“Is this mine to keep?” 3D printing enables active, personalised learning in anatomy

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Ocular & orbital anatomy

• Core competency for optometrists
• 3D spatial relationships
Dr Simon Backhouse
Deakin strategic plan

Learning: offer a brilliant education

*where you are* and where you want to go

—Anywhere, anytime
The Solution

• Personalised learning experience where students can truly **grasp** spatial relationships between the orbital bones
• High resolution 3D scanner & consumer grade 3D printer
• Printed one model per student: 3D orbit was theirs to **keep**
The solution

<table>
<thead>
<tr>
<th>Consideration</th>
<th>Traditional resource</th>
<th>3D printed model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expensive</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Ethical issues</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Fragile</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Student: resource ratio</td>
<td>high</td>
<td>1:1</td>
</tr>
<tr>
<td>Active learning</td>
<td>Low-med</td>
<td>high</td>
</tr>
<tr>
<td>Personalised experience</td>
<td>✗</td>
<td>✓</td>
</tr>
</tbody>
</table>

Learning activity

**Art 2: Orbital Bones and Orbital and Facial Muscles (Anatomy Dry Lab)**

Work in groups of 2 to 4. There are three tasks to complete in this section, and each task should take approximately 15 minutes. Due to the limited numbers of some of the resources you will have to rotate through each of the tasks. Please ensure you get through each of the tasks and make sure you are courteous to others in your class by not spending too long with one resource to enable everyone to get through all the tasks in the allotted time.

**Ask 1: Orbital Bones**

You will each be provided with a 3D printed scale model of the human orbit. These have been reconstructed from a high-resolution 3D scan of an existing skull in our inventory.

**Step 1:** Using a fine black marker, **draw in the sutures** (connections) between the different bones that make up the orbit.

**Step 2:** Using a different coloured marker for each bone, **colour in each of the bones of the orbit**. You can use any of the other resources available to you in the practical class to help you to complete this. Pay particular attention to how the bones sit **relative to each other**. Ensure you also colour in your posterior or lateral aspects of the bones, where present, to give you a better understanding of their relationships and locations. Please note that some bones are only partially represented in this model, and other resources should be used in conjunction with these models to provide a thorough understanding of the orbital bones.

**Step 3:** Complete the table below by indicating which colour you have made each of the orbital bones.

**Step 4:** Repeat Step 3 using the models prepared by three of your classmates. Once you have all completed this task, discuss with each other any difficulties you had identifying the bones or any differences in bone identification that may have occurred.

**Practical Class Reflection:**

Please write an approximately 100 word piece below reflecting on the knowledge you acquired during the practical class.

- What did I learn that is new?
- What do I need to spend more time on?
The prac class
Evaluating Students’ Opinions

Voluntary & anonymous survey
n = 69, 85% response rate

Complete this sentence...

In terms of my learning, the best thing about the 3D model was...

The 3D orbit: Helped me understand spatial relationships btw orbital bones

Strongly disagree  Disagree  Neutral  Agree  Strongly agree
Understanding of spatial relationships

The 3D orbit helped me to understand the spatial relationships between the orbital bones.

Having my own 3D orbit allowed me to...

<table>
<thead>
<tr>
<th>Rating</th>
<th>Frequency (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
<td>45</td>
</tr>
<tr>
<td>Agree (4)</td>
<td>5</td>
</tr>
<tr>
<td>Neutral (3)</td>
<td>1</td>
</tr>
<tr>
<td>Disagree (2)</td>
<td>2</td>
</tr>
<tr>
<td>Strongly disagree (1)</td>
<td>1</td>
</tr>
</tbody>
</table>

n=69; \( \chi^2(4) = 100.78, p<0.001 \)
Co-creating the learning resource

I liked that I added to the creation of the 3D orbit by colouring in the sutures and bones

<table>
<thead>
<tr>
<th>Rating</th>
<th>Frequency (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
<td>25</td>
</tr>
<tr>
<td>Agree (4)</td>
<td>30</td>
</tr>
<tr>
<td>Neutral (3)</td>
<td>10</td>
</tr>
<tr>
<td>Disagree (2)</td>
<td>5</td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>1</td>
</tr>
</tbody>
</table>

n = 69, $\chi^2 (4) = 45.71$, p < 0.001
In terms of my learning, the best thing about the 3D orbit was:

In terms of my learning, the worst thing about the 3D model was:
## Impact on confidence

<table>
<thead>
<tr>
<th>Because of the 3D orbit I am confident that I can....</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>locate &amp; identify the different bones that comprise the orbit</td>
<td>31</td>
<td>27</td>
<td>9</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>understand the spatial rels. btw the orbital bones</td>
<td>28</td>
<td>33</td>
<td>6</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>visualise the spatial rels. btw the orbital bones</td>
<td>28</td>
<td>34</td>
<td>6</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>visualise the important structures in OA</td>
<td>25</td>
<td>29</td>
<td>8</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>describe the important structures in OA</td>
<td>16</td>
<td>34</td>
<td>14</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>
## Impact on learning

<table>
<thead>
<tr>
<th>The 3D orbit helped my learning because it...</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>motivated me to learn about OA</td>
<td>11</td>
<td>24</td>
<td>29</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>I could touch and feel it</td>
<td>40</td>
<td>23</td>
<td>5</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>I had access to it whenever I liked</td>
<td>44</td>
<td>19</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>it suited my way of learning</td>
<td>32</td>
<td>26</td>
<td>8</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>offered me a highly personalised learning experience</td>
<td>20</td>
<td>37</td>
<td>10</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
Future use

I think I will use the 3D orbit in the future in the following ways
Resource preference

Rate the following resources in terms of your preference for learning orbital anatomy.

- 3D orbit Videos/Animat
- Discuss with tutor
- 3D PDF
- Lectures
- Disartic skull
- Written text
- 2D images

Deakin University CRICOS Provider Code: 00113B
Resource preference

I would like to use more personalised 3D resources in my course

n = 69, $\chi^2_{(4)} = 82.31$, p < 0.001

“...look at the various bones - feel things like sutures which you can't do [through] notes or text”

“being able to visualise how certain structures actually appear in 3D...rather than learning from boring 2D images”
Active ‘hands-on’ learning

• Hands-on: educational experience where students are actively involved in manipulating objects
• Co-creator /personalisation of learning resources
• Hands-on/minds-on: engaging and maintaining student interest

“Have ownership of my learning experience”

“I was engaged in the moment”

Limitations

• No objective measure of impact on learning
• Self-report
• No control group
Application of technology

Source: Dr. Ruben Puentedura, Ph.D. http://www.hippasus.com/rrpweblog/

Romrell, Kidder & Wood (2014) *Online learning*
Recommendations

• 3D printed resources are effective at engaging students, anywhere-anytime

• Co-creation: higher order cognitive engagement (hands-on/minds-on)

• Desire for more personalised 3D resources

• Topic suitability: visualising spatial relationships

• Set-up time/cost, size of model
Acknowledgements

• DLF Health Pod for video production (Peter Lane, Tim Crawford & Nicole Tran)


