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University of Iowa Carver College of Medicine
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# Virtual Reality as an Educational Tool for Teaching Congenital Heart Disease

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# Background

In the field of medicine, virtual reality (VR) is already used to teach anatomy, simulate surgical environments, and visualize patient-specific medical issues

Students using VR and 3D visualization to study anatomy have reported that this technology aids them in better understanding the location of anatomic structures. There is evidence to suggest that using 3D visualization to study anatomy can improve student performance [1,2,3]

In 2020, a Korean group of researchers reviewed the utility of three-dimensional visualization techniques (VR, augmented reality, 3D printing, etc.) in teaching congenital heart disease (CHD) and concluded, "A digital library of 3D images and 3D printed models embracing the entire spectrum of CHD should be established and would be tremendously beneficial for medical education."[4]

Project Aim:

# Develop and Evaluate the Effectiveness of VR Educational Modules to Teach Congenital Heart Disease

# Methods

### Segment

Generate heart models from patient CT scans

### Build

Combine models with other learning tools to create educational VR modules

### Evaluate

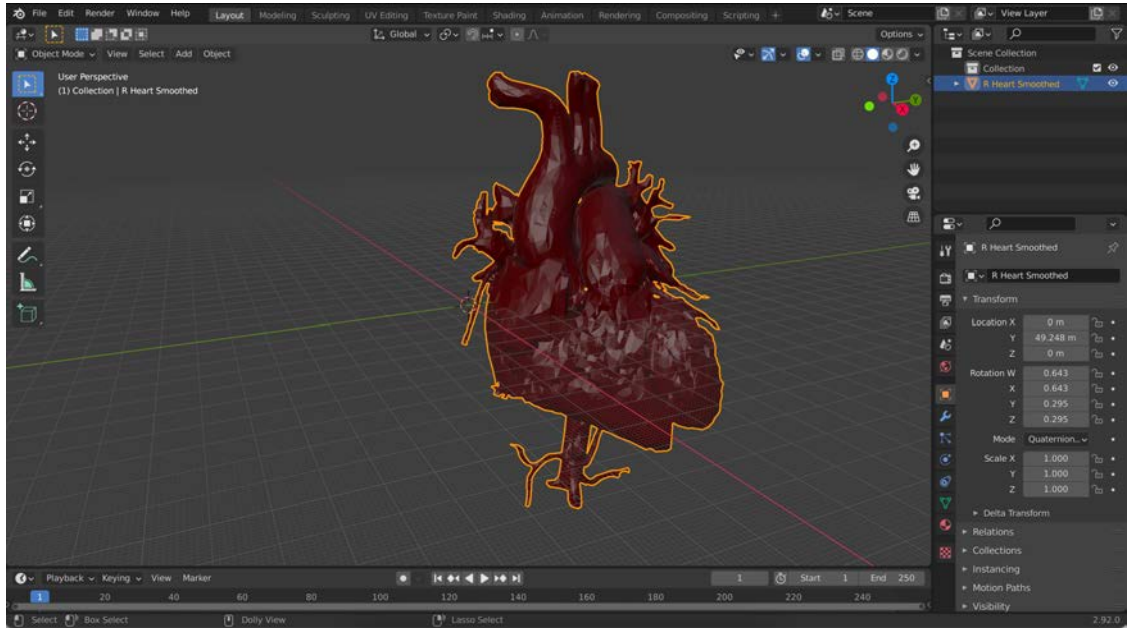
Use quizzes and surveys to compare VR modules to traditional learning techniques

# Methods: Segmentation

Use Materialise Mimics Medical (or equivalent segmentation software) to generate a heart model from the CT scan of a patient with a congenital heart defect

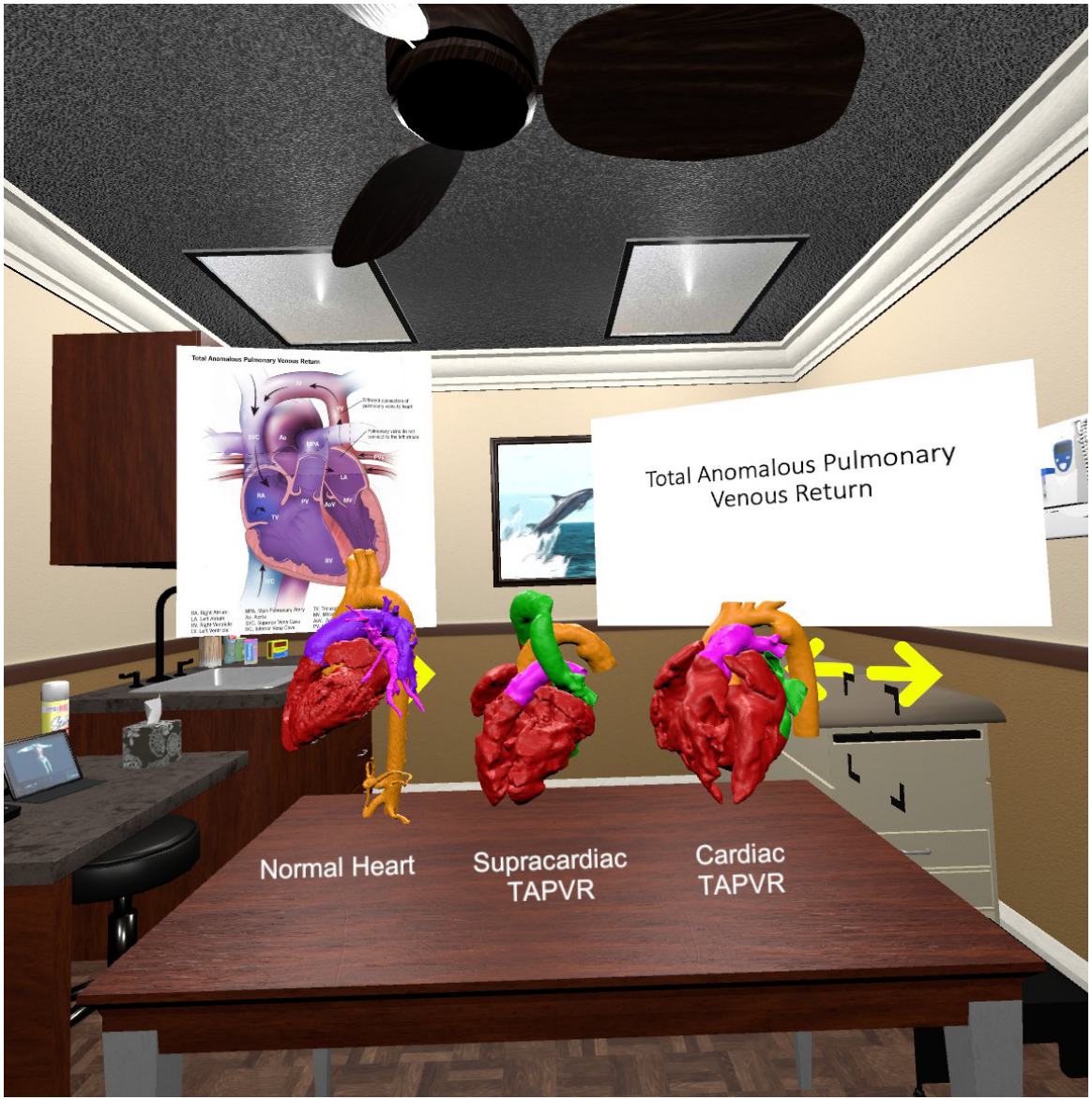
# Methods: Model Processing

Process models using Blender to hollow the model, add color, smooth blemishes, and reduce the file size

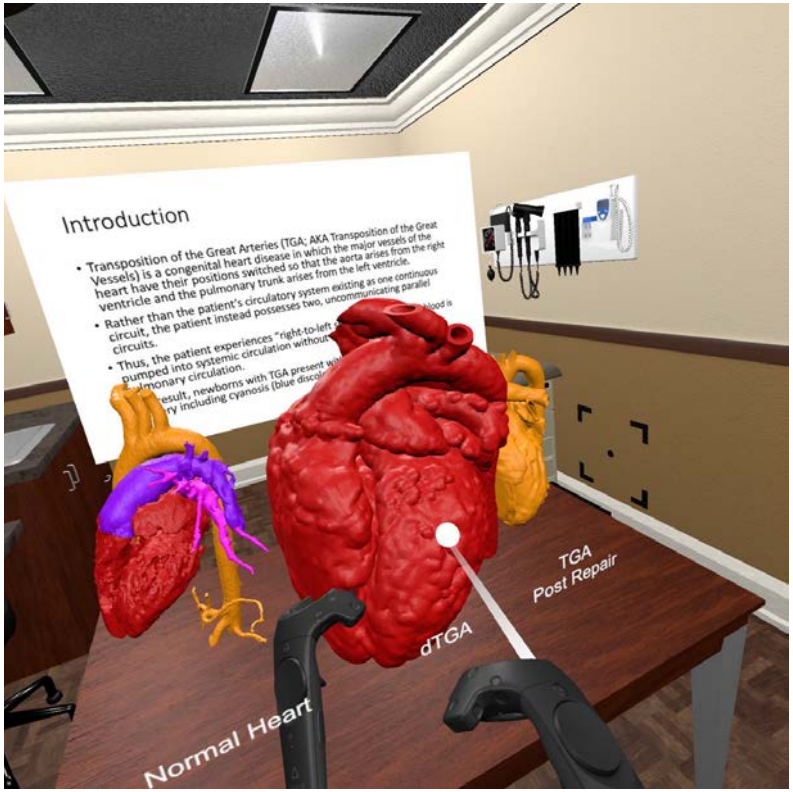


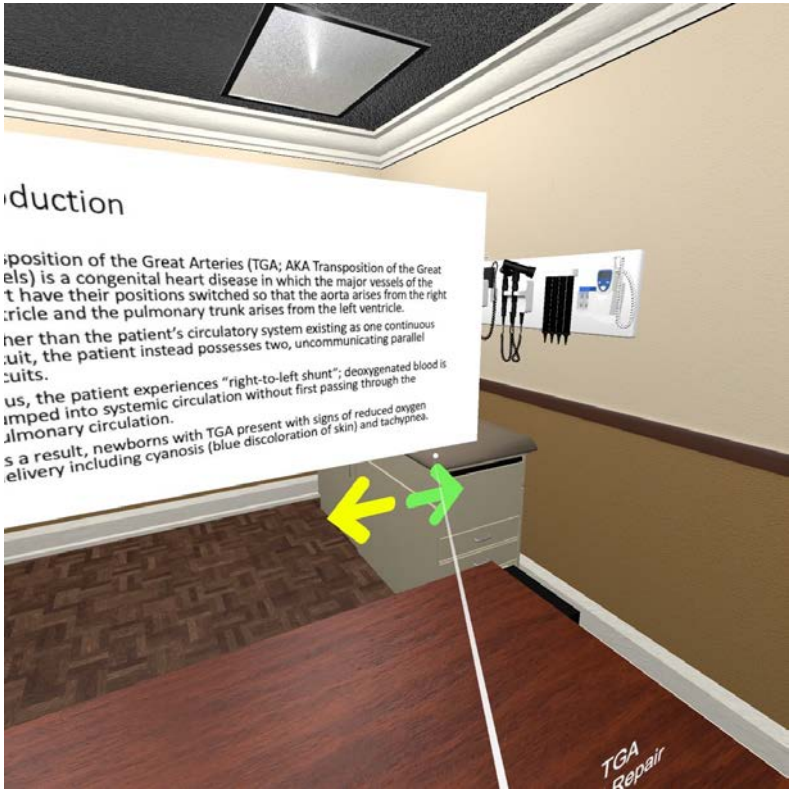
# Methods: Module Development

- Combine heart models with informative text, diagrams, videos, and echocardiogram clips in Unity (a video game development software) to create an interactive, VR module
- Modules were created to teach the five cyanotic congenital heart diseases to medical students, residents, and fellows at UIHC

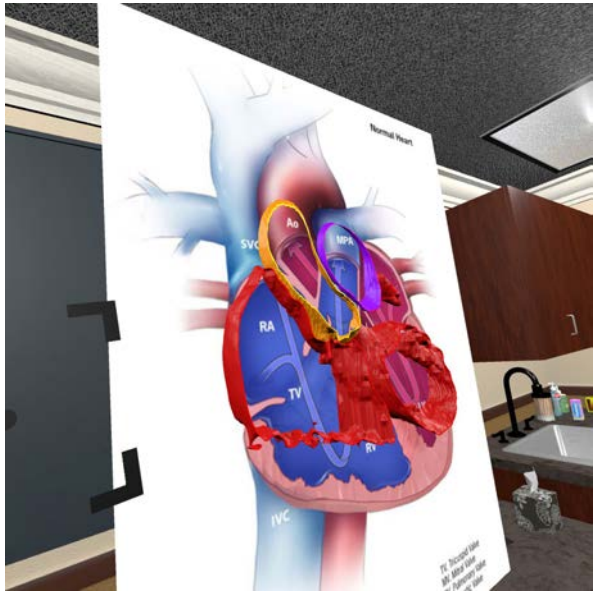


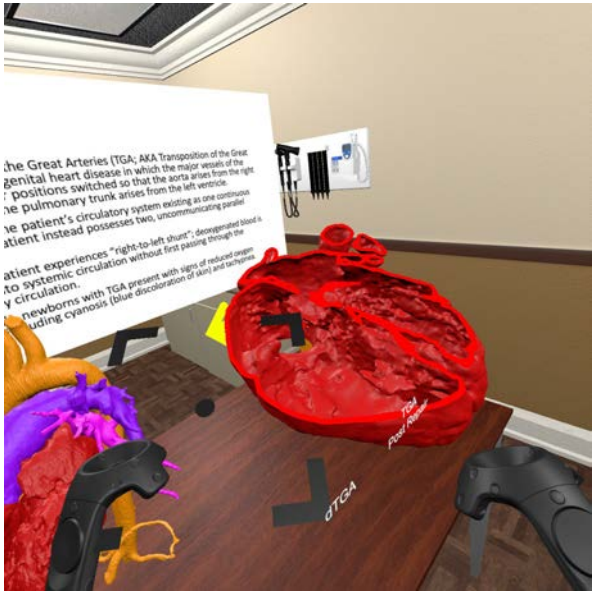
# Interactive models and study materials

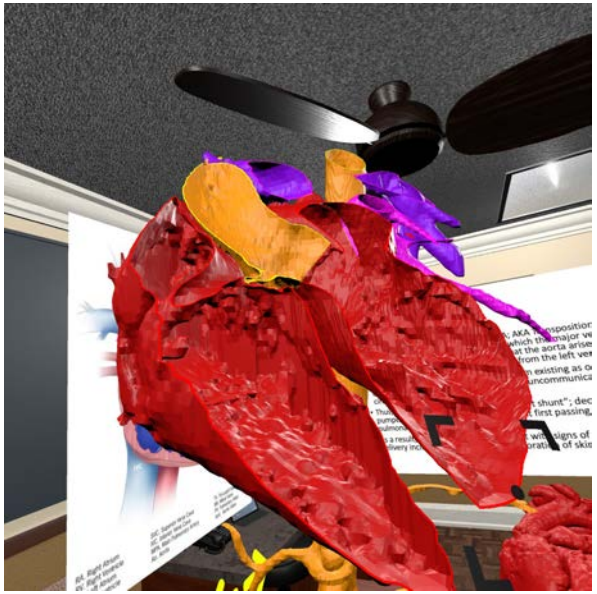


# Cutting tool to view internal features



# Methods: Evaluation of Modules


**Step 1:**
**Pre-quiz over heart defect**

**Step 2:**
**Participants spend 15 minutes interacting with VR module or study guide with equivalent information**

**Step 3:**
**Post-quiz over heart defect**

**Step 4:**
**Control group tests VR modules**

**Step 5:**
**Survey over VR experience to measure enjoyability, engagement, and ease-of-use**

# Participant and Quiz Information

- 32 medical students from the Carver College of Medicine
- Participants were recruited via mass email to the college
- Students were randomly assigned one of two heart defects (Transposition of the Great Arteries or Tetralogy of Fallot) and to the experimental or control group
- The VR modules and the study guide contained the same information and diagrams

# Results: Quiz Scores

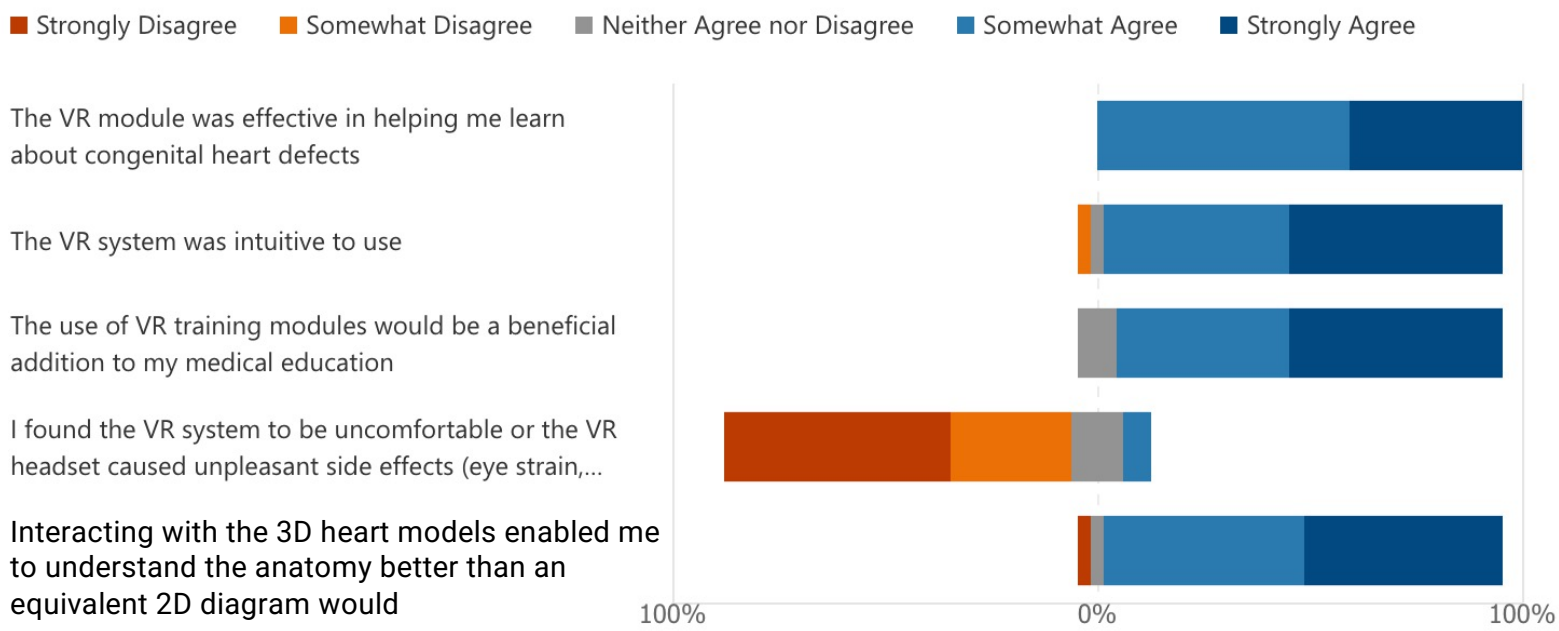
**Transposition of the Great Arteries**

| Group | Pre-Quiz Average | Post-Quiz Average | Average Improvement |
|---|---|---|---|
| Control (n=8) | 44.79% | 93.75% | 48.96% |
| Experimental (n=8) | 50% | 91.66% | 41.66% |
| | | p=0.62 | p=0.58 |

**Tetralogy of Fallot**

| Group | Pre-Quiz Average | Post-Quiz Average | Average Improvement |
|---|---|---|---|
| Control (n=8) | 47.92% | 90.63% | 42.71% |
| Experimental (n=8) | 63.54% | 93.75% | 30.21% |
| | | p=0.089 | p=0.126 |

# Results: Survey Answers

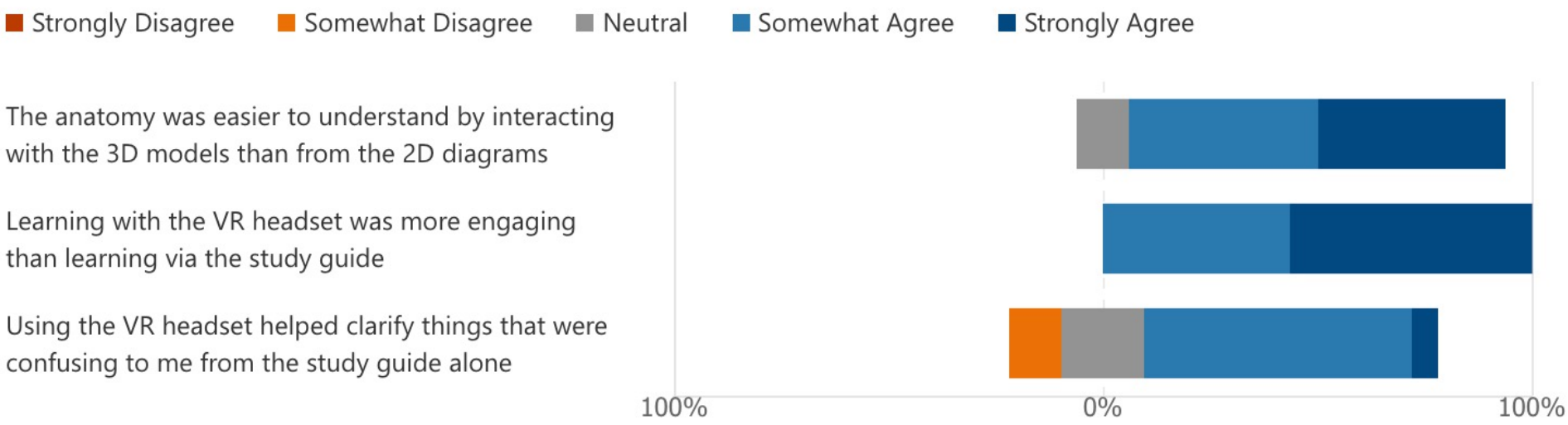



How likely would you be to use [the VR educational modules] to study for an anatomy class? (5 = likely; 1= not likely at all)

Average response: 4.22

# Survey Answers cont.

Of the 16 members of the control groups who used both study materials:



# Select comments from the survey

- “Compared to cyber anatomy or other anatomical computer models, this is second to none.“
- “I loved seeing the heart models in a 3d way. It was amazing to be able to control/manipulate the models and see cross-sections.“
- “This was much easier than looking at multiple 2D diagrams and trying to connect them into a ‘mental 3D image’.”
- “This was absolutely awesome. I would definitely use this as a learning module. I truly believe that this would be an incredibly valuable learning tool for learning both healthy anatomy and pathological specimens.”

# Conclusions

- VR modules can be developed cheaply for the purposes of education and case-specific visualization of abnormal anatomy
- Although we could not show that VR was better or worse than a study guide at helping students learn and retain information about heart defects, the responses on the survey demonstrate that virtual reality can provide a welcome and beneficial supplement to the education of medical students when studying congenital heart defects

# Looking Ahead

- We plan to use these modules to develop further VR projects involving cyanotic patient workup simulation
- The techniques described can be used to create educational modules for additional topics within Cardiology and other medical specialties
- Case-specific models can be made to assist surgeons and interventional cardiologists while preparing to treat patients with complex, abnormal cardiac anatomy

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# Questions? Contact:

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# Thank you!

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