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Community Partnership Placement Program: Reflection on learning innovative 3D technologies in medical applications

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EDITOR NOTE

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ABSTRACT

Dear Editor,

In this letter, I would like to share my experience undertaking an observational placement during late March and early April of 2023. I am a third-year medical student studying at Curtin University and was recently given the opportunity to work with established researchers at Curtin Medical School, learning research studies using the latest technologies in the medical domain. The overarching aim of the placement arranged by Curtin Medical School is to give medical students more awareness of the various community organisations and research groups that play a role in advancing and providing equitable healthcare, which traditional general practice or hospital placements do not necessarily provide.

During the two-week immersion program, my placement peer colleague and I experienced the use of three-dimensional (3D) printing and virtual reality (VR) in medical education and clinical practice (preoperative planning and diagnosis). With a focus on congenital heart disease, we observed the role of 3D printed heart models in knowledge acquisition in second- and third-year medical students, and the utility of 3D printing and VR in assisting cardiac specialists and other physicians with diagnosis, preoperative planning, simulation of complex surgical procedures, and patient communication. In this short communication, we will share our unique experiences and what we have learnt through participating in this project, as well as how the use of these innovative technologies will enhance our career progression as future medical doctors.

Research Activities

The first week of placement had a focus on 3D printing. We visited the 3D printing laboratory in the John de Later Centre Building, Perth Campus, where several 3D printers are available for research purposes. I was able to examine 3D models of congenital heart defects, vasculature and tumours, as well as tour the 3D printing laboratory (Figure 1).

The second week involved an introduction to the Curtin Hub for Immersive Visualisation and eResearch (HIVE), where I learned about the clinical value of simulation, visualisation, and how it can allow researchers from a diverse range of disciplines to advance their data collection and utilisation (Figures 2 and 3). Curtin HIVE offers cutting-edge technologies in 3D visualisations including VR, augmented reality, holograms, and other stereoscopic facilities.

The placement concluded with a demonstration of a PhD student's recent work of using VR for surgical planning of congenital heart disease management, followed by an insightful conversation regarding his research process involving image post-processing and segmentation of cardiac CT data for generation of 3D printed models and VR views.

Learning about 3D printing and VR for medical applications presented several challenges. Firstly, these rapidly evolving technologies require an understanding of complex hardware and software systems. Furthermore, 3D printing requires some understanding of material properties, whilst knowledge of programming and game engine software is necessary to develop VR. A sound knowledge of medical

imaging modalities and how to interpret them is also important.

Personal Feelings

With my only previous exposure being a seminar in which Vantari VR showcased the application of VR in simulating surgical procedures, I felt excited to learn more about the medical purposes of 3D printing and virtual reality before placement. I was curious about the technical aspects of these increasingly employed technologies and their role in enriching medical research and improving patient outcomes.

During my placement, I experienced a range of emotions, thoughts, and questions. I was amazed by the 3D models of congenital heart defects, vasculature, and tumours, comprehending the potential benefits of this technology to assist diagnoses and patient planning. However, with little background knowledge, I found the technical elements of these technologies difficult to understand and at times felt overwhelmed by their complexity. Additionally, I was disappointed to discover that my ability to interpret medical imaging was lacking but it drove me to review these learning gaps later. I wondered how I may be able to implement these technologies in my future career as a medical doctor, considering the specialities that I am interested in such as dermatology and surgery. I also thought about the ethical implications of employing these technologies and how patient privacy could be maintained.

I now have a greater appreciation for the potential of 3D printing and VR in medicine and feel inspired to further explore their applications in the coming years when we start our clinical placement in the fourth and fifth year.

Placement Reflection

Upon analysis of my placement experiences, one factor that stood out was the potential impact of socioeconomic factors on health in relation to 3D printing and VR. For example, medical schools that have more funding and resources may be able to access more advanced technologies, which may allow for an improved learning experience for their students and may in turn enhance the quality of patient care they can provide in the future[1]. Furthermore, patients living in lower socioeconomic areas may not have access to the same level of care that incorporates the use of these technologies, which could limit the outcome of their healthcare[2]. On the other hand, the utilisation of these technologies could also help to provide more cost-effective and accessible treatment options, which may benefit those with lower incomes[3].

Furthermore, facilitating communication and interaction between professionals from different disciplines and organisations such as universities and hospitals is important for the successful incorporation of 3D printing and VR in medical education and practice[4]. The result is effective collaboration that will allow these technologies to be utilised to their full potential so that their benefits can be shared across the medical community. One barrier to these interactions or collecting research data is time, with some clinicians being lost to follow up or simply being unable to participate in interviews due to their busy schedules[4,5]. Other limitations include the extensive time required, high cost of certain materials, and limited choices of printing material to simulate required tissue properties[6].

It is essential to recognise the strengths and needs of the community and individual groups targeted by the research group. It is clear that clinicians could experience great benefits in their training from access to 3D visualisation of anatomy and pathology[5,6]. However, different individuals may have different levels of comfort and familiarity with these technologies so focused support and training may be needed to allow for effective utilisation[6]. During the HIVE visit, I personally found that the VR technology is quite intuitive and easy to learn and use, as the user interface implemented simple hand gesture tracking or single button hand remote controls.

I had several opportunities to reflect and receive feedback on my skills and their relation to working in a research environment. Along with learning that I need to enhance my background knowledge of imaging modalities, 3D printing and VR technicalities, it was also highlighted to me how important a willingness to learn about other fields is in increasing the quality of interdisciplinary communication and collaboration.

Outcome Evaluation

Overall, my experience on placement was positive. I believe that this could be attributed to my willingness to engage in meaningful conversations and ask many questions, and I tried my best to articulate my thoughts and queries clearly and display active listening. However, there are a few aspects that could be improved. Although I had a very basic understanding of relevant topics, I still lacked knowledge regarding the technicalities of 3D printing and virtual reality, which was a minor hindrance in allowing me to fully engage in the placement. Hence, for future placements, it would be extremely useful to identify knowledge gaps and conduct more pre-reading to better prepare myself.

The research group is commendable in relation to promoting health and wellbeing. By innovating new techniques and tools to help doctors provide optimal care for patients with complex congenital heart diseases, they

are contributing valuable information and ideas to the medical science field that may address socioeconomic limitations.

Moreover, the exploration of the role of 3D printed heart models in knowledge acquisition and retention for medical students has potential for the promotion of medical training [7]. In the future, this could give rise to better-informed doctors who can achieve accurate diagnosis and produce more effective management plans, which could ultimately result in better patient care. Although a recent study by Lau and Sun showed that 3D printed heart models did not significantly enhance knowledge acquisition among medical students, the majority of those students subjectively felt that the models could improve their learning experience[7].

By improving medical education and clinical practice, especially for patients in underserved locations, health inequalities such as limited access to advanced medical technologies and resources could potentially be addressed[8]. Information for research could be collected in various ways, such as by conducting literature reviews, interviews or surveys with healthcare professionals, students and patients, as well as researching the impact of these technologies on health outcomes.

Summary

The placement offered a valuable opportunity that allowed me to learn about the use of innovative technologies in medical research and understand how 3D printing and VR research can potentially influence the future of medical education and clinical practice. The learning objectives regarding socioeconomic factors, processes that influence interactions between different organisational groups, and strengths and needs of groups, and communication skills, were all achieved. Overall, the main contributing factors to achieving a successful placement were a curiosity for learning, enthusiasm, effective communication, and time management. The placement lays a good foundation for me to understand value of advanced technologies in medical practice and how they can benefit healthcare service and patient care.

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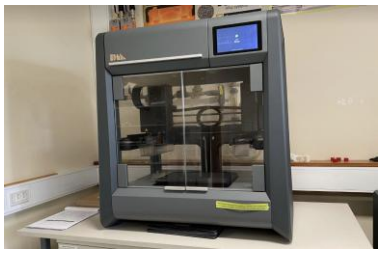
Figures

(a)



(b)

Figure 1: 3D printing laboratory (John de Laeter Centre Building). a) Examples of 3D printed items using different materials including metal printing. b) 3D Formlabs Form 3 printer.

Figure 2: Virtual reality simulation of tumours (pink colour) of the liver at Curtin HIVE.

Figure 3: Stereoscopic panoramic visualisation at Curtin HIVE.

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