Do game elements enhance learning?
Exploring the role of integrated game design elements in a vascular anatomy study aid

Andrea Gauthier (MScBMC), Michael Corrin (MScBMC), Mike Wiley (PhD), Jodie Jenkinson (PhD, MScBMC)
Division of Anatomy, Faculty of Medicine, University of Toronto

Problem
The study of vascular anatomy can be challenging because of diverse branching patterns, anastomoses, vessel supply, and complex spatial relationships between structures. In the past, games have been used to aid in engagement, knowledge retention, and systems-thinking in anatomy classrooms[1]. However, there is little evidence that shows whether game design encourages study aid-use outside of the classroom, whether increased engagement leads to improved learning outcomes, and which game elements contribute most to students’ desire to use the resource[2]. In order to help bridge these knowledge gaps, we developed two parallel study aids for students studying vascular anatomy: (1) the Vascular Anatomy Study Aid (VASA), and (2) Vascular Invaders (VI), which incorporates game design elements such as a leaderboard, achievements, mini-goals, rules, penalties, points systems, power-ups, music, etc. These were given to medical anatomy students at the University of Toronto to be accessed online on their own time over a period of 35 days, to support their learning of the anatomy of the head and neck.

Methods
General info + anatomy preview

Tool-use statistics

Study Aid Success Rate (SASR)

How does tool use differ between groups?

What role do game elements play in this difference?

35-day tool-use period

Pre-test differential

Study Aid Success Rate (SASR) in VASA is more predictable, but less so in VI.

Conclusion
As with VASA, it is more predictable, but less so in VI.

Study aid used contains the same tasks as VASA, but incorporates social features, reward and punishment features, as well as narrative features in an attempt to increase engagement.

Results

Summary of findings

1. Game elements increase medical students’ study aid-use but not significantly.
   - Moderately higher use seen in experimental group (refer to Figure 1 A and B).
   - Use statistics positively and significantly correlated with interaction with game elements.

2. Game elements are not the determining factor for students’ learning.
   - Moderately higher test improvement seen in experimental group (refer to Figure 1 E).
   - Game element interaction statistics (VI only).
   - Study aid success rate complete a task; and completed path-finding tasks; Tool-use sessions (logins); Average moves by the user in order to complete a task; Achievements completed; Power-ups used; Misc-goals completed; Leaderboard accessed.

3. Game elements change how different types of students use the study aid.
   - Age is positively correlated with attempted tasks in VI (r=0.43, p=0.04) but NOT in VASA (r=0.07, p=0.77).
   - Tool-use was positively correlated with “good/frequent studying habits” in VI (r=0.56, p=0.01).
   - Tool-use negatively correlated with “good/frequent studying habits” in VASA (r=-0.63, p=0.00).
   - Gaming habits and gender appeared to have no major impact on tool-use in either group.

4. Game elements change the manner of interaction within the study aid.
   - Control group completed tasks in significantly more moves than experimental group (refer to Figure 1 C).
   - VI has rules, incentives, penalties that encourage strategic thinking while completing tasks.

5. Game elements make learning more predictable.
   - Tool-use is more predictable in VASA than in VI (p=0.14, W=196.5).

References
5. Do game elements enhance learning? Exploring the role of integrated game design elements in a vascular anatomy study aid

Figure 1 - Comparison of telemetric tool-use data and anatomy test scores for VASA- and VI-assigned groups. A) Tool-use assistance (games); B) Attempted and completed path-finding tasks; C) Average moves by the user in order to complete a task; D) Study aid success rate (SASR); E) Achievements test scores; F) Game element interaction statistics (VI only).

Figure 4 - Control Tool: Vascular Anatomy Study Aid (VASA). Screen shot of path-finding task. This study aid contains 10 pre-defined tasks, as well as a random task generator, where the user must find their way from one blood vessel to another.

Figure 5 - Experimental tool: Vascular Invaders (VI). Screenshot of game play. This study aid contains the same tasks as VASA, but incorporates social features, reward and punishment features, as well as narrative features in an attempt to increase engagement.