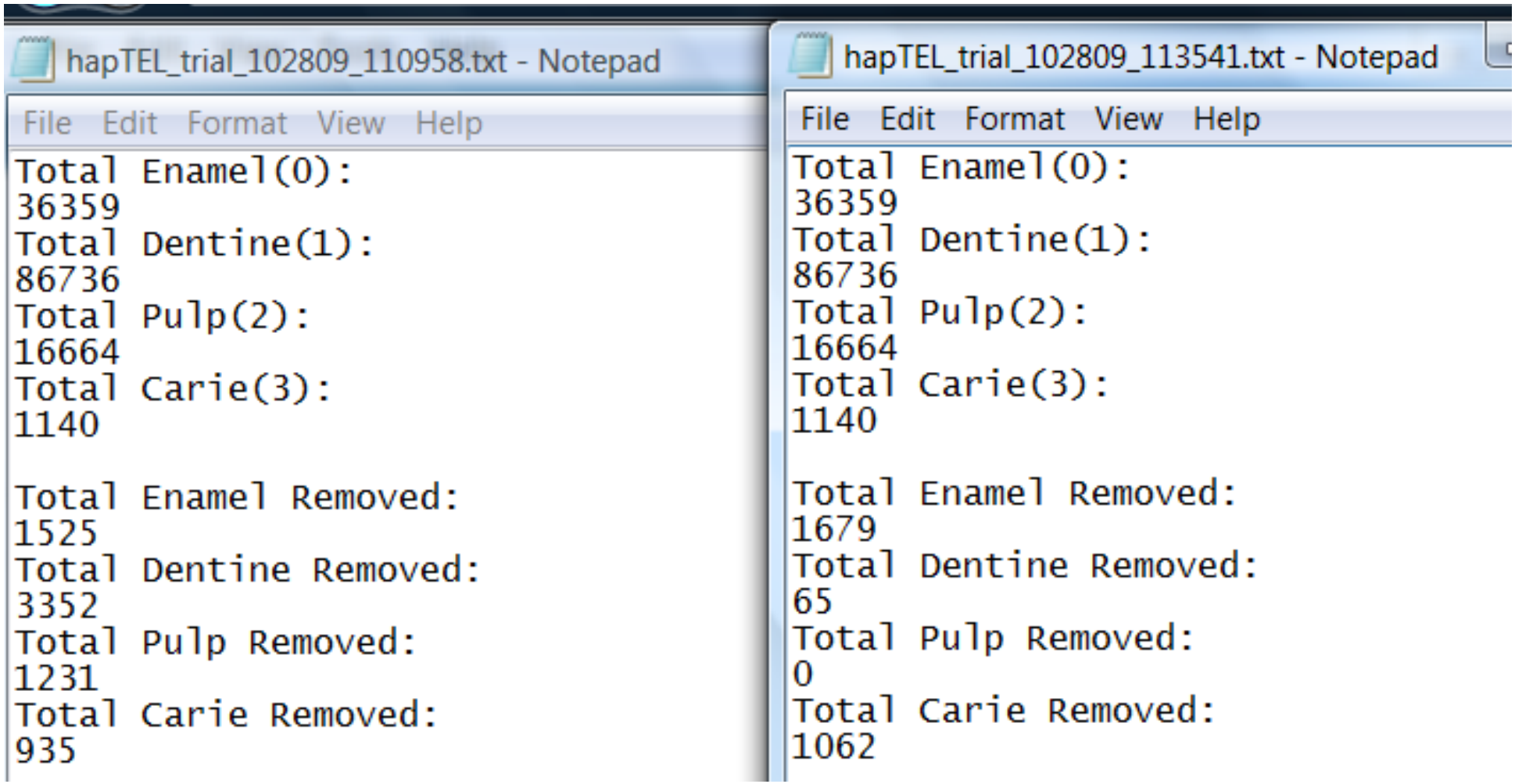
Clinical skills assessment methods

- **Traditional methods**
  - Observation by tutors during manikin-head work
  - Reviewing finished work at end of treatment/course
  - Practical examination of specific clinical skills tasks
- **TEL methods**

Based on logs, screen capture and live feedback

  - Reviewing in-progress virtual clinical treatment on screen
  - Post-evaluation of each recorded student's task procedure
  - Examining series of completed of tasks

Examples of assessment techniques



hapTEL_trial_102809_110958.txt - Notepad

File Edit Format View Help

```
Total Enamel(0):
36359
Total Dentine(1):
86736
Total Pulp(2):
16664
Total Carie(3):
1140

Total Enamel Removed:
1525
Total Dentine Removed:
3352
Total Pulp Removed:
1231
Total Carie Removed:
935
```

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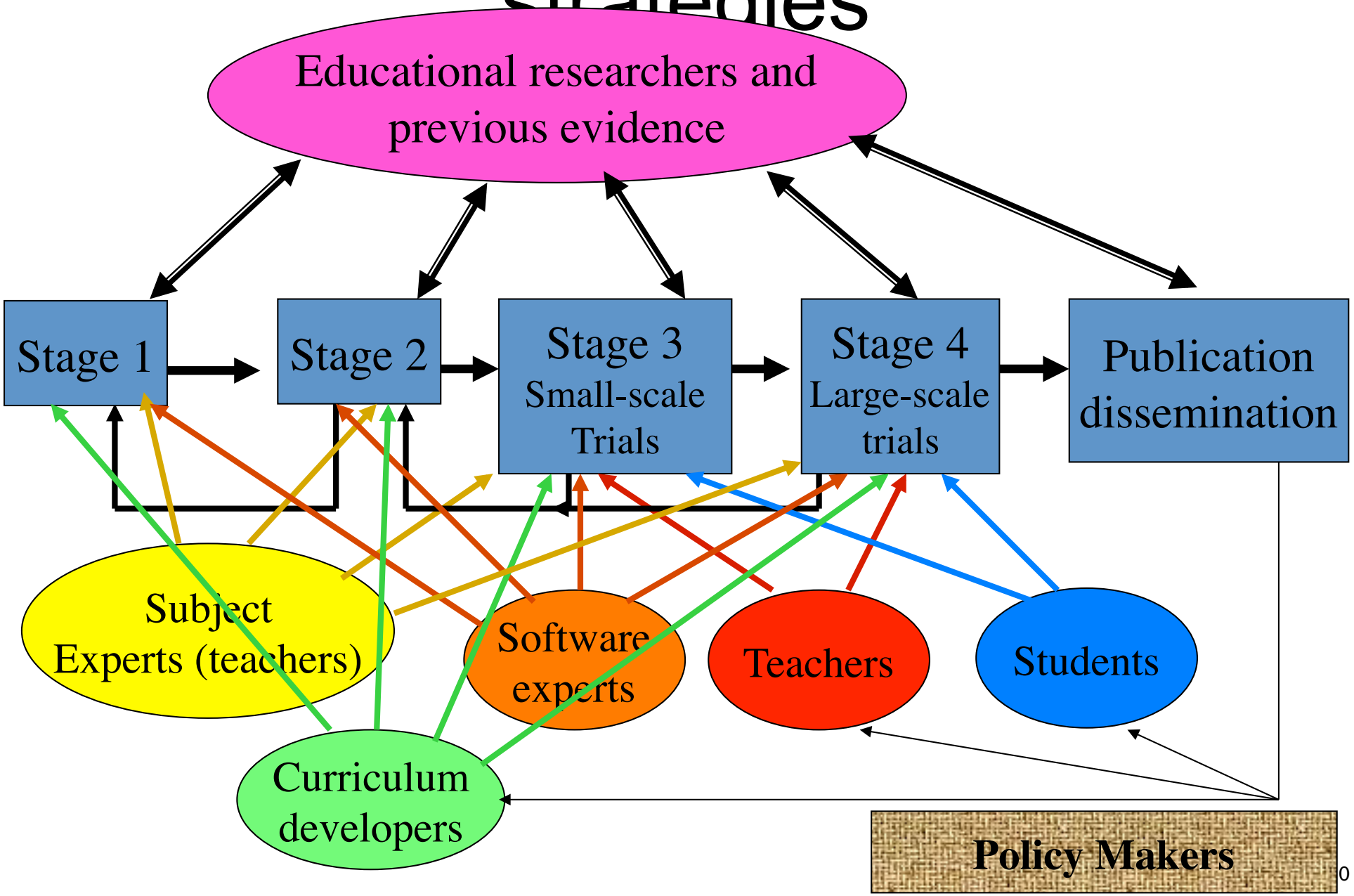
Total Enamel(0):
36359
Total Dentine(1):
86736
Total Pulp(2):
16664
Total Carie(3):
1140

Total Enamel Removed:
1679
Total Dentine Removed:
65
Total Pulp Removed:
0
Total Carie Removed:
1062
```

Evaluators and formative strategies



Measuring the impact of Virtual Reality on students' learning

- Building on previous evidence and theories
- Different types and diversification of VR resources
- Research methods used in different subjects and settings
- Different scope of the learning experience according to the human computer interfaces
- Impact due to immediate synchronous and asynchronous learning experiences
- Learning environment, context and boundaries
- Level of immersion and transfer from the virtual to the real world

Formative evaluations of functionality and learning context

Functionality

- robustness
- reliability
- computer platform mobility
- attractiveness of screen presentation
- user-friendliness
- program structure

Learning context

- relevance to the curriculum
- addressing specific learning difficulties
- teaching strategies
- student and teacher responses
- classroom organization
- Integration in the time-table

Evaluation instruments

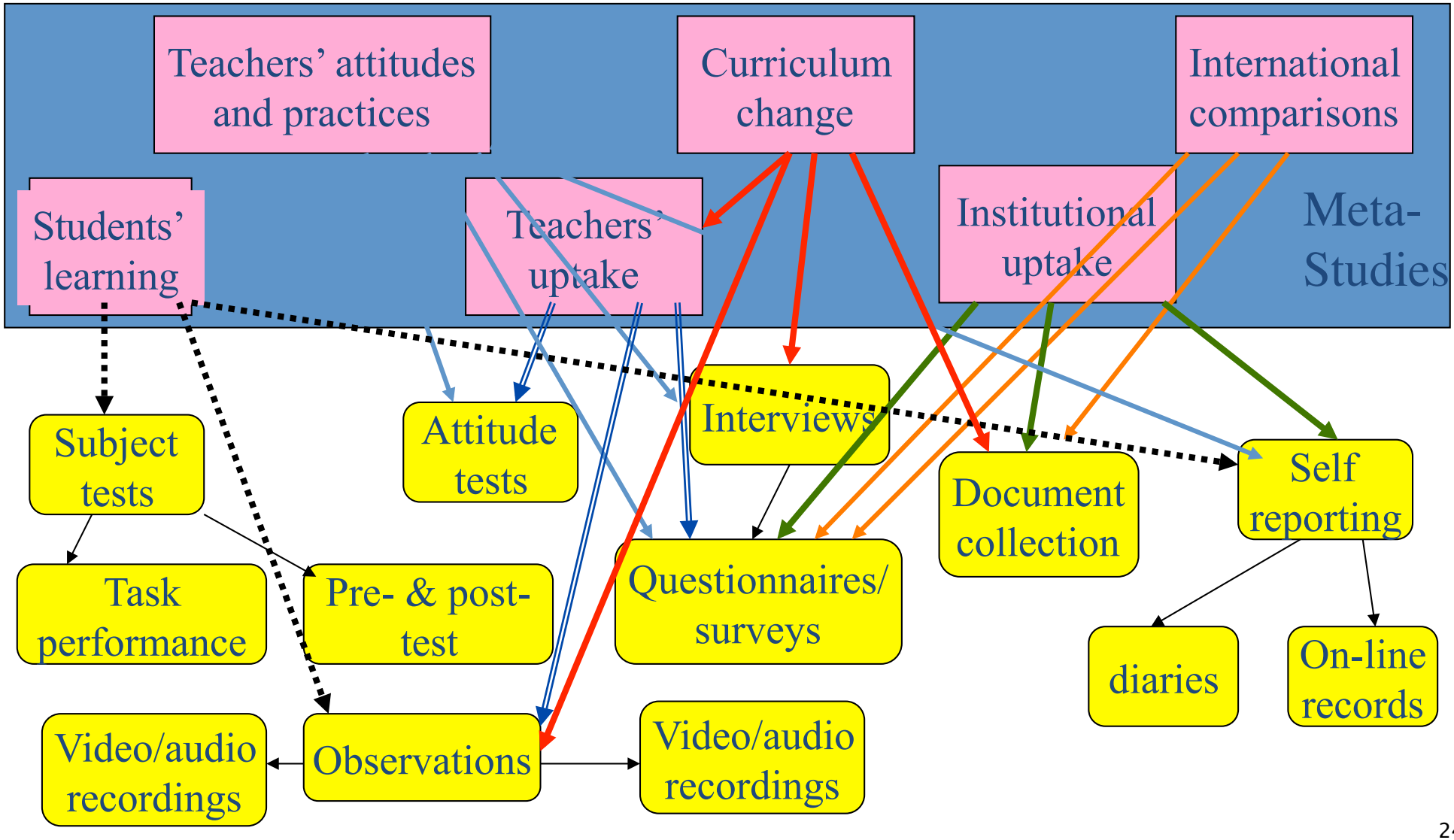
Limited effectiveness

- checklists of reliability and performance
- Student and teacher feedback on opinions
- Comparisons between VR impact and traditional teaching method impact

More effective and educationally relevant

- **Pedagogical dimensions**
  - Learning theories
  - Concepts and processes
  - Learning contexts
  - Curriculum relevance
  - Identifying what VR is being used and what it represents

Researching VR in Dental Education: Aims and Research Techniques



Lessons from the past

- Disregard and ignorance of previous evidence, methods and theories has resulted in many repetitious and mediocre studies of little value to progressing research in VR dental in education.
- Lack of understanding of VR technologies and their potential amongst educational researchers can result in inappropriate research designs, methods, analyses and consequent outcomes
- International comparative TEL/VR-assessments need to contribute to national policy analysis processes
- The dichotomy between researching VR in dental education within existing paradigms and the need to accommodate the changing nature of knowledge representation requires researchers to adopt new techniques and methods to capture new types of use and diverse ways of impact.
- Critical Factors for effective research are – building on past evidence, reliability, consistency over time and validity

hapTEL
enhancing learning through haptics

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University of London

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