



Change of Heart: Clinically Oriented Learning Outcomes from Virtual Embryonic 3D Heart Model

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BACKGROUND

- Teaching and learning of embryology are difficult due to complex four-dimensional changes.
- There are few virtual and 3D models, even though they are proven helpful. Typically, 2D illustrations are used as visual aids, but they ineffectively depict changes in 3D. (Figure 1)
- Heart outflow tract septation is exceptionally difficult to teach and learn due to the 3D complexity.
- This project aimed to; 1) create a 3D embryonic virtual heart (EVH) model demonstrating the normal and abnormal conotruncal septation, and 2) assess the educational impact and perception of the EVH.

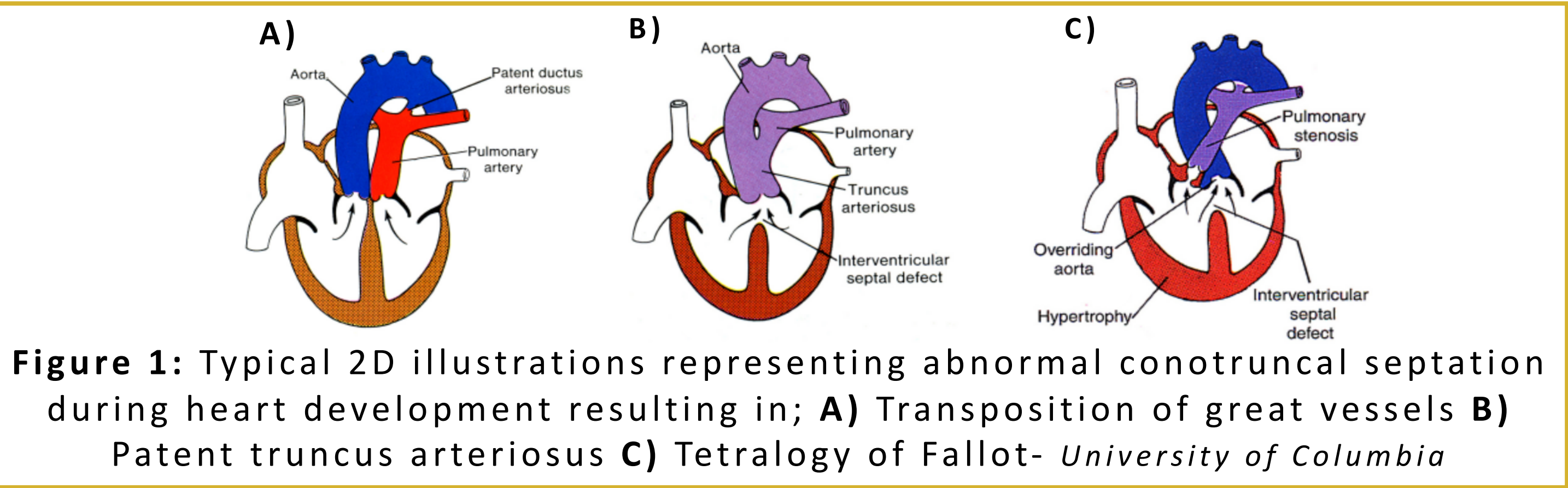


Figure 1: Typical 2D illustrations representing abnormal conotruncal septation during heart development resulting in; A) Transposition of great vessels B) Patent truncus arteriosus C) Tetralogy of Fallot- University of Columbia

HYPOTHESIS

- Interaction with the EVH during an active learning session will increase learning outcomes on the subject and positive perception of the resource in the first-year medical students.

MATERIALS & METHODS

- The EVH was created using Carnegie Collection from the National Museum of Health and Medicine as reference for anatomical accuracy. (Figure 2)

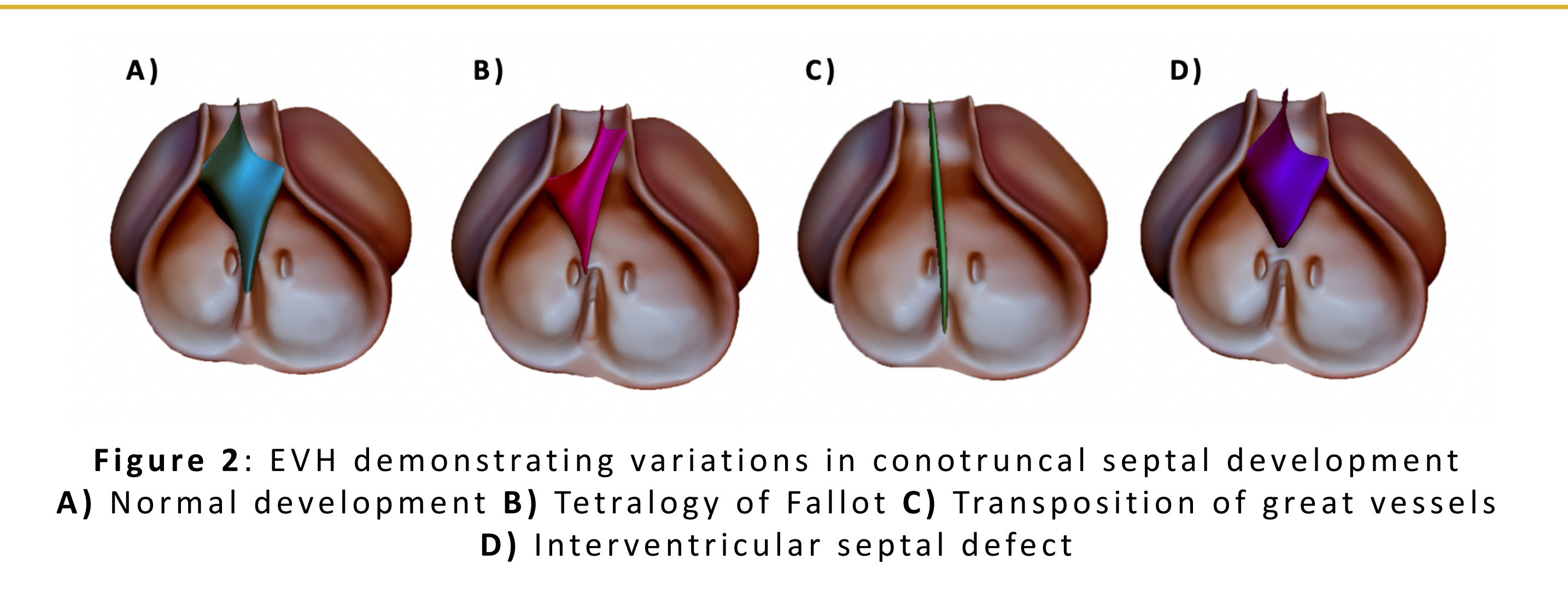


Figure 2: EVH demonstrating variations in conotruncal septal development A) Normal development B) Tetralogy of Fallot C) Transposition of great vessels D) Interventricular septal defect

- The educational efficacy of the EVH was assessed in a randomized single blind study with 1st year medical students during a synchronous virtual class. (Figure 3)

METHODS

Figure 3: Research Design

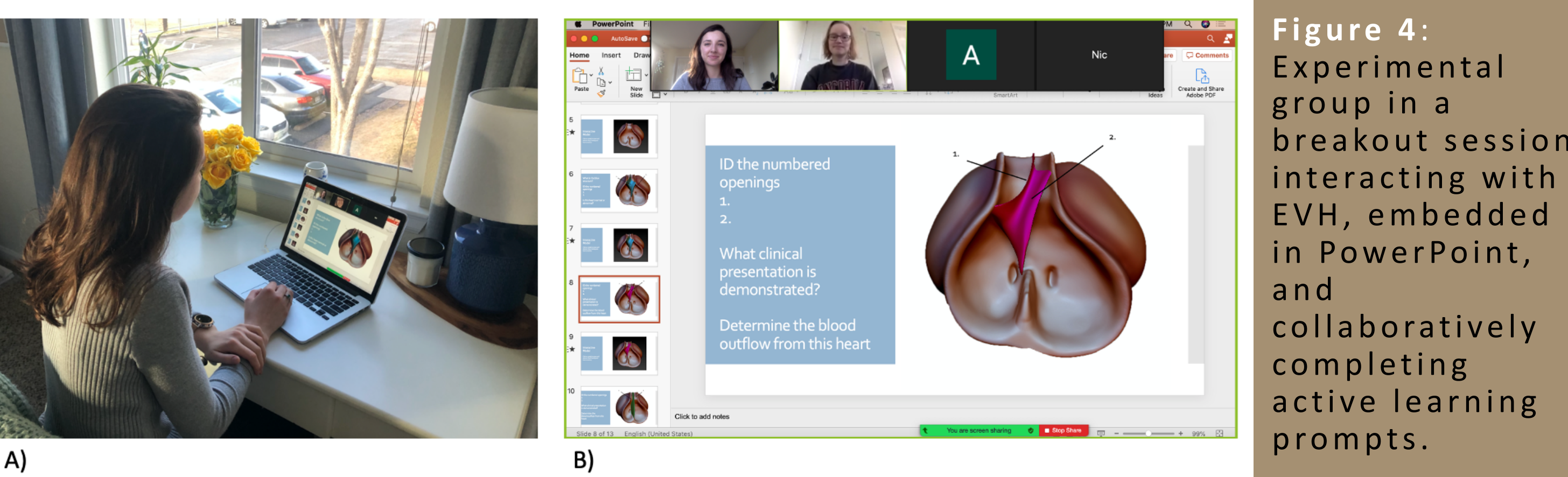
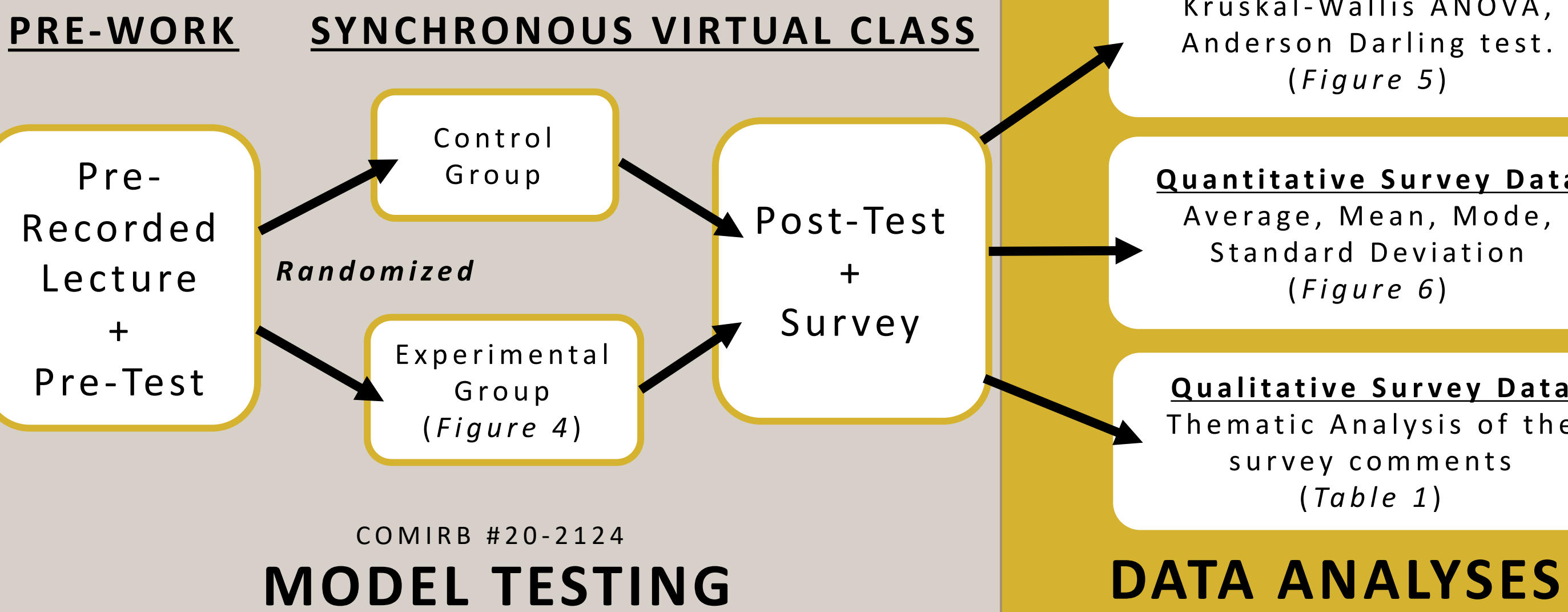


Figure 4: Experimental group in a breakout session interacting with EVH, embedded in PowerPoint, and collaboratively completing active learning prompts.

RESULTS

- Students did not perform statistically better on the post quiz compared to the pre quiz. Kruskal-Wallis (P=0.4348, df=3). (Figure 5)
- The EVH was rated highly helpful in understanding embryonic heart development, spatial, and temporal changes. (Figure 6)
- Despite high EVH perception, students rated themselves low on their confidence level in the material after EVH interaction. (Figure 6)

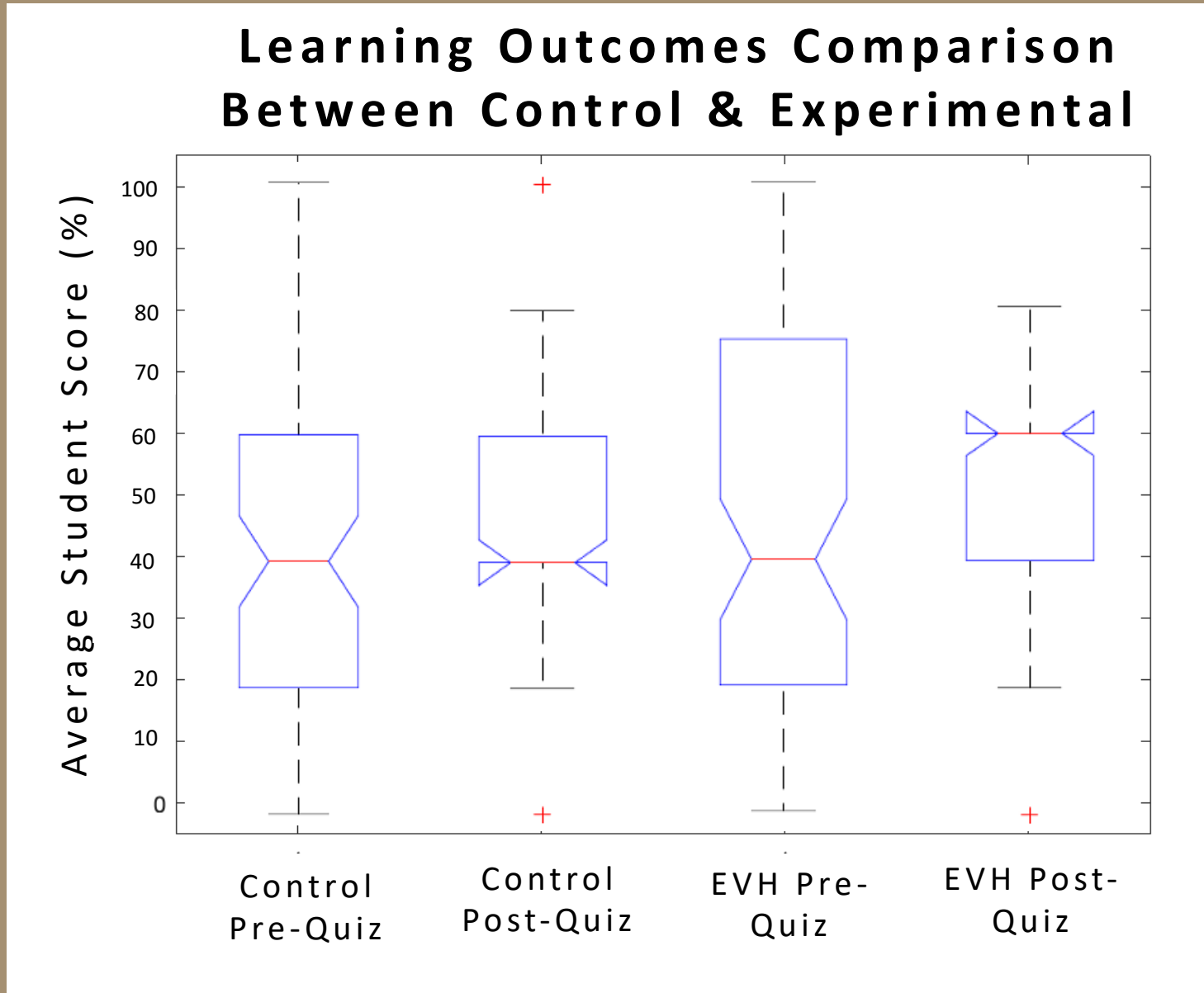


Figure 5: Distribution of student quiz scores for control and experimental groups

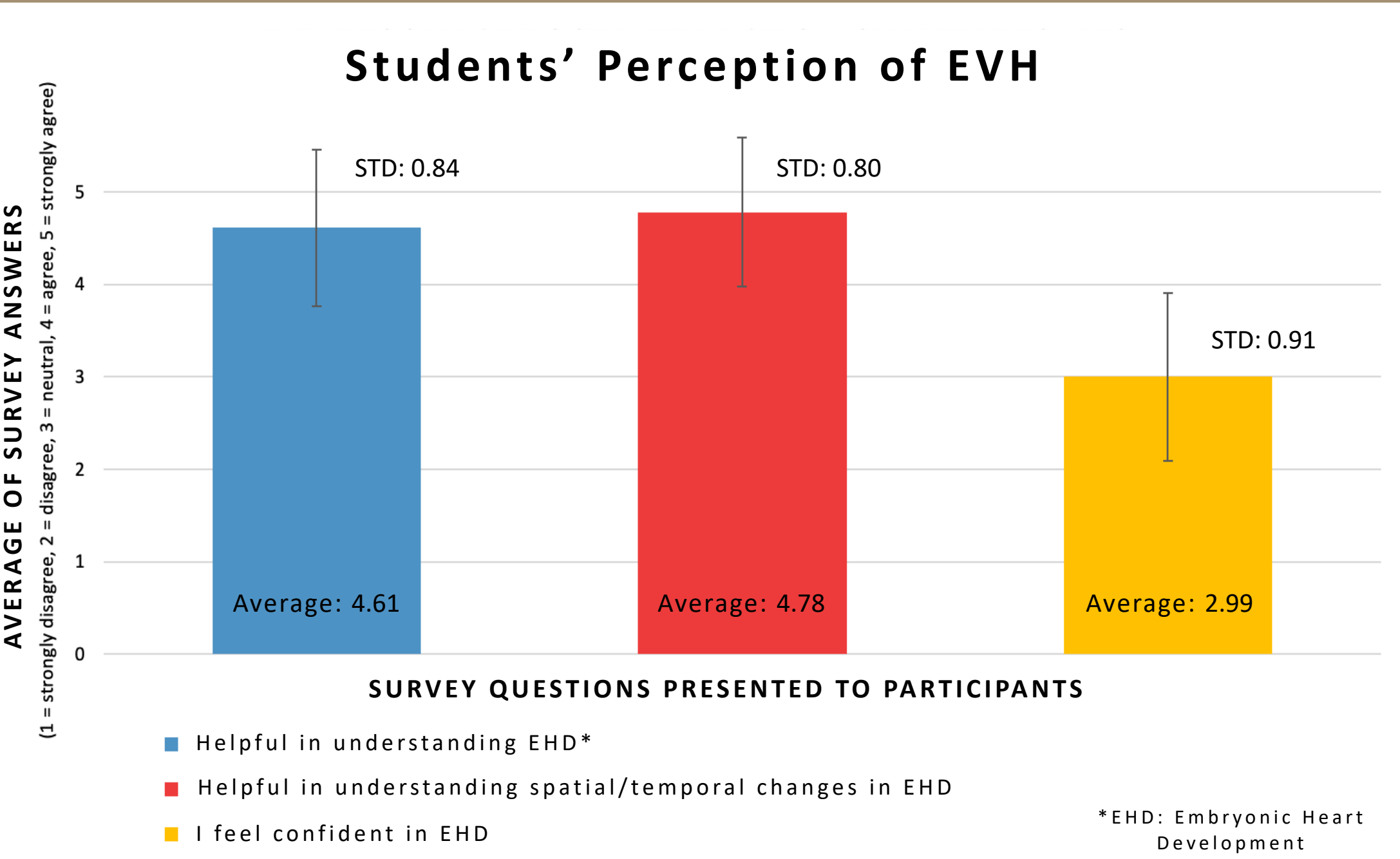


Figure 6: Survey Likert scores on student perception of the resource and confidence level.

RESULTS

Table 1: Themes from survey comments on perceived strength and weakness of the EVH

THEMATIC ANALYSIS RESULTS	
EMBRYONIC VIRTUAL HEART STRENGTHS	<ul style="list-style-type: none">INCREASED UNDERSTANDING: "I am really impressed by Marissa's model -- it truly helped me visualize the clinical presentations of the abnormalities, as well as have a better understanding of the normal morphology."STRUCTURE VISUALIZATION: "I really appreciated the 3D models - during the lecture it was hard for me to visualize the structures."NEED FOR MODEL: "I loved the model! This type of model saves me so much time of trying to guess what it actually would look like in 3D. For the prior unit, I had to scour the internet looking for a 3D model of the gastrulation and neurulation processes with no luck. I wish I had something like this before!"
EMBRYONIC VIRTUAL HEART AREAS OF IMPROVEMENT	<ul style="list-style-type: none">MORE INFORMATION: "I would love to see more detail in the cardiac folding process or septation. I'm having trouble visualizing all the folding, blood flow, and various embryonic layers that contribute (particularly in the formation of the diaphragm)."REVISED PLATFORM: "I love that you have control of the video, though it might be more helpful to have control of the entire structure and be able to move it around yourself."TIME CONSTRAINTS: "There was very limited time to interact with the resource, so I feel that I did not get to adequately evaluate the utility of the resource at the time of taking this survey."

CONCLUSION & DISCUSSION

- EVH did not enhance learning outcomes.
- EVH is perceived to be high in educational value.
- Spatial and temporal demonstration of complex developmental events are important in a virtual and interactive model such as EVH.
- Lack of sufficient time for EVH interaction was identified as an area of improvement.
- Other confounds related to virtual classroom environment should be considered in interpretation of study outcomes.

FUTURE AIMS

- Further development of EVH with an added animation of the normal and abnormal blood flow and heartbeat in an app interface. (Figure 7)
- Confound reduction and increased allotment time for EVH interaction.

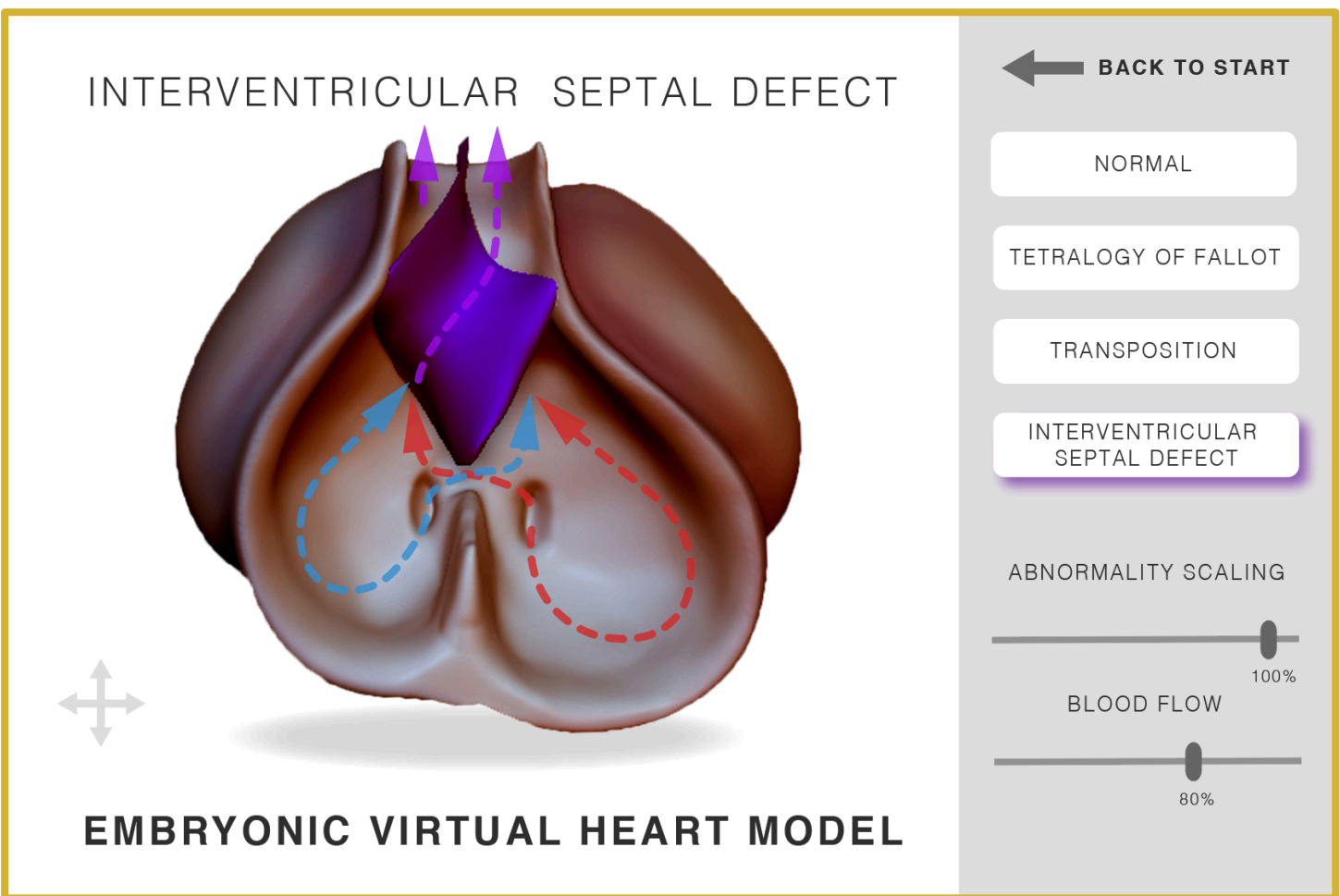


Figure 7: Developing app storyboard.

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