Learning with haptic technologies: what has worked so far and why

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Aim of the study

To analyse 18 years of research evidence into the uses of haptic technologies for learning in higher education drawing on Entwistle and Peter's evaluation framework of the many factors influencing student learning.

Background

Haptics means the sense of touch and involves the science of incorporating this and the interaction with the external environment through touch. As a tool for teaching and learning it is one example of Technology Enhanced Learning (TEL) which is particularly useful for teaching skills involving touch control, fine and gross motor skills, hand-eye coordination, precision and timing and 3-D perceptions.

Haptic Virtual Simulators

Figures 2 and 3 show two of the haptic dental simulators most widely evaluated in higher education to date. These enable students to work singly or in pairs operating on teeth in a jaw or injecting a patient etc. to improve their clinical skills before treating real patients.

Range of evaluation methods

- A range of psychometric tests to measure the students' spatial reasoning perceptions, fine and gross motor skills at stages in their undergraduate programmes.
- Student records of their accuracy of performance recorded on the haptic systems which showed the amount of decayed and healthy tooth they had removed from the teeth and the time taken.
- The human computer interactions between the student, the tutor and the simulator through observations and interviews.
- The attitudes of the students using the hapTEL systems before and after based on Ajzen's theory of planned behaviour

Educational Framework

Figure 4 shows the evaluation framework used for this review and meta-analysis linking the variables of Entwistles' framework (Fig. 1) and the three evaluation strands needed to address the range of relevant variables

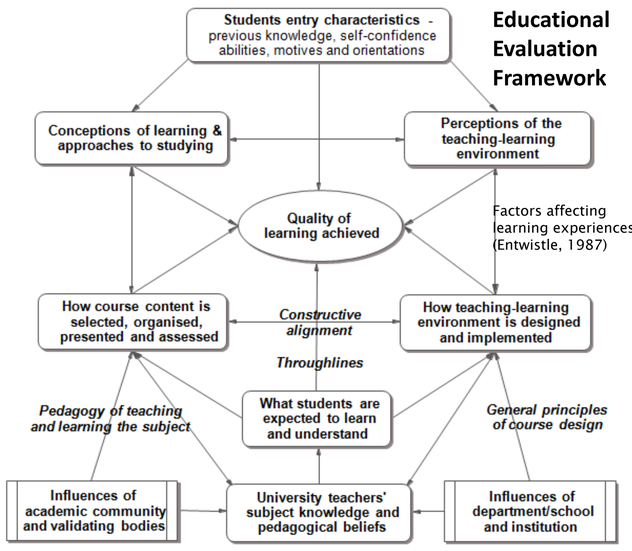

Figure 1: Entwistle and Peter's evaluation framework (1)

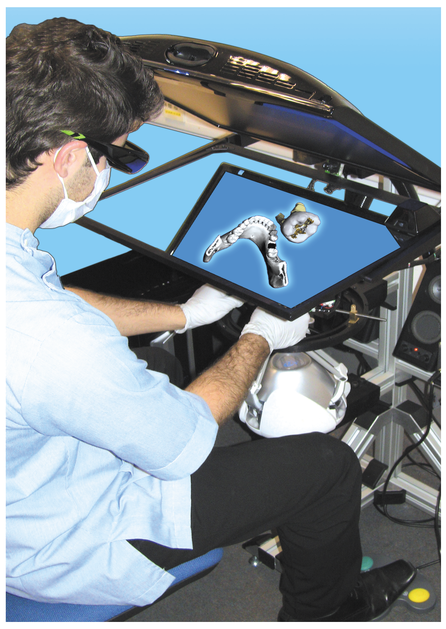

Figure 2: Dental student using the hapTEL system (2)

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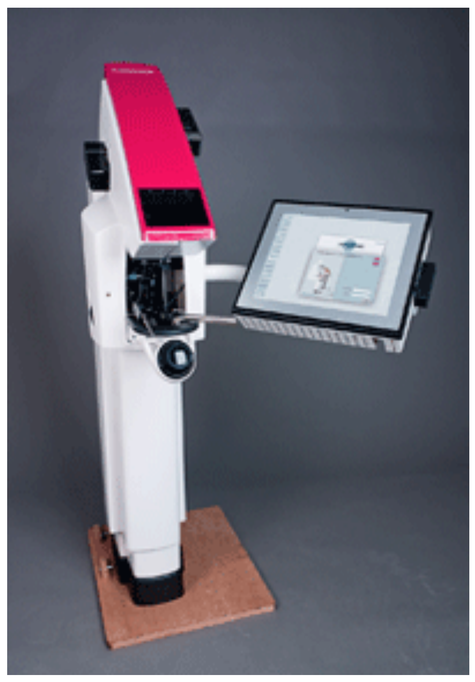

Figure 3: The ACTA Dental Simulator

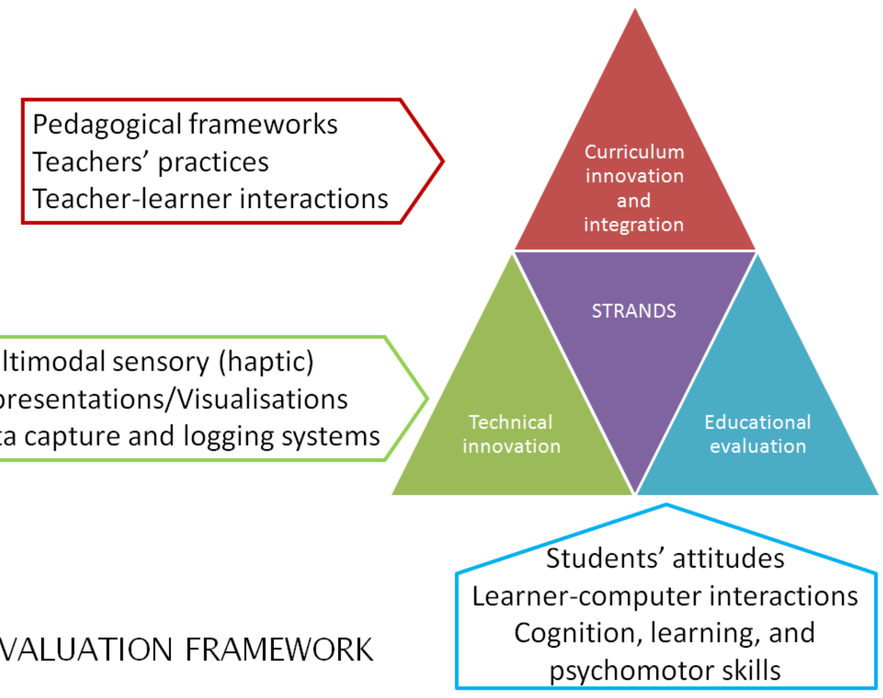

Figure 4 – Evaluation Framework

Results and Conclusions

This analysis of the research evidence to date (too extensive to present here) based on the frameworks presented here has shown that the uses of VSHD systems have a positive impact on students' learning which justifies the uptake and uses in higher education. In particular, the integrated use in the curriculum has been shown to improve:

- Students' fine and gross motor skills – working on these devices has resulted in students being able to perform dental and other medical procedures more precisely, consistently and more quickly over time.
- Manual dexterity – students who regularly use these devices improve their manual dexterity which they retain long after they have moved onto other more traditional systems and which they need for many other dental procedures.

Selected References

1. Entwistle, N. & Peterson, E. Conceptions of learning and knowledge in higher education: relationships with study behavior and influences of learning environments. International Journal of Educational Research. 41 (6), 407-428. (2004).
2. San Diego, J.P.; Newton, T.J.; Sagoo, A.K.; Aston, T.-A.; Banerjee,A.; Quinn, B.F.A.; Cox, M.J. Learning Clinical Skills Using Haptic vs. Phantom Head Dental Chair Simulators in Removal of Artificial Caries: Cluster-Randomized Trials with Two Cohorts' Cavity Preparation. Dent. J. (2022), 10, 198.

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