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Title: The role of an immersive 3-D virtual reality environment in the development of the spatial visualisation skill of pre-registration therapeutic radiography students

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Abstract

Background

The treatment of cancer with radiation uses advanced techniques such as intensity modulated and stereotactic radiotherapy. These modalities can provide sub millimetre accuracy, delivering high radiation dose to the tumour and reduced dose to the surrounding normal anatomy. Building a mental model of the size, shape and position of the tumour in relation to the surrounding anatomy and proposed radiation beam direction requires radiotherapy radiographers to have well developed three- spatial visualisation skills. The introduction of the Virtual Environment for Radiotherapy Training (Vertual Ltd, Hull, United Kingdom), an immersive 3-D visualisation platform in 2007, offered the potential for developing new ways of supporting the development of these visualisation skills in pre-registration radiotherapy learners in a simulated environment.

Aims

This programme of research aimed to measure the baseline three dimensional spatial visualisation skills of new radiotherapy learners, to compare their performance with new learners in diagnostic imaging, to determine if 3-D visualisation skills could develop over time and to identify those learners most likely to benefit from learning in the virtual environment for radiotherapy training.

Methods

This programme of research employed a QUANT + qual mixed model approach with purposive convenience sampling of year one diagnostic imaging and radiotherapy students to develop an online, three-dimensional spatial visualisation test using objects from two traditional paper based spatial visualisation tests for mental rotation and cross sectional visual perception (the pilot phase). The experimental phase employed an online test platform in a controlled, single subject design, longitudinal study using a second cohort of students to determine their 3-D spatial visualisation skill at the start of their pre-registration radiography programme and to track any change over three additional time points during an 18-month period between the start of year one and the end of year

two. For the radiotherapy cohort, the relationship between baseline spatial visualisation skill and patient positioning performance was investigated using a simulated treatment delivery task conducted within the Virtual Environment for Radiotherapy Training.

Results

The pilot phase comparison of performance scores for the paper based and online versions of the three-dimensional spatial visualisation test did not produce statistically significant differences, suggesting that a move to an online test platform would not disadvantage any participant. Results from the experimental phase (study four) identified that the baseline 3-D spatial visualisation skill of 54 pre-registration learners in radiotherapy (n = 15) and diagnostic imaging (n = 39) could be measured and performance classified as being low, intermediate or high at the start of their radiography education. Across both pathways, 13 participants (24%) were identified as having low skill, 36 (67%) were intermediate and 5 (9%). Performance gains were observed in the growth trajectory for mean spatial visualisation test score over the 18 month time period for both pathways. Analysis of performance in the mental rotation and cross section subcomponents indicated that one third of all participants might benefit from additional support in mental rotation or perception of cross sections. For the radiotherapy positioning task, correlations between task performance metrics for task completion time, number of equipment adjustments and set up accuracy and baseline demonstrated a weak positive relationship meaning that the results were inconclusive.

Conclusions and contributions to knowledge

The measurement of 3-D spatial visualisation subcomponent performance as a surrogate for accurate patient positioning and beam alignment has provided an enhanced understanding of baseline visualisation skill. Analysis of these subcomponents, with an emphasis on patterns of incorrect answers, in addition to overall performance score provides a method for identifying those individuals with less well-developed skills. These are the learners who may have difficulty with mental model and relationship building and would benefit from the additional support of focused tutorials with personalised spatial visualisation syllabus activities. This enhanced understanding will provide opportunities for the development of the spatial visualisation syllabus beyond the often opportunistic, and ad-hoc structure of clinical practice and a one-size fits all approach to campus based simulation and visualisation activities.