ASCILITE 2024

Navigating the Terrain:

Emerging Frontiers in Learning Spaces, Pedagogies, and Technologies

Designing branching scenarios to support clinical reasoning in dental education

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Abstract

Branching scenarios are educational tools where dental students can explore their decision making in a clinical environment without risking harm to patients. By incorporating productive failure, adaptive learning and serious gaming elements into their design, they offer interactive and personalised learning environments. We aimed to design a branching scenario based on a patient presenting with dental pain and evaluate its implementation in a classroom setting. We employed a validated serious gaming model as the framework for our design and mapped a decision tree on a scalable whiteboard for the case. A survey platform was used to build the scenario using rule-based logic. The scenario included multiple 'learning points' with tailored feedback. Students can track how many learning points they have 'unlocked' and are encouraged to revisit previously uncovered pathways. Classroom observations, learning analytics and student feedback have been collected to evaluate the activity. Preliminary feedback has informed improvements to the branching scenario design and educators have found the learning analytics can be used to tailor future teaching sessions. Future steps include useability testing and design improvements based on student feedback.

Keywords: Branching scenarios, Serious gaming, survey platform, Dental education, Design Based Research

Background

In dental education, students learn and perform irreversible treatments on patients very early in their clinical training. Learning environments that allow students to explore real-world clinical problems in low-risk settings can provide opportunities for students to practice clinical reasoning skills and understand the consequences without causing patient harm. This in turn supports their learning and assists in preparing them for higher stakes clinical environments.

Branching scenarios (BrSc) are educational tools that present students with decision-making challenges. As learners navigate through the BrSc, their choices determine the story's progression. These scenarios often incorporate multiple endpoints, including suboptimal results, creating a safe environment for students to experience consequences without real-world risks. Informed by productive failure (Kapur, 2008; Steenhof, Woods, & Mylopoulos, 2020), BrSc allow for multiple attempts, promotes experiential learning and encourages reflection. Furthermore, BrSc can be designed to incorporate elements of serious games and build on a constructivist pedagogy (Sawyer, 2001) to create interactive learning experiences by incorporating game elements. Gamification can provide opportunities for repetition, collaboration, fun and friendly peer competition, and have been reported to increase learner motivation and engagement (Zainuddin, Chu, Shujahat & Perera, 2020).

Patients presenting with dental pain are challenging for dental students to manage (Guivarc'h, 2017) and BrSc may assist in bridging the gap and dissonance phase from preclinical to clinical practice (Serrano, 2023). It has been shown that medical students who engage with serious games are more than twice as likely to accurately diagnose, facilitating application of knowledge transfer (Raupach T et al. 2021). This project's aim was to

understand the processes required to design BrSc that simulate patient management to develop students clinical reasoning and understand decision consequences.

Methods

This research was conducted with the approval of its institutional Human Research Ethics Committee (HREC No.28062). We used a Design-Based Research (DBR) approach (Bakker, 2018). A DBR framework emphasises the design process as a vital component of the research, and involves an iterative process of implementing, testing and evaluating learning activities in real world settings. The following section describes the design, implementation and evaluation of the BrSc learning activity.

Branching scenario case development

A validated serious gaming model was adapted to inform the design of the BrSc (Argueta-Muñoz, 2023). The case was based on a patient presenting with atypical dental pain. The patient has provided informed and written consent for the use of their dental records and diagnostic imaging for the purpose of designing online education environments for dental students. The case was mapped on Miro board, a scalable whiteboard which allowed for real time collaboration amongst dental experts. The case had four main sections; 1. Arriving at the clinic, 2. Information gathering, 3. Diagnostic tests and 4. Patient management. The mapping process resulted in a large decision tree with a series of decision points (fig.1). Each decision point was associated with possible actions the student could take. The option selected resulted in the student following a particular storyline through the BrSc, which we defined as 'learning pathways'. The team identified common erroneous 'learning pathways', that students encounter when managing patients presenting with pain in the dental teaching clinic. These pathways could lead to early 'end points' in the BrSc 'game', where the student would be asked to try again, and was re-directed back to the start. These areas were defined as 'learning points' and were an opportunity for students to reflect on the decisions before they were given, with tailored feedback for the learning point (fig.1).

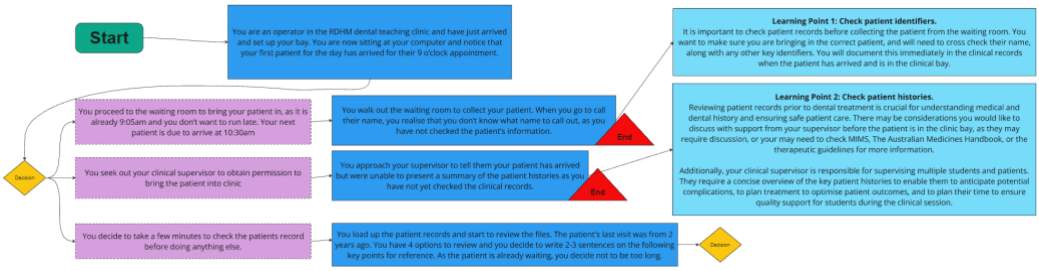

Figure 1 Example of Miro board section with decision point and Learning Pathways

Branching scenario design and platform

Using a platform (program) that produced learning analytic data was identified as being a requirement for this project. Learning analytics assist educators in understanding how students interacted with the BrSc. An environmental scan of potential platforms included scoping of text-based (Twine, Squiffy), visual-based (H5P, Ren'py), survey platforms (REDCAP, Qualtrics), and game engine/e-learning software (Unity, Unreal, and Articulate Storyline). The latter were considered out of scope for the initial project due to high level of skills required to operate the tool, limited time for development and unknown data tracking functionalities. Qualtrics was selected to provide the best combination of student experience, reporting, and functionality. The privacy, IT security and data retention risks associated with the platform have been reviewed as part of a privacy impact assessment conducted by The University and found it to be low risk.

The survey functions used in Qualtrics to design the BrSc included but were not limited to free text responses, multiple choice questions, branching logic, display logic, section blocks and loop sequences. The free text responses were used for students to enter their interpretation of key findings, and the multiple-choice questions were implemented at each decision point. Branching logic was used to create different pathways

based on the choices of the learner. The display logic feature was employed to allow specific content or hints to appear based on the previous options selected by the user. Additionally, the use of section blocks allows for grouping of questions or content within the scenario. Loop sequences enable users to revisit previous points or be brought back into the main branch. They were used in key areas but were found to overcomplicate the BrSc Design. We opted not to use them at the end of each learning pathway to loop the user back the beginning, and instead opted to use the submit function after each learning point was reached, which resulted in completion of the survey. This re-directed the learner back to the beginning, and enabled tracking of student attainment of learning pathways. These functionalities allowed us to build a complex scenario with multiple learning points, where we could track students attempts and learning pathways.

A range of multimedia elements such as photos, images, documents and videos were used throughout the scenario to simulate real-world clinical practice, familiarise students with the teaching clinic setting, model key processes, and to demonstrate how nuances such as changes in tone and body language when communicating can influence outcomes.

A serious gaming element incorporated into the scenario was to encourage students to identify all the possible learning pathways embedded in the scenario, after they have reached the end of case. There were seventeen learning points strategically placed throughout the case. When a learning point was discovered, it becomes "unlocked" and is permanently displayed on the home dashboard for the student to refer to. Students can then compare how many learning points they have reached. The dashboard feature also displays information such as the number of attempts, and the learning points discovered in each section of the scenario.

Branching Scenario implementation

The BrSc were implemented as an in-class activity for second year Bachelor of Oral Health (BOH) and Doctor of Dental Surgery (DDS) students. Fifty-nine second year BOH students were provided with a short pre-briefing about the activity and were given freedom to engage in discussion with other students. The DDS students were divided into four classes, with twenty-five students in each. The first session, which contained all of the BOH students, were advised to attempt the tasks individually. Based on the classroom observations, the remaining four sessions were structured to enable the students to work through the case individually for the first 30 minutes, and then they could collaborate after that time. Learning analytics, classroom observations and free text feedback from all participating students has been collected to date, to inform future iterations of this learning activity.

Results

Classroom observations

The students showed high engagement with the BrSc, and their interaction with the tool differed based on the pre-briefing instructions. The BOH students who were given freedom in how to engage with the tool and each other, tended to start the activity individually, and then began forming small groups. They were more inclined to select incorrect learning points to see the outcomes. Robust discussions about the scenario occurred and students shared their unique journey through the clinical case with each other. When students split into groups it created opportunities for peer learning, as they shared their individual experiences and reflections. Initially, DDS students were tasked to work independently for the first 30 minutes, after which they could choose to work in small groups. They appeared more focused on identifying the correct path through the entire case. It was noted that they seemed hesitant to explore alternative learning points, as they perceived it meant failing the BrSc. As a result of the above observations, we updated the pre-briefing to emphasise the activity was designed for the students to "fail". Students were encouraged to 'unlock' the learning points. The explicit verbal instructions, rather than relying on the written instructions at the commencement of the BrSc shaped how they appeared to engage with the activity.

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Student feedback from the survey

Students provided insights on how the user interface, navigation, and overall student experience of the BrSc enabling enhancements for greater usability. Student stated they enjoyed the game and found it a fun way to approach case learning. Some students indicated frustration with the design, in that they felt they had to repeat sections multiple times to unlock learning pathways. In response to this feedback, a skip functionality to bypass sections completed in previous attempts was incorporated into the design. Additionally, a warning message was employed to prompt the student they were following a pathway they had already discovered. This allows the student to explore alternative options and optimise their learning experience, be respectful of their time, and avoid students losing interest in the BrSc. Students also stated they wanted information they provided in the free text fields to be carried over into future attempts. A function was implemented that allowed for this.

Learning Analytics

A total of 149 second-year MDS students participated in the activity, with a total of 775 attempts. On average, each student made approximately 5.2 attempts with the average time taken to complete the BrSc 15.5 minutes. Sankey diagrams (Figure 2) provide visual representations of the different learning pathways students selected in the scenario.

For the students' first attempt, in Section 1, 112 students out of 149 (75.2%) selected a learning point. In Section 3, 31 students out of 149 (20.8%) selected a learning point. In Section 4, only 5 out of 149 (3.4%) arrived at the final decision point. As most students selected learning points within Section 1, this indicates that students were exploring the variety of branches available. If students had raced to the final question, then they weren't engaging with productive failure and the BrSc. In their final attempt (excluding students who only completed the BrSc once), most students would end on the final question, 88 out of 127 (69.3%). For all student attempts (Fig.2), the most commonly selected learning points were identified as learning point 07 (Indications for diagnostic tests), learning point 03 (Time management for history taking), and learning point 17 (Referring appropriately).

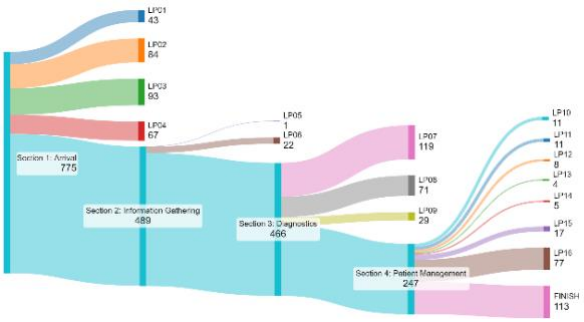

Figure 2 All student attempts

Discussion

The advantages of using a survey platform, is the ability to track learning analytics. From an educator perspective, identification of common learning points students struggle with in the scenario can address gaps in current teaching practices and be used to inform future lesson planning. "The wide range of functions enabled the learning path to change when students interacted with the BrSc, creating an adaptive learning experience for the students.. Lastly, whilst BrScs are traditionally designed for students to use independently as an adjunct to their learning, we found that their implementation in a classroom setting created opportunities for collaborative learning face-to-face, which was highly valued by the students and will inform strategies in the future.

Conclusion

Survey platforms and scalable whiteboards can be utilised to design user friendly BrSc for dental education that promote peer collaboration and experiential learning. The audience is being expanded to include students from other year levels to identify where this activity is best placed in the program to enhance learning outcomes. Learning analytics, classroom observations and free text feedback from students has been collected to date to inform future iterations of this learning activity.

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