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Contents

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Viewpoint

Resilience Training Web App for National Health Service Keyworkers: Pilot Usability Study

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Abstract

Background: It is well established that frontline health care staff are particularly at risk of stress. Resilience is important to help staff to manage daily challenges and to protect against burnout.

Objective: This study aimed to assess the usability and user perceptions of a resilience training web app developed to support health care keyworkers in understanding their own stress response and to help them put into place strategies to manage stress and to build resilience.

Methods: Nurses (n=7) and other keyworkers (n=1), the target users for the resilience training web app, participated in the usability evaluation. Participants completed a pretraining questionnaire capturing basic demographic information and then used the training before completing a posttraining feedback questionnaire exploring the impact and usability of the web app.

Results: From a sample of 8 keyworkers, 6 (75%) rated their current role as “sometimes” stressful. All 8 (100%) keyworkers found the training easy to understand, and 5 of 7 (71%) agreed that the training increased their understanding of both stress and resilience. Further, 6 of 8 (75%) agreed that the resilience model had helped them to understand what resilience is. Many of the keyworkers (6/8, 75%) agreed that the content was relevant to them. Furthermore, 6 of 8 (75%) agreed that they were likely to act to develop their resilience following completion of the training.

Conclusions: This study tested the usability of a web app for resilience training specifically targeting National Health Service keyworkers. This work preceded a larger scale usability study, and it is hoped this study will help guide other studies to develop similar programs in clinical settings.

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KEYWORDS

resilience; workplace stress; National Health Service; NHS keyworker; digital learning; digital health; usability; feasibility; mental health; pilot study; learning; training; exercise; primary care provider; health care professional; occupational health; worker; hospital; emergency; survey; questionnaire; mobile phone

Introduction

Resilience allows individuals to manage everyday challenges and changes. For health care professionals who are working in highly emotive and stressful situations, resilience skills are particularly important [1]. It is well established that frontline staff such as nurses are particularly at risk of stress due to factors such as long shifts, organizational pressures, and the emotional impact of their work [2]. During the COVID-19 pandemic, there were high rates of mental health problems among health care staff. For example, a survey of 255 nurses working with respiratory patients found 21% to be experiencing moderate or severe symptoms of anxiety and 17.2% to be experiencing depression. A total of 18.9% scored low or very low on a measure of resilience [3]. A study of 1106 physicians also reported high levels of anxiety and low levels of resilience during the pandemic [4]. Building emotional resilience is therefore imperative to prevent burnout in health care staff, to keep them healthy both physically and mentally, to improve well-being, and to ensure job retention in the workplace [1].

One way that employers can meet this need is through the provision of resilience training. Key benefits of resilience training include improvements in mental health and well-being, social support, self-efficacy, and coping. Further benefits include

improved ability to adapt to pressures and demands in the workplace and other areas of life [5]. In health care settings, nurse resilience interventions have been highlighted as a potential way of enhancing staff coping and well-being, job satisfaction, and retention [2]. Greater nurse resilience has also been associated with better work performance [6].

A constraint of traditional resilience training programs is the time required to attend in person, which can exclude certain staff groups, such as nurses, from participation. Smartphone apps have the potential to offer training in resilience to large numbers of people while overcoming barriers, such as stigma, time, and acceptability, and can be integrated easily into the wider organizational well-being strategy [7-11].

The aim of this study was to evaluate whether health care keyworkers would be willing to carry out resilience training via an online platform specifically designed to enable them to understand their own stress response and put in place strategies to manage stress, build emotional resilience, and maintain well-being. The data collected would generate important information for future implementation, while contributing feedback for a more refined usability study with this population.

Methods

Participants

The recruitment process was carried out by the Medical Devices Testing and Evaluation Centre (MD-TEC) team. A study sample was recruited from the University Hospitals Birmingham National Health Service (NHS) Foundation Trust, and participation was incentivized with Continuing Professional Development credits for participation. This study was advertised over the web via the internal trust-wide communications bulletin and targeted emails. There was not an enforced inclusion criterion, but this study requested for participants who were a nurse or health care professional and worked in either the emergency department, intensive care unit, or critical care.

Ethical Considerations

This study was run as a formative usability study by MD-TEC with human participants. The University of Sheffield Re-Use of Existing Data Questionnaire was completed, and the Psychology Research Ethics Committee deemed this study exempt from ethical approval because the data were fully anonymized. A short self-declaration form was submitted. This application went to the Psychology Departments Ethics Administrator for a final check before a letter of confirmation was issued.

Informed consent was derived through the sharing of a recruitment flyer with potential participants. This explained the research and its function as part of medical device usability testing for further development.

All the data were received fully anonymized from MD-TEC post study. The participants were not personally identifiable by the researchers. Research participants were offered Continuing Professional Development credits for their participation. They self-selected for and undertook the research voluntarily.

The training web app was developed by the third author without funding. The content of the training web app drew on the Skills-Based Model of Personal Resilience [12] and included a selection of evidence-based skills and exercises to regulate distress emotions and build positive emotions, such as slow rhythmic breathing and mindfulness practice. The selection of skills and exercises were chosen for their capacity to provide maximum benefit to participants, calming stress, and facilitating improved coping, in the context of this brief trial.

Bennion et al [8] highlight four key indicators of quality drawn from effective digital psychotherapy approaches. These include clinician involvement, academic involvement, research, or other evidence and use of specific psychological approach or theory. The intervention followed these recommendations, drawing on academic and clinical theory [13] and involving clinicians, academics, and computer scientists in its development to ensure greater quality and effectiveness.

The web-based training was published using Articulate Storyline (Articulate Global, LLC) and accessed via a web browser. It consisted of both written and spoken content on a series of slides, short videos, and experiential exercises which could be moved through at participants' own pace using "previous" and "next" buttons. The estimated time to complete the training was 20 minutes.

Pretraining Questionnaire

The pretraining questionnaire captured basic demographic information: gender, age range, job role, current area of work, current band, and years of nursing experience. Current job stress was rated on a 5-point scale (never, hardly ever, occasionally, sometimes, and very). Participants were also asked whether they had heard of or previously undertaken any resilience training.

Posttraining Feedback Questionnaire

The posttraining feedback questionnaire focused on 6 areas: app design and navigation, app content, app impact, app training exercises, app relevance, and app access. Each question was posed on a Likert scale with five possible answer options to allow the user to respond to each statement on a range from "strongly agree" to "strongly disagree."

Procedure

Upon contacting the MD-TEC team to participate, interested individuals were provided the opportunity to ask any questions about participation in this study. If willing to consent, participants were then sent the link and password to access the training. The training and surveys were hosted on the MD-TEC Software Usability Testing Site (MD-TEC), and thus could be completed on any device with internet access. Once logged in on an internet browser, individuals were presented with the precourse survey before completing the full training module.

Once the training module was completed, participants were taken to a landing page and requested to click a link to take them to the feedback survey. They were reminded at this point that no identifiable information would be collected from them. As the surveys were completed anonymously, participants who completed the training and survey were asked to inform the

MD-TEC team via email once they had done so. They were then sent a certificate toward Continuing Professional Development for their time contributed to research, which they could add to their personal records. The total time for each participant to complete the training module and feedback survey was approximately 45 minutes.

Statistical Analysis

This study did not use a specific sample size calculation as it was focused on app usability. It instead aimed to achieve at least 5 participants which is deemed an optimal number to reveal 77% to 85% of problems [14]. Data were analyzed using IBM SPSS (version 26; IBM Corp). The pretraining and posttraining feedback questionnaires were summarized as a mix of continuous variables with medians and categorical ordinal variables with percentages.

Results

Participants

The age of participants ranged from 25 to 64 years. The total sample (N=8) was comprised of 8 (100%) females, 7 (87.5%) nurses, and 1 (12.5%) keyworker of other professions. Grades ranged from 5 to 7 with a median of 6 (IQR 5-6). Five of the participant's had over 15 years of nursing experience. All 8 participants completed baseline measures and posttraining measures.

Pretraining Questionnaire

Sample Overview

Of the 8 participants who completed this study, 3 (37.5%) worked in the hospital's intensive care unit, 1 (12.5%) worked in the emergency department, and 4 (50%) worked in other undisclosed areas of the hospital.

Current Role Stress

Most participants (6/8, 75%) rated their current role stress as "sometimes" stressful, while 1 of 8 (12.5%) said "occasionally" stressful and 1 of 8 (12.5%) said "very" stressful.

Awareness and Knowledge of Resilience Training

Most participants (6/8, 75%) had heard of resilience training, and those that had taken part (4/8, 50%) had done so in a face-to-face setting.

Posttraining Feedback Questionnaire

App Design and Navigation

Feedback regarding the design of the training was predominantly positive. All participants found the training easy to navigate, 6 of 8 (75%) deemed the default speed at which the training progressed to be acceptable, and 7 of 8 (97.5%) thought the appearance of the buttons was OK.

App Content

Feedback for the content indicated that all participants (8/8, 100%) found the training easy to understand, 6 of 8 (75%) felt there was enough text content, 4 of 8 (50%) felt there was enough spoken content, and 5 of 8 (62.5%) felt there were enough interactive exercises.

App Impact

A large number of the participants (5/7, 71%) agreed that the training increased their understanding of both stress and resilience, while 6 of 8 (75%) agreed that the resilience model had helped them to understand what resilience is.

App Training Exercises

The training exercise feedback was positive but varied. For the breathing and positive tips exercises, 6 of 8 (75%) participants agreed they were likely to try the exercises again in the future. The mindfulness exercise had 4 of 8 (50%) participants agree they were likely to try the exercise again.

App Relevance

There was a high level of agreement that the training was relevant to nurses, with 6 of 8 (75%) participants agreeing that the content was relevant to them.

Furthermore, 6 of 8 (62.5%) participants agreed that they were likely to act to develop their resilience following completion of the training.

Access to Training

All the participants indicated a different personal preference to how they would prefer to access the training. Participants felt the package should be made available across all platforms to allow the training to be completed where and when it was most convenient to them. When asked their preferred location of access, 5 of 8 (62.5%) indicated their preference as being "at home."

Discussion

Principal Findings

We explored the perceived usability and feasibility of a resilience training web app created for NHS health care keyworkers. Data collected covered a number of areas: design and navigation, content, impact, and relevance. The results showed that 100% (8/8) of participants found the training easy to understand and agreed that it had increased their understanding of both stress (5/7, 71%) and resilience (6/8, 75%). Three-quarters of participants agreed that the content was relevant to them, and this corresponded with the number of participants rating their current role as "sometimes" stressful. Furthermore, three-quarters of participants agreed that they were likely to take action to develop their resilience following completion of the training. This information was used to inform the design of a larger usability study.

A total of 8 participants were recruited, with 7 being from the target population. All participants completed the process from start to finish. Participants successfully carried out what was required of them based on this study's protocol, although some participants did not complete all the questions asked on the posttraining questionnaire. There was no indication given as to why this was the case. In a follow up usability study [13] validation checks were put in place within the surveys to stop questions from being missed by mistake.

The findings of this study indicated that participants found the training app design and navigation acceptable and usable. However, the measure used was not a standard model of system usability (eg, International Organization for Standardization, 2018). This study's design was updated to use two validated measures (the System Usability Scale and the Usability Metric for User Experience) to strengthen the robustness of a follow-up usability study [14]. Adding these two additional validation measures to this study's design helped to strengthen assessment of the training app's usability.

Participants indicated that the training was easy to understand and that there was enough text content; however, they also indicated that there was a need for the training to have more spoken and interactive content. This fits with a recent study [15] in which nurses' interactive behavior was identified as an influencing aspect of nurse satisfaction with online learning. Based on these findings, we recommend the training's interactive content be revisited in its next design iteration.

Most participants perceived that the training increased their understanding of both stress and resilience and that the resilience model had helped them to understand what resilience is. A more robust method of measurement was required to further explore the impact of the training and this study's design was updated to incorporate ratings of perceived knowledge regarding stress and resilience. These new scales were used in a follow up usability study [14] and found to increase significantly between pre- and postapp training.

The training exercise feedback was positive but varied. Both the breathing and positive tips exercises were well received, with participants agreeing they were likely to try the exercises again in the future. However, only half of the participants agreed that they would try the mindfulness exercise again. This may have been due to the difficulty in carrying out the exercise in a busy work environment.

Many participants agreed that the training was relevant to them and believed that they were likely to act to develop their resilience following completion of the training.

Limitations

Recognized limitations of usability studies include that testing is conducted in an artificial situation and personal preferences of the participants are not representative of the wider user population [16]. The digital training app used in our study is an early prototype. This may need multiple design developments to create a smartphone app that can be used to deliver the resilience training. The aim of this formative usability study was to assess the acceptability and user perceptions of the current version of the training program. As such, this study is part of the iterative product development process and is different to a summative usability study, conducted for validation and regulatory purposes [17].

This study had a single-group design and advertised for a specific group; however, anyone employed by the trust who contacted MD-TEC regarding this study could be involved. This was done primarily to allow anyone employed by the trust to gain access to training that could benefit them. Potential participants who were unaware of this clause may have been lost because of this decision. The initial training materials were designed with nurses in mind but were not specifically tailored for the demographic. This may have changed participants' initial perception of the suitability of the training to them personally. A single-group design can limit the ability to draw definitive conclusions about the effectiveness of the training due to its lack of a control or comparison group [18]. However, since this study was focused on the usability of the training and not the effectiveness, and it was not seeking to make a comparative analysis, a single-group design was appropriate.

This study limited its evaluation to perceived usability, which was not obtained through laboratory-based observations. As such, the positive ratings reported may not be representative of true user experience. A heuristic evaluation of the training to detect usability problems was not carried out, due to pandemic restrictions making this problematic to implement. This study used quantitative scales and measures to collect data but did not use qualitative measures to gain deeper insight into what NHS health care staff felt about the training. A measure of time spent using the training was not collected. This could have also given an indication of acceptability. This study used two single Likert scales to measure perceived increases in knowledge about stress and resilience. Studies have shown that perceptions of learning may not reflect knowledge gains, when compared with evidence of actual learning [19]. A more robust method of measuring knowledge retention would have benefitted this study. This could have been achieved by having a pre- and postquiz based on the content of the training to see what knowledge was retained.

While the majority of participants gave positive responses in the evaluation of this study, the generalizability of these outcomes is limited due to the disproportionate number of female participants and participants from a nursing background. Only 1 (12.5%) participant was from a different professional group. This limits the inferences that can be drawn about usability and acceptability of the training to male participants and those with other keyworker roles. It is recommended that future studies recruit a more representative sample to enhance generalizability of the results.

Conclusions

Overall, the resilience training module was well received by the participants. The participants felt the package was easy to navigate. There was a high level of agreement that the visual delivery of the training was acceptable, as well as the speed at which this was delivered.

A number of techniques demonstrated during the training were also well received, with 6 of 8 participants agreeing that they would use them in future stressful situations. Mindfulness was the only exercise that received more varied feedback, with half agreeing on its utility in the work environment.

Health care staff participating in this study largely agreed that the training was relevant to their group and that the tone of the delivery was appropriate. No clear preference regarding how to access the training was identified, highlighting the need for accessibility via computer, tablet, and smartphone. Participants

expressed a wish to to access the training when they have a moment of need and the opportunity in their busy working day.

Future Directions

As one of the first NHS web-based resilience programs to be tested, this first usability study aimed to understand whether web-based training for resilience is deemed usable and acceptable by health care staff. The results of this study will be used to expand and build upon the initial prototype to make a more interaction enriched version of the training.

This study also provided an understanding of the program's limitations and highlighted some aspects which require further adaptation for delivery via a new medium. Future research would aim to evaluate the impact of including greater interactivity on engagement and learning. It would also aim to extend the accessibility and acceptability of the program to a wider audience by developing an effective prototype for a smartphone app.

This study was run externally by MD-TEC, who had their own processes for running usability studies of this nature. This study's design covered some of the key factors required for an effective online survey, but it could have been further improved by seeking acknowledgment with MD-TEC regarding the CHERRIES (Checklist for Reporting Results of Internet E-Surveys) checklist [20].

It is clear from the results that there is a need for future research to evaluate how skills-based learning using web-based training impacts long term resilience. A larger scale study would allow for more in-depth investigation of the impact of such training on participants' levels of stress and resilience as well as their perspectives on acceptability.

Given the diversity of NHS staff, it will be important for any future study to gather a wide set of demographic information to investigate acceptability and generalizability across diverse populations. With increasing awareness (ie, gained through the COVID-19 pandemic) of the pressures faced by all NHS staff, across a breadth of ethnic and socioeconomic groups, a larger scale study would allow for a wider inclusion criterion covering all NHS staff groups.

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Data Availability

The datasets generated and analyzed during this study are available from the corresponding author on reasonable request.

Authors' Contributions

JB did the conceptualization, methodology, writing of the original draft, review and editing of the writing, visualization, supervision, project administration, and funding acquisition. FB handled the conceptualization, methodology, writing of the original draft, review and editing of the writing, visualization, and supervision. MRB worked on the conceptualization, methodology, software, validation, formal analysis, resources, data curation, writing of the original draft, review and editing of the writing, visualization, and supervision.

Conflicts of Interest

JB and FB are employees of Ultimate Resilience LTD, creators of the Skills-Based Model of Personal Resilience applied to the web app. MRB developed the web app.

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Abbreviations

CHERRIES: Checklist for Reporting Results of Internet E-Surveys
MD-TEC: Medical Devices Testing and Evaluation Centre
NHS: National Health Service

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Digital Dentists: A Curriculum for the 21st Century

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Abstract

Future health professionals, including dentists, must critically engage with digital health technologies to enhance patient care. While digital health is increasingly being integrated into the curricula of health professions, its interpretation varies widely depending on the discipline, health care setting, and local factors. This viewpoint proposes a structured set of domains to guide the designing of a digital health curriculum tailored to the unique needs of dentistry in Australia. The paper aims to share a premise for curriculum development that aligns with the current evidence and the national digital health strategy, serving as a foundation for further discussion and implementation in dental programs.

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KEYWORDS

digital health; digital transformation; informatics; ehealth; dentistry; dental informatics; curriculum; competence; capability; dental education

Introduction

As the world continues to be digitally transformed, there are increasing expectations for health care providers to use technology and handle health information safely and ethically [1]. It is likely that future health professionals will also need to think critically about how digital health technologies can be used to transform models of care [2].

Digital health and informatics remain relatively new curriculum topics for many health professions, including dentistry. Defining the relevant curricular objectives in entry-to-practice degrees can be particularly challenging for several reasons. First, there are several definitions and conceptualizations of the term “digital health” [1,3-6]. Second, the implementation of digital health education in health profession degrees has largely been ad hoc, with different schools adopting varied approaches [7]. This has resulted in inconsistent learning outcomes and a fragmented understanding of digital health competencies for health profession graduates. Third, although a multitude of digital health competency frameworks exist [8-11], there is a notable absence of shared curriculum models specific to dentistry. Therefore, dentistry educators are not aware of or struggle to adopt best practices in the teaching of digital health.

In this viewpoint, we argue that there is a need to integrate digital health education into dentistry curricula to prepare future practitioners for the increasingly digitized health care environment. Specifically, we propose a distinct point of view for defining "digital health" in dental education, a structured set of domains to guide the design of digital health curriculum, and a framework for curriculum development that aligns with current evidence.

Beginning With the End in Mind

In Australia, a country that ranks consistently high for digital health maturity [12], clear digital health objectives are set out through national strategies such as the Australian Digital Health Agency (ADHA) Capability Action Plan (2023) and the National Healthcare Interoperability Plan (2023 - 2028) [1,13]. The government body for digital health (ie, the ADHA), peak bodies such as the Australasian Institute of Digital Health (AIDH), and digital health innovation centers all identify building workforce capability as a critical part of achieving digital transformation of health care [1,13-15]. These organizations envision a future where health professionals will work in integrated and multidisciplinary environments. Digital health education in entry-to-practice degrees is thus a core element of advancing workforce capability; however, the specific content, including priority areas of knowledge and skills, must be tailored to the unique demands of each discipline and local context. For dentistry in Australia, this means aligning the curriculum with the national digital health strategy while addressing the current maturity level and future needs of the dental profession.

Reframing "Digital Health" for the Next Generation of Australian Dental Practitioners

A lack of standardized digital health education in entry-to-practice degrees in Australia has been recognized for decades [16-18] and has been demonstrated by gaps in workforce competency [19]. Global interest in the digital transformation of health care is accelerating, catalyzed by the COVID-19 pandemic and advances in artificial intelligence (AI). However, not all health professions have advanced equally considering their digital transformation. In Australia, as in many countries, the dental sector remains traditionally siloed from the rest of the health care system and faces fragmentation in its information systems [20]. In the dental sector, the most progress in digital health has been observed in restorative and surgical procedures, where technology is directly integrated into clinical workflows [21]. For example, conventional manual techniques and laboratory workflows for the design and fabrication of dental restorations have evolved into in-house, fully digitized workflows with the application of intraoral scanners and chairside milling machines [22]. In contrast, dentistry has a relatively nascent data culture [23], with less focus on the broader scope of digital health, which we define in this viewpoint to encompass virtual care, remote monitoring, mobile health (mHealth), wearables, big data analytics, platforms, and "the exchange of data and sharing of relevant information across the health ecosystem creating a continuum of care" [4].

Developing digital health–capable dentists thus involves more than simply teaching the technical aspects of digital tools used in service delivery; it requires a shift towards understanding how digital data can inform clinical decisions, enhance patient care, and contribute to system-wide improvements. This conceptual change is crucial for moving from a service-focused practice to one that leverages digital health as an integral part of modern dental care. The Learning Health Systems (LHS) framework [24] is one example of how to help dental professionals characterize digital health. LHS are health care environments where science, informatics, incentives, and culture align to promote continuous improvement and innovation. In these systems, best practices are embedded in care, patients actively participate, and new knowledge is generated from every care experience [25]. Building on this vision, dental education should emphasize models where digital health is central to both practice and continuous improvement. This approach will foster digital health capability by cultivating a deeper understanding of how and why digital health technologies enable the delivery of high-quality, safe, and sustainable care.

Textbox 1 outlines the questions that can guide the development of a digital health curriculum for entry-to-practice dental education. These questions are intended to help educators and curriculum developers define clear goals aligned with the specific needs of the discipline and the local health care context.

Textbox 1. Defining the goals of digital health curriculum for entry-to-practice degrees.

- What is outlined in national and local digital health strategies for the next 5-10 years? What does the political and funding environment look like?
- What are the digital health-related accreditation standards of the profession?
- What does the current and future digital health maturity of the primary work environments of your graduates look like?
  - Consider the difference in goals for:
    - A rural school where graduates may work in areas with limited digital maturity
    - A health discipline or specialty where graduates will typically work in tertiary care rather than primary care

Considerations for Curriculum Development

The Australian Dental Council (ADC) recently revised its competencies for newly qualified dental practitioners; they updated the requirement to include "using digital technologies and informatics to manage health information and inform person-centred care" [26]. This prompted the authors to develop a digital health curriculum to be implemented in a higher education institution that has graduating dental professionals in Australia. As per the best practice in curriculum development [27], we considered the existing digital health competency and capability frameworks as part of our curricular needs assessment. An environmental literature scan found that only a few frameworks had been created specifically for dentistry or involved dental experts in their consultations, reflecting a lag in dentistry's digital health participation (Multimedia Appendix 1). As a result, not all topics in these existing frameworks were relevant or current to the reality of training dental professionals in Australia, who will predominantly work in small clinics in primary care, in practices with varying digital health maturity [28,29]. An exception was the digital dentistry curriculum proposed by the American College of Prosthodontists [30], which is well-researched but focused solely on digital skills for prosthodontics. This highlighted a gap in resources to support the broader skill set of graduating dentists in Australia, as outlined by the ADC.

The process of designing higher education courses aims to align industry standards with a scaffolded approach for developing effective learning outcomes that produce work-ready graduates. While the ADC's revised competency served as a catalyst for curriculum development, our efforts extended beyond the ADC's scope to meet standards such as those overseen by the Tertiary Education Quality and Standards Agency (TEQSA), which

performs the quality assurance checks for all participants, delivered as part of higher education in Australia. TEQSA's emphasis on authenticity in curricula design, as well as contemporary leading practice [31,32], influenced our approach towards designing a curriculum that not only meets regulatory competencies but also prepares students for practical, professional challenges in the evolving digital health landscape.

Finally, a critical component of our approach was to tailor the curriculum to the local context. While internationally recognized informatics competencies [33] often underpin digital health capability frameworks, they do not alone fully capture the breadth and nuances of digital health proficiency. Digital health encompasses a range of skills, including digitally enabled clinical processes, care pathways, and behavior change management, all of which are shaped by local variations in digital health maturity and sociocultural contexts. Furthermore, curriculum development often occurs under significant time and resource constraints, requiring an approach that is rigorous but targeted. For example, rural schools may not yet prioritize AI competencies if electronic health records are not yet in use locally.

Key Domains

Two frameworks were selected to inform the development of the dental digital health curriculum, both of which are government-sponsored, peer-reviewed, and directly relevant to the Australian setting [Textbox 2]. The domains in Table 1 are an abridged synthesis created by the authors, drawing on elements from the two selected frameworks. This reimagined structure is intended to facilitate the development of a digital health curriculum for dentistry, aligning learning objectives, instruction, and assessment with the national strategy in Australia.

Textbox 2. Frameworks selected to inform development of the dental digital health curriculum.

1. Framework 1 (2018): eHealth Capabilities Framework for Graduates and Health Professionals [34]. This framework was developed by the University of Sydney and eHealth New South Wales, consisting of a tri-phase literature review, focus groups with faculty and government representatives (n=23), and a Delphi method refinement with 4 iterations. The framework is structured in 4 domains and describes recommended knowledge and skills for health professions graduates in digital health.
2. Framework 2 (2021): Digital Health Capability Framework for Allied Health Professionals [35]. This framework was developed by the Department of Health, Victoria, and consisted of a 3-part development program including a competency framework review, expert discussion panel interviews (n=28), and an online survey of Victorian allied health professionals (n=164). This document draws from Framework 1 and is similarly structured into 4 domains of 3-6 subdomains, with the addition of levels of digital health proficiency ranging from Foundation, Consolidation, Expert, and Leadership.

Table . Domains and goals for digital health curriculum for an entry-to-practice dental degree.

Domain	Learning goal	Suggested learning topics
1. Digital transformation of health	Newly graduated dental practitioners will actively lead the digital transformation of dentistry by using technology to deliver patient-centred care and by recognizing the role of data and analytics in improving it.	Electronic health records, digital dentistry (radiography, intraoral scanning, CAD/CAM[a], and other digital workflows) data, interoperability and learning health systems, artificial intelligence
1. Legislation, policy, and governance	Newly graduated dental practitioners will drive improvements in the privacy and security of patient data, and model the safe, ethical, and responsible use of digital health technologies in the dental practice.	Data privacy and cybersecurity
1. Digital health for patients	Newly graduated dental practitioners will promote patient engagement in health care, prescribe appropriate digital resources, and support digital health literacy.	Digital health literacy, patient engagement in health care, and digital health equity
1. Digital professionalism	Newly graduated dental practitioners will model a professional and appropriate digital identity.	Social media and digital professionalism

[a]CAD/CAM: computer-aided design/computer-aided manufacturing.

The first domain recognizes that along with technical proficiency in digital clinical workflows, dental practitioners must be able to think in multidisciplinary terms of the flow of data and information across health care [13]. Dental practitioners must understand the importance of informatics, interoperability, and a quality improvement mindset to be the building blocks for creating LHS [24,25].

The second domain recognizes the role of the dental practitioner in safe and ethical governance of patient data across digital workflows, noting that health care is the consistently top-reporting sector for data breaches in Australia [36].

The third domain recognizes the shift from the paternalistic model of health care towards a person-centered one where the person receiving care plays an active role in shared health care decision-making. The OpenNotes mandate in the US is a good

example of this [37]. This domain is also particularly relevant to the rapid pace of AI development and the accessibility of generative AI models that patients may use to access health (mis)information. Dental practitioners must understand digital health literacy; how patients may engage with digital health technologies and services; and the uses, ethics, benefits, and risks of AI in health care.

The fourth domain recognizes that dental practitioners must develop a professional identity, which is multidimensional across social media and the internet. The obligation for a dental practitioner to uphold their professional code of conduct is binding for both their in-person and digital profiles [38].

This holistic overview of digital health in dentistry is a step towards addressing the observation that digital health education tends to be focused on medical degrees—mostly in electives or single-unit areas such as telehealth—and in utilizing diverse approaches for delivery, development, and assessment [39]. A similar observation was found during our curricular needs assessment, revealing a strong focus in single content areas such as telehealth and digital dentistry, but confirming opportunities to facilitate a more coordinated and comprehensive learning pathway to support full digital health competency.

Final Thoughts

Viewing dentistry through a "digital health" lens may seem like a small matter. However, the change in perspective for dental educators is important. Dentistry has traditionally focused on individual patient care and procedural intervention, but contemporary health care is increasingly shaped by system-level forces. AI, interoperability, value-based care, and increasing consumer participation are now current realities [40-43]. The potential for digital health to drive meaningful systemic improvements in oral health and health care cannot be truly realized without first building the necessary capability at the graduate level. Consequently, these topics can and should be taught in a structured manner in entry-to-practice dental education.

Critically, although newer generations are often seen as digitally adept, they do not automatically master the necessary digital skills simply from being exposed to technology [44]. This gap in digital competency underscores the importance of intentional curriculum design. Universities are increasingly using the approach of constructive alignment to enhance outcome-based education [45], and this approach should be used to design a longitudinal digital health curriculum that can align with the intended graduate attributes.

This viewpoint has outlined the premise for designing a digital health curriculum in dentistry, using a structured set of domains based on current evidence and adapted to the Australian context. The proposed domains provide a foundation for educators to build a curriculum that aligns with the unique needs of dental professionals and the national strategy for digital health. This approach is intended for integration into the University of Melbourne's dentistry program and aims to encourage the further development and discussion of digital health education within dental programs, both nationally and globally.

Conclusion

It can be difficult for educators to define digital health curriculum that is both evidence-based and relevant to their discipline and local context; to design it is to predict the future. However, keeping pace involves changing our view of digital health in dentistry. A common understanding about the language of digital health is important for developing health professionals who will be able to navigate the environment of the modern health care system. We found that existing digital health capability frameworks were useful to define a view of digital health across an entry-to-practice dental degree, and high level roadmaps and frameworks are valuable to envision a future-ready dental graduate who can embrace the next wave of digital transformation. This perspective will be useful for developing the curriculum aligned with the national vision of building workforce capability and realizing the aim of safe, connected care.

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Authors' Contributions

Conceptualization: MM
Supervision: SB, KL
Writing – original draft: MM
Writing – review & editing: MM, SB, LS, KL

Conflicts of Interest

None declared.

Multimedia Appendix 1
Digital health capability and competency frameworks considered for curriculum development in dentistry.
[DOCX File, 22 KB - mededu_v11i1e54153_app1.docx]

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Abbreviations

ADC: Australian Dental Council
ADHA: Australian Digital Health Agency
AI: artificial intelligence
AIDH: Australasian Institute of Digital Health
CAD/CAM: computer-aided design/computer-aided manufacturing
LHS: learning health system
mHealth: mobile health
TEQSA: Tertiary Education Quality and Standards Agency

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Enhancing Medical Student Engagement Through Cinematic Clinical Narratives: Multimodal Generative AI–Based Mixed Methods Study

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Abstract

Background: Medical students often struggle to engage with and retain complex pharmacology topics during their preclinical education. Traditional teaching methods can lead to passive learning and poor long-term retention of critical concepts.

Objective: This study aims to enhance the teaching of clinical pharmacology in medical school by using a multimodal generative artificial intelligence (genAI) approach to create compelling, cinematic clinical narratives (CCNs).

Methods: We transformed a standard clinical case into an engaging, interactive multimedia experience called "Shattered Slippers." This CCN used various genAI tools for content creation: GPT-4 for developing the storyline, Leonardo.ai and Stable Diffusion for generating images, Eleven Labs for creating audio narrations, and Suno for composing a theme song. The CCN integrated narrative styles and pop culture references to enhance student engagement. It was applied in teaching first-year medical students about immune system pharmacology. Student responses were assessed through the Situational Interest Survey for Multimedia and examination performance. The target audience comprised first-year medical students (n=40), with 18 responding to the Situational Interest Survey for Multimedia survey (n=18).

Results: The study revealed a marked preference for the genAI-enhanced CCNs over traditional teaching methods. Key findings include the majority of surveyed students preferring the CCN over traditional clinical cases (14/18), as well as high average scores for triggered situational interest (mean 4.58, SD 0.53), maintained interest (mean 4.40, SD 0.53), maintained-feeling interest (mean 4.38, SD 0.51), and maintained-value interest (mean 4.42, SD 0.54). Students achieved an average score of 88% on examination questions related to the CCN material, indicating successful learning and retention. Qualitative feedback highlighted increased engagement, improved recall, and appreciation for the narrative style and pop culture references.

Conclusions: This study demonstrates the potential of using a multimodal genAI-driven approach to create CCNs in medical education. The "Shattered Slippers" case effectively enhanced student engagement and promoted knowledge retention in complex pharmacological topics. This innovative method suggests a novel direction for curriculum development that could improve learning outcomes and student satisfaction in medical education. Future research should explore the long-term retention of knowledge and the applicability of learned material in clinical settings, as well as the potential for broader implementation of this approach across various medical education contexts.

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KEYWORDS

artificial intelligence; cinematic clinical narratives; cinemeducation; medical education; narrative learning; AI; medical student; pharmacology; preclinical education; long-term retention; AI tools; GPT-4; image; applicability

Introduction

Background

Student and trainee engagement is a critical factor in medical education, influencing outcomes such as academic achievement, overall well-being, satisfaction, and reduced burnout [1,2]. High levels of engagement have been linked to increased motivation and better learning experiences, as active participation encourages deeper understanding and application of complex material [3]. In contrast, traditional lecture-based learning often results in passive absorption of information, limiting student engagement and negatively affecting the ability to interact meaningfully with content [4]. To address this, we developed a cinematic clinical narrative (CCN), an interactive multimedia learning experience designed to enhance student engagement by integrating cinematic storytelling and narrative-based learning techniques. This method builds upon the principles of

cinemeducation, a teaching approach that uses film to create emotional connections and foster active learning [5]. By using generative artificial intelligence (genAI) tools, we have further enhanced the learning experience and decreased the barrier to entry for instructors, making it more immersive and adaptable to current educational needs. GenAI has been recognized as a transformative tool in reshaping medical education, offering new opportunities for interactive, technology-driven learning environments that promote active student engagement [6,7].

The target audience for our CCN comprises first-year medical students learning pharmacology related to the immune system. Medical students often face a knowledge gap in understanding complex pharmacological interactions and the intricacies of immune responses largely due to the difficulty of the material [8,9]. Furthermore, there is speculated to be a skill gap in medical and other professional health science students in applying theoretical knowledge to clinical scenarios [10] and the real problem of burnout due to many factors, one of which is the large amount of knowledge required to retain in a short amount of time [11]. The CCN aims to address these issues by enhancing comprehension, clinical application skills, and empathy toward patients with autoimmune diseases.

The CCN used a unique instructional approach by merging cinemeducation [5] with multiple genAI platforms, tailored for first-year medical students in pharmacology. This method addresses the challenge of enhancing engagement and knowledge retention in complex subjects such as immune system pharmacology. Unlike traditional didactic teaching, our approach, supported by others advocating for innovative teaching strategies, uses storytelling to deepen understanding and empathy [12-14]. Use of genAI in medical training, particularly in personalizing learning experiences and competencies for genAI-based tools, is also a current area of active research [15,16]. This aligns with other researchers who highlight the importance of interactive and engaging content in medical education [17]. Our project also leverages the effectiveness of narrative-based learning, which offers an experiential learning environment over conventional teaching methods and is more accurate to real-world situations [18].

Medical students often struggle to engage with and retain complex pharmacological concepts, especially in preclinical education, where traditional teaching methods can lead to passive learning and poor knowledge retention. To address this challenge, we developed and implemented a novel instructional approach, CCNs, which leverages multimodal genAI tools to create immersive, engaging learning experiences. The aim of this study is to evaluate the effectiveness of these genAI-enhanced CCNs in increasing student engagement, interest, and knowledge retention in medical pharmacology concepts. We tested this intervention by assessing student interest using the Situational Interest Survey for Multimedia (SIS-M) and measuring examination performance on content covered by the CCNs. We hypothesize that students exposed to CCNs will report higher levels of engagement compared with traditional case-based learning and have passing examination grades on questions related to the CCN.

Theoretical Framework

The instructional method in the CCN uses contemporary educational theories emphasizing active, learner-centered approaches. Drawing inspiration from the Constructivist Learning Theory, which advocates for knowledge construction through experience [19], our approach uses an adaptation of cinemeducation to create an immersive learning environment [5]. This also aligns with Mayer's Cognitive Theory of Multimedia Learning, which suggests that learning is enhanced through multimodal presentations [20]. Furthermore, our multimodal use of various genAI platforms for content development is informed by the Technological Pedagogical Content Knowledge (TPACK) framework [21], ensuring an effective integration of technology in teaching. This methodology responds to identified needs in medical education for more engaging and effective teaching strategies, bridging theory and practice in a novel and impactful way.

Methods

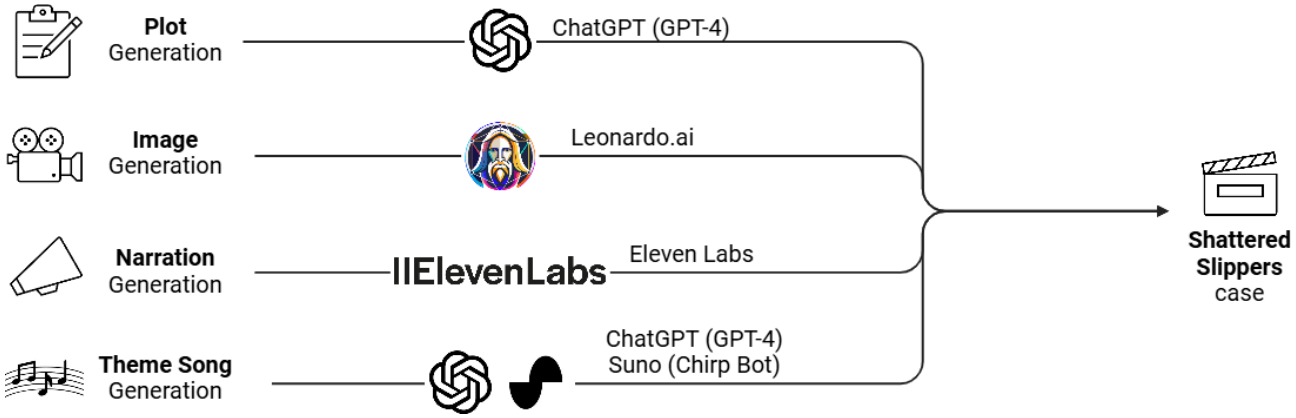
Participants and CCN Design Overview

This study was conducted at the University of Idaho WWAMI Medical Education Program, which is part of a collaborative University of Washington School of Medicine program serving Washington, Wyoming, Alaska, Montana, and Idaho. The WWAMI program provides medical education to students across these states, offering them the opportunity to complete their first 2 preclinical years of medical school in their home states before transitioning to clinical training. The target learners for this study were first-year medical students in the WWAMI program enrolled in a 6-week foundational infections and immunity course, which included topics covering immune system pharmacology. Students in this course attend pharmacology lectures that culminate in clinical cases, allowing them to apply their newly acquired knowledge of medications to real-world patient scenarios.

We decided to reimagine one of these cases into "Shattered Slippers," a CCN that was presented as a fictional sequel to the movie "Another Cinderella Story" (Multimedia Appendices 1 and 2). This fictional sequel features the star from the original movie, Selena Gomez, which was purposeful, given her real-life battle with lupus and her experience receiving a kidney transplant. This choice not only provides a strong thematic link connecting the CCN to the source material but also serves to humanize and demystify the conditions under study.

The development of "Shattered Slippers" used a suite of genAI platforms to create an immersive and engaging learning experience (Figure 1). The plot was crafted using GPT-4, known for its language understanding and generation capabilities. For visual imagery, Leonardo.ai and Stable Diffusion were used to generate high-quality, contextually relevant images. Narration was produced using Eleven Labs, ensuring a coherent and captivating storytelling experience. Furthermore, the theme song, integral to setting the tone of the educational module, was composed using the combined efforts of GPT-4 and Suno.

Figure 1. Multimodal generative artificial intelligence (genAI) case generation approach. Each portion of the case used a different genAI platform for material generation. These included ChatGPT (GPT-4), Leonardo.ai, Eleven Labs, and Suno.



These artificial intelligence (AI)–generated materials were all integrated into 2 PowerPoint presentations. Part I of the CCN was presented at the end of a 1-hour pharmacology lecture on immunomodulatory drugs with specific focus on nonsteroidal anti-inflammatory drugs, glucocorticoids, and innate immune system inhibitors. Part II of the CCN was presented 4 weeks later at the end of a 1-hour pharmacology lecture on immunomodulatory and transplant drugs with specific focus on cytokine inhibitors, cytotoxic drugs, and antimetabolites. Both lectures were presented in-person with >90% of students attending both lectures. The combined CCN is provided as a supplemental file (Multimedia Appendix 2).

At the conclusion of the course, students were informed about Selena Gomez's actual medical journey. This revelation effectively bridged the gap between the fictional narrative of "Shattered Slippers" and real-world medical scenarios, thereby enhancing the educational impact and relevance of the clinical cases discussed.

Plot Development

The process of developing the plot for "Shattered Slippers" began with a reimagining of a clinical case initially presented in the first-year medical school curriculum. This original case centered around a ballerina struggling with rheumatoid arthritis, where students were tasked with diagnosing the sources of her pain and inflammation and selecting suitable immunomodulatory medications.

Using ChatGPT (GPT-4) [22], a large language model (LLM), we transformed this clinical scenario into a compelling narrative for "Shattered Slippers." The sequential steps of the medical case were input into GPT-4, with instructions to adapt these into a fictional storyline (Figure 2 and Multimedia Appendix 3). To enhance thematic resonance and real-world connection, the ballerina's diagnosis in the plot was altered from rheumatoid arthritis to lupus, mirroring the real-life medical condition of Selena Gomez, who stars in the CCN.

Further expanding the scope of the narrative, the plot incorporated a kidney transplant storyline. This addition served a dual purpose. First, it aligned with the second lecture on immunoregulatory pharmacology focusing on organ transplant pharmacology. Second, it resonated with Selena Gomez's personal medical history, as she has undergone a kidney transplant. This incorporation not only ensured continuity with the educational objectives of the course but also added depth and authenticity to the fictional narrative, making it more engaging and relatable for the students.

Figure 2. Excerpt of plot generation. The initial prompt in the conversation covered the development of a separate CCN. Prompt engineering techniques in this initial prompt included Persona Prompting [23,24] and a modified version of Zero-Shot CoT [25]. Excerpts of the first prompt and output related to the Shattered Slippers CCN are provided. CCN: cinematic clinical narrative; CoT: Chain of Thought; LLM: large language model.

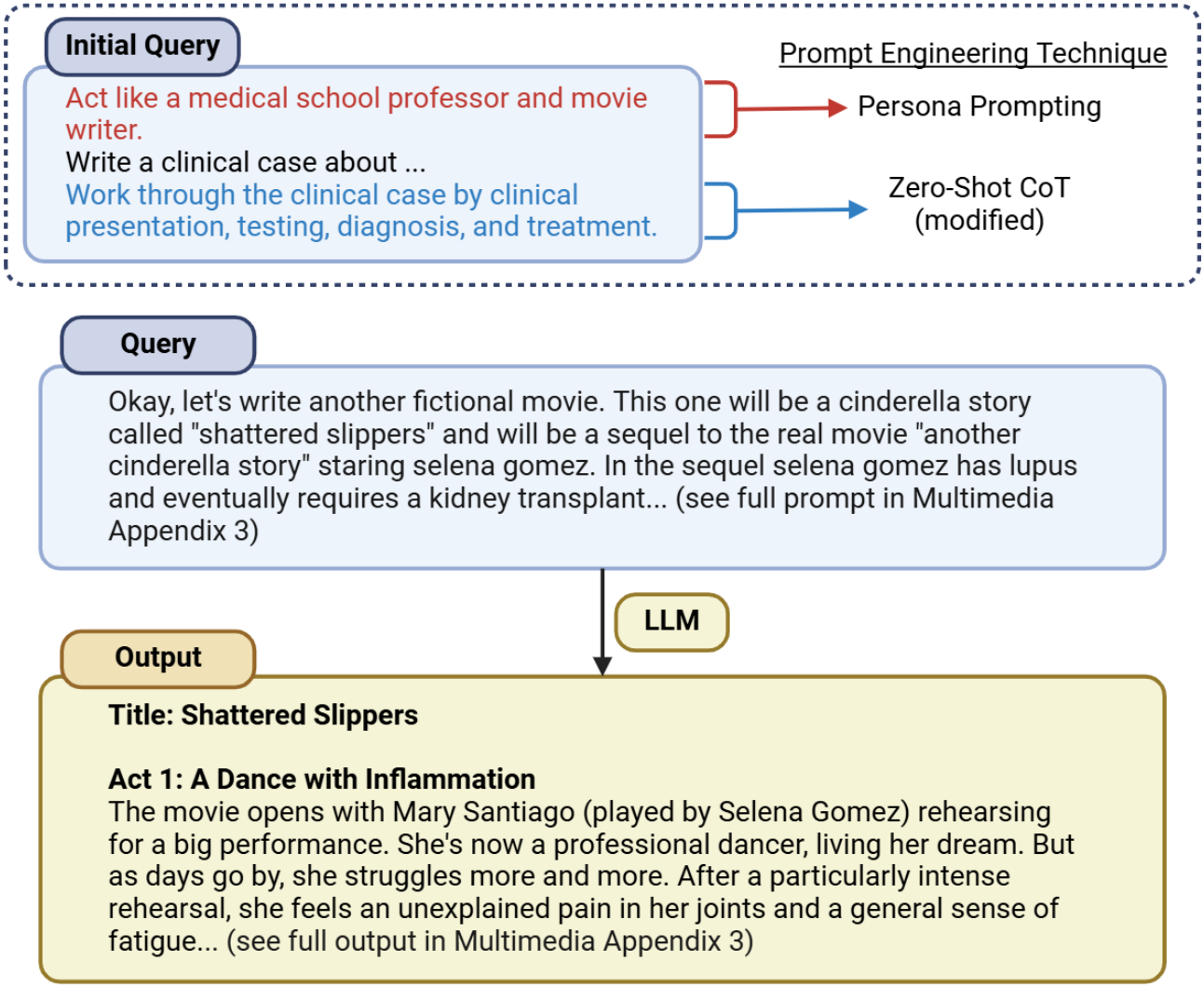


Image Generation

In order to create a more immersive educational experience, fictional images were integrated into the “Shattered Slippers” case study. These images were generated using the Leonardo.ai platform [26], which harnesses the capabilities of the Stable Diffusion XL image–generating technology (Figure 3 and Multimedia Appendix 4).

In an effort to maintain transparency and distinguish between real and AI-generated content, all images depicting real people were marked with an “AI-generated image” icon. This icon, chosen for its symbolic significance, is the spinning top from the movie “Inception.” The selection of this particular icon was purposeful; it serves as a metaphor for the increasingly blurred lines between reality and artificial constructs, mirroring the movie’s thematic exploration of distinguishing reality from illusion. This concept was explained to the students prior to their engagement with the case, setting the stage for a thoughtful consideration of the role and impact of genAI in content creation. This iconography not only helped in identifying AI-generated images but also subtly underscored the advanced capabilities of genAI in creating hyperrealistic images.

Figure 3. Artificial intelligence (AI)-generated image of Selena Gomez singing with Justin Bieber. The prompt used was "adult Selena Gomez and Justin Bieber singing together." The spinning top in the bottom right corner was added as a watermark to denote an AI-generated image. Generated with Leonardo.ai.

Narration Generation

Enhancing the immersive aspect of the CCN, an audio narration was incorporated to accompany the text on the PowerPoint slides. This element was designed to emulate the experience of listening to a movie narrator, thereby bringing the story of "Shattered Slippers" to life in an auditory format. To achieve this, the finalized script of the plot was submitted to the Eleven Labs platform [27], which specializes in converting text into lifelike audio narration (Multimedia Appendix 5).

Each of these audio narrations were incorporated into their corresponding PowerPoint slides. As each slide was presented during the course, the audio narration played automatically, further synchronizing the visual and auditory elements of the learning experience. This integration of audio narration with the visual content not only enriched the storytelling aspect of the module but also supported diverse learning styles, facilitating a more engaging and multisensory educational experience for the students.

Theme Song Generation

Although not directly educational, a theme song for "Shattered Slippers" was created to complete the immersive experience. The inclusion of a theme song aimed to add an additional layer of engagement and context to the fictional movie, contributing to a more comprehensive and cinematic learning environment.

The lyrics for the theme song were generated using GPT-4 [22]. Following the lyric generation, Suno Chirp Bot, a genAI tool for music composition [28], was used to create the melody and vocals for the theme song. This genAI-driven process allowed for a harmonious blend of lyrics and music, resulting in a fully rendered theme song (Multimedia Appendix 6).

Once completed, the theme song was embedded into the PowerPoint presentation. This musical addition served as a capstone to the multisensory educational module, further enriching the student's experience by providing a unique auditory element that complemented the visual and textual components of "Shattered Slippers."

Data Collection

The "Shattered Slippers" CCN was integrated into 2 distinct pharmacology lectures, both of which focused on medications used in immune system modulation. The target audience for this CCN was a class of 40 first-year medical students (n=40). This approach aimed not only to enrich their understanding of immunomodulatory pharmacology but also to engage them in a unique and memorable learning experience.

To evaluate student interest in the CCN as an educational tool, at the conclusion of the course, students were invited to participate in a feedback process using the SIS-M [29-31] (Table 1) of which 18 students responded (n=18). The SIS-M was developed by Dr Tonia Dousay, a professor in instructional design and educational technology, to assess various constructs of situational interest in multimedia-based learning environments. Originally created for the educational field, the SIS-M focuses on adult learners and measures constructs such

as triggered situational interest (initial engagement with multimedia), maintained interest, and value interest (perceived usefulness of the content). The survey was originally used to evaluate the effectiveness of multimedia in promoting engagement and motivation in higher education and adult learning settings [29,30] and has recently been used in medical education research [31], making it an appropriate tool for assessing learner engagement in this study. This survey was used to capture their views and opinions on the "Shattered Slippers" case, providing insights into student engagement, interest, and the overall impact of the CCN on their learning experience. The survey includes items to rank on a 1 - 5 scale (1=strongly disagree, 5=strongly agree), a question asking for preference of clinical case format, and an open-ended question asking, "Why do you think this is your preference." The CHERRIES report for this survey is supplied (Multimedia Appendix 7).

Table . SIS items.

SIS[a] type	Survey item
SI-triggered	The multimedia presentation was interesting.
SI-triggered	The multimedia presentation grabbed my attention.
SI-triggered	The multimedia presentation was often entertaining.
SI-triggered	The multimedia presentation was so exciting, it was easy to pay attention.
SI-maintained-feeling	What I learned in the multimedia presentation is fascinating to me.
SI-maintained-feeling	I am excited about what I learned in the multimedia presentation.
SI-maintained-feeling	I like what I learned in the multimedia presentation.
SI-maintained-feeling	I found the information in the multimedia presentation interesting.
SI-maintained-value	What I studied in the multimedia presentation is useful for me to know.
SI-maintained-value	The things I studied in the multimedia presentation are important to me.
SI-maintained-value	What I learned in the multimedia presentation can be applied to my job.
SI-maintained-value	I learned valuable things in the multimedia presentation.

[a]SIS: Situational Interest Survey.

Data Analysis

The research team used Microsoft Excel for the analysis of the SIS-M survey results. The average class pharmacology examination grades (n=40) from questions covered by the "Shattered Slippers" case study (n=2) were analyzed for achievement data. These included a multiple-choice question, selected by the course lead (not the study author) from a pool of questions that tested pharmacology content covered in each pharmacology lecture. The questions were administered during the students' weekly examinations, scheduled for the week immediately following the presentation of the material. Importantly, these questions were modeled after USMLE-style step 1 board questions, which assess students' ability to apply their pharmacological knowledge in a clinical context. Using this format provides a rigorous and standardized measure of student understanding of the material, ensuring that the assessment reflects the type of knowledge and critical thinking required for success on future board examinations.

The SIS-M survey's analysis focused on various dimensions of situational interest: triggered interest, maintained-value (MV), maintained interest, and maintained-feeling (MF). Thematic analysis was conducted using ChatGPT (GPT4o and o1-preview) and Claude 3.5 Sonnet. This involved generating initial codes and identifying themes, followed by the researcher combining and refining these themes for overlap and relevancy between the 3 LLMs [31]. Prompt engineering techniques used included Persona Prompting [23,24], Zero-Shot Chain of Thought (CoT) [25], and Self-Criticism [32]. The Zero-Shot Chain of Thought prompting was not used with the ChatGPT o1-preview model, as it has built-in Tree-of-Thought functionality in every output. The initial prompt was the following:

> *Act like a brilliant medical education researcher. I am doing a study on a Cinematic Clinical Narrative (CCN) which is an educational tool that combines clinical case studies with storytelling techniques typically seen in movies or TV shows. By embedding medical information within a compelling fictional storyline, CCNs help medical students retain complex medical concepts in an engaging, memorable way. The CCN in the study was called "Shattered Slippers," was a fictional sequel to the movie "Another Cinderella Story," and stars Selena Gomez. It covered the topics of immunomodulatory medications for treating lupus, and kidney transplants. I surveyed the participants on their preference of the CCN over traditional clinical cases and asked them to explain their preference. Please perform a thematic analysis on the below participant responses marked between <response> </response>. Let's work this out in a step by step way to be sure we have the right answer.*
>
> *<response>*
>
> *Participant responses here*
>
> *</response>*

This was then followed by the following Self-Criticism prompt: "Please reflect on your previous answer for any errors."

Ethical Considerations

This educational research was approved as exempt by the institutional review board of the University of Idaho (21-223). As the CCN incorporated references to real celebrities and included AI-generated images of actual people, we consulted legal counsel to ensure compliance. The counsel advised that, given the educational context and the clear labeling of images as AI-generated rather than real, the usage was permissible. Furthermore, we end the CCN with a brief description of the real-life health struggles of the celebrities, which is all public information. However, since this remains a legally gray area, we recommend exercising caution in future projects that use similar techniques. The SIS-M was conducted anonymously to ensure the confidentiality of participants' responses. No identifying information was collected, allowing students to provide honest feedback without concern for personal attribution.

Results

The quantitative assessment of the "Shattered Slippers" CCN using the SIS-M is summarized in Table 2. The results indicated high levels in participants' interest with the "Shattered Slippers" CCN, with the majority of students (14/18) indicating a preference for the CCN over traditionally presented clinical cases, only 1 student preferring the traditional approach, and 3 expressing no preference (Table 3).

Table . Situational Interest Survey for Multimedia results (N=18): scores.

Question	Minimum[a]	Maximum[a]	Mean[a]	SD	Variance
The Shattered Slippers case was interesting.	4.00	5.00	4.61	0.49	0.24
The Shattered Slippers case grabbed my attention.	4.00	5.00	4.72	0.45	0.20
The Shattered Slippers case was often entertaining.	3.00	5.00	4.67	0.58	0.33
The Shattered Slippers case was so exciting, it was easy to pay attention.	3.00	5.00	4.33	0.58	0.33
What I learned from the Shattered Slippers case is fascinating to me.	4.00	5.00	4.39	0.49	0.24
I am excited about what I learned from the Shattered Slippers case.	4.00	5.00	4.39	0.49	0.24
I like what I learned from the Shattered Slippers case.	3.00	5.00	4.39	0.59	0.35
I found the information from the Shattered Slippers case interesting.	4.00	5.00	4.33	0.47	0.22
What I studied in the Shattered Slippers case is useful for me to.	4.00	5.00	4.50	0.50	0.25
The things I studied in the Shattered Slippers case are important to me.	3.00	5.00	4.28	0.56	0.31
What I learned from the Shattered Slippers case can be applied to my major/career.	3.00	5.00	4.44	0.60	0.36
I learned valuable things from the Shattered Slippers case.	4.00	5.00	4.44	0.50	0.25

[a]Rated on a 5-point scale (1=Strongly disagree, 5=Strongly agree).

Table . Situational Interest Survey for Multimedia results (N=18): preferences for case type.

Which case type do you prefer?	Count
Traditional case studies	1
Shattered Slippers case study	14
No preference	3

Participants indicated a high average triggered situational interest in the CCN (mean 4.58, SD 0.53), as well as high maintained interest scores indicated by the students (mean 4.40, SD 0.53).

The results for MF interest indicated high MF in students receiving the CCN (mean 4.38, SD 0.51). A feeling of educational value by the participants was supported by high scores for MV interest (mean 4.42, SD 0.54).

Bridging quantitative data with qualitative insights, the survey conducted among participants also provided an open-ended question for students to reflect on their opinion of the CCN. Thematic analysis of the responses revealed the following:

- *Enhanced engagement through storytelling and entertainment*: The combination of storytelling and entertainment in the CCN heightened student engagement, making the learning process more enjoyable and effective compared with traditional methods.
- *Improved memorability and recall of medical concepts*: The CCN's engaging narrative and multimedia elements enhanced memory retention, making complex medical information more accessible and memorable.
- *Relatability through pop culture and personal connection*: Leveraging familiar pop culture icons such as Selena Gomez helped students form a personal connection with the material, enhancing engagement and motivation to learn.
- *Preference for interactive and detailed learning*: Some students value interactive learning environments and detailed information, suggesting that while the CCN is engaging, it could be further enhanced by incorporating active learning elements and comprehensive content.
- *Suggestions for improvement*: Attention to technical elements, such as the use of genAI voice narration, could improve the overall effectiveness and reception of the CCN.

The thematic analysis reveals that the CCN "Shattered Slippers" was preferred over traditional case studies due to its engaging storytelling, enhanced memorability, and relatability through pop culture references. While students appreciated the innovative approach, some expressed a desire for more interactive learning methods and provided suggestions for technical improvements. Incorporating these insights can further refine the CCN as a valuable tool in medical education.

In addition to the survey feedback from the SIS-M, the success of the "Shattered Slippers" CCN was further demonstrated academically. Students displayed strong comprehension and knowledge of the material covered, achieving an average score of 88% on examination questions pertaining to the case study content. This high performance underscores the effectiveness of the CCN as a teaching tool, suggesting that it may also be useful in promoting academic performance as well as student preference and interest.

Discussion

Principal Findings

The "Shattered Slippers" CCN supports the pedagogical value of integrating innovative genAI-driven methods and culturally resonant themes into medical education. Our study shows the capacity of this approach to not only enhance student interest but also promote their understanding and retention of complex subject matter. Furthermore, it adds very little to no extra time to the lecture material, as it basically reskins the existing material into a more cinematic experience. This is particularly important, as many new active learning teaching methodologies either extend the amount of time students spend with the material or cause instructors to remove large amounts of material in order to incorporate novel active learning activities. We considered it ethical to clearly mark AI-generated images of real individuals to avoid confusion but did not deem it necessary to label AI-generated material such as text or audio that was not mimicking a real-world person. As genAI models continue to improve in generating realistic images and cloned voices, it will become increasingly important to label AI-generated materials that mimic real-world individuals to prevent confusion with reality and avoid potential legal issues.

This study shows the importance of engaging students beyond conventional didactic methods, suggesting that the inclusion of elements such as plot development, multimedia, and popular culture can make learning more relatable and impactful. The feedback from the SIS-M supports that this approach can effectively address the initial problem of student disengagement and the need for more effective educational strategies as identified in the introduction.

The process of creating CCNs with genAI tools is highly efficient and cost-effective. Designing the case outline took about a day, while plot and narration generation were completed in seconds using GPT-4 and Eleven Labs. Image and theme song generation took under an hour each, with slight delays due to iterative refinement. Overall, the time investment was minimal compared with traditional methods. The required technical skills are basic, involving familiarity with genAI platforms for text, image, and audio generation and standard project management skills to integrate these elements into a PowerPoint slide deck. In terms of cost, the only expense was a US $20 per month subscription to ChatGPT; other platforms were used on free tiers. This low cost, combined with fast production times, makes migrating to this format highly accessible and efficient for educators, offering significant time and cost savings compared with traditional content creation methods of this caliber.

Future directions of this work will explore how similar immersive educational experiences can be scaled and adapted for diverse student populations and learning environments. The versatility of genAI-enhanced CCNs extends beyond pharmacology, offering potential applications in other areas such as anatomy, pathology, and clinical skills. This pedagogical strategy can be adapted to various medical disciplines, making abstract topics more engaging and accessible to diverse learners. It also asks questions on how educational policies might evolve to integrate this type of AI-generated material into curricula systematically. As genAI becomes more integral to education, policies must address both the ethical use of genAI and the need for genAI literacy among educators and students. Personalized, genAI-driven learning experiences could revolutionize how content is delivered, providing flexibility and tailored learning opportunities. There is an opportunity to explore interdisciplinary collaborations, merging medical education with fields such as AI, storytelling, and multimedia design. These collaborations could further refine educational tools and help bridge the gap between traditional learning and modern health care technologies, fostering genAI literacy in future medical professionals. This promising pilot study shows potential for scalability and broad applicability of genAI-enhanced CCNs. The strategy offers a model for

transforming how complex medical topics are taught, providing a scalable, engaging solution that can be adapted across different medical content areas to meet evolving educational needs.

Limitations

Our project has limitations in terms of cultural adaptability due to its reliance on specific cultural references and celebrity figures, which may not resonate with all audiences. Furthermore, the use of genAI technologies presents challenges in environments with varying levels of technological resources and differing instructor familiarity with these platforms. While the skills required to effectively use genAI can vary depending on the model, these challenges are mitigated by the increasing availability of more user-friendly genAI platforms. These platforms are simplifying AI integration in educational contexts, expanding the potential for their broader application. For instance, prompt engineering, which is crucial for optimizing output from LLMs, is becoming less essential with newer versions such as ChatGPT's o1-preview model, which incorporates many of these strategies into the system itself. This reduces the need for advanced user expertise and lowers the barrier to efficient LLM use.

Another limitation of our study is the process of validity checking for AI-generated content. Although the materials were reviewed by medical professionals, including physicians, PhDs, and PharmDs, to ensure accuracy, the use of genAI introduces potential risks in content reliability, especially as AI-generated content may produce subtle inaccuracies or lack the nuanced context that a human expert might provide. Future implementations of this approach would benefit from a formalized validation process to ensure that the clinical and educational integrity of AI-generated materials is maintained.

The evaluation methodology, focusing on immediate reactions via the SIS-M, provides a single time point of the resource's impact but does not capture the longevity of knowledge retention or the applicability of the learned material in clinical settings. Furthermore, the study included a limited sample size, with only 18 respondents to the SIS-M survey, which may not provide a comprehensive view of the broader student population. Future research could explore longitudinal studies to measure the lasting educational benefits of such methodologies with a larger participant population.

Furthermore, our study lacked a control or comparison group, a common challenge in medical education research. All students in the study were exposed only to the CCN case, and without a traditional case-based learning comparison, it is difficult to isolate the exact impact of the CCN on student performance. While we acknowledge that a control group could provide valuable insights, the integration of such comparisons is often logistically difficult in medical school settings. Future studies could address this by designing more controlled experimental conditions or through the use of quasi-experimental designs to better understand the differential effects of various educational interventions on learning.

Conclusions

The "Shattered Slippers" CCN demonstrates the effectiveness of combining cinemeducation with genAI in medical education. This approach enhanced student engagement, promoted knowledge retention, and offered a novel perspective on complex pharmacological clinical cases. The application and positive student feedback suggest that this multimodal genAI approach to educational content creation has potential for broader application in medical education. Our project also highlights the need for continuous innovation and adaptation in teaching methodologies to meet the evolving demands of health care education. Future research and development in this area could further transform medical education, making it more engaging, effective, and aligned with modern technological advancements.

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Conflicts of Interest

None declared.

Multimedia Appendix 1
Shattered Slippers: cinematic clinical narrative.
[PDF File, 878 KB - mededu_v11i1e63865_app1.pdf]

Multimedia Appendix 2
Shattered Slippers full presentation.
[MP4 File, 134196 KB - mededu_v11i1e63865_app2.mp4]

Multimedia Appendix 3
ChatGPT plot generation.
[DOCX File, 20 KB - mededu_v11i1e63865_app3.docx]

Multimedia Appendix 4
Leonardo.ai image generation.
[DOCX File, 3053 KB - mededu_v11i1e63865_app4.docx]

Multimedia Appendix 5
Eleven Labs narration generation and audio clips.
[DOCX File, 13 KB - mededu_v11i1e63865_app5.docx]

Multimedia Appendix 6
ChatGPT and Suno Chirp Bot theme song generation and audio clip.
[DOCX File, 15 KB - mededu_v11i1e63865_app6.docx]

Multimedia Appendix 7
Situations Interest Survey of Multimedia CHERRIES (Checklist for Reporting Results of Internet E-Surveys) report.
[DOCX File, 15 KB - mededu_v11i1e63865_app7.docx]

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Abbreviations

AI: artificial intelligence
CCN: cinematic clinical narrative
genAI: generative artificial intelligence
LLM: large language model
MF: maintained-feeling
MV: maintained-value
SIS-M: Situational Interest Survey for Multimedia
TPACK: Technological Pedagogical Content Knowledge

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