Innovation and design of a web-based pain education interprofessional resource

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INTRODUCTION: The present article describes educational innovation processes and design of a web-based pain interprofessional resource for prelicensure health science students in universities across Canada. Operationalization of educational theory in design coupled with formative evaluation of design are discussed, along with strategies that support collaborative innovation.

METHODS: Educational design was driven by content, theory and evaluation. Pain misbeliefs and teaching points along the continuum from acute to persistent pain were identified. Knowledge-building theory, situated learning, reflection and novel designs for cognitive scaffolding were then employed. Design research principles were incorporated to inform iterative and ongoing design.

RESULTS: An authentic patient case was constructed, situated in interprofessional complex care to highlight learning objectives related to preoperative, postoperative and treatment up to one year, for a surgical cancer patient. Pain mechanisms, assessment and management framed content creation. Knowledge building scaffolds were used, which included video simulations, embedded resources, concurrent feedback, practice-based reflective exercises and commentaries. Scaffolds were refined to specifically support knowledge translation. Illustrative commentaries were designed to explicate pain misbeliefs and best practices. Architecture of the resource was mapped; a multimedia, interactive prototype was created. This pain education resource was developed primarily for individual use, with extensions for interprofessional collective discourse.

DISCUSSION: Translation of curricular content scripts into representations supported the collaborative design process by establishing a common visual language. The web-based prototype will be formatively and summatively evaluated to assess pedagogic design, knowledge-translation scaffolds, pain knowledge gains, relevance, feasibility and fidelity of this educational innovation.

Key Words: Innovation; Interprofessional; Pain; Resource; Web-based

Web-based innovations are pervasive in health professions education. However, there is a paucity of research on what constitutes effective web-based educational innovations (1). Many current studies merely provide a description of the innovation, followed by an evaluation of participants’ knowledge acquisition and satisfaction ratings. Studies often fail to address educational theory, pedagogic design, innovation processes, barriers to implementation, sustainability, lessons learned, potential influences on the field, and new ideas or problems for further exploration. Missing in the literature are scholarly and reflective descriptions of these important aspects of innovations that could inform our understanding and improve teaching, learning, research and/or patient care (2). The editor of Academic Medicine has refused to publish studies that ask the questions: ‘What was done?’ and ‘Did it work?’, in favour of articles that provide ‘better descriptions of innovations’ (2).

The present article is framed within a descriptive construct and will begin by detailing the educational problem that was the catalytic agent for development. A description of the web-based innovation will outline how educational theory is operationalized through pedagogic design. Knowledge-building scaffolds will be highlighted to demonstrate use in supporting authentic and complex web-based learning. In the second section, evaluation is linked to pedagogic design. Concepts of design research are explored through the lens of knowledge building theory and the shared notion of ‘improvability’ and compared with more traditional concepts of experimental research. In the final section of the present article, interdisciplinary team and collaborative design processes are explained. Translation of the curricular content script to a visual map of the entire resource is clarified, along with details demonstrating how this process guides web-based multimedia development. These elements are examined within the
TABLE 1
Knowledge building principles for pedagogic design

| 1. Real ideas, authentic problems |
| 2. Improvable ideas |
| 3. Idea diversity |
| 4. Rise-above |
| 5. Epistemic agency |
| 6. Community knowledge, collective responsibility |
| 7. Democratizing knowledge |
| 8. Symmetric knowledge advancement |
| 9. Pervasive knowledge building |
| 10. Constructive use of authoritative sources |
| 11. Knowledge building discourse |
| 12. Embedded and transformative assessment |

Adapted from reference 13
‘reflection on reflection’. Two specific types of commentaries, called interpretive and application commentaries, previously used in microdissection of video exemplars with formative feedback on communication skills (9), were reviewed for the current program.

Knowledge building scaffolds were specifically created in the PEIR to support active cognitive engagement for self-learning, self-assessment and self-reflection within an authentic and complex clinical case. Teaching pain management concepts in an interprofessional context can be considered a ‘complex and ill-defined domain’ (22). Knowledge building scaffolds were refined to provide a foundation for the pedagogic design of the PEIR aimed at knowledge translation. PEIR concepts for designing knowledge building scaffold strategies focused on prompting reflection, providing in-depth formative feedback, and enabling recursion for multi-level learning with authentic visual demonstrations and audio explanations, to support high-level cognitive and metacognitive work, similar to real-world practice.

Educational or pedagogic design is driven by content, theory and evaluation. The concept of improvability (13) is key across these three aspects, and provides links between knowledge transfer and translation of content to practice, knowledge building theory and principles of design research. In the next section, concepts of design research formative evaluation and experimental design summative evaluation are discussed in relation to the PEIR.

Design research and experimental research in education
Design research, for formative feedback and iterative improvement of the PEIR site, was selected as the evaluation method to be used during the development phase and coupled with postdevelopment summative evaluation of program implementation outcomes. These evaluation methods complement one another, yet are distinct. Design research was recently introduced in the education literature (23,24); its quick rise in popularity led the American Educational Research Association to devote a special issue to articles illuminating this type of research (25). Design research can be distinguished from more traditional types of research design common in health professions education, such as experimental research (Table 2).

Design research has been characterized as multidimensional, authentic and inductive. These types of studies usually examine multiple variables, using multiple methods in real-world educational environments. The focus is on obtaining formative feedback results, which can be quantitative and/or qualitative, during development and upon implementation of an educational innovation. The distinctive feature of design research studies is that they are conducted at strategic points in the process of innovation design. Results are then fed back into the system, and used to improve pedagogic design and educational outcomes. Hence, design research results inform design and continued development. This is a process-oriented model of evaluation that focuses on iterative improbability. In contrast, experimental education research design, with the randomized control trial (RCT) approach, is an outcomes-oriented model. Although it is often considered the most rigorous research approach, it has also been characterized as limited (23,24). RCTs are deductive and summative. Typically RCTs are conducted after an educational program has been created and is, therefore, termed summative evaluation.

Much of today’s experimental research in health professions education is devoted to examining whether specific educational programs or manipulations result in knowledge gains or improved performance, in either educational or clinical settings. The existence of such a cause-effect relationship requires that two conditions be met (26): First, changes in the outcomes must be observed after the institution of the program and, second, the researcher must make every attempt to remove the influence of other factors that may influence the outcomes, either by virtue of design or analysis. There are many factors in an educational environment that may explain changes in outcomes (27). Failure in eliminating these alternate explanations in RCT designs is considered to lead to erroneous interpretation of the findings. Conversely, exploration of multiple factors and emergent issues is considered fundamental to the design research. A rigorous approach to research design and methodology is advocated (28) in both paradigms.

In summary, both design research and experimental research are systematically conducted, but for different reasons and around different questions. Design research is often used for the purpose of iterative improvement – for formative evaluation during the process of educational innovation, as well as outcomes. Experimental research designs are often used to establish validity or ‘worth’ of an innovation. Both models have their strengths and weaknesses. Both paradigms are useful and necessary, in our opinion. Design research, for formative evaluation of the PEIR, is planned at two points during development. The PEIR site was divided into three sections: preoperative, postoperative and pain management. Design research studies are planned after the second and third sections are created. The site will be tested with health sciences students, multiprofessional consultants and patient representatives. Summative evaluation, using a traditional experimental design approach, is planned at postpilot implementation of the PEIR program.

Evaluative content
Design of the web-based PEIR was framed by determination of educational content. Content drove pedagogic design; technology was used to support design and content. Pain misbeliefs and teaching points along the continuum from acute to persistent pain were identified through an examination of the literature, previous research and expert knowledge (4,29,30). The design team’s first hand experiential understanding of content and process of knowledge advancement in the University of Toronto Interfaculty Pain Curriculum (6) was advantageous. Content and script development used definitions and concepts from the Canadian Pain Society position statement on pain relief (31) and the current International Association for the Study of Pain Core Curriculum (32). The aim was to create an authentic patient case, situated in interprofessional complex care for students to learn about pain, with and from one another, as well as about one another (33,34).

RESULTS
Authentic patient content scripts were constructed and situated in the interprofessional complex care of a surgical cancer patient to highlight pain learning objectives related to preoperative, postoperative and treatment up to one year (Figure 1). Video vignettes were created not only to convey the script narrative, but also to simulate real-world authenticity within the web-based environment.

Innovation design
The original framework of knowledge building scaffolds was expanded (9). Illustrative commentaries were designed in the form of visual explanations conveyed by video vignettes to focus students’ understanding on various sociocognitive aspects of authentic practice. Illustrative commentaries were created to clarify what often remains tacit in practice (35). They articulate and demonstrate best practices. The illustrative, visual commentaries and associated auditory explanations are specifically intended to scaffold knowledge translation to practice. For example, in the preoperative section of the PEIR, an interactive, pain beliefs/misbeliefs checklist was created. Students are

| TABLE 2 Comparative dimensions of experimental design randomized controlled trials and design research |
|---------------------------------|---------------------------------|
| **Experimental research**       | **Design research**              |
| Deductive                        | Inductive                       |
| Outcomes                         | Process/outcomes                |
| Summative                        | Formative/iterative             |
| Randomized                       | Nonrandomized                   |
| Control group                    | No control group                |
| Validation                       | Improvement                     |

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asked to read the list of statements and check the ‘true’ or ‘false’ box for each statement (Figure 2). All statements are common misbeliefs and should be checked as ‘false’. Regardless of whether students answer correctly or incorrectly, responses are indicated and concurrent explanatory feedback is provided. Feedback goes beyond the scoring of checked boxes. An illustrative visual commentary is immediately displayed to highlight the misbelief and how this, in turn, commonly results in poor practice and ultimately affects patient care – in this case, the patient’s pain. A voiceover explanatory commentary then explicitly addresses the pain misbelief, the relationship to care and clarifies best practices (Figure 2). Evidence-based digital resources and references are embedded at point of need for immediate access to scaffold further depth of understanding.

Collaborative pedagogic design of the PEIR resulted in a revised framework of knowledge building scaffolds. The addition of illustrative commentaries, in visual and auditory formats, was specifically designed to support cogent explanations to scaffold knowledge translation to practice. Four types of commentaries are now listed. The revised knowledge building scaffolds are as follows:
1. Virtual patient video simulations;
2. Contextualized evidence-based resources;
3. Concurrent, explanatory feedback;
4. Reflective exercises;
5. Reflective commentaries;
6. Interpretive commentaries;
7. Application commentaries; and
8. Illustrative commentaries.

Using this framework for innovation and pedagogic design, guided by pain learning objectives and case content scripts, the architecture of the web-based curriculum was mapped for full multimedia and web-based development. This collaborative design process is described next.

Collaborative design

An important outcome in creating the PEIR was the collaborative design process that emerged. The design team consisted of experts from a variety of disciplines including health sciences, education, research, videography and web-development. Each member brought specialized expertise to the team, as well as their own background and perspectives, which required the establishment of a common language in the discussions about the resource. Another consideration was the need to organize emerging ideas and the complexity of the design. The goal was to create a rich, highly interactive educational resource that incorporates several different media (eg, video, animation, interactivity and slides). To facilitate the collaborative discourse the group drew on concepts of ‘envisioning information’ (35) ‘visual thinking’ (36) and cognitive theory of multimedia learning (37). A mapping visualization was developed to represent the content scripts, interactivity and application flow of the resource, framed by a user-centred perspective (38) (Figure 3).

Drawing from web conventions in flowcharting sitemaps (39), and film and animation storyboarding (40), the mapping visualization enabled ideas to be visualized, added, deleted and shifted during the ideation process. Each box in the map represents a unit of content (ie, sections and subsections), and lines between the boxes represent how content is linked throughout the application. Symbols were used to identify the type of content each box (eg, blue film wheel representing video, green music note for voiceovers, and a Flash icon representing interactive content). Web-based screenshots served to describe the content quickly, with relatively little use of screen real estate. For example, box 3.1 in Figure 3 indicates that the patient chart section is played after the introduction to the case patient, Maria; the Flash icon denotes that it is an interactive piece and the screen shows that the section is styled in the form of a traditional patient chart.

Nodes and links convey a high-level overview of the site, as well as providing information on relationships between elements. In addition, the numbering system on the map corresponds to those in a text file, known as a copy deck – the copy deck documents content information. Typically, there are two columns in a copy deck (Figure 4), delineating audio content and visual content. The beginning of a section is marked by the number and title of the section followed by the appropriate content. For example, in the section ‘2.0 – Introduction to Maria’, the narration script for video content is on the left and the description of the hospital scene is on the right. The combination of copy deck along with the mapping visualization allowed the team members to discuss everything from broad application flow to interactivity and detailed content scripts in the PEIR. The site visualization provided the team with a common language and a map for continued development.

Discussion

The PEIR was primarily designed for individual web-based use, with access to collective discourse, whether online or face-to-face. Content, theory and evaluation inform design. The operationalization of educational theory in pedagogic design and details of the collaborative design process are often not well described in the literature. By framing the present article as a descriptive report, these aspects are explicated. The current article addresses the call for better descriptions to inform our understanding of educational innovation design.
Novel ideas and artefacts emerged through collaborative design. Pedagogic design of the PEIR resulted in a revised framework of knowledge-building scaffolds. Noteworthy, is the addition of illustrative, visual and voiceover commentaries specifically created to scaffold knowledge translation to practice. The shared expertise from the variety of disciplines represented in the design team facilitated this process. Each member brought not only specialized expertise, but also experiential perspectives related to clinical, education, media, design and research relevance. Our collaborative design process illuminated how content scripts can be used to create visual representations of the website and provide a common language and map of ideas to support and advance development. These concepts may be useful and generalizable across contexts.

The present article provides a description of design-driven strategies for web-based educational innovation. It underscores the
importance of the reformulation of research and reporting to advance new directions in this relatively new field (2,41). Furthermore, it advocates the use of design research for formative feedback on pedagogic design at points throughout site development, in addition to summative evaluation using a traditional experimental design approach. These research paradigms are regarded as complementary. The PEIR web-based prototype will be piloted with health science students, multiprofessional consultants and patient representatives, to validate the fidelity, feasibility and relevance of this educational innovation. Reporting of these outcomes will be the subject of a future article.

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REFERENCES
3. Sessle B. President’s address. IASP Newsletter, Fall 1, 1999.
41. Cook DA. The failure of e-learning research to inform educational practice, and what we can do about it. Med Teach 2009;31:158-62.