

# Steps for Adapting Augmented Reality Learning Modules in Dental Education Utilizing the Microsoft Hololens

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## Background and Purpose

Over the past decade there has been a continuous debate over the needed change for dental education.<sup>1</sup> The question in dentistry is no longer, “Should we acquire new technologies,” but which ones are most beneficial to patient care.<sup>2</sup> The face of dentistry has changed outside the classroom, which calls for an equally impressive change within. One such change is the utilization of Augmented Reality (AR) to create an immersive learning environment through the utilization of the Microsoft’s HoloLens. AR is a technology that superimposes a computer-generated image on a user’s view of the real world.

## Specific Aims

1. Analyze the dental curriculum to establish where incorporation of AR is needed.
  - Gross Anatomy and Dental Anatomy and Occlusion
2. To establish an effective AR learning module in dental education.
  - Tooth Identification, Dental Anatomy, and Comparative Anatomy
3. Qualitatively compare AR learning modules to traditional learning modules and lecture styles.
  - Student and Faculty Analysis

## Hardware

- OS: Windows 7 SP1+, 8, 10, 64-bit versions only; Mac OS X 10.9+.
- CPU: SSE2 instruction set support.
- GPU: Graphics card with DX9 (shader model 3.0) or DX11 with feature level 9.3 capabilities.
- Ram: Minimum 6GB
- Processor: I6 or I9

## Software

- Windows Store: Windows 8.1 (64-bit)
- Visual Studio and platform SDK:
  - Universal Windows Platform (UWP): Windows 8.1 (64-bit), Visual Studio (2015+) and Windows 10 SDK;
  - IL2CPP scripting backend also requires C++ compiler feature to be installed with Visual Studio.
- Unity 2017
- MixedRealityToolkit-Unity
  - Window Device Portal
- HoloLens Emulator
- Holographic Remote Player



## Intergrative Timeline

Year 1 (2016-2017)	Years 2-3 (2017-2019)	Years 4-5 (2019-2021)	Years 6-8 (2021-2023)
<ul style="list-style-type: none"><li>• Receive Microsoft Inc. HoloLens hardware.</li><li>• Purchase additional computers with Windows 10 (Sole purpose of holographic application development).</li><li>• Identify 1-2 representatives from each class to utilize the HoloLens for enhancing their ability to analyze 3D CBCT renderings of surgical sites for addressing pathology and determining dental implant placement.</li><li>• Instructor guided teaching of Medical and Dental students through demonstrations of cadaver dissections in gross anatomy lab, dental laboratory procedures, and surgical procedures while wearing smart glasses.</li><li>• Formally adopt the holographic technology through the grand opening of the Holographic Simulation Center.</li><li>• Purchase 3D iSense scanner.</li><li>• Establish a holographic database image collection.</li><li>• Begin scanning key images/objects to be added to holographic image database.</li><li>• Begin engaging our collaborative external partners through plans to implement model at other institutions.</li><li>• Create comparative dental anatomy App. for HoloLens.</li><li>• Implement student usage of 3D design software for the practice of digitally designing 3D teeth.</li></ul>	<ul style="list-style-type: none"><li>• Obtain specialized holographic camera thereby allowing multiple students to view same images as wearer/user simultaneously.</li><li>• Purchase additional HoloLens units.</li><li>• Utilize HoloLens while assisting during an oral surgery procedure (after determining best methods for infection control).</li><li>• Students begin interacting with holographic simulation patients.</li><li>• Students begin utilizing distance learning and simulated tele-dentistry through the use of the holographic technology at other institutions.</li><li>• Formal grades given for HoloLens utilization within several preclinical and behavioral didactic courses: 1) D2 Analytical Reasoning and Critical Thinking, 2) D2 Biomedical Integration, 3) D2 Dental Implantology, 4) D3 Behavioral Management</li></ul>	<ul style="list-style-type: none"><li>• Integrate the HoloLens into clinical setting for patient anxiety control measures.</li><li>• Establish simulated holographic injection technique application with collaborative partners (incorporate 3D printing to tangibly foster this process).</li><li>• Begin administering formal holographic examinations to assess students' knowledge.</li><li>• Students are allowed to explore their own ideas for various uses of the technology.</li><li>• Utilize this technology within the Operating Room (develop any additional applications needed for this process).</li></ul>	<ul style="list-style-type: none"><li>• Students develop holographic dental portfolios.</li><li>• Continue to upgrade all systems/products at least every 3-years.</li><li>• Quality assurance assessment of surgical cases that utilized holographic technology compared to those that did not.</li></ul>

The color of the cell in the table, corresponds to the years in which that particular aspect of the holographic technology integration process will occur in the curriculum. Blue: Yr. 1, Purple: Yrs. 2-3, Orange: Yrs. 4-5, Green: Yrs. 6-8

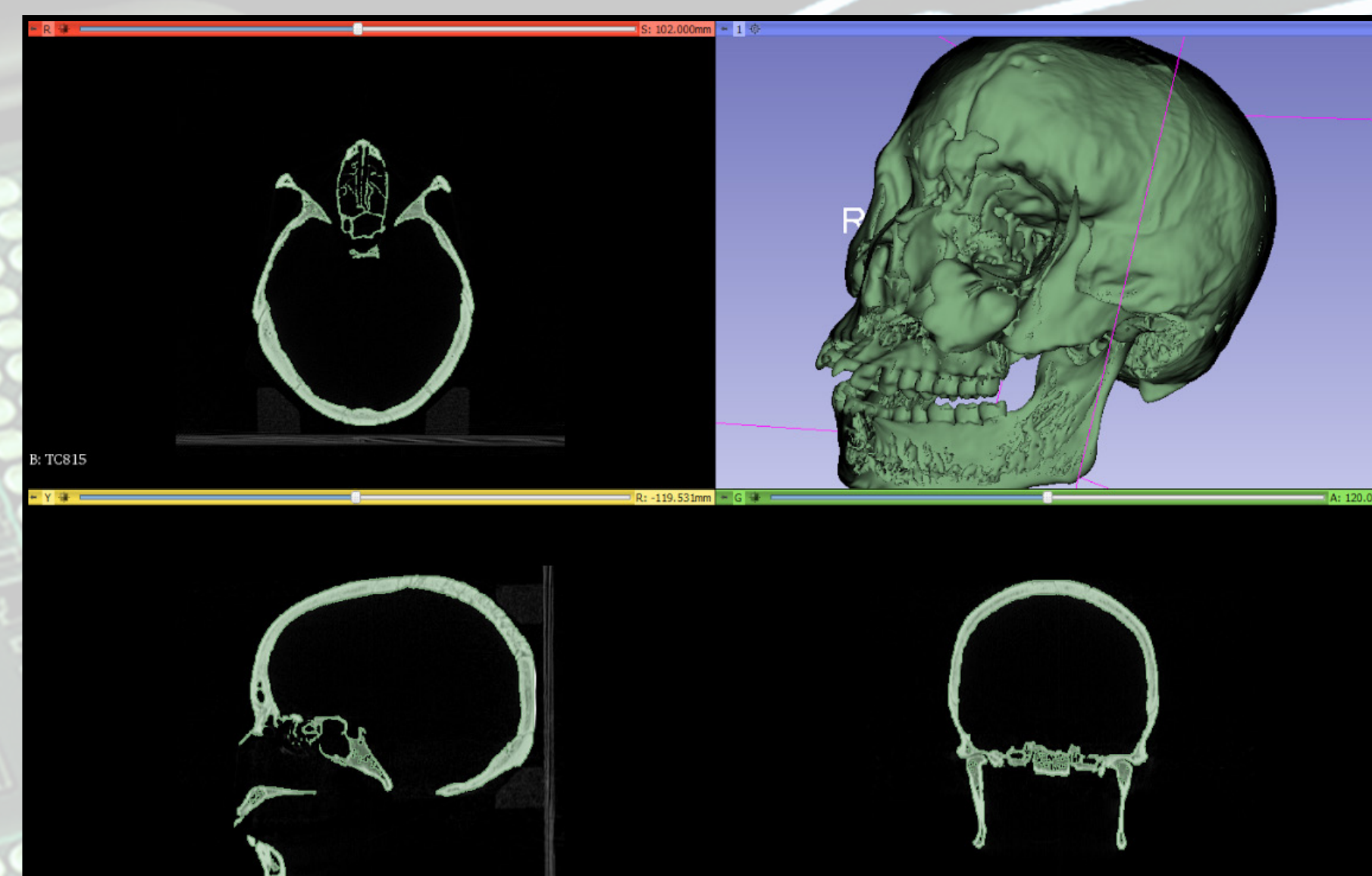
## Steps of Application Building

### Step 1

#### Create 3D Assets

1. Digital format conversion
2. DICOM, NRRD, NIFTI
3. 3D Slicer

### 3D Slicer



### Step 2

#### Coding (C#)

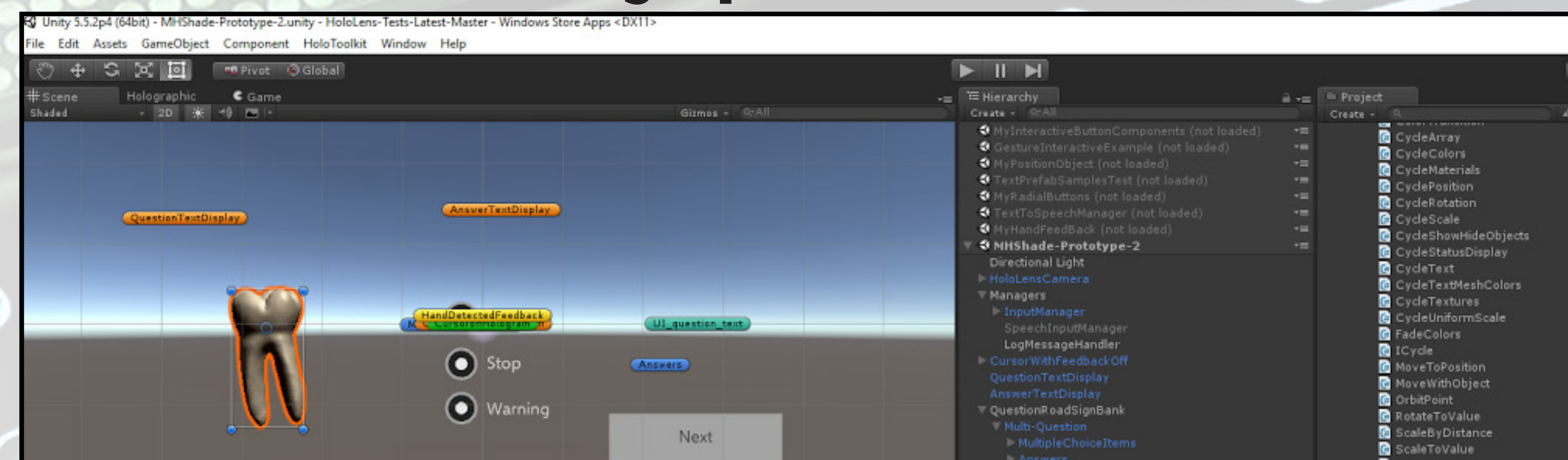
1. Implement Features (gaze, gesture, speech, spatial understanding)

### Step 3

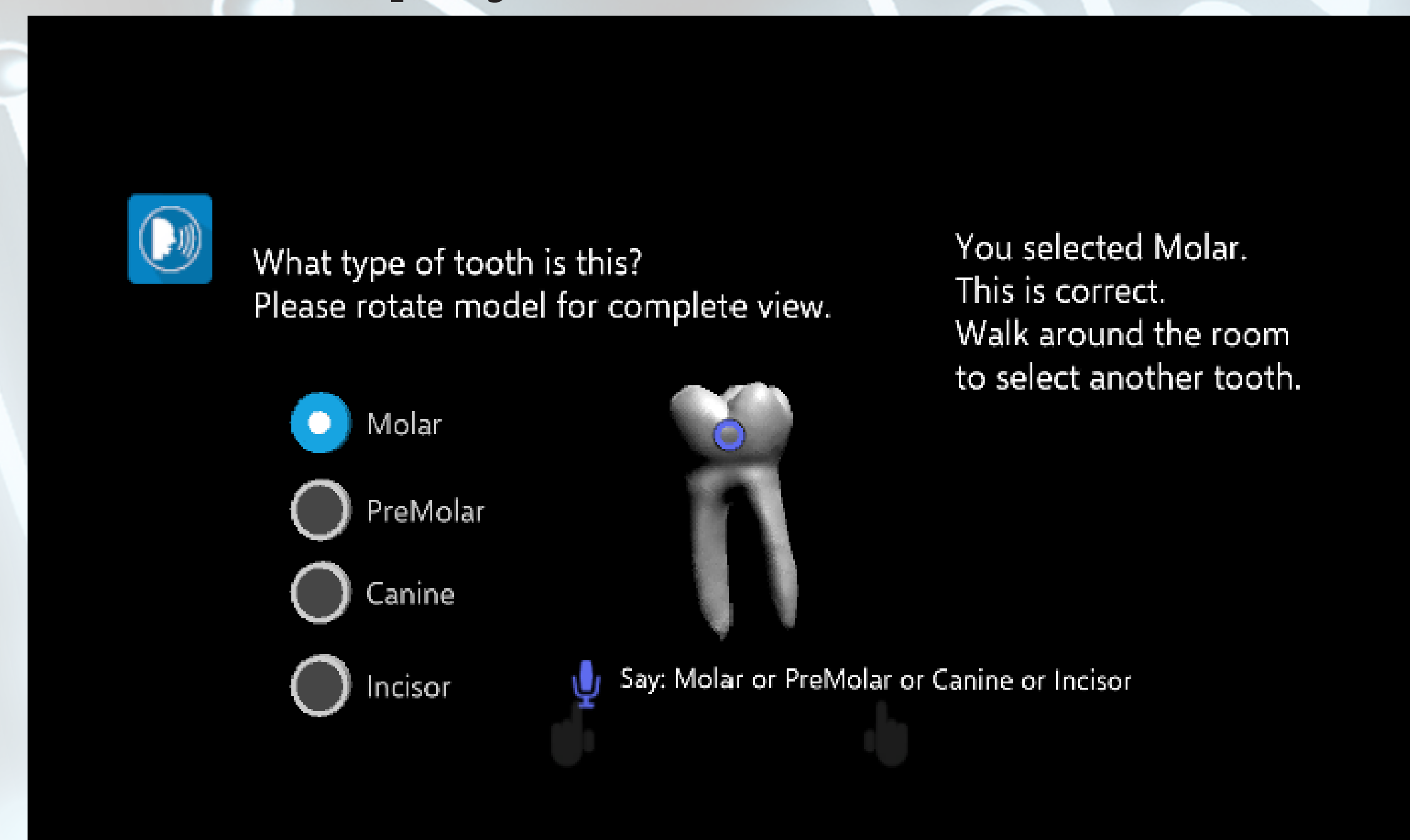
#### Application Testing

1. Holographic Remote Player
2. Holographic Emulator
3. Unity

### Holographic Emulator



### Deployed with Visual Studio



## Technological Development

Date	Student Doctor	Task Completed	Time Logged (hrs)
5/4/17	Mitchell Mascaro and Malcolm Shealer	Research Articles	2
5/18/17	Mitchell Mascaro and Malcolm Shealer	Research Articles	2
6/13/17	Mitchell Mascaro and Malcolm Shealer	Starting Project / Downloads	4
6/28/17	Mitchell Mascaro and Malcolm Shealer	Prototype 1.1	2
6/27/17	Mitchell Mascaro and Malcolm Shealer	Prototype 1.2-1.4	4
7/14/17	Mitchell Mascaro and Malcolm Shealer	Bounding box / Prototype 1.5 Test	3
7/15/17	Mitchell Mascaro and Malcolm Shealer	Sharing package and Update	3
7/18/17	Mitchell Mascaro and Malcolm Shealer	Sharing Gesture 1.1	1.75
7/21/17	Mitchell Mascaro and Malcolm Shealer	Sharing Gesture 1.2 Tooth	1.5
7/27/17	Mitchell Mascaro and Malcolm Shealer	Sharing Gesture 1.5-1.6	2
Total Time Logged:			25.25 Hours

Time log for application building and development.

## Conclusion

The study investigates the correlation between learning outcomes and the utilization of AR and the Microsoft HoloLens in education. Learning outcomes are based on how the information is delivered and what learning styles are incorporated. Because of the holistic environment that the Microsoft HoloLens provides, all seven learning styles: Visual, Aural, Verbal, Physical, Logical, Social, and Solitary can be tied together; thus creating the most effective learning environment. The incorporation of Augmented Reality technology will not only move dental education to the forefront of mainstream education, but also promote a trend of enhanced quality of care.

## References

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2. Levin R. Technology in dentistry. *Compendium of Continuing Education in Dentistry*. 2002; 23: 774-776.
3. ADEA Commission on Change and Innovation New Orleans, Louisiana, June 2016
4. ADEA Dean's Conference San Francisco, November 2016
5. ADEA Annual Conference San Diego, March 2017
6. Tennessee Tribune May 2017
7. Black Caucus, Washington D.C. October 2017
8. ADA News October 2017
9. TedMed Nashville, TN, November 2017

## Acknowledgments

- Microsoft Corporation
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- Thelma Looms, D.Sc., M.Ed
- **Principal Investigator:** Gerald Davis II, D.D.S., M.A

**Application Release:** 2017-2018 Application release in Google Play, Microsoft and Apple App. Stores.