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Letter - Education in Anatomy and Embryology

Learning and revising anatomy through 3D printing

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Modern medical education in general and anatomical education in particular have been profoundly influenced by new technologies. Among these technologies, one of the most promising seems to be 3D printing. An increasing number of studies show that 3D printed models of human tissue can be produced cost effectively and with high accuracy, strongly suggesting that they are a potentially valuable educational resource (Baskaran et al., 2016; Langridge et al., 2018). The utilisation of 3D printing within the anatomical education setting has so far been investigated only in terms of accuracy and value of the final product, while the possible educational benefit of producing 3D prints has not been examined yet. We conjectured that learning how to 3D print anatomical models could also be beneficial in learning anatomy.

We offered an informal (not part of any degree/program) training in 3D printing to senior students, including postgraduate (Master of Research) students in anatomy and postgraduate (coursework) students in health professions. We also offered it to tutors (sessional academics) in anatomy as part of their upskilling and continuous professional development. This training included production and preparation of 3D images, through surface scanning or from available MRI and CT scans, and production of models from these images on consumer grade, desktop 3D printers. Participants worked in groups which enabled them to share experiences, and more efficiently respond to time constraints and a variety of technical challenges. They were coached and supported by Anatomy, IT, Engineering as well as Learning and Teaching academics and technicians. Participants were expected to assess the accuracy of the produced models using a battery of anthropometric techniques. In addition, they were given an opportunity to get involved in small educational research projects focusing on efficacy of 3D prints as a teaching resource such as surveys of students and comparisons of assessment results (e.g., AbouHashem et al., 2017).

Learning about 3D printing and applying the process in production of anatomical models seemed to provide several educational benefits. Participants had to be well prepared and needed to revise their knowledge of anatomy. While good knowledge of anatomy was a prerequisite, the actual process of producing images and prints

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required application of this knowledge in a new context, facilitating deep learning. Learning how to transform tri-dimensional objects into two-dimensional images and *vice versa* seemed to be particularly beneficial. The investigation of prints' accuracy strengthened participants' research competencies. Furthermore, they became proficient in a number of skills, such as image segmentation and 3D printing, which are potentially useful not only in the anatomical education setting but also in medical research and practice. Producing images and prints also facilitated group work as well as interprofessional collaboration which transcended the boundaries of medical specialties to include life sciences and engineering. Finally, participants, especially those belonging to Millennial and younger generations, seemed to find activities related to 3D printing highly satisfying and were eager to engage.

While the focus here was on the process of printing it should not be forgotten that another outcome of these activities was creation of 3D printed models that were subsequently utilised in the undergraduate teaching of anatomy.

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