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Multisensory Science, Technology, Engineering and Mathematics Learning: Combined Hands-on and Virtual Science for Distance Learners of Food Chemistry

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Abstract : It has been shown that laboratory activities can help cement understanding of theoretical concepts, but it is difficult to deliver such an activity to an online cohort and issues such as occupational health and safety in the students' learning environment need to be considered. Chemistry, in particular, is one of the sciences where practical experience is beneficial for learning, however typical university experiments may not be suitable for the learning environment of a distance learner. Food provides an ideal medium for demonstrating chemical concepts, and along with a few simple physical and virtual tools provided by educators, analytical chemistry can be experienced by distance learners. Food chemistry experiments were designed to be carried out in a home-based environment that 1) Had sufficient scientific rigour and skill-building to reinforce theoretical concepts; 2) Were safe for use at home by university students and 3) Had the potential to enhance student learning by linking simple hands-on laboratory activities with high-level virtual science. Two main components of the resources were developed, a home laboratory experiment component, and a virtual laboratory component. For the home laboratory component, students were provided with laboratory kits, as well as a list of supplementary inexpensive chemical items that they could purchase from hardware stores and supermarkets. The experiments used were typical proximate analyses of food, as well as experiments focused on techniques such as spectrophotometry and chromatography. Written instructions for each experiment coupled with video laboratory demonstrations were used to train students on appropriate laboratory technique. Data that students collected in their home laboratory environment was collated across the class through shared documents, so that the group could carry out statistical analysis and experience a full laboratory experience from their own home. For the virtual laboratory component, students were able to view a laboratory safety induction and advised on good characteristics of a home laboratory space prior to carrying out their experiments. Following on from this activity, students observed laboratory demonstrations of the experimental series they would carry out in their learning environment. Finally, students were embedded in a virtual laboratory environment to experience complex chemical analyses with equipment that would be too costly and sensitive to be housed in their learning environment. To investigate the impact of the intervention, students were surveyed before and after the laboratory series to evaluate engagement and satisfaction with the course. Students were also assessed on their understanding of theoretical chemical concepts before and after the laboratory series to determine the impact on their learning. At the end of the intervention, focus groups were run to determine which aspects helped and hindered learning. It was found that the physical experiments helped students to understand laboratory technique, as well as methodology interpretation, particularly if they had not been in such a laboratory environment before. The virtual learning environment aided learning as it could be utilized for longer than a typical physical laboratory class, thus allowing further time on understanding techniques.

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