Design and engineering of new simulations for risk-free surgery training

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Background
Simulation based training has previously been proved to improve the performance of surgeon residents, while reducing errors and patient discomfort of the first real procedures performed by simulation trained residents. Dental education in Sweden include the theoretical approach to surgical wisdom tooth extraction, but none or very limited practice. Previous work, such as a temporal bone surgery simulator (Agus 2004) shows that haptic (touch) feedback enabled virtual reality based simulations can well be used for training of bone drilling tasks. However, the design and engineering process from a usage perspective is not as well explored.

Purpose
The larger goal of this research is to improve the methods for design and engineering of new simulations to enable sustainable business models, by utilization and development of open technologies, and thereby increase the general availability and usage of simulation based training. In the Oral surgery simulation project, a new simulator for training of surgical extraction of wisdom teeth has been developed in collaboration with the division of oral and maxillofacial surgery, department of dental medicine, Karolinska Institutet. The particular goal is to discover and implement the most important aspects of the procedure and create a sufficiently realistic simulation that supports the surgical training in a student-teacher environment.

Method
Design and implementation of simulations has follow the User Centered Design approach, which involves a iterative design process consisting of contextual inquiry, prototype construction and cooperative evaluations with both experienced surgeons and undergraduate students. Evaluation of the visual, auditive and haptic (force feedback) interface as well as the systems usability is evaluated with qualitative studies and experiments. The resulting simulator is subject to a larger double-blinded validation study conducted by Karolinska Institutet, where 20 students will perform patient extractions of which half the students will have received training with the simulator.

Results
The work has resulted in an open architecture and open source software, as well as a particular simulation model for training of surgical extraction of wisdom teeth. The simulator provide patient x-ray based visualization, haptic (touch) feedback and audio. In an independent course intervention study of the oral surgery simulator conducted by Karolinska Institutet, 73% of the 60 students that participated in the course very much agree on that this training should be a permanent part of the course (Rosén et al 2009). The validation study is currently in progress.

Conclusions
By focusing on the most important aspects, reviled and iteratively developed with a User Centered Design method, a surgical simulator is possible to develop. Further validation is required to prove cost-effectiveness but the very positive student acceptance rate is encouraging. The development project's significant size and thus high costs, is however a barrier in development of new simulations, since validation can only be done with a finalized simulator. Further investigations has to be done on how development of new simulations in a variety of surgical areas can be financed, and the cost be put in relation with the increased value of risk-free training and reduction of overall errors in surgical practices.

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