MSC2004H Research Methods
Proposal
07.07.2020

E-Learning Tool for Congenital Heart Disease in Post-Graduate Medical Education

Abeeshan Selvabaskaran

Supervisor	Dr. Derek Ng, BSc, MScBMC, PhD
Content Advisor	Dr. David Barron, MB, BS, MD, FRCP, FRCS(CT)
Third Voting Member	Michael Corrin, BFA, BA, Hons BSc, MScBMC, CMI

Key words:
Congenital heart disease, surgery, anatomy, medical education, self-directed learning, e-learning, multimedia instruction, interactive visualization

1. Abstract

Congenital heart disease (CHD) is the most common congenital birth defect worldwide and represents a wide range of abnormal cardiovascular morphologies. The severity of CHDs can be highly variable with many cases requiring immediate diagnoses and intervention planning. Hence, proper education and medical training is essential to adequately preparing for these situations. However, the complexity of interventions can be extensive and requires a high degree of specialty care training during residency and fellowships. Current gaps in surgical learning opportunities outside the operating room fail to replicate the clinical context of CHD. Additionally, it has been found that many surgical residents felt that they needed more instruction or lacked confidence with congenital cardiac conditions, presumably because of the scarcity of accurate clinical models. Thus, it is within our best interests to provide more accessible and data-driven education modules for health professionals to improve the outcomes for patients. This project aims to incorporate a multimedia and novel teaching approach to improve post-graduate medical education within pediatric cardiac surgery. Using a method informed by learning science and formative assessments, the objectives of this project are to create a framework to build a CHD e-learning platform on.

2. Introduction

Congenital Heart Disease (CHD) comprises a broad group of diseases that involve structural abnormalities in the heart due to maldevelopment caused by genetic and environmental triggers (Bernier et al., 2010). It represents the most common congenital birth defect and is the main cause of death in the first year of life with an estimated prevalence of 8 per 1000 live births (Bernier et al., 2010). The severity of CHDs can be highly variable with 1 in 4 patients requiring critical procedures within their first year of life (Oster et al., 2013). Despite incredible improvements to palliative care for CHD patients over the past few decades, there are still key areas that need to be addressed to enhance quality of care. Intensive care unit providers have a difficult time managing these patients, as they usually undergo complex surgical procedures and suffer serious complications (Pagowska-Klimek et al., 2011). These children can typically also be found with prolonged post-operative stays in the intensive care unit after undergoing complex surgeries, which have a greater impact on the unit, the patients, and their families. Furthermore, the risk of intra-operative infections (Prasad et al., 2010), and post-operative cardiac dysfunction (Simmonds et al., 2008; Wu et al., 2015) continue to strain the medical system. With all these considerations and the resource demands that these operations necessitate, patients consume a sizable amount of hospital resources and finances (Dean et al., 2011).

Immediate diagnoses and intervention planning can mean life or death in many of these cases. However, the complexity of interventions can be difficult to train for, given the rarity and unique presentation of these diseases (Musa et al., 2017; Yoo et al., 2017). George Miller's framework of clinical competence describes knowledge as the foundation for clinical performance (Miller, 1990). According to Miller's framework for clinical competence, increased access to knowledge through accessible learning tools in medicine may have profound effects to patient care. Building on the current educational foundations for CHD may represent a desirable approach to advance palliative care in this field. Especially given the relatively recent incidence of successful palliation in CHD pathology and the increasing prevalence of CHD patients as they overcome diseases previously thought fatal, there is a requirement to more effectively prepare medical graduates to manage these patients (Weeks & Friedman, 2004).

This project proposal outlines a framework for the development of an e-learning tool for CHD in post-graduate medical education. Research behind existing visuospatial learning methods, teaching theories, and digital pedagogy for medical training were studied to inform a media and design audit. This audit revealed a limited number of digital education resources by which medical graduates could further develop their skills in CHD training. By addressing the current gaps in digital learning structures for CHD, this project may help address the difficulties in translating rare morphologic and physiologic abnormalities to the clinical context. Consequently, this may lead to improved clinical competence in CHD training which can directly translate to improved patient outcomes.

3. Background

3.1. Educational resources as a solution

A graduate of any pediatric residency program will encounter patients living with heart disease regardless of the specific path chosen through their program (Weeks & Friedman, 2004). This means a comprehensive knowledge basis of pediatric cardiology should be an essential element of any pediatric residency program. However, there are currently gaps that should be addressed to facilitate patient providers' confidence in performing surgical procedures for congenital heart disease. In a survey of 55 cardiothoracic surgeons, it was shown that a majority (59.6; 31/52) admitted that they required more instruction and lacked confidence with CHD-specific surgical procedures (Chu et al., 2016). A similar survey among pediatric residents found that there was a lack of confidence demonstrated by residents on CHD screening guidelines which suggested that improved education on CHD screening programs would be beneficial to implement (Garg et al., 2016). Surgical practice opportunities are also inadequate which, outside the operating room setting, have primarily relied on extracted animal hearts or prosthetic models that are mostly inapplicable in this clinical context (Yoo et al., 2017).

As advances in surgical therapeutics continue to form the basis for lower mortality rates (Bernier et al., 2010), a parallel increase in the development of surgical training programs will be necessary to reap the benefits. Several simulation boot camps for pediatric cardiac care practitioners have proven their value in improving knowledge, confidence, and satisfaction of education experience (Allan et al., 2016; Brown et al., 2018). Providing clinically relevant educational resources for medical professionals can have significant effects in downstream clinical contexts and must be explored in further detail.

3.2. Current teaching tools for pediatric cardiology and medical education

The standard pediatric cardiology curriculum incorporates on-the-job training in the cardiac care unit (inpatient/outpatient care) and additional training can be obtained through a formal rotation in the pediatric cardiology unit. (Weeks & Friedman, 2004)**.** Graduates are typically familiar with obtaining medical histories of patients and performing physical examinations - although they are rarely provided with actual pediatric CHD patients. The level of comfort that residents feel is primarily influenced by the rotations they complete (Weeks & Friedman, 2004), which suggests that graduates experience higher discomfort levels in CHD care due to it being so rare.

A tool that is currently being heavily researched in pediatric cardiology is the use of 3D printed models derived from MRI data. In understanding the anatomy of rare morphologies and for surgical preparation, this has been shown to be an extremely useful tool, particularly for complex lesions. However, there are still some limitations to consider. Many users found that there was insufficient time to look at the models, and given their physical nature and the cost of reproducing copies, they would typically be limited in access to a lecture room which further restricts accessibility to the models (Biglino et al., 2017). Furthermore, costs currently associated with its implementation can be high enough to limit it's availability to some institutions. (Anwar et al., 2018; Cantinotti et al., 2017).

E-learning tools can be a potential solution to combat these issues, as they can be more accessible for the trainee and financially liberating. E-learning has also been shown to provide benefits beyond traditional means in post-graduate medical education including improvements to knowledge retention, anatomical understanding, convenience, and clinical practice. However, digital tools specifically catered for professional training in CHD are severely limited, and a thorough literature review failed to show any relevant learning resources for a post-graduate medical audience. However, there are more general pediatric resources which exist that can be studied to create learning tools for CHD care.

Clinical Sense: Clinical sense is a mobile application that follows a 'choose-your-own-adventure' style narrative where the user is placed in a clinical scenario and must correctly answer multiple choice questions to diagnose and treat the patient. It is a highly rated app on both the Google play store and Apple app store and used by a variety of healthcare professionals. This general framework, however, limits detailed information that could be beneficial for medical graduates (i.e., information on surgical procedures, medical imaging techniques, etc.). It also relies heavily on multiple choice questions to progress the story and lacks a multimedia design approach which has previously been shown to be effective for virtual patient simulations (Criley et al., 2008).

Open Pediatrics: Open Pediatrics is a web application that serves as an accessible online bank of videos and resources for medical professionals. The UI/UX is very well made and allows for account creation,

ease of navigation, topic preferences, and course accreditation. However, many of the videos are focused on lecture-based learning which mostly fails to recognize important patient-centered needs.

3.3. Effectiveness of digital education in medicine

A study conducted in 2015 showed an overarching positive feedback for improved quality of training and confidence in medical graduate professional roles following the use of an e-learning platform (Maheshwari et al., 2015). Likewise, multiple studies have shown, in a variety of medical specialties, that e-learning materials can provide benefits beyond traditional teaching styles. These can include improvements in short-term and long-term knowledge retention (Criley et al., 2008), practical surgical skills and time-efficiency (Vernon & Peckham, 2002), as well as attainment of new skills (i.e., learning how to perform a surgery) since media can be played, paused, and re-winded as many times as preferred (Stegeman & Zydney, 2010). Considering the paucity of e-learning resources specifically catered to CHD, creating such a tool can improve the instruction provided to pediatric cardiology trainees in comparison to traditional means.

Finally, it is critical to recognize that there is a generational difference in approach, strategy, and interest among medical trainees. There is a growing demand for medical education tools that cater to the changing learning preferences of a technology-savvy generation. A desire for a customized experience with expectation for on-demand information is characteristic of the new generation Z (born between 1996-2012) (Rogers & Cohen, 2020). It is our responsibility, as providers of biomedical communicative tools, to implement innovative learning strategies that adapt to the changing needs of healthcare professionals. E-learning can provide the necessary customized experience and on-demand training which accommodate the preferences of generation Z. Online learning has the advantage of being asynchronous and provide flexibility to both trainees and faculty. Curricula and technology-based tools built on empirical research should be continually developed to offer better patient care. (Rogers & Cohen, 2020)

3.4. Teaching Theories

While several e-learning tools exist in the general medical professional space, many of these resources are established on poor learning principles and design considerations. In developing a medical learning application, Bajpai and colleagues have established the importance in preparing appropriate learning objectives and theories prior to the development phase of a project (Bajpai et al., 2019). According to their study, several digital health professional learning applications use an inappropriate or no learning theory which hampers the efficacy of the final product. In designing my project, it is important to determine an appropriate learning theory to implement before building any of the framework.

Problem-based learning (PBL) environments are one of the most widely implemented teaching theories in medical schools and revolves around the idea of students working together in a team to solve a problem. PBL engages students in active learning as opposed to traditional methods of teaching that are rooted in passive learning and rote memorization (LO et al., 2002). The learning benefits of PBL have been widely studied and shown to improve knowledge retention, effective communication, and critical thinking skills (Crawford, 2011). ePBL modules have already been implemented into several studies to take advantage of the benefits of digital education (Crawford, 2011; KJ & C, 2013; B. M et al., 2017). However, understanding the specific theory to support PBL must be understood before implementing it into an application.

There are five main theories supporting PBL learning: contextual learning theory, information-processing theory, cooperative learning theory, self-determination theory, and control theory (A. M, 2000).

Contextual learning theory posits that learning material in the context of how it will be used promotes the ability to effectively use that information.

Information-processing theory argues that student knowledge activation occurs when they apply knowledge already possessed to build upon new information.

Cooperative learning theory describes the idea that individuals are held to believe that they can only achieve their goals if and only if their peers do so as well.

Self-determination theory promotes autonomous motivation by allowing students to make informed choices, and encourage students to agree to take more responsibility for their learning.

Control theory argues that successful learning must satisfy an individual's ability to take control over their lives – in the context of learning, this should cater to increased freedom of time, power to determine learning needs, increased personal connection, and enjoyment.

Identifying an appropriate learning theory will be crucial to understand how to structure the hierarchy of this application and must be determined during the needs assessment and pre-production stage (5.1).

3.5. UI and UX Design Considerations

Several recommendations have been suggested in UI/UX design to promote digital education for surgical trainees. These include: the importance to facilitate task-focused navigation, provide interactivity support to allow the trainee complete control/access to the content, integrate multimedia to increase 'learning by observation as an apprentice', and enhance a virtual patient scenario, implement a clear visualization of content/structure (clear hierarchy) as well as present all available options and recognize any errors, and personalize the content to the skill/knowledge of the user (Coughlan & Brinkman, 2011).

User navigation and experience (UX) must be designed clearly with the implementation of a clear hierarchy, consistent scaffolding, and navigational redundancies. Regarding problem-solving approaches, the UX and media used should show the approach to solving a problem along with how a solution was achieved - consideration of alternative outcomes is essential to provide a successful resolution to patient care problems (Slotnick, 1996).

4. Research goals and objectives

4.1. Problem

While patients have seen stark improvements in longevity and quality of life over the past few decades, factors such as prolonged hospitalization time, risk of surgery, and operative complications still burden both patients and the healthcare system (Dean et al., 2011; Pagowska-Klimek et al., 2011; Prasad et al., 2010; Simmonds et al., 2008; Wu et al., 2015). Improved education may be a route to mitigate these problems, especially in consideration that a majority of cardiothoracic surgical trainees feel inadequately instructed in congenital cardiac conditions (Chu et al., 2016). However, little attention has been paid to addressing the educational needs of this audience. Outside the operating room, clinically relevant surgical learning opportunities are limited, especially due to the unique variants seen with these rare cardiac malformations. The research question we are trying to address is whether an e-learning application can serve as an effective tool to improve post-graduate cardiac pediatric professional education regarding visuospatial learning, surgical procedures, and diagnostic tools.

4.2. Research goal

The primary goal of this project is to increase both effectiveness of educational tools and their accessibility in cardiac pediatrics for post-graduate medical professionals.

4.3. Objectives

1) To implement an iterative design process with formative assessments to understand what content is important to include and what learning theory is most beneficial to apply;
2) to determine what types of media are most effective for learning and which should be included for this audience; and
3) to determine and implement the best way of distributing this app to effectively address the accessibility concerns seen with other learning formats by way of digital learning platforms

5. Methods

5.1. Stage 1: Pre-Production Stage

5.1.1. Audience

The primary audience of this tool will be targeted towards post-graduate medical professionals in pediatric cardiac surgery. However, this audience can be generalized to the wider health care worker population including pediatric cardiology professionals, and nurses that work with CHD. While the tool may not be meant for direct access to the lay public, there is also potential to create resources that can be used by physicians to inform patient families about the details and pathophysiology of their diseases. Finally, the data collected from this project can serve as an additional design reference in teaching pedagogy for the biomedical communication community.

5.1.2. Needs Assessment

In understanding the important learning objectives for this audience, a general needs assessment survey (Appendix E) has been developed. The purpose of this need's assessment procedure is to survey post-graduate medical professionals (i.e., residency students) (n ≈ 20) in pediatric cardiology and pediatric cardiac surgery regarding the following: (1) determine the value and needs for different learning objectives in CHD, (2) determine an appropriate learning format/platform and what media to include in a new learning tool, and (3) seek additional inputs about what may be beneficial to include. Educational content and learning objectives have been informed by the subject matter expert for the project, Dr. David Barron. For each learning objective, the survey will seek to identify: (1) the value proposition of different types of content, and (2) the current learning needs for different congenital heart diseases (and their associated interventions). We will also seek to identify general user experience and design decisions regarding the platform of choice (for accessibility and ease of use), media inclusion preferences, and how the learning tool will be likely used. The survey will be implemented through an anonymous Microsoft Forms document. Both quantitative and qualitative data will be collected for analysis.

Concurrently, we will also be conducting more detailed needs assessment interviews. Interviews will be held online over Zoom with consenting medical residents (n ≈ 5-10) in pediatric cardiology and pediatric cardiac surgery. The purpose of this interview will be to establish a more specific set of inclusion and exclusion criteria for the user needs and learning objectives. Questions will be based on some of the analysis obtained from the initial survey. These interviews will also help generate user personas that will inform UI/UX design decisions, appropriate learning theories, and storyboarding. The results will be analyzed to guide decision-making about the content and design of the learning tool.

As of July 1, 2021, the University of Toronto research ethics board has approved the needs assessment protocol and we will be distributing the surveys and conducting interviews throughout July and August. Results are expected by late August 2021.

5.1.3. Recruitment for Evaluations

The study population will consist of pediatric cardiology and pediatric cardiac surgery medical residents appointed with the University of Toronto. My target audience for these assessments is more generally medical personnel involved in post-graduate pediatric cardiology and pediatric cardiac surgery education. Participants will be recruited from the pediatric cardiology and pediatric cardiac surgery residency and fellowship programs associated with the University of Toronto. Dr. David Barron (subject matter expert) will disseminate the survey (Appendix E) along with a cover letter (Appendix C) to residents and fellows in the associated programs. A similar e-mail will be sent for the interviews, with its own cover letter (Appendix F).

5.1.4. Analyses

Likert scale survey data will be analyzed with descriptive statistics through parametric t-tests and non-parametric Mann-Whitney-Wilcoxon tests as described by Winter and Dodou (2019) (Winter & Dodou, 2019). Qualitative data obtained through the survey and interview will be analyzed by identifying recurring words/themes.

5.2. Stage 2: Prototyping and Development

5.2.1. UI & UX production

The user interface (UI) should be easy to use and intuitive to reduce any cognitive load on users. UI design principles will be learnt from Google and Apple developer websites; this allows us to exploit an exceptionally mature design architecture and should also offer a more seamless experience with the rest of the mobile UI. Design principles catered to a surgical trainee audience have been described by Coughlan and Brinkman (2011) and will also be incorporated in this application.

Some feature accommodations that can be included are the ability to create user profiles to track and save progress of work, allowance for both vertical and horizontal orientations on mobile, and the ability to comment and interact with other users on different modules. The deliverable will likely be produced in Unity and exported in an appropriate mobile format. Time-permitting, the tool will undergo 'progressive enhancement' to be ported into an online web format

5.2.2. Formative and Summative Assessments

Development of the visual product will be informed by the results obtained from the needs assessment (5.1.2). This will primarily include information on the content scope and what types of media will be important to include. Comprehensive formative assessments will be conducted throughout the development of this application to assess learning solutions, UI usability, and UX navigation of low and medium-fidelity prototypes. The necessary ethics applications will be completed by October 2021 and will likely involve the same cohort of participants recruited from the needs assessments. In consideration of the feedback obtained from the medium-fidelity prototype, iterations towards a high-fidelity prototype will be generated.

A final summative assessment will be designed to quantify the efficacy of the learning tool and fulfillment of the research objectives.

5.2.3. Usage

The deliverable will likely be developed on mobile to accommodate daily ease of use for healthcare professionals (Boruff & Storie, 2014); there should also be downloadable modules for different CHDs to circumvent the need for a steady internet connection. A framework should be designed to allow for a web-interface as well to facilitate better accessibility – there may be a possibility to integrate this into an existing learning platform (i.e., Quercus), although this goal will not be within the scope of the current timeline (possible future implementation). In terms of intended usage, the application will likely be used as a supplementary learning resource to help during rounds. However, this is subject to change as the needs assessment will inform preferred learning methods and application usage for the target audience.

6. Limitations

Although this project aims to identify key accessibility and knowledge gaps in CHD medical professional education, there are a few key limitations that should be considered. Much of the data and content surrounding this project will be extracted from the needs of medical graduate students at the University of Toronto which may represent a bias for the formative assessments and employed learning objectives. Given that this application may be distributed on a national or international platform (i.e., Google Playstore/Apple app store), the needs of students from other institutions may need to be considered in the future.

Parallel to this point, access to a statistically significant population for needs and formative assessments may be another major limitation. There are roughly 8-10 pediatric cardiology residents associated with the University of Toronto. Adding pediatric cardiac surgery residents into this cohort as well will only marginally increase the total participant pool. Therefore, ensuring that adequate engagement with the target audience during the needs and formative assessment stages is met will be crucial to receiving sufficient feedback.

Finally, we must ensure that the integration of our deliverable does not compete with any institutional firewalls. In doing so, the development must be carefully planned with hospital and university integration in mind.

7. Outcomes & Significance

The final aim of this project is to create a low barrier-to-entry application that can be used as a supplementary educational resource for post-graduate cardiac pediatric medical professionals. Visual education resources and modules compiled through rigorous testing and review with clinicians will be developed to create a better knowledge foundation for training physicians. Within the timespan of this master's research project, a framework for the application along with a high-fidelity prototype should be completed. In the long-term, this may be used for implementation in a cardiac pediatric residency curriculum with user profiles and course accreditation. Additionally, there may be potential to expand this to a larger audience that includes medical professionals in third-world countries where accessibility to CHD learning resources is even more limited and valuable. As a predicted consequence, this project will enhance professional cardiac pediatric education through a digital tool that can be integrated into an existing post-graduate curriculum. Implementing a tool that can assist physician awareness of different congenital heart pathologies and how to treat them may potentially lead to better outcomes for patients. Lastly, this research project will demonstrate the efficacy of implementing e-learning modules for medical professionals in higher education and establish emergent approaches for underrepresented pedagogy in medicine.

8. References

Allan, C. K., Tannous, P., DeWitt, E., Farias, M., Mansfield, L., Ronai, C., Schidlow, D., Sanders, S. P., Lock, J. E., Newburger, J. W., Newburger, J. W., & Brown, D. W. (2016). A Pediatric Cardiology Fellowship Boot Camp improves trainee confidence. *Cardiology in the Young*, *26*(8), 1514–1521. https://doi.org/10.1017/S1047951116002614

Anwar, S., Singh, G. K., Miller, J., Sharma, M., Manning, P., Billadello, J. J., Eghtesady, P., & Woodard, P. K. (2018). 3D Printing is a Transformative Technology in Congenital Heart Disease. *JACC: Basic to Translational Science*, *3*(2), 294–312. https://doi.org/10.1016/j.jacbts.2017.10.003

Bajpai, S., Semwal, M., Bajpai, R., Car, J., & Ho, A. H. Y. (2019). Health professions' digital education:review of learning theories in randomized controlled trials by the digital health education collaboration. *Journal of Medical Internet Research*, *21*(3). https://doi.org/10.2196/12912

Bernier, P. L., Stefanescu, A., Samoukovic, G., & Tchervenkov, C. I. (2010). The challenge of congenital heart disease worldwide: Epidemiologic and demographic facts. *Seminars in Thoracic and Cardiovascular Surgery: Pediatric Cardiac Surgery Annual*, *13*(1), 26–34. https://doi.org/10.1053/j.pcsu.2010.02.005

Biglino, G., Capelli, C., Koniordou, D., Robertshaw, D., Leaver, L. K., Schievano, S., Taylor, A. M., & Wray, J. (2017). Use of 3D models of congenital heart disease as an education tool for cardiac nurses. *Congenital Heart Disease*, *12*(1), 113–118. https://doi.org/10.1111/chd.12414

Boruff, J. T., & Storie, D. (2014). Mobile devices in medicine: A survey of how medical students, residents, and faculty use smartphones and other mobile devices to find information. *Journal of the Medical Library Association*, *102*(1), 22–30. https://doi.org/10.3163/1536-5050.102.1.006

Brown, K. M., Mudd, S. S., Hunt, E. A., Perretta, J. S., Shilkofski, N. A., Diddle, J. W., Yurasek, G., Bembea, M., Duval-Arnould, J., & McMillan, K. N. (2018). A Multi-Institutional Simulation Boot Camp for Pediatric Cardiac Critical Care Nurse Practitioners. *Pediatric Critical Care Medicine*, *19*(6), 564–571. https://doi.org/10.1097/PCC.0000000000001532

Cantinotti, M., Valverde, I., & Kutty, S. (2017). Three-dimensional printed models in congenital heart disease. *International Journal of Cardiovascular Imaging*, *33*(1), 137–144. https://doi.org/10.1007/s10554-016-0981-2

Chu, D., Vaporciyan, A. A., Iannettoni, M. D., Ikonomidis, J. S., Odell, D. D., Shemin, R. J., Starnes, S. L., Stein, W., & Badhwar, V. (2016). Are There Gaps in Current Thoracic Surgery Residency Training Programs? *Annals of Thoracic Surgery*, *101*(6), 2350–2355. https://doi.org/10.1016/j.athoracsur.2016.01.038

Coughlan, J., & Brinkman, W.-P. (2011). Design considerations for delivering E-learning to surgical trainees. *International Journal of E-Health and Medical Communications*, *2*(2), 14–23. https://doi.org/10.4018/jehmc.2011040102

Crawford, T. R. (2011). Using problem-based learning in web-based components of nurse education. *Nurse Education in Practice*, *11*(2), 124–130. https://doi.org/10.1016/J.NEPR.2010.10.010

Criley, J. M., Keiner, J., Boker, J. R., Criley, S. R., & Warde, C. M. (2008). Innovative web-based multimedia curriculum improves cardiac examination competency of residents. *Journal of Hospital Medicine*, *3*(2), 124–133. https://doi.org/10.1002/jhm.287

Dean, P. N., Hillman, D. G., McHugh, K. E., & Gutgesell, H. P. (2011). Inpatient costs and charges for surgical treatment of hypoplastic left heart syndrome. *Pediatrics*, *128*(5). https://doi.org/10.1542/peds.2010-3742

Garg, A., Arora, A., & Hand, I. L. (2016). Pediatric Resident Attitudes and Knowledge of Critical Congenital Heart Disease Screening. *Pediatric Cardiology*, *37*(6), 1137–1140. https://doi.org/10.1007/s00246-016-1407-6

KJ, K., & C, K. (2013). Evaluation of an e-PBL model to promote individual reasoning. *Medical Teacher*, *35*(3). https://doi.org/10.3109/0142159X.2012.717185

LO, D., J, B., M, B. F., I, R., & M, H. (2002). Pros and cons of vertical integration between clinical medicine and basic science within a problem-based undergraduate medical curriculum: examples and experiences from Linköping, Sweden. *Medical Teacher*, *24*(3), 280–285. https://doi.org/10.1080/01421590220134097

M, A. (2000). Problem-based learning: why curricula are likely to show little effect on knowledge and clinical skills. *Medical Education*, *34*(9), 729–738. https://doi.org/10.1046/J.1365-2923.2000.00753.X

M, B., M, F., J, H., CS, T., & ID, K. (2017). Improvements in anatomy knowledge when utilizing a novel cyclical "Observe-Reflect-Draw-Edit-Repeat" learning process. *Anatomical Sciences Education*, *10*(1), 7–22. https://doi.org/10.1002/ASE.1616

Maheshwari, S., Zheleva, B., Rajasekhar, V., & Batra, B. (2015). E-Teaching in pediatric cardiology: A paradigm shift. *Annals of Pediatric Cardiology*, *8*(1), 10–13. https://doi.org/10.4103/0974-2069.149512

Miller, G. E. (1990). The assessment of clinical skills/competence/performance. In *Academic Medicine* (Vol. 65, Issue 9, pp. S63–S67). Acad Med. https://doi.org/10.1097/00001888-199009000-00045

Musa, N. L., Hjortdal, V., Zheleva, B., Murni, I. K., Sano, S., Schwartz, S., & Staveski, S. L. (2017). The global burden of paediatric heart disease. *Cardiology in the Young*, *27*(S6). https://doi.org/10.1017/S1047951117002530

Oster, M. E., Lee, K. A., Honein, M. A., Riehle-Colarusso, T., Shin, M., & Correa, A. (2013). Temporal trends in survival among infants with critical congenital heart defects. *Pediatrics*, *131*(5). https://doi.org/10.1542/peds.2012-3435

Pagowska-Klimek, I., Pychynska-Pokorska, M., Krajewski, W., & Moll, J. J. (2011). Predictors of long intensive care unit stay following cardiac surgery in children. *European Journal of Cardio-Thoracic Surgery*, *40*(1), 179–184. https://doi.org/10.1016/j.ejcts.2010.11.038

Prasad, P. A., Dominguez, T. E., Zaoutis, T. E., Shah, S. S., Teszner, E., Gaynor, J. W., Tabbutt, S., & Coffin, S. E. (2010). Risk factors for catheter-associated bloodstream infections in a pediatric cardiac intensive care unit. *Pediatric Infectious Disease Journal*, *29*(9), 812–815. https://doi.org/10.1097/INF.0b013e3181df6c54

Rogers, L. S., & Cohen, M. S. (2020). Medical education in pediatric and congenital heart disease: A focus on generational learning and technology in education. *Progress in Pediatric Cardiology*, *59*. https://doi.org/10.1016/j.ppedcard.2020.101305

Simmonds, J., Burch, M., Dawkins, H., & Tsang, V. (2008). Heart transplantation after congenital heart surgery: improving results and future goals. *European Journal of Cardio-Thoracic Surgery*, *34*(2), 313–317. https://doi.org/10.1016/j.ejcts.2008.04.004

Slotnick, H. B. (1996). How doctors learn: The role of clinical problems across the medical school-to-practice continuum. *Academic Medicine*, *71*(1), 28–34. https://doi.org/10.1097/00001888-199601000-00014

Stegeman, C. A., & Zydney, J. (2010). Effectiveness of multimedia instruction in health professions education compared to traditional instruction. *Journal of Dental Hygiene : JDH / American Dental Hygienists' Association*, *84*(3), 130–136.

Vernon, T., & Peckham, D. (2002). The benefits of 3D modelling and animation in medical teaching. *Journal of Visual Communication in Medicine*, *25*(4), 142–148. https://doi.org/10.1080/0140511021000051117

Weeks, B., & Friedman, A. H. (2004). Training pediatric residents to evaluate congenital heart disease in the current era. *Pediatric Clinics of North America*, *51*(6 SPEC. IS), 1641–1651. https://doi.org/10.1016/j.pcl.2004.07.003

Winter, J. F. C. de, & Dodou, D. (2019). Five-Point Likert Items: t test versus Mann-Whitney-Wilcoxon (*Addendum added October 2012*). *Practical Assessment, Research, and Evaluation*, *15*(1), 11. https://doi.org/https://doi.org/10.7275/bj1p-ts64

Wu, M.-H., Lu, C.-W., Chen, H.-C., Chiu, S.-N., Kao, F.-Y., & Huang, S.-K. (2015). Arrhythmic burdens in patients with tetralogy of Fallot: A national database study. *Heart Rhythm*, *12*(3), 604–609. https://doi.org/10.1016/j.hrthm.2014.11.026

Yoo, S.-J., Spray, T., Austin, E. H., Yun, T.-J., & van Arsdell, G. S. (2017). Hands-on surgical training of congenital heart surgery using 3-dimensional print models. *Journal of Thoracic and Cardiovascular Surgery*, *153*(6), 1530–1540. https://doi.org/10.1016/j.jtcvs.2016.12.054

Appendix A – Ethics Submission and Approval Form

Human Participant Ethics Protocol Submission

CONFIDENTIAL

0 - Identification

RIS Human Protocol Number
41207

Protocol Title
Identifying Learning Objectives for Post-graduate Medical Professionals Regarding Congenital Heart Disease

Protocol Type
Investigator Submission

Applicant Information

Applicant Name
Mr Abeeshan Selvabaskaran

Rank / Position
N/A

Department / Faculty
UTM: Biology - UofT Mississauga

Business Telephone
6476698345

Extension

Email Address
abeeshan.selvabaskaran@mail.utoronto.ca

Faculty Sponsor Information

Sponsor Name
Prof Derek Ng

Rank/Position

Department
UTM: Biology - UofT Mississauga

Business Telephone
905-569-4266

Extension

E-mail
d.ng@utoronto.ca

Research Type

Is this course based research? ◯ Yes ◉ No

Course Code	Title	Level	Session	Section	Start Date

Division **Department** **Unit Head Name**

Collaborators/Co-Investigators

OFFICE OF RESEARCH ETHICS
McMurrich Building, 12 Queen's Park Crescent West, 2nd Floor, Toronto, ON M5S 1S8 Canada
Tel: +1 416 946-3273 ● Fax: +1 416 946-5763 ● ethics.review@utoronto.ca ● http://www.research.utoronto.ca/for-researchers-administrators/ethics

Name	Department	Email	Phone	Designation	Alt Contact
Michael Corrin	UTM: Biology	m.corrin@utoronto.ca	9055694263	Collaborator & Alt	X

Projected Project Dates

Estimated Start Date
1-Jul-21

Estimated End Date
31-Dec-21

2 - Location

Location of the Research: ☒ University of Toronto ☐ Other Locations

Administrative Approval/Consent

Administrative Approval/Consent Needed: ○ Yes ◉ No

Community Based Particatory Research Project? ○ Yes ◉ No

Other Ethic Boards Approval(s)

Another Institution or Site involved? ○ Yes ◉ No

3 - Agreements and Reviews

Funding

Project Funded? ○ Yes ◉ No

Explain why no funding is required

This project is a survey and will be created using Microsoft Forms -- a free, publicly available survey creation tool. As such, the research to be conducted has no associated costs. The minor expense of gift certificates for participants will be covered by the BMC supervisor's research stipend.

Agreements

Funding/non-funding Agreement in Place? ○ Yes ◉ No

Any Team Member Declared Conflict of Interest? ○ Yes ◉ No

Reviews

☒ This research has gone under scholarly review by thesis committee, departmental review committee, peer review committee, or some other equivalent

Type of Review : -e.g.: departmental research committee, supervisor, CIHR, SSHRC, OHTN, etc.

Master's research project committee

☒ This review was specific to this protocol

☐ The review was part of a larger grant

☐ This research will go under scholarly review prior to funding

☐ This review will not go under a scholarly review

4 - Potential Conflicts

Conflict of Interest

Will researchers, research team members, or immediate family members receive any personal benefit? ○ Yes ◉ No

OFFICE OF RESEARCH ETHICS
McMurrich Building, 12 Queen's Park Crescent West, 2nd Floor, Toronto, ON M5S 1S8 Canada
Tel: +1 416 946-3273 ● Fax: +1 416 946-5763 ● ethics.review@utoronto.ca ● http://www.research.utoronto.ca/for-researchers-administrators/ethics

Restrictions on Information

Are there any restrictions regarding access to, or disclosure of information (during or after closure)? ○ Yes ◉ No

Researcher Relationships

Are there any pre-existing relationships between the researchers and the researched? ◉ Yes ○ No

Relationship Description

The principal investigator (Abeeshan Selvabaskaran) and faculty supervisor (Dr. Derek Ng) have no direct relationship with the participant groups. Abeeshan's subject matter expert for his master's research project is Dr. David Barron, who is the division head of cardiovascular surgery at Sick Kids. Dr. Barron may have relationships with the medical professional user groups in this survey. However, all questionnaires and participation in this study will remain anonymous and will not impact the relationships with individual participants.

Collaborative Decision Making

Is this a community based project - i.e.: a collaboration between the university and a community group? ○ Yes ◉ No

5 - Project Details

Summary

Rationale

Describe the purpose and scholarly rationale for the project

Congenital heart disease (CHD) is the most common congenital birth defect worldwide (Bernier et al., 2010) and represents a wide range of abnormal cardiovascular morphologies. The severity of CHDs can be highly variable with 1 in 4 patients requiring critical procedures within their first year of life (Oster et al., 2013). Immediate diagnoses and intervention planning can mean life or death in many of these cases. Thus, proper education and medical training is imperative in adequately preparing for these situations. However, the complexity of interventions can be extensive and difficult to train for, given the rarity and unique presentation of these diseases (Musa et al., 2017; Yoo et al., 2017). While patients have seen stark improvements in longevity and quality of life over the past few decades, factors such as hospitalization time, risk of surgery, and complications still burden both patients and the healthcare system (Dean et al., 2011; Pagowska-Klimek et al., 2011; Prasad et al., 2010; Simmonds et al., 2008; Wu et al., 2015). George Miller's framework of clinical competence describes knowledge as the foundation for clinical performance (Miller, 1990) According to Miller's framework for clinical competence, increased access to knowledge through accessible learning tools in medicine may have profound effects to patient care. Building on the current educational foundations for CHD may be an optimal way to advance palliative care in this field.

The use of digital media including medical scans and 3D models have been invaluable to understanding and preparing for CHD surgeries. Recently, the use of 3D printing has taken the field of cardiac pediatric surgery and proven itself as a great resource for surgical training and preparation (Anwar et al., 2018; Yoo et al., 2017) . However, these resources are still burdened by factors such as their cost and availability (Biglino et al., 2017). An avenue of education that has been successful in other professional medical fields is the use of virtual interactive e-learning platforms. These have very few accessibility concerns and may even prove favorable to the new generation Z population of learners (Rogers & Cohen, 2020). For instance, a system implemented by Glittenberg and Binder used 3D computer simulations to enhance ophthalmic training led to significant (17 ± 5%) increases in test results as compared to a control group (Glittenberg & Binder, 2006). And of more relevance, Criley and colleagues showed that multimedia digital education in resident training for cardiac examination resulted in significantly improved knowledge retention and performance (Criley et al., 2008).

Abiding by Miller's framework of clinical competence and previous studies in other medical fields, the use of digital learning tools in medicine may provide significant beneficial effects to patient care. Unfortunately, there is still a paucity of digital e-learning tools for post-graduate cardiac pediatric surgery and pediatric cardiology professionals. The goal of this project is to create a digital application for use by pediatric cardiac surgeons and pediatric cardiologists, which we believe can become an effective learning tool for this field. In developing a medical learning application, Bajpai and colleagues have established the importance of preparing appropriate learning objectives and theories for use by the intended audience (Bajpai et al., 2019). Inappropriate objectives or theories can hamper the efficacy of a model, so ample consideration must be taken early in the creation process. After conducting an extensive literature review on the effectiveness of current educational tools as well as potential learning theories we can implement, there are still gaps regarding the value of different learning objectives and the appropriate format and intended use of such a tool. This provides an impetus to fill in these gaps by directly asking the target audience.

This protocol seeks to identify important learning objectives as perceived by post-graduate medical professionals for congenital heart disease. The goals are to: (1) determine the value and needs for different learning objectives in CHD, (2) determine an appropriate learning format/platform and what media to include, and (3) seek additional inputs about what may be beneficial to include.

Reference List attached (Appendix A).

Methods

Describe formal/informal procedures to be used

1. General Needs Assessment Survey

The purpose of this need's assessment procedure is to survey post-graduate medical professionals (i.e. residency students) ($n \approx 20$) in pediatric cardiology and pediatric cardiac surgery regarding the following: (1) determine the value and needs for different learning objectives in CHD, (2) determine an appropriate learning format/platform and what media to include in a new learning tool, and (3) seek additional inputs about what may be beneficial to include. Educational content and learning objectives are informed by the subject matter expert for the project, Dr. David Barron. For each learning objective, the survey will seek to identify: (1) the value proposition of different types of content, and (2) the current learning needs for different congenital heart diseases (and their associated interventions). We will also seek to identify general user experience and design decisions regarding the platform of choice (for accessibility and ease of use), media inclusion preferences, and how the learning tool will be likely used. The survey will be implemented through an anonymous Microsoft Forms document (see example questions attached). Both quantitative (Likert scale) and qualitative (open-ended) data will be collected for analysis. Dr. Derek Ng and Abeeshan Selvabaskaran will be provided access to the survey data for analysis (including descriptive statistics for quantitative data and identifying recurring words/

OFFICE OF RESEARCH ETHICS
McMurrich Building, 12 Queen's Park Crescent West, 2nd Floor, Toronto, ON M5S 1S8 Canada
Tel: +1 416 946-3273 ● Fax: +1 416 946-5763 ● ethics.review@utoronto.ca ● http://www.research.utoronto.ca/for-researchers-administrators/ethics

themes for qualitative data).
2. Detailed Needs Assessment Interviews
Interviews will be held online over Zoom with consenting medical residents (n ≈ 5-10) in pediatric cardiology and pediatric cardiac surgery. The purpose of this interview will be to establish a more specific set of inclusion and exclusion criteria for the user needs and learning objectives. Questions will be based on some of the analysis obtained from the initial survey. These interviews will also help inform the learning theories that will be employed (case-based learning, problem-based learning, lecture-based learning, etc.) and help generate user personas that will inform UI/UX design decisions and storyboarding. The interviews will be ~30 minutes each and will not be recorded. The results will be analyzed to guide decision-making about the content and design of the learning tool. Any data obtained will be anonymized.

Copies of questionnaires, interview guided and/or other instruments used

Document Title	Document Date
Proposal reference list	2021-06-13
Cover letter sent to participants in e-mail requesting participation for the survey	2021-06-13
Informed consent form for the survey (first page of Microsoft Forms survey)	2021-06-13
Sample survey questions	2021-06-13
Cover letter sent to participants in e-mail requesting participation for the interview	2021-06-13
Informed consent form for the interview (attached in e-mail)	2021-06-13
Sample interview questions	2021-06-13

Clinical Trials

Is this a clinical trial? ○ Yes ◉ No

6 - Participants and Data

Participants and/or Data

What is the anticipated sample size of number of participants in the study? 20

Describe the participants to be recruited, or the individuals about whom personally identifiable information will be collected. List the inclusion and exclusion criteria. Where the research involves extraction or collection personally identifiable information, please describe where the information will be obtained, what it will include, and how permission to access said information is being sought.

The study population will consist of pediatric cardiology and pediatric cardiac surgery medical residents appointed with the University of Toronto. My target audience is more generally medical personnel involved in post-graduate pediatric cardiology and pediatric cardiac surgery education. Participants will be recruited through Dr. David Barron (subject matter expert) who is the head of the division of Cardiovascular Surgery at SickKids hospital and a Professor of Surgery at the University of Toronto. All participants can participate if they choose to complete the survey or be interviewed. Area of medical training and current level of training will be collected; personal information will otherwise remain anonymous.

Is there any group or individual-level vulnerability related to the research that needs to be mitigated (for example, difficulty understanding consent, history of exploitation by researchers, or power differential between the researcher and the potential participant)? ○ Yes ◉ No

Recruitment

Is there recruitment of participant? ◉ Yes ○ No

Recruitment details including how, from where, and by whom

Participants will be recruited from the pediatric cardiology and pediatric cardiac surgery residency and fellowship programs associated with the University of Toronto. Dr. David Barron (subject matter expert) will disseminate the survey (Appendix D) along with a cover letter (Appendix B) to residents and fellows in the associated programs. A similar e-mail will be sent for the interviews, with its own cover letter (Appendix E).

Is participant observation used? ○ Yes ◉ No

Will translation materials be used/required? ○ Yes ◉ No

Attach copies of all recruitment posters, flyers, letters, email text, or telephone scripts

OFFICE OF RESEARCH ETHICS
McMurrich Building, 12 Queen's Park Crescent West, 2nd Floor, Toronto, ON M5S 1S8 Canada
Tel: +1 416 946-3273 ● Fax: +1 416 946-5763 ● ethics.review@utoronto.ca ● http://www.research.utoronto.ca/for-researchers-administrators/ethics

Document Title	Document Date
Cover letter sent to participants in e-mail requesting participation for the survey	2021-06-13
Cover letter sent to participants in e-mail requesting participation for the interview	2021-06-13

Compensation

Will the participants receive compensation? (•) Yes ( ) No

Type of Compensation

- [ ] Financial
- [ ] In-kind
- [x] Other — Gift Cards

Compensation Justification Details

The research team is aware of the demanding nature of post-graduate medical professionals' program. For this reason, participants of interview sessions will receive a $10 gift card as compensation for their time.

Is there a withdrawal clause in the research procedure? (•) Yes ( ) No

Is compensation affected when a participant withdraws?

Compensation will be provided to participants who take part, whether in whole or in part, in the interview session. Participants withdrawing from the interview once it has been initiated, but before it has concluded, will receive the same compensation as those completing the entire session.

7 - Investigator Experience

Investigator Experience with this type of research

Please provide a brief description of the previous experience for this type of research by the applicant, the research team, and any persons who will have direct contact with the applicants. If there is no previous experience, how will the applicant and research team be prepared?

1. Abeeshan Selvabaskaran (PI) is currently a student of the MScBMC program in Biomedical Communications. He is currently completing a graduate research methods course and in addition will be completing the TCPS 2: Course on Research Ethics. 2. Dr. Derek Ng has considerable experience in human subjects' research. This includes research involving the evaluation of educational material for post-secondary student populations.

Are community members collecting and/or analyzing data? ( ) Yes (•) No

8 - Possible Risks and Benefits

Possible Risks

Potential Risk Details:

Physical Risks	( ) Yes	(•) No
Psychological/emotional Risks	( ) Yes	(•) No
Social Risk	( ) Yes	(•) No
Legal Risk	( ) Yes	(•) No

Potential Benefits

Benefit Description

This project will be the first educational media tool for congenital heart disease (CHD) that integrates a multi-media design approach to teach post-graduate medical professionals. We plan on distributing the tools/resources developed from this project to different health organizations around the world to serve as an

9 - Consent

OFFICE OF RESEARCH ETHICS
McMurrich Building, 12 Queen's Park Crescent West, 2nd Floor, Toronto, ON M5S 1S8 Canada
Tel: +1 416 946-3273 ● Fax: +1 416 946-5763 ● ethics.review@utoronto.ca ● http://www.research.utoronto.ca/for-researchers-administrators/ethics

Consent Process Details

When participants access the surveys, they will be presented with consent information (appendix C). Consent will be implied by the participant submitting the survey form. For the interviews, if a participant is interested in participating, they will be sent an Informed Consent Form (ICF) (Appendix F), which they will be encouraged to review prior to their participation in the interview session. Prior to each interview session, the student PI will review the contents of the ICF with each participant and provide him/her/them the opportunity to ask any questions they have. Consent will be recorded through signature of the ICF following this review and question period.

Uploaded letter/consent form(s)

Document Title	Document Date
Informed consent form for the survey (first page of Microsoft Forms survey)	2021-06-13
Informed consent form for the interview (attached in e-mail)	2021-06-13

Is there additional documentation regarding consent such as screening materials, introductory letters etc.: ○ Yes ◉ No

Uploaded letter/consent form(s)

Will any information collected in the screening process - prior to full informed consent to participate in the study - be retained for those who are later excluded or refuse to participate in the study? ○ Yes ◉ No

Is the research taking place within a community or organization which requires formal consent be sought prior to the involvement of the individual participants ○ Yes ◉ No

Are any participants not capable (e.g.: children) of giving competent consent? ○ Yes ◉ No

10 - Debriefing and Dissemination

DeBrief

Will deception or intentional non disclosure be used? ○ Yes ◉ No

Will a written debrief be used? ○ Yes ◉ No

Do participants/communities have the right to withdraw their data following the debrief? ○ Yes ◉ No

Information Feed Back Details following completion of a participants participation in the project

No additional feedback or information will be provided following participation. Participants and the larger scholarly community will have access to any publications resulting from this study.

Procedural details which allow participants to withdraw from the project

Participants will be notified in the cover letter that their participation is voluntary; the participant's completion of the survey is entirely at their discretion. Due to the anonymous nature of the survey, participants will not be able to withdraw once they have submitted the form. Regarding the interview, the participant's right to withdraw from any stage of the project will be clearly explained by the student PI during the informed consent procedure; it will also be outlined in the consent form the participants receive by email beforehand. Participants can choose to end their participation at any time during the interview without having to provide a reason. Should a participant choose to withdraw from the session, he/she/they may do so by informing the session facilitator and then simply leaving the locale.

☐ Not Applicable

What happens to a participants data and any known consequences related to the removal of said participant

☒ Not Applicable

List reasons why a participant can not withdraw from the project (either at all or after a certain period of time)

Participants can withdraw from the project by not submitting a survey. Once a survey has been submitted, it will not be possible to withdraw any answers due to the anonymous nature of this study. Regarding the interview, participants may choose to end their participation in the study after completing the interview if they choose to. They can do so by contacting the student PI and asking for removal of their data.

☐ Not Applicable

11 - Confidentiality and Privacy

Confidentiality

OFFICE OF RESEARCH ETHICS
McMurrich Building, 12 Queen's Park Crescent West, 2nd Floor, Toronto, ON M5S 1S8 Canada
Tel: +1 416 946-3273 ● Fax: +1 416 946-5763 ● ethics.review@utoronto.ca ● http://www.research.utoronto.ca/for-researchers-administrators/ethics

Is the data confidential? (•) Yes ( ) No

Will the confidentiality of the participants and/or informants be protected? (•) Yes ( ) No

List confidentiality protection procedures

To ensure confidentiality, participants will be instructed in the cover letter to avoid entering their names or other identifiers in the survey. For the interview, each participant will be assigned a unique code that will be used to label field notes taken during the interview. These codes and the associated names/emails of the participants will be kept in a separate digital file from any field notes. No personally identifiable information will be used in the data analysis and reporting phases of this study.

Are there any limitations on the protection of participant confidentiality? ( ) Yes (•) No

Is participant anonymity/confidentiality not applicable to this research project? ( ) Yes (•) No

Data Protection

Describe how the data (including written records, video/audio recordings, artifacts and questionnaires) will be protected during the conduct of the research and subsequent dissemination of results

All data obtained from the anonymous survey will be implemented through Microsoft forms. Identifying data will not be requested nor used for any data review/ analysis. Only members of our research team will have access to this data. For the interviews, notes taken during the sessions will not contain any personally identifiable information. All digital files and notes associated with the interviews will be stored on a password protected and encrypted computer.

Explain for how long, where and what format (identifiable, de-identified) data will be retained. Provide details of their destruction and/or continued storage. Provide a justification if you intend to store identifiable data for an indefinite length of time. If regulatory requirements for data retention exists, please explain.

The survey data will automatically be recorded and stored on the Microsoft Form servers which will be password-protected. The interview data (including the list of participant codes/ names/emails and the field notes) will be stored on a password protected and encrypted computer. Upon completion of the project, all data will be permanently deleted. Only summary data will be published.

Will the data be shared with other researchers or users? (•) Yes ( ) No

Please describe how and where the data will be stored and any restrictions that will be made regarding access.How will participant consent be obtained? If data is to be made open access, please describe how and where they will be maintained.

Only anonymous data will be shared with other researchers on this team for the purpose of data analysis.

12 - Level of Risk and Research Ethics Board

Level of Risk for the Project

Group Vulnerability: Low

Research Risk: Low

Risk Level: 1

Explanation/Justification

Explanation/Justification detail for the group vulnerabilty and research risk listed above

We foresee minimal risk with the group being surveyed. The data collected will be through (1) an online survey, which does not require any more risk than what is experienced during daily life (use of a computer) or, (2) interview, which may cause some anxiety. However, this group is not known to have any pre-existing conditions that can be exacerbated with this study. Participation is also completely voluntary and we will not be collecting any personally identifiable information.

Research Ethics Board

REB Associated with this project: Social Sciences, Humanities & Education

13 - Application Documents Summary

Uploaded Documents

OFFICE OF RESEARCH ETHICS
McMurrich Building, 12 Queen's Park Crescent West, 2nd Floor, Toronto, ON M5S 1S8 Canada
Tel: +1 416 946-3273 ● Fax: +1 416 946-5763 ● ethics.review@utoronto.ca ● http://www.research.utoronto.ca/for-researchers-administrators/ethics

Document Title	Document Date
Proposal reference list	2021-06-13
Cover letter sent to participants in e-mail requesting participation for the survey	2021-06-13
Informed consent form for the survey (first page of Microsoft Forms survey)	2021-06-13
Sample survey questions	2021-06-13
Cover letter sent to participants in e-mail requesting participation for the interview	2021-06-13
Informed consent form for the interview (attached in e-mail)	2021-06-13
Sample interview questions	2021-06-13
Cover letter sent to participants in e-mail requesting participation for the survey	2021-06-13
Cover letter sent to participants in e-mail requesting participation for the interview	2021-06-13
Informed consent form for the survey (first page of Microsoft Forms survey)	2021-06-13
Informed consent form for the interview (attached in e-mail)	2021-06-13

14 - Applicant Undertaking

I confirm that I am aware of, understand, and will comply with all relevant laws governing the collection and use of personal identifiable information is research. I understand that for research involving extraction or collection of personally identifiable information, provincial, federal, and/or international laws may apply and that any apparent mishandling of said personally identifiable information, must be reported to the office of research ethics.

As the Principal Investigator of the project, I confirm that I will ensure that all procedures performed in accordance with all relevant university, provincial, national, and/or international policies and regulations that govern research with human participants. I understand that if there is any significant deviation in the project as originally approved, I must submit an amendment to the Research Ethics Board for approval prior to implementing any change.

☒ I have read and agree to the above conditions

OFFICE OF RESEARCH ETHICS
McMurrich Building, 12 Queen's Park Crescent West, 2nd Floor, Toronto, ON M5S 1S8 Canada
Tel: +1 416 946-3273 ● Fax: +1 416 946-5763 ● ethics.review@utoronto.ca ● http://www.research.utoronto.ca/for-researchers-administrators/ethics

RIS Protocol Number: 41207

Approval Date: 1-Jul-21

PI Name: Mr Abeeshan Selvabaskaran

Division Name:

Dear Mr Abeeshan Selvabaskaran:

Re: Your research protocol application entitled, "Identifying Learning Objectives for Post-graduate Medical Professionals Regarding Congenital Heart Disease"

The Social Sciences, Humanities & Education REB has conducted a Delegated review of your application and has granted approval to the attached protocol for the period 2021-07-01 to 2022-06-30.

If this research involves face-to-face (F2F) in person research, please note that REB approval alone is not sufficient to commence research. You must wait for an approval letter from the F2F COVID-19 Review Committee. The approval letter will be sent to the Principal Investigator's email address once the Committee has deemed the F2F in-person research ready to start.

Please be reminded of the following points:

- An **Amendment** must be submitted to the REB for any proposed changes to the approved protocol. The amended protocol must be reviewed and approved by the REB prior to implementation of the changes.
- An annual **Renewal** must be submitted for ongoing research. Renewals should be submitted between 15 and 30 days prior to the current expiry date.
- A **Protocol Deviation Report** (PDR) should be submitted when there is any departure from the REB-approved ethics review application form that has occurred without prior approval from the REB (e.g., changes to the study procedures, consent process, data protection measures). The submission of this form does not necessarily indicate wrong-doing; however follow-up procedures may be required.
- An **Adverse Events Report (AER)** must be submitted when adverse or unanticipated events occur to participants in the course of the research process.
- A **Protocol Completion Report** (PCR) is required when research using the protocol has been completed. For ongoing research, a PCR on the protocol will be required after 7 years, (Original and 6 Renewals). A continuation of work beyond 7 years will require the creation of a new protocol.
- If your research is funded by a third party, please contact the assigned Research Funding Officer in Research Services to ensure that your funds are released.

Best wishes for the successful completion of your research.

OFFICE OF RESEARCH ETHICS
McMurrich Building, 12 Queen's Park Crescent West, 2nd Floor, Toronto, ON M5S 1S8 Canada
Tel: +1 416 946-3273 ● Fax: +1 416 946-5763 ● ethics.review@utoronto.ca ● http://www.research.utoronto.ca/for-researchers-administrators/ethics

Appendix B – Ethics Form Reference List

Allan, C. K., Tannous, P., DeWitt, E., Farias, M., Mansfield, L., Ronai, C., Schidlow, D., Sanders, S. P., Lock, J. E., Newburger, J. W., Newburger, J. W., & Brown, D. W. (2016). A Pediatric Cardiology Fellowship Boot Camp improves trainee confidence. *Cardiology in the Young*, *26*(8), 1514–1521. https://doi.org/10.1017/S1047951116002614

Anwar, S., Singh, G. K., Miller, J., Sharma, M., Manning, P., Billadello, J. J., Eghtesady, P., & Woodard, P. K. (2018). 3D Printing is a Transformative Technology in Congenital Heart Disease. *JACC: Basic to Translational Science*, *3*(2), 294–312. https://doi.org/10.1016/j.jacbts.2017.10.003

Bajpai, S., Semwal, M., Bajpai, R., Car, J., & Ho, A. H. Y. (2019). Health professions' digital education:review of learning theories in randomized controlled trials by the digital health education collaboration. *Journal of Medical Internet Research*, *21*(3). https://doi.org/10.2196/12912

Bernier, P. L., Stefanescu, A., Samoukovic, G., & Tchervenkov, C. I. (2010). The challenge of congenital heart disease worldwide: Epidemiologic and demographic facts. *Seminars in Thoracic and Cardiovascular Surgery: Pediatric Cardiac Surgery Annual*, *13*(1), 26–34. https://doi.org/10.1053/j.pcsu.2010.02.005

Biglino, G., Capelli, C., Koniordou, D., Robertshaw, D., Leaver, L. K., Schievano, S., Taylor, A. M., & Wray, J. (2017). Use of 3D models of congenital heart disease as an education tool for cardiac nurses. *Congenital Heart Disease*, *12*(1), 113–118. https://doi.org/10.1111/chd.12414

Boruff, J. T., & Storie, D. (2014). Mobile devices in medicine: A survey of how medical students, residents, and faculty use smartphones and other mobile devices to find information. *Journal of the Medical Library Association*, *102*(1), 22–30. https://doi.org/10.3163/1536-5050.102.1.006

Brown, K. M., Mudd, S. S., Hunt, E. A., Perretta, J. S., Shilkofski, N. A., Diddle, J. W., Yurasek, G., Bembea, M., Duval-Arnould, J., & McMillan, K. N. (2018). A Multi-Institutional Simulation Boot Camp for Pediatric Cardiac Critical Care Nurse Practitioners. *Pediatric Critical Care Medicine*, *19*(6), 564–571. https://doi.org/10.1097/PCC.0000000000001532

Cantinotti, M., Valverde, I., & Kutty, S. (2017). Three-dimensional printed models in congenital heart disease. *International Journal of Cardiovascular Imaging*, *33*(1), 137–144. https://doi.org/10.1007/s10554-016-0981-2

Chu, D., Vaporciyan, A. A., Iannettoni, M. D., Ikonomidis, J. S., Odell, D. D., Shemin, R. J., Starnes, S. L., Stein, W., & Badhwar, V. (2016). Are There Gaps in Current Thoracic Surgery Residency Training Programs? *Annals of Thoracic Surgery*, *101*(6), 2350–2355. https://doi.org/10.1016/j.athoracsur.2016.01.038

Coughlan, J., & Brinkman, W.-P. (2011). Design considerations for delivering E-learning to surgical trainees. *International Journal of E-Health and Medical Communications*, *2*(2), 14–23. https://doi.org/10.4018/jehmc.2011040102

Crawford, T. R. (2011). Using problem-based learning in web-based components of nurse education. *Nurse Education in Practice*, *11*(2), 124–130. https://doi.org/10.1016/J.NEPR.2010.10.010

Criley, J. M., Keiner, J., Boker, J. R., Criley, S. R., & Warde, C. M. (2008). Innovative web-based multimedia curriculum improves cardiac examination competency of residents. *Journal of Hospital Medicine*, *3*(2), 124–133. https://doi.org/10.1002/jhm.287

Dean, P. N., Hillman, D. G., McHugh, K. E., & Gutgesell, H. P. (2011). Inpatient costs and charges for surgical treatment of hypoplastic left heart syndrome. *Pediatrics*, *128*(5). https://doi.org/10.1542/peds.2010-3742

Garg, A., Arora, A., & Hand, I. L. (2016). Pediatric Resident Attitudes and Knowledge of Critical Congenital Heart Disease Screening. *Pediatric Cardiology*, *37*(6), 1137–1140. https://doi.org/10.1007/s00246-016-1407-6

KJ, K., & C, K. (2013). Evaluation of an e-PBL model to promote individual reasoning. *Medical Teacher*, *35*(3). https://doi.org/10.3109/0142159X.2012.717185

LO, D., J, B., M, B. F., I, R., & M, H. (2002). Pros and cons of vertical integration between clinical medicine and basic science within a problem-based undergraduate medical curriculum: examples and experiences from Linköping, Sweden. *Medical Teacher*, *24*(3), 280–285. https://doi.org/10.1080/01421590220134097

M, A. (2000). Problem-based learning: why curricula are likely to show little effect on knowledge and clinical skills. *Medical Education*, *34*(9), 729–738. https://doi.org/10.1046/J.1365-2923.2000.00753.X

M, B., M, F., J, H., CS, T., & ID, K. (2017). Improvements in anatomy knowledge when utilizing a novel cyclical "Observe-Reflect-Draw-Edit-Repeat" learning process. *Anatomical Sciences Education*, *10*(1), 7–22. https://doi.org/10.1002/ASE.1616

Maheshwari, S., Zheleva, B., Rajasekhar, V., & Batra, B. (2015). E-Teaching in pediatric cardiology: A paradigm shift. *Annals of Pediatric Cardiology*, *8*(1), 10–13. https://doi.org/10.4103/0974-2069.149512

Miller, G. E. (1990). The assessment of clinical skills/competence/performance. In *Academic Medicine* (Vol. 65, Issue 9, pp. S63–S67). Acad Med. https://doi.org/10.1097/00001888-199009000-00045

Musa, N. L., Hjortdal, V., Zheleva, B., Murni, I. K., Sano, S., Schwartz, S., & Staveski, S. L. (2017). The global burden of paediatric heart disease. *Cardiology in the Young*, *27*(S6). https://doi.org/10.1017/S1047951117002530

Oster, M. E., Lee, K. A., Honein, M. A., Riehle-Colarusso, T., Shin, M., & Correa, A. (2013). Temporal trends in survival among infants with critical congenital heart defects. *Pediatrics*, *131*(5). https://doi.org/10.1542/peds.2012-3435

Pagowska-Klimek, I., Pychynska-Pokorska, M., Krajewski, W., & Moll, J. J. (2011). Predictors of long intensive care unit stay following cardiac surgery in children. *European Journal of Cardio-Thoracic Surgery*, *40*(1), 179–184. https://doi.org/10.1016/j.ejcts.2010.11.038

Prasad, P. A., Dominguez, T. E., Zaoutis, T. E., Shah, S. S., Teszner, E., Gaynor, J. W., Tabbutt, S., & Coffin, S. E. (2010). Risk factors for catheter-associated bloodstream infections in a pediatric cardiac intensive care unit. *Pediatric Infectious Disease Journal*, *29*(9), 812–815. https://doi.org/10.1097/INF.0b013e3181df6c54

Rogers, L. S., & Cohen, M. S. (2020). Medical education in pediatric and congenital heart disease: A focus on generational learning and technology in education. *Progress in Pediatric Cardiology*, *59*. https://doi.org/10.1016/j.ppedcard.2020.101305

Simmonds, J., Burch, M., Dawkins, H., & Tsang, V. (2008). Heart transplantation after congenital heart surgery: improving results and future goals. *European Journal of Cardio-Thoracic Surgery*, *34*(2), 313–317. https://doi.org/10.1016/j.ejcts.2008.04.004

Slotnick, H. B. (1996). How doctors learn: The role of clinical problems across the medical school-to-practice continuum. *Academic Medicine*, *71*(1), 28–34. https://doi.org/10.1097/00001888-199601000-00014

Stegeman, C. A., & Zydney, J. (2010). Effectiveness of multimedia instruction in health professions education compared to traditional instruction. *Journal of Dental Hygiene : JDH / American Dental Hygienists' Association*, *84*(3), 130–136.

Vernon, T., & Peckham, D. (2002). The benefits of 3D modelling and animation in medical teaching. *Journal of Visual Communication in Medicine*, *25*(4), 142–148. https://doi.org/10.1080/0140511021000051117

Weeks, B., & Friedman, A. H. (2004). Training pediatric residents to evaluate congenital heart disease in the current era. *Pediatric Clinics of North America*, *51*(6 SPEC. IS), 1641–1651. https://doi.org/10.1016/j.pcl.2004.07.003

Winter, J. F. C. de, & Dodou, D. (2019). Five-Point Likert Items: t test versus Mann-Whitney-Wilcoxon (*Addendum added October 2012*). *Practical Assessment, Research, and Evaluation*, *15*(1), 11. https://doi.org/https://doi.org/10.7275/bj1p-ts64

Wu, M.-H., Lu, C.-W., Chen, H.-C., Chiu, S.-N., Kao, F.-Y., & Huang, S.-K. (2015). Arrhythmic burdens in patients with tetralogy of Fallot: A national database study. *Heart Rhythm*, *12*(3), 604–609. https://doi.org/10.1016/j.hrthm.2014.11.026

Yoo, S.-J., Spray, T., Austin, E. H., Yun, T.-J., & van Arsdell, G. S. (2017). Hands-on surgical training of congenital heart surgery using 3-dimensional print models. *Journal of Thoracic and Cardiovascular Surgery*, *153*(6), 1530–1540. https://doi.org/10.1016/j.jtcvs.2016.12.054

Appendix C - Survey Cover Letter [Included in E-mail to Participants]

Hello,

My name is Abeeshan Selvabaskaran, and I am a graduate student in the Biomedical Communications program at the University of Toronto Mississauga. For my master's research project, I am developing a learning resource/tool (animation, app, etc.) on congenital heart disease to be used in post-graduate medical education. My goal is to create a multimedia app that combines videos, animations, and interactive models that can be an accessible learning tool for both students and professionals in cardiac pediatrics.

You are invited to participate in this research study by completing the following survey. This survey will take **10-15 minutes** of your time and participation is strictly voluntary. You may refuse to participate at any point or skip any questions you prefer not to respond to. To ensure anonymity, please do not include any personally identifiable information (name, institution name, exact geographic location, etc.) as they will not be associated in any way with your responses. There are no direct benefits from completing this survey, however your responses will provide valuable information regarding the educational needs for congenital heart disease in the medical field.

Here is the link to the survey: **https://bit.ly/3hDUmBr**

Thank you for your time in completing this survey. **Please try to complete this survey by Friday, July 23, 2021**. If there are any questions regarding this survey or the learning resource/tool being developed, please do not hesitate to contact me.

I would also like to formally invite you to participate in a 30-minute interview where you will be asked to talk about some of the current learning challenges that exist for CHD. All participants will receive a $25 e-gift card to a dining place of their choice. For more information about this interview or to participate in this interview, please contact me at abeeshan.selvabaskaran@mail.utoronto.ca.

Sincerely,
Abeeshan Selvabaskaran

Master of Science in Biomedical Communication 2022 Candidate
Institute of Medical Science, Temerty Faculty of Medicine, University of Toronto
Email: abeeshan.selvabaskaran@mail.utoronto.ca
Phone: (647) 669-8345

Appendix D - Survey Consent Form [First Page of Microsoft Forms Survey]

Digital Learning Tool for Post-Graduate Medical Professionals in Cardiac Pediatrics

Principal Investigator: Abeeshan Selvabaskaran, MScBMC candidate
Dept. of Biology/Institute of Medical Science

Co-investigators: Dr. Derek Ng, BSc, MScBMC, PhD
Dr. David Barron, MB BS, MD, FRCP, FRCS(CT)
Michael Corrin, BFA, BA, Hons BSc, MScBMC, CMI

Invitation
You have been invited to participate in this short, anonymous survey on congenital heart disease for post-graduate medical education. Your responses will be valuable in helping us better understand the educational needs that exist in this field.

Risks/Benefits
This survey will take 10-15 minutes of your time to complete and your participation is strictly voluntary. There is no compensation for responding, nor is there any known risk. Please note that once you have submitted your responses, we will not be able to remove any data you have provided due to the anonymous nature of this survey. There will be no direct benefits from taking this survey, however your responses will provide valuable information regarding the educational needs for congenital heart disease in the medical field.

Feel free to contact the Office of Research Ethics at ethics.review@utoronto.ca or (416) 946-3273, if you have any questions about your rights as a participant.

Confidentiality
All responses that you provide will be anonymous. Please do not include any personally identifiable information (name, institution name, exact geographic location, etc.) as they will not be associated in any way with your responses.

If you have any questions or concerns about participating in this survey, please feel free to contact the student PI (Abeeshan Selvabaskaran) at abeeshan.selvabaskaran@mail.utoronto.ca.

Thank you in advance for your participation!

Survey
[Insert survey questions here]

Summary
By participating in this survey, you:

- Agree to participate in this study as described above;
- Understand that your participation in this study is voluntary;
- Understand that your name or any other personally identifiable information will not be associated in any way with the feedback you provide;
- Understand that your feedback may be included in future publications related to this study;
- Understand that there is minimal risk associated with your involvement in this study.

[Submit Button]

Appendix E - Sample Survey Questions

1. Please indicate your area of training:
    a. Pediatric cardiac surgery
    b. Pediatric cardiology
2. Please indicate your current level of training:
    a. Residency (In progress)
    b. Fellowship (In progress)
    c. Attending Physician
    d. Other _____
3. Please indicate the visual aids you have typically used in learning about congenital heart diseases (check all that apply)
    a. Static images (E.g. Illustrations, photos, diagrams, etc.) from printed materials (textbooks, papers, etc.)
    b. Self-created static images
    c. Operating Video Footage
    d. Animations
    e. Other _____
4. With regard to accessibility and ease of use, which educational platform do you prefer using in order of most (1) to least (5) (ranking)?
    1. Print textbooks
    2. Electronic textbooks
    3. Internet/Online websites
    4. Desktop apps
    5. Mobile apps
    6. Augmented reality/virtual reality apps
5. If you have used any e-learning apps/modules in the past during your medical career, please list them below and any features you liked/disliked about them (E.g. Khan academy, Clinical Sense, Open pediatrics) (Open-text field)

The learning resource/tool we are planning to create will be used by post-graduate medical professionals for congenital heart disease. What would you find most valuable from this type of resource? Please rate the following on a scale of very valuable to not valuable at all.

	Not Valuable	Somewhat Valuable	Neutral	Valuable	Very Valuable
Anatomy and morphology of individual lesions	◯	◯	◯	◯	◯
Natural History	◯	◯	◯	◯	◯
Physiology of the lesions	◯	◯	◯	◯	◯
Clinical presentation	◯	◯	◯	◯	◯
Diagnosis	◯	◯	◯	◯	◯
Imaging	◯	◯	◯	◯	◯
Initial management and assessment	◯	◯	◯	◯	◯
Medical management and treatment	◯	◯	◯	◯	◯
Intervention options	◯	◯	◯	◯	◯
Surgical options	◯	◯	◯	◯	◯
Surgical technique	◯	◯	◯	◯	◯
Surgical decision making	◯	◯	◯	◯	◯
ICU management	◯	◯	◯	◯	◯
Post-op general management	◯	◯	◯	◯	◯
Ward management	◯	◯	◯	◯	◯
Follow-up	◯	◯	◯	◯	◯

Information on outcomes	◯	◯	◯	◯	◯
Information on prognosis	◯	◯	◯	◯	◯

The following items are proposed learning objectives we intend to implement into the first iteration of the app. For each proposed learning objective, please indicate the degree to which you believe that the current learning tools available for the topic are sufficient for your learning needs:

	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Aortic Valve Disease	◯	◯	◯	◯	◯
Pulmonary Valve Stenosis	◯	◯	◯	◯	◯
Pulmonary atresia, intact septum	◯	◯	◯	◯	◯
Pulmonary atresia with MAPCAs	◯	◯	◯	◯	◯
Functionally single ventricle circulations	◯	◯	◯	◯	◯
Truncus arteriosus	◯	◯	◯	◯	◯
Atrial septal defects	◯	◯	◯	◯	◯
Coarctation of the Aorta	◯	◯	◯	◯	◯
Complete Atrioventricular Canal defect	◯	◯	◯	◯	◯
Ebstein's anomaly	◯	◯	◯	◯	◯
Total anomalous Pulmonary Venous Connection	◯	◯	◯	◯	◯
Ventricular septal defects	◯	◯	◯	◯	◯
Patent Ductus Arteriosus	◯	◯	◯	◯	◯
Tetralogy of Fallot	◯	◯	◯	◯	◯
Hypoplastic Left Heart Syndrome	◯	◯	◯	◯	◯
Transposition of the Great Arteries	◯	◯	◯	◯	◯
Congenitally corrected transposition	◯	◯	◯	◯	◯
Transplantation	◯	◯	◯	◯	◯
Mechanical Support	◯	◯	◯	◯	◯
ECMO	◯	◯	◯	◯	◯
Mitral Valve Disease	◯	◯	◯	◯	◯
Adult Congenital Heart Disease	◯	◯	◯	◯	◯
Cardiomyopathy	◯	◯	◯	◯	◯
Myocarditis	◯	◯	◯	◯	◯

Please write in below any additional educational needs that may exist or comments regarding the proposed learning objectives. (Open-text field)

We are planning to create a multimedia tool with media including, but not limited to, operative video footage, animations, interactive 3D models, and plain text. Please rank which type of media you consider to be the most useful in learning about CHD pathophysiology and intervention. (Ranking)

1. Operative video footage
2. Animations
3. Digital interactive 3D models
4. Static 3D models
5. Plain text with accompanying figures
6. Plain text
7. Schematic diagrams
8. Peer-reviewed articles

Please write below any other types of media that might be useful and why you think so. (Open-text field)

What other functionalities would you like to see from an educational e-learning tool? (E.g. Simplified media for patient consultations, option to upload articles and documents, field for note-taking, etc.) (Open-text field)

How would you find a learning platform most useful:

1. Learning tool at home
2. Quick reference for learning about conditions when at work
3. As a source at the bedside to help during rounds
4. As a source at the bedside to help guide treatment
5. Other ____

Appendix F - Interview Cover Letter [Included in E-mail to Participants]

Hello,

My name is Abeeshan Selvabaskaran, and I am a graduate student in the Biomedical Communications program at the University of Toronto Mississauga. For my master's research project, I am developing a learning resource/tool (animation, app, etc.) on congenital heart disease to be used in post-graduate medical education. My goal is to create a multimedia app that combines videos, animations, and potentially interactive models that can be an accessible learning tool for both students and professionals in the cardiac pediatrics. As part of this design process, I am looking for post-graduate medical professionals in pediatric cardiology or pediatric cardiac surgery to inform the user needs for this tool.

I would like to formally invite you to participate in this research study. Your participation will involve a single 30-minute interview where you will be asked to talk about some of the current learning challenges that exist for CHD. All participants will receive a $25 e-gift card to a dining place of their choice. For more information about this study or to participate in this study, please contact me at abeeshan.selvabaskaran@mail.utoronto.ca.

Many thanks,
Abeeshan Selvabaskaran

Master of Science in Biomedical Communication 2022 Candidate
Institute of Medical Science, Temerty Faculty of Medicine, University of Toronto
Email: abeeshan.selvabaskaran@mail.utoronto.ca
Phone: (647) 669-8345

Appendix G - Informed Consent Form [Document sent to participant interviewees]

Digital Learning Tool for Post-Graduate Medical Professionals in Cardiac Pediatrics

Principal Investigator: Abeeshan Selvabaskaran, MScBMC candidate
Dept. of Biology/Institute of Medical Science

Co-investigators: Dr. Derek Ng, BSc, MScBMC, PhD
Dr. David Barron, MB BS, MD, FRCP, FRCS(CT)
Michael Corrin, BFA, BA, Hons BSc, MScBMC, CMI

Invitation
You have been invited to participate in this interview on congenital heart disease (CHD) for post-graduate medical education. The aim of this interview will be to assess the educational needs that exist in this field to help develop a digital learning tool to support medical professional education within the context of CHD. Your responses will be valuable in helping us better understand the needs that exist in this field regarding learning objectives and user design decisions we plan to implement.

Your Role
This study is open to post-graduate medical professionals in pediatric cardiology or pediatric cardiac surgery. If you consent to participate in this study, you will be asked to take part in a 30-minute semi-structured interview about your experience with CHD education, possible learning objectives, and learning preferences. The interview will take place on Zoom at a time convenient for you.

Compensation
Participating in this interview will take approximately 30 minutes of your time. To compensate you for your time, you will be given a $10 gift card to a dining place of your choice. Compensation will be provided to participants who take part, whether in whole or in part, in the interview session. Participants withdrawing from the interview once it has been initiated, but before it has concluded, will receive the same compensation as those completing the entire session.

Voluntary Participation & Withdrawal
Your participation is completely voluntary, and you can choose to stop participating at any time during the interview without having to provide a reason. Should you choose to withdraw from the session, you may do so by informing the session facilitator and then simply leaving the locale or by informing the researcher by e-mail (see below) that you would like to be removed from the study.

Your participation and performance in this study will otherwise have no impact whatsoever on your professional standings or relationships at the University of Toronto. Feel free to contact the Office of Research Ethics at ethics.review@utoronto.ca or (416) 946-3273, if you have any questions about your rights as a participant.

Risks/Benefits
There will be no direct benefits from taking this survey, however your responses will provide valuable information regarding the educational needs for congenital heart disease in the medical field. The information you provide will help inform the creation of a learning tool that may benefit healthcare professionals (including yourself) in the field of CHD.

There are no known risks associated with your participation. Once you have completed the interview, you can remove any information you have provided by contacting the student PI (Abeeshan Selvabaskaran).

Confidentiality
All the information that you provide during this interview will be strictly confidential and anonymous. Any collected data will be identified with a unique, randomized participant number only. Your name or any other personally identifying data will not be associated with the data analysis.

If you have any questions or concerns about participating in this interview or would like to know more information, please feel free to contact this study's principal investigator.

Abeeshan Selvabaskaran, MScBMC candidate
Institute of Medical Science, Temerty Faculty of Medicine, University of Toronto Mississauga
abeeshan.selvabaskaran@mail.utoronto.ca
(647) 669-8345

Appendix H - Sample Interview Questions

1. What is the most challenging aspect of your residency with regard to CHD?
2. Do you currently use any digital learning platforms to help learn about CHD?
    - If so, what platforms do you use? What are the pros and cons about that platform?
3. What type of platform (mobile, desktop, web, textbook) do you prefer to learn on? Why?
    - Are there any accessibility concerns for certain platforms that made you choose your decision? (E.g. WiFi issues)
4. We are planning to create a digital education tool that incorporates the following: (2-3 options informed by survey data) since these were determined to be the most valuable resources for congenital heart disease learning. Do you think that these topics will benefit you in your training? How so?
    - Are there current learning resources available for these learning objectives? If so, are there any areas for improvement?
5. We have identified that some areas in CHD education that need more attention are (2-3 options from survey data). Do you believe that there is a need for learning about the (learning objectives from previous question) for these topics specifically?
    - Are there any other difficulties you have in learning about these topics?
6. Many medical professionals seem to consider these media important in learning about CHD pathophysiology and intervention: (top 2-3 options based on survey results). Do you agree with this?
    - If so, why are these tools most useful to you? (E.g. time consideration, visuospatial learning, etc.)
7. How do you suspect will be the best way to use this tool? (E.g. at home, at work, at bedside, etc.) Why?
8. What is a good indication to you that your education on a topic has improved after using an educational resource? (E.g. Better verbal communication of the problem with patients, more confidence in the topic, better foundational understanding of the topic, etc.)