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Contents

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Original Paper

A Clinical Reasoning Tool for Virtual Patients: Design-Based Research Study

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Abstract

Background: Clinical reasoning is a fundamental process medical students have to learn during and after medical school. Virtual patients (VP) are a technology-enhanced learning method to teach clinical reasoning. However, VP systems do not exploit their full potential concerning the clinical reasoning process; for example, most systems focus on the outcome and less on the process of clinical reasoning.

Objectives: Keeping our concept grounded in a former qualitative study, we aimed to design and implement a tool to enhance VPs with activities and feedback, which specifically foster the acquisition of clinical reasoning skills.

Methods: We designed the tool by translating elements of a conceptual clinical reasoning learning framework into software requirements. The resulting clinical reasoning tool enables learners to build their patient's illness script as a concept map when they are working on a VP scenario. The student's map is compared with the experts' reasoning at each stage of the VP, which is technically enabled by using Medical Subject Headings, which is a comprehensive controlled vocabulary published by the US National Library of Medicine. The tool is implemented using Web technologies, has an open architecture that enables its integration into various systems through an open application program interface, and is available under a Massachusetts Institute of Technology license.

Results: We conducted usability tests following a think-aloud protocol and a pilot field study with maps created by 64 medical students. The results show that learners interact with the tool but create less nodes and connections in the concept map than an expert. Further research and usability tests are required to analyze the reasons.

Conclusions: The presented tool is a versatile, systematically developed software component that specifically supports the clinical reasoning skills acquisition. It can be plugged into VP systems or used as stand-alone software in other teaching scenarios. The modular design allows an extension with new feedback mechanisms and learning analytics algorithms.

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KEYWORDS

learning; educational technology; computer-assisted instruction; clinical decision-making

Introduction

In the context of health care education, virtual patients (VPs) are often described as interactive, computer-based programs that simulate real-life clinical encounters [1]. The technical basis of VPs ranges from low-interactive Web pages to high-fidelity simulations or virtual reality scenarios. In the form of interactive patient scenarios, they are typically used to foster clinical reasoning skills acquisition in health care education [2,3]. Interactive patient scenarios are Web-based applications in which a learner navigates through a VP scenario and interacts with the VP in form of menus, questions, or decision points. A

variety of commercial and open-source VP systems, such as CASUS, OpenLabyrinth, or i-Human are available and applied in health care education [4]. Such systems provide tools for educators to create VP scenarios and deliver them to their students.

Clinical reasoning or clinical decision making encompasses the application of knowledge to collect and integrate information from various sources to arrive at a diagnosis and a management plan. It is a fundamental skill health care students have to acquire during and after their education. In addition to traditional teaching methods, VPs offer a safe environment to practice clinical reasoning without harming a patient and to prepare learners for clerkships or bedside teaching [2].

However, how clinical reasoning is implemented in VPs varies greatly, and the effect of these design variations on learning outcomes is not yet fully understood [5]. Feedback and scoring are often implemented quantitatively, are outcome-oriented, and do not account for the nonlinear nature [6] of the clinical reasoning process. More process-oriented approaches, such as a study described by Pennaforte et al [7], often require an instructor to be present, thus, limiting the scalability of VPs. Additionally, VP systems do not exploit their full potential concerning the clinical reasoning process. For example, dealing with cognitive errors, explicit development of illness scripts [8], or pattern recognition approaches is rarely implemented in VP systems.

Therefore, our aim was to develop a software tool that can be combined with VP systems, specifically supports clinical reasoning skills acquisition, and assesses all steps of this complex process. We will describe the main components of the software and results of usability tests and a pilot study.

Methods

Concept Development

The concept of the tool is based on a grounded theory study, which is an exploratory qualitative research methodology aiming at understanding a phenomenon and developing a theory grounded in the data [9]. We explored the process of learning clinical reasoning based on data resources such as scientific literature or teaching material [10]. The result of the study was an application-oriented framework with five main categories: psychological theories, patient-centeredness, teaching and assessment, learner-centeredness, and context. Each category includes subthemes, such as illness scripts, cognitive errors, self-regulated learning, learning analytics, or cognitive load. This framework served as a basis for developing the concept for the software. We discussed the framework and conclusions on how to transfer it to VPs with health care professionals, educators, and students, and on the basis of these discussions, we developed the functional software requirements (Table 1).

Some of the subthemes of the framework, such as communication, emotions, or authenticity, are related to the design of the VP itself, rather than to the clinical reasoning tool, so they were not translated into software requirements. However, these aspects are important for the VP design process and need to be considered and aligned with the tool.

Design of the User Interface

Figure 1 shows a wireframe model of the clinical reasoning tool with its main components.

For each category (ie, findings, differential diagnoses, tests, and therapies), the learners can search for a term, and either select one from the type-ahead list, which is based on Medical Subject Heading (MeSH) published by the US National Library of Medicine [12], or choose to enter their own entry. Also, negations can be entered, to add negative findings, such as “no fever.”

Differential diagnoses can be marked as “must-not-miss” or as “unlikely/ruled-out” by selecting the option from a context menu. Once the learner has entered a differential diagnosis, the button for submitting a final diagnosis will be activated. After clicking this button, the learner can select one or more diagnoses from his or her differentials and submit them as final diagnoses.

All added nodes (findings, differentials, tests, and therapies) can be deleted, moved within the box, and connected with each other via drag&drop. For example, if a finding speaks against or confirms a diagnosis, the learner can connect the finding with that diagnosis. By clicking on the connection, its color (=weight) and meaning can be changed from red—“speaks against”—to dark blue—“highly related.” Currently, 5 different weights/colors can be assigned to a connection. Thus, learners build their patients’ illness script in the form of a concept map in a step-by-step approach.

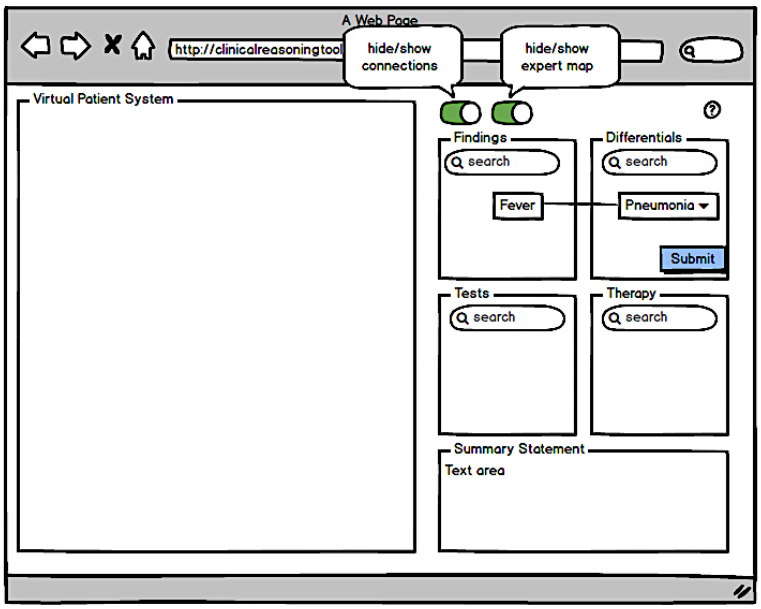
Finally, the learner’s task is to compose a short summary statement, usually 2 to 3 sentences about the VP in a text area at the bottom of the tool’s panel. Such a summary statement is a mental abstraction to transform relevant patient-specific details into abstract terms, preferably using semantic qualifiers [13]. This transformation is a crucial step in the clinical reasoning process.

With the 2 switch buttons on top, the learner can toggle the display of connections and can anytime access an expert’s map.

Table 1. Overview of categories and subthemes, which have been translated into software requirements and how they have been implemented in the clinical reasoning tool.

Category	Subtheme	Requirements
Psychological theories	Patient illness script	The concept of developing an illness script is implemented as a concept map (directed weighted graph), with findings, differential diagnoses, tests, and therapy options as nodes. Relations can be visualized with connections between the nodes, which can be weighted (eg, “slightly related,” “highly related”)
	Dual processing	Learners can submit a final diagnosis anytime in the virtual patient (VP) scenario to encourage pattern recognition approaches.
Patient-centeredness	Cognitive errors	The final diagnosis/-es of the learner are compared with the expert’s diagnoses. In case of a mismatch, the tool analyzes potential sources of errors or biases.
Teaching/assessment	Methods	Concept mapping as a suitable method of teaching and assessing clinical reasoning is the basis of the tool.
	Scoring	The nodes of the concept map are based on the Medical Subject Heading thesaurus; therefore, they can be scored by comparing them with expert nodes, including synonyms and more/less specific entries.
Learner-centeredness	Learning analytics	After each VP session, the learners can access a dashboard with their clustered scores, development of their performance over time/VPs, and comparison with their peers.
	Feedback	Both, process- and outcome-oriented feedback is provided by the tool and can be accessed by the learner anytime.
Context	Cognitive load	In the development process, we conducted usability tests to test the general usability of the tool and specifically uncover potential improvements in terms of extraneous cognitive load [11].

Figure 1. Wireframe model of the clinical reasoning tool (right side) integrated into a virtual patient system (left side).



Technical Approach

The tool is programmed in Oracle Java, using Java Server Faces as a framework; Hibernate, an open-source Object Relational Mapping solution, for Java applications; and JGraphT, which provides mathematical graph-theory objects and algorithms. All user actions, including a time stamp and at which stage in the VP scenario they were performed, are stored in an Oracle database, but alternative database management systems such as MySQL can be used as well. The client side is implemented in dynamic hypertext markup language, including open source libraries and frameworks such as JQuery, JSPlumb, and D3.js.

The tool is available in English, German, and Polish and can be downloaded under a Massachusetts Institute of Technology license [14]. Exemplary VPs are available in the VP system CASUS [15].

Patient Illness Script Modeled as a Concept Map

Concept mapping is an approach applied in medical education in general [16] and in clinical reasoning training and assessment [17,18]. In the grounded theory study, which was the basis for the development of the tool, concept mapping was identified as a suitable method of teaching and assessing clinical reasoning skills [10], as it reflects the nonlinear aspects of the process.

Illness scripts are mental representations, which link clinical information about a disease, examples of that disease, and its symptoms [8]. Illness scripts are developed by experiencing many different patient cases. The tool uncovers the patient's illness script and enables the learners to build their own script in the form of a concept map during a VP scenario. Learners can select and connect elements of the concept map and label the connections (Figure 2). In the back end, the concept map is implemented as a directed weighted graph representation of the learner's and the expert's maps.

Dual Processing and Cognitive Errors

Dual processing is the application of analytical and nonanalytical reasoning [19]. Cognitive errors and biases are associated with both approaches [20] and are an essential component of the clinical reasoning process. We considered it as important to allow and encourage the application of both approaches when learners are working with a VP. Therefore, throughout a VP scenario, learners can submit differential diagnoses as their working or final diagnoses and assess their level of confidence with that decision on a slider (scale from 1="not at all confident" to 100="very confident"). If there is a mismatch between the learner's and the expert's decisions, the software analyzes potential cognitive errors based on the stage, identified findings, differentials, and VPs the learner has accessed previously. The analysis currently focuses on identifying and elaborating 5 common types of cognitive errors—premature closure, availability bias, confirmation bias, representativeness, and base rate neglects [20] (Table 2). To detect base rate neglect and representativeness errors, the experts have to provide additional information, such as disease prevalence, with their concept map. The clinical reasoning tool then provides feedback and explanations about the error, and the user can choose to try again, continue the VP scenario, or get more feedback (Figure 3).

Scoring

Scoring and feedback are based on the process of building the concept map and comparing it with an expert's map.

Partial scores for the final diagnosis submission range between 0.5 and 0.9 (Figure 3), depending on the distance (ie, number of edges) of the learner's diagnosis to that of the expert's in the MeSH tree. The distance can be negative if the student's final diagnosis is more specific than the expert's solution. For example, if the learner has submitted the final diagnosis as "bacterial pneumonia" and the expert has submitted "pneumonia," the distance between those two terms in the MeSH hierarchy is −1. The score is then calculated by a heuristic formula:

$$\text{Score} = 1 - (\text{Math. } abs \text{ (distance)} / 10)$$

All changes to the concept map at each stage of the VP scenario are recorded, stored in a database, and scored in comparison with the expert's map. Because the elements of the map are based on MeSH, we can account for synonyms or more/less specific terms for scoring. Additionally, when the learner moves to the next stage in the VP scenario, all nodes in each category are scored based on the expert's map at this stage. The heuristic algorithm is as follows:

$$\text{Overall score at stage} = \text{all scores} / (\text{correct nodes} + \text{missed nodes}) - 0.05 \times \text{addNodes}$$

Figure 2. Screenshot of an exemplary VP and a learner's map embedded in the VP system CASUS. The switches on top allow to show/hide all connections and the expert's map; a help page and a short introductory video are available. Diagnoses can be marked as final or working diagnoses and as must-not-miss (exclamation mark) diagnosis.

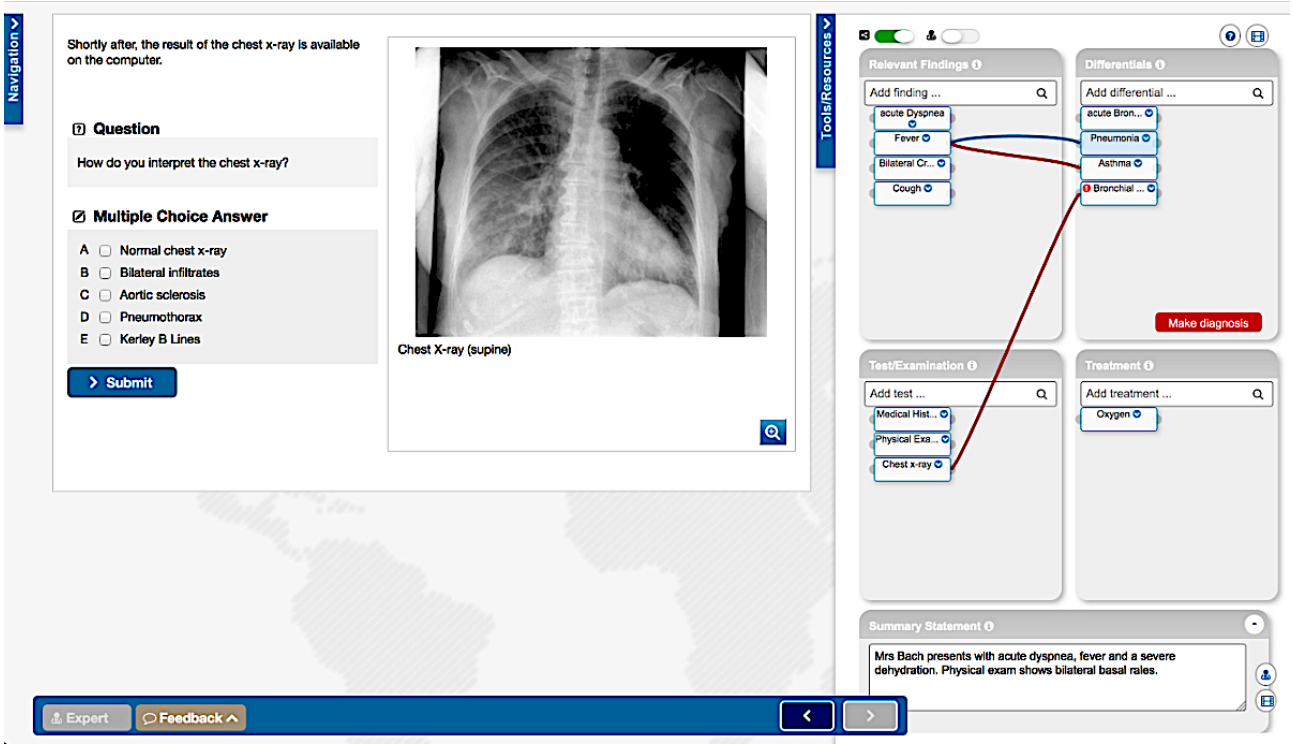
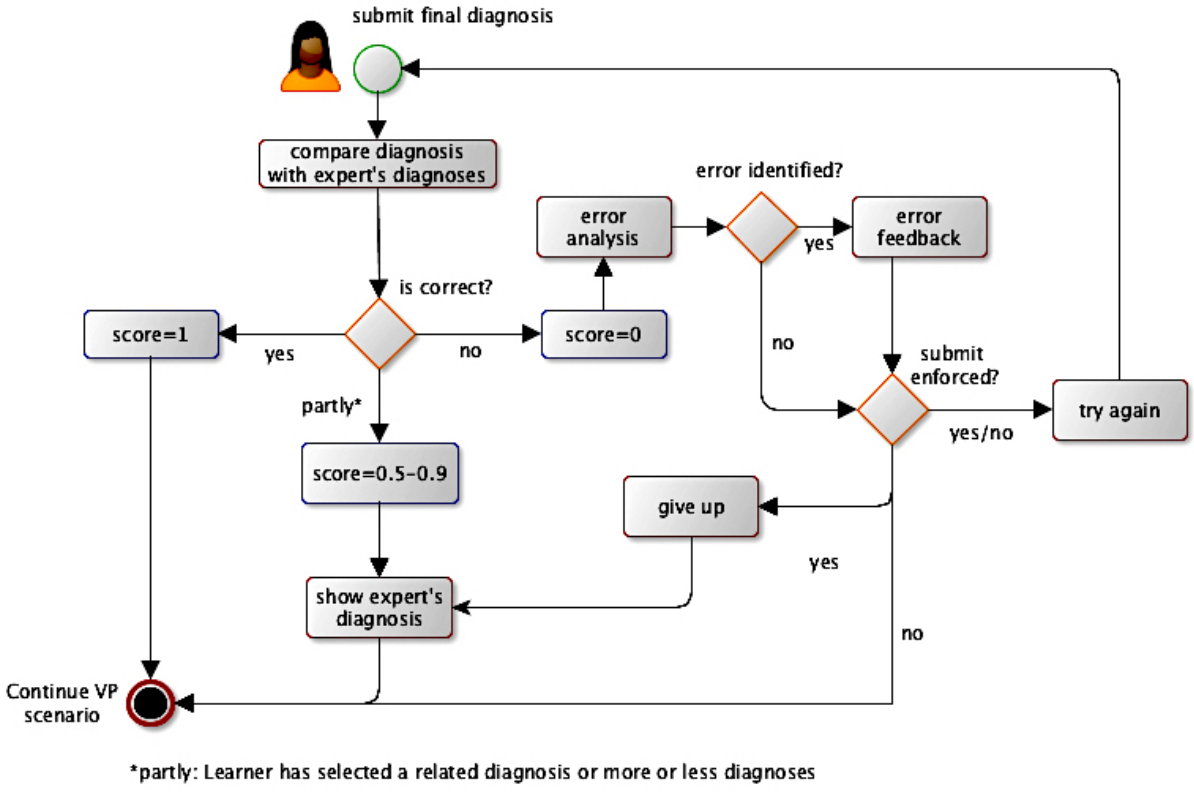


Table 2. Overview of errors that can be detected by the tool in case the learner has submitted a final diagnosis that is different from that of the expert's.

Type of error	Detection	Data required
Premature closure (accepting a diagnosis before it is fully confirmed)	Submission of a final diagnosis at an early stage, after which the expert has added finding(s) or tests that are connected to the final diagnosis	Findings and tests of the learner and the expert (including stage) Connections to final diagnosis of expert Submission stage
Availability bias (what recently has been seen is more likely to be diagnosed later on)	Learner has worked on or accessed a virtual patient with a related final diagnosis (one Medical Subject Heading hierarchy level up/down) within the last 5 days	Previously created concept maps (date of last access and final diagnoses)
Confirmation bias (tendency to look for confirming evidence for a diagnosis)	Learner has not added disconfirming finding(s) or "speaks against" connections between disconfirming finding and the final diagnosis	Findings of the learner and the expert Connections between findings and differential diagnoses
Representativeness (focus on prototypical features of a disease)	Learner has connected nonprototypical findings as "speak against" findings to the correct final diagnosis	Findings of the learner and the expert Nonprototypical findings (additional information in expert map)
Base rate neglect (ignoring the true rate of a disease)	A rare final diagnosis has been submitted instead of the more prevalent correct final diagnosis	Differential diagnoses of the learner and the expert Prevalence of diagnoses (additional information in expert map)

Figure 3. Flowchart of the process of submitting a final diagnosis by a learner.



(all scores=sum of all scores of the user; correct nodes=all nodes scored ≥0.5; missed nodes=nodes added by the expert, but not by the learner at the given stage; addNodes=nodes added by the learner but not present in the expert map).

The learner's problem representation (summary statement) is scored based on a comparison with the expert's statement and a list of semantic qualifiers (eg, "acute" vs "chronic") suggested by Connell et al [21].

The current rating algorithm counts the semantic qualifiers used by the learner and the expert. On the basis of the assessment rubric suggested by Smith et al [22], the score for the use of semantic qualifiers is defined as follows:

- Score 0: Less than 30% of semantic qualifiers used by the expert
- Score 1: <60% and ≥30% of semantic qualifiers used by the expert

- Score 2: ≥60% of semantic qualifiers used by the expert

The weighting of scores is based on the postencounter form scoring model suggested by Durning et al [23].

Learning Analytics, Feedback, and Adaptability

All scores are clustered based on a model of the clinical reasoning process developed by Charlin et al [24] and correspond with the concept map elements (Table 3). The scores are presented in a student-centered dashboard after a VP scenario has been completed.

Additionally, we implemented clusters for self-directed learning and dual processing, which are not yet fed back to the learner.

The self-directed learning cluster is currently based on the percentage of nodes and connections that have been added by the learner before/without consulting the expert solution. Dual processing considers at which stage a learner submits a final diagnosis; that is, submitting a final diagnosis at an early stage of the VP scenario is an indicator of a more nonanalytical reasoning approach. In a process-oriented approach, the learners can at any stage consult and compare their map with the expert's or peers' maps. The progress of the learner is tracked not only within a VP scenario but also throughout a VP collection; these process data feed the learner's dashboard, in which clustered scores and peer scores are visualized and recommendations for further activities are displayed.

Application Program Interface to Virtual Patient Systems

A major technical prerequisite for the implementation was the use of the tool as a plug-in for Web-based VP systems through an open application program interface (API).

The communication between the tool and the VP system is required for (1) the initialization and update during the VP session, (2) the display of performance data, and (3) a search functionality (optional). Further details of the API are available in the GitHub Wiki [25].

For the pilot study, we integrated the clinical reasoning tool into the linear VP system CASUS [15,26], a Web-based application for authoring and delivering case-based learning. A CASUS VP typically presents a patient's story, from the first introduction to the treatment in about 5 to 15 screen cards with a variable combination of text elements, multimedia, and questions. The clinical reasoning tool is displayed in an iframe in the CASUS application; the performance data and the search functionality are integrated in the CASUS dashboard.

Usability Testing and Implementation of a Pilot Study

During the development process, we conducted usability tests based on a VP with a prototypical version of the tool; participants were 2 health care students and 2 health care professionals, who were familiar with the concept of VPs. For the usability test, we adapted a freely available VP from the eViP repository [27] and presented it with the prototypical clinical reasoning tool. In total, 4 sessions were held with the same testing scenario by one of the authors (IH) in a "Think aloud" approach [28]; participants were briefed about the VP, the prototype, and its purpose; were asked about their expectations, before they could freely explore the VP and the tool; and were further asked about their reactions. Finally, in a debriefing, participants were invited to elaborate on their impressions and suggestions for changes. All findings were documented in field notes and subsequently discussed among the authors. Similar structured follow-up sessions with the same participants were held with a more advanced version of the tool in the VP system CASUS.

From October to December 2016, we implemented a pilot field study with an evaluation of the tool based on 3 VPs in the VP system CASUS. The VPs were reviewed by a course instructor, who regarded the level of difficulty as appropriate for the learners' level of expertise and confirmed that the VPs match the curricular objectives.

The VPs were integrated into the VP collection of the internal medicine/surgery course at the medical faculty of Ludwig-Maximilian University of Munich (LMU Munich), Germany. The 3 VPs covered the following topics:

- VP 1: a 19-year-old patient with a sore throat; final diagnosis: mononucleosis
- VP 2: a 66-year-old patient with a syncope; final diagnosis: bronchial carcinoma
- VP 3: a 76-year-old patient with acute dyspnea; final diagnosis: pulmonary embolism

In total, 107 fourth year medical students were offered to participate in the study as part of their regular curricular activities. To evaluate the usability of the tool and the integration into the VP system, we used a 5-item questionnaire (Table 4), based on selected questions of the System Usability Scale [29]. The Web-based questionnaire was accessible after each VP session. Participation was voluntary and anonymous.

Table 3. Description of clusters on which the learning analytics dashboard is based on.

Concepts in the model by Charlin et al	Cluster
Representation of the problem and determination of objectives of encounter	Scores for adding problems/findings
Investigations	Scores for adding tests
Therapeutic interventions	Scores for adding therapeutic options
Categorization for the purpose of action	Scores for generating differential diagnoses and scores for the final diagnosis
Final representation of the problem and semantic transformation	Scores for the summary statement

Table 4. Results of the usability questionnaire (n=10), rated on a 6-point Likert scale (0=totally disagree, 5=totally agree).

Question	Mean response (minimum; maximum)
1. I think that I would like to use the clinical reasoning tool frequently.	3 (0; 5)
2. I found the clinical reasoning tool unnecessarily complex.	3.2 (1; 5)
3. I found the various functions in the clinical reasoning tool were well integrated.	3.4 (2; 5)
4. The clinical reasoning tool helps structuring my thoughts.	2.8 (1; 5)
5. What was good? What should be improved?	3 free text responses

Ethics Approval and Consent to Participate

The implementation of the pilot study and evaluation was approved by the ethical committee at LMU Munich, Germany.

Results

Usability Tests

The prototype-based usability testing revealed some important usability issues; for example, in the prototype, the concept map elements representing the illness script were displayed in a tab layout, thus, unintentionally suggesting an order in which the components had to be worked on. On the basis of this finding, we changed the layout, so that all components were visible at once. Also, two of the participants wanted to enter a negative finding (“no fever”), which was not possible at that time, but was implemented into the next version of the tool. In the follow-up usability tests with a prefinal version of the tool, we identified minor issues, such as the display size and content of tooltips and unclear labeling of buttons. These issues were fixed before the start of the pilot study. The complete usability scenario, the field notes, and a list of the detected and solved issues can be provided on request.

Pilot Study

During the pilot field testing period from October 15, 2016 to January 31, 2017, with the 3 VPs, 64 of the 107 students created 118 concept maps of varying complexity. This response rate is comparable with similar VP integration scenarios [30]. During the testing period, we constantly evaluated the usage data and further developed the tool. For example, we noted at the beginning of the pilot testing that learners hesitated to interact with the tool; therefore, we further expanded and improved the scaffolding and prompting. Overall, the learners entered 284 problems, 324 differential diagnoses, 158 tests, and 21 treatment options, and submitted 65 final diagnoses; however, only 36 connections were drawn and 19 summary statements composed. Table 5 shows the distribution over the 3 VPs. The questionnaire was completed by 10 participants (Table 4); no usability issues were reported.

Of the free text responses, 2 reported a technical glitch, which was fixed immediately; the 3rd response explicitly liked the idea of the clinical reasoning tool.

Table 5. Total number and average number of nodes added per virtual patient (VP) by the users. The number of nodes added by the expert for each VP is shown in parentheses.

Category	Total VP 1	Average VP 1 user (expert)	Total VP 2	Average VP 2 user (expert)	Total VP 3	Average VP 3 user (expert)
Created maps	62		24		31	
Final diagnosis submitted	38 (61%)		7 (29%)		20 (65%)	
Findings/problems	159	2.6 (8)	66	2.8 (7)	59	1.9 (8)
Differential diagnoses	163	2.6 (8)	94	3.9 (8)	67	2.2 (5)
Tests	67	1.1 (5)	50	2.1 (8)	41	1.3 (8)
Therapies	9	0.1 (1)	4	0.2 (1)	8	0.3 (4)
Connections	21	0.3 (5)	14	0.6 (8)	1	0 (5)

Discussion

Overview

On the basis of a previous grounded theory exploration [10], our aim was to develop a tool that supports the training of clinical reasoning skills by addressing the most important steps in the clinical reasoning process. The current version of the tool is a good starting point from which we will continue a cyclic process of further evaluation, adaption, and analysis of research studies to advance the functionalities.

The major contribution of our study is a description of an elaborated clinical reasoning tool based on a qualitative research study [10]. Thus, the tool reflects the current research in clinical reasoning training by translating the outcomes of the study into concrete software components and instructional processes.

Concept mapping as the fundamental principle of the tool has been shown to be an effective teaching and assessment approach in health care education (eg, [31,32]). We adapted the typically unstructured approach of concept mapping by providing four main components of clinical reasoning in which the learner can add nodes: problems, differential diagnoses, tests, and therapies.

Thus, the steps of the clinical reasoning process and components of the patient illness script are explicitly represented in the maps to guide the learners when they are working on a VP scenario. If learners require further support, they can consult an expert's concept map and compare it with their own map.

Pilot Study

The results of the pilot study show that learners interact with the tool, but the average number of nodes added by the learners when compared with the expert map was quite low. Potential explanations could be technical barriers, lack of motivation, or limited clinical reasoning abilities. Because we tried to identify any potential technical barriers with the initial usability tests, we did not receive any support requests by the learners during the pilot study, and an analysis of log files and database entries did not reveal any relevant issues, we believe that technical barriers were not the main reason for the low number of node addition. In 2 of the 3 VPs in more than 60% (n=38) of the VP sessions, the learners submitted a final diagnosis, despite the low number of nodes added, which could indicate a tendency of learners to focus on the outcome (ie, final diagnosis) rather than on the process of clinical reasoning. The participants of the pilot study were students at LMU Munich, who were familiar with VPs since their preclinical years. However, the VPs earlier used by the students were less demanding concerning the clinical reasoning process. Problems and findings of the patient, differential diagnoses, and the final diagnosis were either directly presented in an elaborated way by the VP author, or students had to select appropriate choices from a short list. This simplified approach put the learners in a more passive role and did not emphasize the importance of the process, but the outcome could have influenced students' interaction with the new tool.

Interestingly, on average, learners added slightly more problems and differential diagnoses for VP 2, but only 29% submitted a final diagnosis. This could indicate that VP 2 was more difficult to solve than VP 1 and VP 3, which is also supported by the higher average number of differential diagnoses added for these maps. A follow-up study is necessary to further investigate the potential effect of VP difficulty on the clinical reasoning process.

Connections between the nodes are substantial components of meaningful concept maps and show that learners understood the concepts and their relations [18]. In the pilot study, only a few connections were drawn, and in the questionnaire, we saw a tendency that the tool did not optimally support learners to structure their thoughts. This might indicate a need for further explanations of concept mapping and/or improvement of the functionality. Further data collection and analysis are needed to find out more about these aspects.

For the pilot study, we combined the tool with a type of a VP, in which the patient is represented in a textual description and multimedia elements. However, the tool can also be integrated into scenarios that represent the patient more authentically and in which more emphasis can be laid on emotions of a patient and identification of problems by actively asking questions. Examples are VPs in the format of conversational agents in which the learner can communicate in natural language with a VP [33] or virtual reality applications [34]. We envision that the tool could also be used in bedside teaching scenarios—for example, as follow-up activities after a patient encounter to help students document their reasoning process and to discuss it with their supervisor. However, it is important to keep in mind that authenticity has to be balanced with both cognitive load and level of expertise of the learner [35]. Thus, less authentic VPs as used in the pilot study can be helpful in preparing novice students for more complex and authentic VP scenarios and real-life patient encounters.

Further Development

Further development of the tool will focus on implementing machine learning approaches to advance the comparing and scoring of the summary statements and maps.

In the current version of the tool, the learner dashboard is created and displayed within the tool. However, to allow a full integration into learning and teaching infrastructures, such as learning management systems, e-portfolios, or campus management systems, we intend to map the performance data to xAPI [36]. xAPI offers a vocabulary to collect user experiences from different sources and store it in a learning record store.

The open API allows the integration of the clinical reasoning tool into other VP systems than CASUS. Therefore, we are currently working on integrating the tool into the branched VP system OpenLabyrinth [37] as part of the European project WAVES [38].

The tool will also be used for further research studies about clinical reasoning in VPs aiming at answering open questions on the design of a VP to optimally foster the training of clinical reasoning. For example, we are currently implementing a study investigating differences on the reasoning process in undergraduate medical students comparing outcome- and process-oriented expert feedback [39].

Although the response rate of the questionnaire was low, we sense that learners experienced difficulties in structuring their thoughts with the tool, which is exemplified by the very few connections added to the concept maps. The tool was designed based on the results of a qualitative study on the clinical reasoning learning process and VPs [10], and students were involved in all relevant steps in both, the research and the tool implementation process. However, despite these efforts, it seems that the tool does not fully address the learners' needs; an explanation could be that the students in the pilot study were not familiar with the principles and steps involved in the clinical reasoning process, as this is not explicitly taught at the medical school at LMU Munich. To address this issue, we developed a series of short videos explaining the basic principles of the clinical reasoning process [40], which will be integrated into the tool for the next testing cycle. Additionally, it could be that creating the whole map is too complex for some learners, especially if they are not familiar with this way of thinking. Thus, we are implementing a more adaptive approach in which less advanced learners are guided in a step-wise approach through the map development process, thereby reducing the cognitive load. Depending on the level of expertise and VP

difficulty, learners will be prompted to focus on a specific task in the map-creation process. For example, they will be provided with all the nodes and will be asked to focus on the task of creating relevant connections or on the identification of the problems of the patient.

Limitations

A limitation in our usability testing approach was the low response rate of the survey. This low rate is comparable with the response rates of other VP courses at the medical school at LMU, and we believe that the reason for this is survey fatigue of the participating students; especially in the 4th year, students are exposed to a large number of questionnaires. Furthermore, because of the fact that we only used a subset of the 10-item questionnaire, we are only able to detect usability trends. Our intention was to achieve a higher response rate with a short questionnaire, which turned out to be ineffective. Therefore, we will continue further usability cycles with the full 10-item usability questionnaire in future usage scenarios and studies to collect more reliable and standardized data.

Conclusions

We believe that the clinical reasoning tool is a valuable addition for Web-based VP systems; it specifically aims to support the clinical reasoning process and includes aspects so far not systematically included in VP systems. We recommend combining the tool with short and carefully designed VPs to make full use of it (see examples at [15]). Additionally, the tool can be used independent from VPs in face-to-face teaching scenarios—for example, to complement clinical reasoning curricula, problem-based-learning seminars, or bedside teaching. We believe that the outcome of our study is relevant for educators and researchers interested in advancing the teaching of clinical reasoning in health care professions.

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Conflicts of Interest

None declared.

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Abbreviations

API: application interface
LMU Munich: Ludwig-Maximilian University of Munich
MeSH: Medical Subject Headings
VP: virtual patient

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Original Paper

How Do Clinicians Learn About Knowledge Translation? An Investigation of Current Web-Based Learning Opportunities

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Abstract

Background: Clinicians are important stakeholders in the translation of well-designed research evidence into clinical practice for optimal patient care. However, the application of knowledge translation (KT) theories and processes may present conceptual and practical challenges for clinicians. Online learning platforms are an effective means of delivering KT education, providing an interactive, time-efficient, and affordable alternative to face-to-face education programs.

Objective: This study investigates the availability and accessibility of online KT learning opportunities for health professionals. It also provides an analysis of the types of resources and associated disciplines retrieved by a range of KT synonyms.

Methods: We searched a range of bibliographic databases and the Internet (Google advanced option) using 9 KT terms to identify online KT learning resources. To be eligible, resources had to be free, aimed at clinicians, educational in intent, and interactive in design. Each term was searched using two different search engines. The details of the first 100 websites captured per browser (ie, n=200 results per term) were entered into EndNote. Each site was subsequently visited to determine its status as a learning resource. Eligible websites were appraised for quality using the AACODS (Authority, Accuracy, Coverage, Objectivity, Date, Significance) tool.

Results: We identified 971 unique websites via our multiple search strategies. Of these, 43 were health-related and educational in intent. Once these sites were evaluated for interactivity, a single website matched our inclusion criteria (Dementia Knowledge Translation Learning Centre).

Conclusions: KT is an important but complex system of processes. These processes overlap with knowledge, practice, and improvement processes that go by a range of different names. For clinicians to be informed and competent in KT, they require better access to free learning opportunities. These resources should be designed from the viewpoint of the clinician, presenting KT's multifaceted theories and processes in an engaging, interactive way. This learning should empower clinicians to contextualize and apply KT strategies within their own care settings.

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KEYWORDS

knowledge; translational medical research; diffusion of innovation; health personnel; education, medical, continuing; quality assurance, health care

Introduction

Efforts to improve the quality of health care delivery for better patient outcomes continue to be impeded by a gap between the creation and dissemination of high quality evidence and its translation into clinical practice and policy. We know this disconnect can result in under-prescription of proven, effective treatments, or the continued promotion of less effective or even harmful interventions [1]. It also contributes to wastage of finite health care resources [2,3] and an unacceptable lag time in getting mass recognition of what constitutes best practice [4].

The emergence of the evidence-based medicine (EBM) paradigm in the 1970s focused attention on the need for individual clinicians to seek, appraise, and judiciously apply research evidence in tandem with their own clinical judgment and patient preferences [5]. While EBM has inevitably resulted in a more conscientious seeking of evidence by clinicians with concomitant benefits for patients, its focus is squarely on individual clinician decision-making responsibilities. It does not, and cannot, address the levers, mechanisms, and barriers that effect systematic and sustainable change within the complex organizations and systems in which clinicians work. These concerns are rather the chief domain of an emerging area of research—knowledge translation (KT or "implementation science").

What Is KT and How Can It Help?

KT has emerged as an interdisciplinary field of research and practice to address the gap between what is known to work and what is done in practice [6]. The Canadian Institutes of Health Research (CIHR) provides the most commonly cited formal definition of KT as "a dynamic and iterative process that includes the synthesis, dissemination, exchange and ethically sound application of knowledge to improve health, provide more effective health services and products and strengthen the health care system" [7]. KT practice, as distinct from KT research, is concerned with helping knowledge stakeholders—clinicians, patients, health system managers and administrators, and decision makers—become aware of knowledge and facilitate "use of it in their day-to-day work and decision making" [8].

While KT practice interacts with a range of activities, including EBM, continuing medical education, continuing professional development, and quality improvement, it is much broader than all of these [9]. Its focus is on developing and evaluating interventions capable of bringing about practice change in real world settings, providing evidence of which strategies work and which do not, as well as practical guidance on how these strategies can be used to drive change across health care settings.

Challenges With KT

A number of KT characteristics may present conceptual and practical challenges for the clinician-learner. First, KT does not provide a linear, or even systematic equation for effecting change. It involves complex, multi-dimensional processes incorporating the values, knowledge, and behaviors of individuals from different professions, organizational priorities, and perhaps even conflicting political agendas. Second, multiple theoretical models have emerged in an attempt to reduce the complexity surrounding KT and provide a coherent overarching framework for KT practice [10-13]. This lack of a single, unifying theory may be confusing for would-be KT practitioners.

KT also suffers from a lack of conceptual clarity with many terms competing to describe all or parts of its remit [1,14]. These terms include *knowledge transfer*, *research utilization*, *knowledge-to-action*, *implementation science*, and *diffusion and dissemination*. Some of these (eg, *diffusion and dissemination*) are focused on the researcher's—rather than the knowledge user's—perspective. Other terms, such as *knowledge transfer* or *knowledge exchange*, appear to describe the processes for transmitting knowledge from researcher to user, rather than providing clues as to how clinicians may translate knowledge for use. KT as a metaphor has also been questioned for potentially constraining how we conceptualize both "knowledge" and the ways in which it might be "translated" in real world practice [15].

KT uptake may also be impeded by confusion between what could be termed "knowledge" activities (eg, continuing professional development and evidence based practice), and "improvement" activities such as quality improvement and clinical audit. The consequential risk for clinicians is losing sight of the nexus between the knowledge and translation parts of KT.

Another challenge lies in the fact that while myriad types of KT strategies are described in the research literature, many have shown limited efficacy or have been applied or reported in a way that makes them difficult to replicate or even compare with other studies or interventions [16,17].

KT Education

If KT is complex and yet an important deliberative approach to improving quality of care, we should expect KT education to be foundational and KT training and capacity building to be currently taking place across all levels of health professional education. We might even expect health care organizations to have developed the infrastructure to support, sustain, and normalize KT activities.

Despite these expectations, and the formalization of KT competencies [18,19], health professional KT education opportunities remain far from ubiquitous [6,8,19]. At the time of developing their own national training initiative in 2011, CIHR could not identify existing national programs on which to model theirs [18]. While training programs are now beginning to emerge, many are only available via competitive application [20], formal university-level courses [21,22], or locally run fee-based workshops. These programs, however, require significant time and monetary costs [6], a reality likely to deter the majority of clinicians from engaging in KT education.

Other initiatives are evolving to address this limitation. These include local mentoring programs [23], short-term, contextualized, multidisciplinary team projects focused on a single area of care [24], and online KT communities of practice [8,25]. Educators are also suggesting innovative ways for KT education to be integrated into health professional education curricula [26,27].

What Do Clinicians Want?

Several studies have used qualitative methods to determine clinician understanding of and interest in KT [6,23,28,29]. The Holmes study found that clinicians have a strong desire to learn more about KT, but 63.03% (675/1071) believe they would require beginner level training. Clinicians also want flexible, easily accessible, and inexpensive training options such as small group learning opportunities or self-guided study. Most significantly, 85.99% (921/1071) reported a willingness to engage with free Web-based training programs [28].

Another study found that many clinicians report a basic understanding of the principles of KT while being unfamiliar with the term itself. These clinicians also believed they lacked the skills to undertake KT projects and cited a preference for interactive, time-efficient, and brief training opportunities [23]. A further study by Lal [6] highlighted KT-specific learning challenges such as scarce training resources and practitioner difficulties in adapting KT theories to specific clinical settings.

These findings may be indicative of a need for more readily accessible KT training resources at the foundational level. Ideally, such resources would define KT, explain its benefits in terms of patient outcomes, and provide illustrative examples of how specific KT models and strategies might be adapted and applied to local environments.

The high level of clinician interest in freely available online resources for continuing education warrants attention. We know online learning opportunities offer learners control over how, when, and where they interact with learning materials, making it possible to determine the sequence and pace of one's own learning [30]. Web-based learning can also facilitate self-assessment of competence [31]. For this reason, Web-based learning platforms have become commonplace in postgraduate education provision. One meta-analysis of Web-based learning effectiveness studies found favorable outcomes for this mode of delivery across a range of learning contexts and health and medical topics. These include significant gains in knowledge and flow-on improvements in patient care behaviors [32]. Another synthesis found an association between improved learning outcomes and the degree of resource interactivity, repetition, and feedback, as well as the availability of practice exercises [33]. Other positive outcomes reported in the research literature include improved skills [34,35], higher clinician satisfaction with the online mode over other formats [36], improvements in guideline adherence [37], and increased implementation of knowledge into practice [38]. In this sense, Web-based learning platforms may be regarded as effective KT interventions in their own right.

As part of a project funded by Australia's National Health and Medical Research Centre, we wish to identify existing high quality online training modules on KT targeted at health professionals. If these modules are suitable, our intention is to use them as a template in developing our own learning module or seek permission to incorporate them into a new suite of learning resources provided on a new Centre for Research Excellence website. However, based on clinician reports in the literature, we anticipate that Web-based opportunities are either scarce or difficult to find.

The main objective of this investigation was therefore to conduct a comprehensive open Web search for online KT learning opportunities available to health professionals. Our goal was to determine whether such opportunities already exist or whether there is a need for resource development in this area.

Methods

Resource Selection Criteria

To be eligible for consideration in this review, a Web resource had to be: (1) published in English, (2) freely available online or available via free registration, (3) targeted at health professionals, health researchers, or health students, (4) educational in orientation, meaning its purpose is to develop health professional knowledge of KT in a systematic and incremental way rather than just providing information, and (5) interactive in design.

We defined "Interactive" as meaning end-users engage online with a single standalone resource comprising a mixture of text, images, audio, video, animation, and perhaps even online discussions. Interactive resources require users to work through the materials sequentially, and at their own pace, providing scope for reflection and activities for testing the understanding of the material.

Irrespective of their quality and authoritativeness, static resources such as PDF workbooks and other materials designed to be printed and worked through offline were deemed ineligible for the review due to their lack of interactivity. We also excluded resources for "doing" KT such as toolkits and strategy checklists, as well as didactic PowerPoint presentations, webinars, and resources comprising lists of Web links, unless these resources were part of a broader, cohesive online learning module.

Search Strategies

One author conducted the searches (RD). These were executed, without date restriction, on July 23, 2015. Searches were limited to English language resources only.

We used multiple approaches to identifying online learning resources. These included:

- Limited searches of databases Medline (Ovid), Embase (Ovid), Scopus, and ERIC (ProQuest) for online KT learning resources named in published research articles. An example of our database search strategy is provided as Multimedia Appendix 1. This strategy was modified for each database.
- A sampling approach to online searching using Web search engine Google (advanced option). A number of variant searches were run in an attempt to overcome limitations on search sensitivity imposed by Web search engines.
- A separate search of MOOC sites, webinars, and YouTube clips.
- A scan of the websites of KT-focused organizations identified in stage two (eg, Canadian Institutes of Health Research) for links to other learning resources not picked up by the Web search itself.

Term Variants

KT is known by a wide range of terms [39,40]. To ensure we did not overlook any learning modules, we searched on nine of the most prevalent KT terms:

- Knowledge translation

- Knowledge transfer
- Knowledge exchange
- Research utilization
- Research utilisation
- Implementation science
- Research into practice
- Knowledge-to-action
- Evidence-to-use.

Each term was entered on its own in the Google Advanced "this exact word or phrase" search field.

Search Restrictions

In an attempt to focus the search on sites with educational intent, we added the following search string to each KT term search: *module OR modules OR train OR training OR learn OR learning OR teach OR teaching OR educate OR educating OR education OR educational OR program OR programme OR study OR CME OR CPD.*

We did not include health-related search terms, partly as the limited search features of Google would not allow too many variants at one time. We were also interested to see which health disciplines are associated with KT education efforts.

Allowance for Web Browser Effects

All 9 KT term variants were first searched using Mozilla Firefox (with behavior tracking), and the first 100 results for each term were copied into a Word document. This process was then repeated using Chrome with incognito browsing functionality in an attempt to maximize the number of unique retrievals across browsers. Incognito browsing disables a computer's browsing history and Web cache, ensuring websites are retrieved and ranked based on the weighted inclusion of a specific search term within that website, rather than a searcher's previous browsing activity. We therefore retrieved 200 websites for each of the 9 KT terms searched.

Data Collection and Analysis

All websites identified by each Google search were manually recorded in an EndNote library. Information captured included website author, title of page, and URL. Duplicate entries (ie, websites identified by more than one search) were identified and removed.

Both investigators (RD and JT) independently screened the same random set of 50 items taken from the full results set in order to test inclusion/exclusion criteria and ensure data extraction requirements had been fully thought through. This involved using the URL recorded to access the webpage and review it for relevance. One investigator then screened and categorized the remaining results with the aid of a research assistant.

For each website retrieved, the following details were entered in customized fields of the EndNote record in the form of a yes or no entry:

- For a health audience?
- Educational in intent?
- Freely available online?
- Interactive in design?
- Defines KT?

Quality Assessment

Finally, each included resource was assessed for quality using the AACODS checklist for appraising gray literature [41]. This checklist focuses on six domains: authority, accuracy, coverage, objectivity, date, and significance. Online learning modules not meeting the standard set by this checklist were to be excluded.

Results

The total number of websites retrieved by our multiple search strategies was 1800. This reduced to 971 after duplicate entries were removed. The database searches yielded two reports describing online KT learning resources [20,42]. Both resources were also identified by the Web search.

The results of evaluating retrievals against inclusion criteria are shown in the form of a PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram (Figure 1).

Of the 971 unique websites retrieved, only 43 health-relevant KT websites with educational intent were identified and comprehensively reviewed. Resources were categorized as educational if they contained explicit statements of learning objectives and provided, as a minimum, a basic definition of KT. A breakdown of the types of resources fulfilling these criteria is shown as part of Table 1.

These 43 sites were then judged on the "interactivity" of their design. At this point, 42 of the 43 resources were eliminated on the basis that they comprised a list of resources, or links to resources, without an overarching instructional framework, or provided KT learning materials in the form of non-integrated, non-sequential informational webpages or documents.

Only one resource met all our inclusion criteria and could be designated an online, self-paced learning module on KT for health professionals. This resource was the Dementia Knowledge Translation (DKT) Learning Centre by Canadian Dementia Knowledge Translation Network [42].

The self-described purpose of the DKT Learning Centre is to enable researchers to "learn more about how to conduct and adapt dementia studies to inform further research, and to ultimately use the new knowledge gained to improve the treatment and care of persons with dementia and support their caregivers" [43]. The rationale for this free resource came from a 2011 Web-based survey of Canadian dementia researchers [44]. This survey revealed a high level of practitioner interest in translating dementia knowledge and was instrumental in identifying specific training needs and priorities. There was particular interest in self-paced training programs offered over the Internet.

The DKT Learning Centre presents KT under four broad headings: (1) introduction to KT, (2) what is Dementia KT?, (3) DKT in grants, and (4) DKT dissemination & exchange. Standard sections beneath these headings included "learning objectives," "discuss this topic," and "evaluate." The resource provides access to a wide range of resources such as further

readings, dementia KT examples, and sample budgets. We judged it to be of high quality using AACODS. This was based on its: (1) authoritative authorship, (2) accuracy (states and meets it aims and is well referenced), (3) coverage (has clear parameters), (4) objectivity, (5) date, and (6) significance (adds value in terms of utility and relevance).

Table 1. Knowledge translation (KT) health-relevant retrievals (n=369) by type.

Resource type	Number of websites retrieved	Subset designated "educational in intent"
Journals or journal articles	115	1
Specific project or program descriptions	60	
Information about fee-based KT training opportunities (eg, Descriptions of KT curricula, training courses, conferences, events, face-to-face workshops, summits, and seminars)	40	
Online resources for doing KT (eg, guides, toolkits, templates, lists of links, or advisory services)	28	20
Books or book chapters	21	
Presentations (eg, PowerPoint or Prezi)	18	6
Standalone definitions of KT (the majority describing dissemination to researchers)	17	11
Hubs or networks for sharing research or practice ideas in a specific area of health care (eg, Communities of Practice)	11	1
KT grant information	10	
News items, media releases, or notices	9	
Blog posts mentioning KT	8	1
Unpublished reports	7	
Theses	6	
Conference papers	5	
Policy or position statements	4	
Databases	3	
Job advertisements	2	
Learning modules	2	2
Webinars	2	1
Clinical trials	1	
Total	369	43

To better understand some of the difficulties clinicians would face when searching for KT resources online, we performed some secondary analyses on the dataset retrieved. We first determined the range of different types of health resources retrieved by KT terms in open Web searching (Table 1).

We also categorised all Websites retrieved based on their preferred use of specific KT descriptors, bringing to the fore the distribution of KT synonyms across health and non-health fields (Table 2).

This shows that health websites were predominately retrieved by terms "knowledge translation" (24%), "research utilization/research utilisation" (24%), and "implementation science" (18%). They were rarely retrieved by terms "knowledge transfer" (2%) and "knowledge exchange" (5%).

Outside the health domain, we found the inverse. The most prevalent terms within the non-health sites retrieved were "knowledge exchange" (19%) and "knowledge transfer" (18%), with the least prevalent being "knowledge translation" (2%) and "implementation science" (7%).

Within the 592 non-health sites retrieved, some subject areas showed a stronger preference for specific KT terms than others (Table 3).

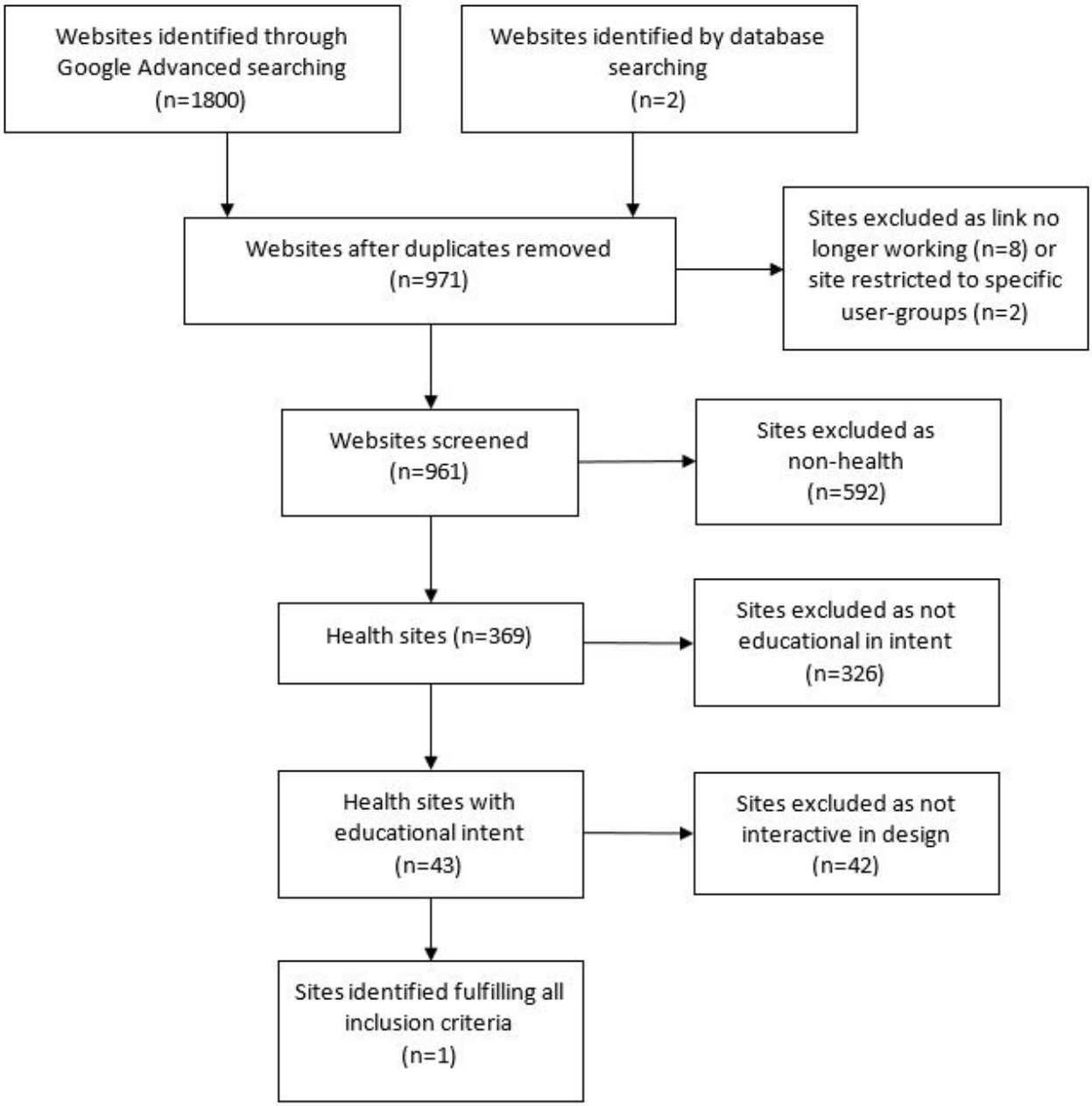
Table 2. Distribution of knowledge translation (KT) synonyms across health and non-health websites retrieved.

KT synonyms	Health & medicine websites retrieved (n=369)	Non-health websites retrieved (n=592)
Evidence-to-use	9%	12%
Implementation science	18%	7%
Knowledge exchange	5%	19%
Knowledge Translation	24%	2%
Knowledge-to-action	9%	12%
Knowledge transfer	2%	18%
Research into practice	10%	12%
Research utilization/research utilisation	24%	17%

Table 3. Non-health subject areas retrieved and their predominant terminology.

Non-health subject areas	Number of websites retrieved	KT terminology within subject areas	Prevalence of terminology across subject areas
Primary/secondary education	125	Research into practice	38%
		Research utilization	21%
Higher education	75	Research utilization	28%
		Knowledge exchange	27%
		Knowledge transfer	21%
Business and finance	60	Knowledge to action	37%
		Knowledge transfer	27%
Innovation/commercialization partnerships	35	Knowledge transfer	55%
		Knowledge exchange	40%
Environment and conservation	33	Knowledge to action	39%
		Knowledge exchange	33%
Social services (ie, disability, child welfare, social work)	32	Research utilization	44%
Technology	30	Knowledge transfer	37%
		Knowledge exchange	27%
Law	20	Evidence-to-use	55%
Public policy or policymaking	14	Evidence-to-use	36%

Figure 1. PRISMA flow diagram of selection decisions.



Discussion

Principal Findings

After reviewing an extensive number of websites retrieved by a wide range of KT terms, we were surprised to find so few examples of KT learning resources, either online or reported in the published literature. Despite a comprehensive search strategy, we only found one resource that fulfilled all our inclusion criteria. Even looking broader than health, we could not identify modules designed to improve understanding on the topic. We must therefore corroborate clinician accounts of a lack of free online KT learning opportunities.

The Web is not short on KT materials for interested clinicians to access. Many of these, such as those provided by CIHR, are of high quality. Arguably, however, these resources put the burden squarely on the clinician-learner to contextualize and interpret KT for real-world implementation. In our assessment, they also assume a certain level of prior knowledge and do not provide instructional scaffolding. Certainly the concepts within the materials we found are not organized in ways to make it easy for beginners to understand the key aspects of KT research and practice. Many resources do not define KT or else describe it in a way that makes it difficult to delineate its components. Given the difficult, sometimes esoteric arguments around deliberative change based on evidence of effectiveness, we view this as problematic for learners.

A further problem with many of the resources we reviewed is that they target one stakeholder group in the KT process (eg, researchers or policymakers) to the omission of others, or fail to clearly define the intended audience altogether. Furthermore, many resources exist as individual objects without integration

into a design with an overarching theoretical framework. They also lack interactivity with no attempt to engage learners through self-reflection or self-assessment tasks.

There is also an existing accessibility issue where KT training is concerned. The majority of KT training opportunities we identified required face-to-face, multi-day, fee-based attendance, or involved a competitive admission process (Table 1). We also suspect many training opportunities lie behind the pay walls of online Learning Management Systems at universities where KT is taught as part of a curriculum. These modes of delivery will inevitably exclude the majority of the health workforce.

A further issue highlighted by this review is the difficulty surrounding KT information retrieval. Even experienced Web searchers may find it time-consuming to identify learning materials on KT given the large number of terms used to describe it, and the fact that many of these terms retrieve materials in non-health domains as diverse as education, business, environment, public administration, and law (Tables 2 and 3). Interestingly, we found some clear differences in term usage between health and non-health sites within our sample. It may be that within health the terms *knowledge translation* and *implementation science* are emergent frontrunners while other disciplines tend to favor alternative terms for describing similar processes and concepts.

KT searching is not helped by the inefficacy of Web searching in general. To achieve a minimal level of precision in our searching, we were required to forgo the simple Google search box for Google's advanced search interface. We also used two different Web browsers, Mozilla and Chrome, and found that there were clear differences in what was retrieved by each browser, despite entering the same search in each. We also went much further than most searchers would in screening the results. As shown in Table 1, even health-related KT resources required extensive sifting to find actual training resources. Using terms indicative of education and learning, we still retrieved everything from journal articles, book chapters, advertisements for programs or grant opportunities, and even blog posts. We believe finding relevant education on a topic as important as this should not be so hard.

For clinicians, there is also the problem that the concept overlaps with other deliberative health care change processes such as quality improvement and guideline implementation. Clinicians may need KT training to disambiguate the many activities that form part of it (research creation, synthesis, dissemination, exchange, and transfer) and focus firmly on locally contextualized knowledge-practice gaps and ways to bridge them for optimized patient and health care outcomes.

Limitations

Our investigation has several limitations. First, we did not use an exhaustive list of synonyms for KT. Terms such as *knowledge mobilisation* and *translational research*, for example, were not included and may have resulted in us overlooking appropriate resources. We may have also used rather narrow inclusion criteria where the concept of "interactivity" is concerned. Several of the resources we retrieved aimed at clinicians could be described as having an educative purpose. However, these same resources were excluded based on their design, rather than their content per se. A further limitation may be the use of a single, rather than dual, reviewing process when determining eligibility of each website. This was a pragmatic decision which may have resulted in some contestable exclusion decisions.

Conclusions

Health care professionals have a stake in the widespread translation of well-designed research evidence into clinical practice. It is therefore important that they have access to opportunities to learn about KT and how it might drive improvements in the health outcomes of their patients. These learning opportunities should be available at times convenient to the clinician and would ideally present the complex concepts and processes associated with KT in a graduated and interactive way.

This review found only one Web-based resource that could be considered an interactive educational resource on KT for clinicians (Dementia KT). There is a need for more free online KT training resources targeted at clinicians that clearly define KT and its theories and methods, and help clinicians visualize how KT might work within their own local context.

Acknowledgments

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Authors' Contributions

JT conceived the study. RD and JT devised the methodology. RD ran the searches, extracted and recorded the data required for analysis, and conducted the review of websites. RD and JT drafted the manuscript and both authors read and approved the final manuscript.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Sample database search strategy.

[PDF File (Adobe PDF File), 26KB - mededu_v3i2e12_app1.pdf]

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Abbreviations

AACODS: Authority, Accuracy, Coverage, Objectivity, Date, Significance
CIHR: Canadian Institutes of Health Research
DKT: Dementia Knowledge Translation
EBM: Evidence-Based Medicine
KT: knowledge translation
PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

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Original Paper

Evaluation of Web-Based Continuing Professional Development Courses: Aggregate Mixed-Methods Model

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Abstract

Background: Many continuing professional development (CPD) Web-based programs are not explicit about underlying theory and fail to demonstrate impact.

Objective: The aim of this study was to develop and apply an aggregate mixed-methods evaluation model to describe the paradigm, theoretical framework, and methodological approaches used to evaluate a CPD course in tobacco dependence treatment, the Training Enhancement in Applied Cessation Counseling and Health (TEACH) project.

Methods: We evaluated the effectiveness of the 5-week TEACH Web-based Core Course in October 2015. The model of evaluation was derived using a critical realist lens to incorporate a dimension of utilitarian to intuitionist approaches. In addition, we mapped our findings to models described by Fitzpatrick et al, Moore et al, and Kirkpatrick. We used inductive and deductive approaches for thematic analysis of qualitative feedback and dependent samples *t* tests for quantitative analysis.

Results: A total of 59 participants registered for the course, and 48/59 participants (81%) completed all course requirements. Quantitative analysis indicated that TEACH participants reported (1) high ratings (4.55/5, where 5=best/excellent) for instructional content and overall satisfaction of the course (expertise and consumer-oriented approach), (2) a significant increase (P .001) in knowledge and skills (objective-oriented approach), and (3) high motivation (78.90% of participants) to change and sustain practice change (management-oriented approach). Through the intuitionist lens, inductive and deductive qualitative thematic analysis highlighted three central themes focused on (1) knowledge acquisition, (2) recommendations to enhance learning for future participants, and (3) plans for practice change in the formative assessment, and five major themes emerged from the summative assessment: (1) learning objectives, (2) interprofessional collaboration, (3) future topics of relevance, (4) overall modification, and (5) overall satisfaction.

Conclusions: In the current aggregate model to evaluate CPD Web-based training, evaluators have been influenced by different paradigms, theoretical lenses, methodological approaches, and data collection methods to address and respond to different needs of stakeholders impacted by the training outcomes.

(JMIR Med Educ 2017;3(2):e19) doi:10.2196/mededu.7480

KEYWORDS

learning; Internet; evaluation studies; tobacco use

Introduction

Web-based courses for busy health care providers (HCPs) allow for iterative knowledge acquisition and application in real-world practice settings at a relatively low cost. A variety of different online tobacco dependence treatment training programs and evaluation methods for HCPs have been used [1]; however, establishing a comprehensive evaluation of the effectiveness of the Web-based program through a dimension of utilitarian to intuitionist remains a challenge. Existing frameworks developed to evaluate classroom-based continuing education trainings are inadequate in evaluating Web-based courses. Evaluation is a necessary component of curriculum design and innovation, assessing the ability to which curricula can meet established benchmarks. However, evaluation design and implementation can also work toward advancing the scholarship of teaching and learning [2]. Despite general consensus on the importance of training and development for increased self-confidence and competence in health care delivery, research suggests insufficient attention is paid to the quality and long-term effect of training [3]. The many evaluation models that have emerged since 1965 range from basic checklists to comprehensive frameworks, aimed at addressing different needs (ie, self, stakeholders, program planners, etc). In order to use an evaluation model effectively, it is necessary to first identify one's evaluation needs and subsequently determine what is useful in each model [4]. A conceptual framework in its entirety, which may contain a number of tested theories, is neither necessarily a completely tested theory nor is it a linear process [5]. In the absence of a comprehensively tested theory, conceptual frameworks are useful to guide program planners and advance teaching and learning scholarship. The increasing variety of methodological approaches is not only changing the ways in which evaluations are designed and implemented but is also adding rich perspectives to a burgeoning field still too young to settle on any singular, ideal evaluation approach. Evaluators' preference on paradigm, theoretical lens, methodological approach and methods of data collection leads to different design, data collection, analysis, and interpretation [6]. These divergent visions evaluation resulted in a variety of frameworks used in program evaluation, as they are derived from philosophical and ideological beliefs, different methodological predilection, value assignment, and end user interests.

The goal of this study was to develop a comprehensive, aggregate, and conceptual evaluation framework focusing on the use of paradigm, theory, and methodology for a Web-based training program. The embodiment of a critical realist lens, characterized through a dimension of utilitarian (the greatest good for the greatest number) to intuitionist (the greatest good requires the attention to each individuals benefit) [4], formed the foundational philosophical beliefs of our program evaluation approach. This study pilots this evaluation framework using a Web-based training in tobacco dependence treatment, the Training Enhancement in Applied Cessation Counseling and Health (TEACH) Core Course, to identify the primary factors that guide the TEACH evaluation and to examine the feasibility of its application for researchers, HCPs, and other relevant stakeholders.

Methods

Over the past decade, the TEACH Project at the Centre for Addiction and Mental Health (CAMH), has become a benchmark training program for health care providers (HCPs) at local, national, and international levels [7]. The TEACH model incorporates all components of the Knowledge-to-Action (KTA) framework to address the wider tobacco epidemic through evidence-based tobacco dependence treatment [8]. As part of the TEACH Project's Certificate Program in Intensive Cessation Counseling, participants are expected to complete: (1) a 10-hour Web-based prerequisite course, (2) a 19.5-hour Web-based Core Course, and (3) a 13.5-hour Web-based specialty course.

Developing an Aggregate Model for Evaluation

The TEACH Project based their evaluation approach on Moore et al's and Kirkpatrick's frameworks to evaluate continuing professional development (CPD) education [5,7,9,10]. The Moore et al's evaluation framework, which includes seven levels of training impact to evaluate, is the gold standard in evaluating CPD education. Moore et al's framework is an ideal approach to measure CPD educational outcomes, assess impact by focusing on the target outcomes of training, and iteratively modify training to achieve the intended results (ie, the evaluator must ask themselves *How will I do it?*) [5,10]. Also, we chose Kirkpatrick's evaluation framework which outlines four levels of training effectiveness by tracking improvements in participant's reactions, learning, behavior and results (ie, the evaluator must ask themselves *How will I know when I have done it?*). This framework is one of the most well-known and widely used evaluation models in assessing the effectiveness of training and learning [9]. However, we decided to add on Fitzpatrick's approach [11] to create an aggregate model in order to discuss, identify, and justify the primary factors that guide or direct our evaluation approach including paradigm, theory, methodology and methodological tools (ie, the evaluator must ask themselves *What am I doing and why am I doing this?*) [11]. Fitzpatrick et al classifies evaluation into four core approaches: (1) comprehensive judgment of the quality of the training, including expertise and consumer/learner-oriented evaluations, (2) characteristics of the training, including objective-oriented evaluations, (3) decisions to be made about the program, including management-oriented evaluations, and (4) participation of stakeholders (including patients, managers, HCPs, and funders) in the program. These four Fitzpatrick categories can respond to differing needs among stakeholders impacted by the evaluation in multiple contexts and can be easily distributed along House's dimension [12] of utilitarian to intuitionist approaches for program evaluation. Embodying a critical realist lens [6,13] through House's dimension could support the notion that quantitative and qualitative methodologies are both equally warranted in fulsomely understanding training success and impact.

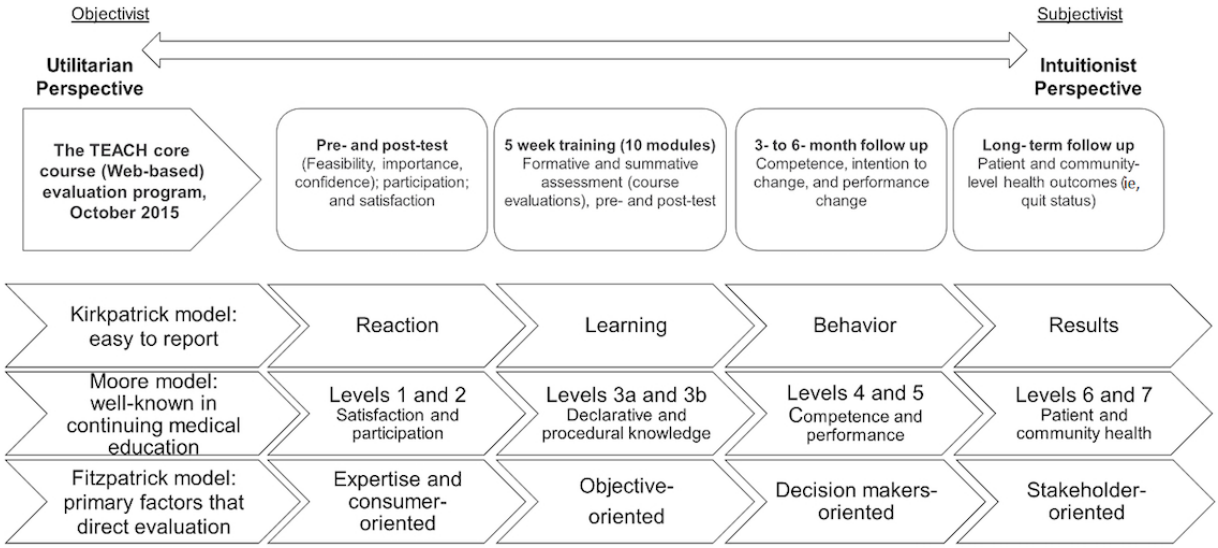
We developed an aggregate evaluation framework (Figure 1), adopted from three conceptual frameworks, Fitzpatrick et al

[11], Moore et al [5], and Kirkpatrick [9], to assess a CPD program (the TEACH project) in order to focus on achieving desired outcomes with a critical realist lens through House's dimension of utilitarian (objectivist ontology) to intuitionist (subjectivist ontology) [4].

Taken together, this aggregate evaluation model can elicit the following primary factors: (1) direct instructional design strategies during educational planning, organizing, implementing, and evaluating, (2) identify how HCPs learn, (3) determine how and where assessment can be used to measure progress of the program, and (4) identify ways to inform decision makers regarding evaluation outcomes.

We examined the aggregate model's feasibility by evaluating the data which has been collected through one of our cohorts of the TEACH Web-based Core Course in October 2015 with a total of 48 participants. We measured training effectiveness through the following four evaluation approaches, developed based on the aggregate model:

Figure 1. Distribution of four categories of aggregate evaluation approaches on the dimension of utilitarian to intuitionist perspective for the study.



Approach 1 (Utilitarian)

Approach 1 is based on Fitzpatrick et al's expertise and consumer/learner-oriented approaches, Moore et al's Levels 1 and 2 (Participation and Satisfaction), and Kirkpatrick's Level 1 (Reaction). This approach focuses on the number of participants (learner-oriented) who completed the training, overall satisfaction, the degree to which participant's expectations of the quality of the training were met, and quality of the program as compared with other existing programs. We capture participation and satisfaction through the registration database, formative evaluations administered throughout the training, and a summative evaluation administered at the end of the training. We measure quality of the program through evidence of accreditation by an external body. This is aligned with an expertise- and consumer/learned-oriented approach in which participants make valuable judgments based on training credibility (eg, *is the training peer-reviewed, reputable, will I receive a certificate*).

Approach 2 (Utilitarian to Intuitionist)

Approach 2 is based on Fitzpatrick et al's objective-oriented approach, Moore et al's Levels 3a and 3b (Declarative and Procedural Knowledge), and Kirkpatrick's Level 2 (Learning). This approach focuses on the impact of training on participants involved (ie, the degree to which participants can (1) state what the training intended them to know and (2) state how to do what the training intended them to know). To achieve this, an evaluator needs to determine the extent to which clearly defined course objectives have been met immediately post course. We capture declarative and procedural knowledge through pre- and postcourse assessments. This approach helps instructional designers, evaluators, and other stakeholders judge the training's success or shortcomings through some of the trainings immediate outcomes (eg, have knowledge and skills improved among participants post course). We also capture participant learning through the administration of a competency-based exam administered post course. Participants are required to achieve a grade of 70% or higher in order to pass the course. Additionally, participants are able to provide free text comments and open-ended feedback questions for course development to enhance learning for future participants in the formative evaluations administered during the course.

Approach 3 (Utilitarian to Intuitionist)

Approach 3 is based on Fitzpatrick et al's management-oriented approach, Moore et al's Levels 4 and 5 (Competence and Performance), and Kirkpatrick's Level 3 (Behavior). The central concern for this approach is to identify and meet the information needs of managerial decision makers, evaluate self-assessed practice change, and implementation of knowledge and skills (ie, the degree to which participants do what the training intended them to do in their practice setting). We measure competence and performance through follow-up surveys administered 3- and 6- months post training. Quantitative data collected 3- and 6- months post training can provide decision makers with evaluation data that demonstrates program effectiveness over a longer period, which can be helpful in guiding decisions for program continuation or expansion. To

ensure an intuitionist approach to evaluation, 3- and 6-month surveys should include qualitative response options to capture participants' experience with practice change post course. This cohort study did not include qualitative response options in the 3- and 6-month follow-up surveys; however, our revised tools will incorporate this approach.

Approach 4 (Intuitionist)

Approach 4 is based on Fitzpatrick et al's stakeholder-oriented approach, Moore et al's Levels 6 and 7 (Patient and Community Health), and Kirkpatrick's Level 3 (Results). This approach focuses on a practical participatory evaluation approach, the long-term outcome in job-related performance, and institutional and community level changes as a result of the training program. Patient and community health outcomes are measured through connecting previous evaluation data with the current health outcomes and subsequent linkage with population health data. However, practice change and implementation is dynamic and complex behavior. Additionally, connecting previous evaluation data to patient and community health outcomes is not always easy, feasible, and will only be able to show a marginal effect of the training because of competing factors. Accordingly, a more intuitionist approach rooted in subjectivist epistemology is required for Approach 4. Long-term follow-up through qualitative inductive and/or deductive approaches should involve multiple stakeholders (including administrators, patients, HCPs, and faculty members) in determining the program's success and shortcomings (ie, by using retrospective post then predesign in-depth-interviews). This cohort study did not include Approach 4 in the protocol; however, our future evaluation research will explore this level.

Figure 1 provides a visual representation of these four evaluation approaches, unequally distributed along House's dimension of utilitarian to intuitionist evaluation [4,12]. Although the many different approaches to evaluation may appear convoluted, their diversity allows evaluators to pick and choose either the approach or the elements of an approach that will work best for program evaluation.

Application of the Aggregate Model: Evaluation of the TEACH Web-Based Core Course

A mixed-methods design was undertaken using data collected through formative evaluations administered following each Web-based module and a summative evaluation administered post course, which collected both quantitative and qualitative feedback, pre-and postcourse assessments of knowledge and skills, a competency-based exam administered post course, and 3- and 6-month follow-up surveys measuring self-reported practice change. Accordingly, we were able to pilot Approaches 1 to 3 of our aggregate model. The numeric data were summarized as descriptive statistics using IBM SPSS Statistic 24 for analysis. Simple frequencies and percentages were calculated; additionally, means and standard deviation for the pre- and postcourse assessments were obtained. Paired *t* tests, analysis of variance (ANOVA) and CI were calculated to test the difference between and within the groups with a probability level of .05. Missing data were replaced with grand mean or modal responses for continuous and categorical variables. To gather qualitative data, the formative and summative questionnaires with extensive qualitative comments used thematic analysis to present participant's evaluation of the course. SPSS 24 and NVivo 11 (QSR International) were used to perform analysis of quantitative and qualitative data. At the time this study was designed, the CAMH Research Ethics Board deemed that formal review and approval was not required for the study.

Results

Approach 1

Following expertise-oriented approach, TEACH is accredited by the University of Toronto's Faculty of Medicine CPD program, as well as the College of Family Physicians of Canada, Royal College of Physicians and Surgeons of Canada, Canadian Addiction Counsellors Certification Federation, and Royal College of Dental Surgeons of Ontario. A total of 59 participants registered for the course, and 48 participants (81%) completed all course requirements. Table 1 shows 42 % (20/48) of the participants were nurses (registered nurses, nurse practitioners, and case manager nurse). Using the utilitarian lens and consumer/learner-oriented approach, the overall satisfaction rating for the course was 4.55/5 (where 5=best/excellent).

Approach 2

The pre- and postcourse assessments consisting of 29 closed-ended questions related to course competencies were used to collect quantitative data, and paired samples *t* tests were undertaken. Table 2 presents results of quantitative analysis of self-perceived knowledge for each course competency, demonstrating an objective-oriented approach. A Wilcoxon test was used, and the findings indicated a significant difference between self-reported pre- and postknowledge ranks for all course competencies during the TEACH Core Course, Z=6.03, P<.005.

In addition, we measured participants' feasibility, importance, and confidence of applying course competency areas, through 12 closed-ended questions. For each domain, a 0-10 Likert-scale (10 being the highest rating) was used. Data normality can be observed in the analysis of feasibility and confidence with the Kolmogorov-Sminrov & Lilliefors test (95% CI). However, data normality was not observed (P<.001) for the importance variable. A nonparametric approach was used to support the analysis of the Likert scale responses of feasibility, confidence, and importance (Table 3). Wilcoxon tests of the responses to performance statements about feasibility, importance, and confidence revealed significant differences between self-reported pre- and postlearning at P .001.

Table 1. Reporting of demographic variables in 48 participants who completed the Training Enhancement in Applied Cessation Counseling and Health (TEACH) Core course in October 2015.

Discipline represented	Participants, n (%)
Health care professionals	
Pharmacist	9 (18.75)
Nurse	20 (41.67)
Allied health care professionals	
Aboriginal health worker	1 (2.08)
Addiction counselor	2 (4.17)
Dental assistant, hygienist, or therapist	1 (2.08)
Dietitian or nutritionist	1 (2.08)
Occupational therapist	2 (4.17)
Respiratory therapist, clinical perfusionist, or asthma educator	1 (2.08)
Social worker	4 (8.33)
Health support services	
Health promoter/educator	2 (4.17)
Manager/coordinator	2 (4.17)
Other	3 (6.25)
Clinical contact with clients	
Yes	42 (87.50)
No	4 (8.33)
Unsure	2 (4.17)
Years providing cessation	
1 year or less	16 (33.33)
2-5	11 (22.92)
6-10	8 (16.67)
10+	4 (8.33)
Never	9 (18.75)
Total number of participants, N	48 (100)

Table 2. Wilcoxon test (95% CI) of reaction of health care providers to eight competency domains (pre- and postcourse assessment) through objective-oriented approach (0-10 rating scales, 10 being the highest rating).

Pre-post learning objective	Domain	*Z*	Significance (*P* value)
1	Impact of tobacco use	4.49	<.001
2	Tobacco use assessments	5.86	<.001
3	Motivational interviewing	5.42	<.001
4	Developing a quit plan	5.81	<.001
5	Evidence-based psychosocial interventions	5.85	<.001
6	Evidence-based pharmacological interventions	5.41	<.001
7	Harm reduction approaches	5.43	<.001
8	Relapse prevention strategies	5.86	<.001

Table 3. *Z* and *P* values of health care professionals' self-reported response to feasibility, importance, and confidence in use of the modules before (n=48) and after (n=48) conducting Web-based Training Enhancement in Applied Cessation Counseling and Health (TEACH) core course in October 2015.

Questions	*Z*	*P* value
Feasibility	3.90	<.001
Importance	2.59	<.001
Confidence	5.87	<.001

In order to measure if the participants' discipline had an effect on their self-reported knowledge and skills post course, a between- and within-group ANOVA was performed. The assumption of normality was evaluated using the Shapiro-Wilk test at a 5% significance level. We found evidence to conclude that self-reported knowledge and skills postcourse assessment scores are normally distributed for HCPs, *W*=.96, *P*=.38, and for Allied HCPs, *W*=.91, *P*=.21. However, in addition, we found evidence to conclude that self-reported knowledge and skills postcourse assessment scores are not normally distributed for Health Support/Research Services, *W*=.65, *P*=.002.

The percentage distribution for the competency-based exam indicates successful achievement of intended outcomes whereby 47 out of 48 participants received a passing grade (n=10 between 80%-90% and n=37 between 90%-100%), with only one participant receiving a failing grade below 70%. Finally, thematic content analysis was conducted for the qualitative comments provided by participants in the formative (34 comments) evaluations which were related to the three themes: (1) *knowledge acquisition*, (2) *recommendations to enhance learning for future participants*, and (3) *plans for practice change* (Table 4). To follow subjectivist epistemology through the intuitionist evaluation concept, the following five themes emerged from 61 qualitative comments in the summative evaluation administered at the end of course: (1) *learning objectives*, (2) *interprofessional collaboration*, (3) *future topics of relevance*, (4) *overall modification*, and (5) *overall satisfaction.*

Table 4. Qualitative formative feedback provided by participants of the Training Enhancement in Applied Cessation Counseling and Health (TEACH) cohort core course in October 2015.

Themes	Total coverage	Examples
Knowledge acquisition	18.5%	"Having had no prior experience in tobacco cessation, I learned a great deal from this module. Overall constructive for me."
		"Difficulty with some material because of lack of knowledge with medications. Noted as an area to spend more time on, personally. I believe the material provided will be beneficial in enhancing my knowledge base."
Recommendations to enhance learning for future participants	70%	"For questions answered incorrectly, it would be helpful if there was a reference provided so that I could go back and locate where that information to taught."
		"More examples of case studies for complex clients, when and how to double patch, etc."
Plans for practice change	11.5%	"I found this module very useful in helping me think of ways in which I can change my practice to include the 5Rs and tobacco cessation discussion for every client at every visit."
		"Great Module!! There are so many concrete clinical tools that I plan to utilize from this module."

Approach 3

Follow-up surveys administered 3- and 6-months post training were analyzed with a management-oriented approach. We evaluated participant's self-reported implementation of tobacco cessation knowledge and skills, the number of clients seen, the dissemination of program material to other providers, barriers to change, and future intentions to implement knowledge and skill into practice. The average response rate for the 3-month follow-up survey was 27.08% and 29.17% for the 6-month follow-up survey. Responses indicate that at 3-month follow-up, 76.9% of participants were offering individual tobacco cessation sessions with clients, which increased to 85.7% at the time of 6-month follow-up. Participants provided information on what they perceived to be barriers to changing their practice and implementing new cessation programming post course. The need for *more practice* was identified as the major barrier at the 3-month follow-up point. At 6-month follow-up, 64% of respondents still identified the need for more practice as a barrier. Three additional barriers were identified at the 6-month follow-up and included *finding the time* to offer tobacco cessation counseling (an average of 71%), struggling with *patients' motivation* to attend cessation sessions and *wanting more financial support* for cessation programs and services (50% for each). Another important outcome from using a utilitarian lens through a management–oriented approach relates to the dissemination of tobacco cessation knowledge and skills to other providers. At both follow-up time points, participants were asked whether they had communicated any of the knowledge or skills they had learned to colleagues since completing the course. At the 6-month follow-up time point, 78.90% of participants indicated that they had been involved in informal discussion/information sharing with colleagues; 32.90% indicated that they had offered brief presentations (up

to 1 hour) with colleagues; and 8.11% indicated that they had written articles or reports to share with colleagues.

Discussion

Principal Findings

Previously, the TEACH project was introduced as the first university-accredited continuing education certificate program in Canada that focused on evidence-based research for intensive cessation training, leading to enhanced system capacity. Study findings suggest that the certificate program impacted clinical practice, highlighting successful knowledge transfer from research to practice [7]. With its focus on a detailed evaluation plan that adds rigor to knowledge translation initiatives, we developed an aggregated evaluation model in which different models of evaluation were grouped according to the similarity of their values, their philosophies, and their methodological approaches. This study demonstrates the feasibility of embodying a critical realist lens, through a dimension of utilitarian to intuitionist evaluation, and use of a mixed-methods approach to design an aggregate model of Fitzpatrick, Moore, and Kirkpatrick for the purpose of quality improvement and to achieve evaluation goals. We then applied this model to evaluate the effectiveness of the TEACH Web-based Core Course, and the results from Approaches 1 to 3 demonstrated that TEACH has been successful in the following: providing Web-based training in cessation counseling to a range of HCPs with different disciplines; high ratings for instructional content and overall satisfaction (expertise and consumer-oriented approaches); a significant increase in participants' knowledge and skills (objective-oriented approach); and high motivation to change and sustain practice change (management -oriented approach). This model has also helped us to (1) identify the primary factors that guide our program evaluation, (2) balance the importance of utilitarian and intuitionist philosophy in guiding methodological approaches and tools, and (3) encourage the involvement of multiple stakeholders in CPD program evaluation. Our aggregated model classifies the different evaluation approaches influenced by differing views of ontology and epistemology, as well as the methods for obtaining valid information based on what we see as the driving force behind doing the evaluation, and the factors that influence the choice of what to study and the way in which the study is conducted [14].

Approach 1 of our evaluation model directs us to a comprehensive judgment of the quality of the program, which includes expertise-oriented and consumer-oriented evaluation. They are the oldest approaches in evaluation, directing evaluators to focus on valuing or judging the quality of the program they are evaluating [15,16]. Scriven [16] argues that consumer/learner-oriented evaluation factors such as participation and satisfaction can serve as the key criteria for evaluating a program. Participation can elicit some indication whether training is competitive (consumer/learner-oriented), particularly if the training is accredited (expertise-oriented). The consumer/learner-oriented approach in Approach 1 is consistent with House's [12] conception of utilitarian evaluation to maximize satisfaction among participants. Accordingly, evaluators can focus on total group gains by using outcome scores (eg, satisfaction data). An expertise-oriented approach to evaluation through accreditation is assuring the academic community, the general public, HCPs and other related agencies that a training has been designed using appropriate educational objectives and has the established infrastructure to facilitate participant achievement. This finding is aligned with a previously published study by Kirkwood who emphasized the impact of course accreditation in program evaluation [17].

Approach 2 of our evaluation model helps us to determine the extent to which our training objectives have been achieved. Bloom et al [18] not only emphasize the importance of identifying appropriate objectives in training development for the subject matter but also in developing and measuring participant achievement of these objectives. Cronbach [19,20] also developed an approach to using an objective and associated measurement technique for the purpose of quality improvement in training content, consistent with our objective-oriented approach to evaluation, where the focus is on specifying objectives and determining the extent to which these objectives have been met (ie, measuring changes in knowledge, feasibility, importance and confidence in course competencies). Aligned with intuitionist philosophy, collection of qualitative feedback can also elicit the extent to which training objectives were achieved. For instance, qualitative feedback in this pilot illuminated potential areas for future skill development and comments for improvements.

Approach 3, which is oriented to decision making, focuses on how evaluation outcomes can support decision makers (eg, managers and funders) in making judgments regarding program improvements and continuation. On the basis of a review of studies on commitment to change (that can predict actual change in practice) [21,22], we conducted 3- and 6-month follow-up surveys post training to evaluate practice change. Whereas collecting self-reported practice change data through our current quantitative approach is helpful in identifying implementation of knowledge and skills post course, it does not provide the information needed to guide specific program improvement [5]. Accordingly, our future evaluation design, informed by intuitionist philosophy, will incorporate qualitative questions in the 3- and 6-month follow-up surveys to support decision makers with their ability to make judgments regarding program improvement (management-oriented approach).

The application of the entire aggregate model through Approach 4 has the potential to involve different stakeholders, including those directly impacted by training (eg, patients) rather than leaving decision making of program changes and implementation to training participants and program managers. Future directions of our program evaluation will involve a long-term evaluation of TEACH through administration of in-depth interviews with previous participants, their patients, and their managers in order to fully capture the intuitionist approach to program evaluation. This evaluation will also connect participant previous evaluation data to patient health outcomes in order to determine training impact beyond the participant [12]. This aggregated model has a number of limitations. At various times, policy makers, funding organizations, planners, managers, or HCPs need to distinguish

worthwhile training programs from ineffective ones and revise existing ones so as to achieve desirable results. To do this comprehensively, an evaluation approach needs to include cost-benefit analysis measures. Approach of aggregate model has the potential to objectively measure the effectiveness and efficiency of training by adding a question related to time spent completing the course in formative or summative evaluations.

Another limitation of this study was that we performed our pilot study through the Web-based version of the TEACH course in 2015 with 48 participants. This was done to assess the feasibility of the new evaluation model that required a redesign of evaluation questions and approaches. We were consequently unable to utilize our available, large-scaled data from our previous study [7] since the previous evaluation data did not match our newly piloted questions. Furthermore, we did not use a sample size calculation for this study. We tested the aggregate evaluation model with a cohort of participants in 2015 who were the first to experience our new evaluation model. The purpose of the pilot study was to test the feasibility of addressing the four approaches of the new aggregate model and our design. In general, sample size calculations may not be required for some pilot studies [23]. In addition, as argued by Connelly [24], Hill [25], Julious [26] in the medical field, and Van Belle [27], 10 to 30 participants is a sufficient sample size for a pilot study. This pilot study of 48 participants was a good way to troubleshoot our developed aggregated model, familiarize the team with the procedures, and to test for potential flaws in the model and experimental design.

Another limitation of the aggregate model is applied in its entirety (ie, including Approach 4)—the evaluation can be complex and resource intensive. To address this limitation, evaluators need to consider the resources and time they have available and if Approach 4 fits within a feasible scope of work. Also, we achieved 27% and 29% response rates for the 3-month and the 6-month Web-based follow-up surveys despite subsequent mailing reminders to nonrespondents. Although we hoped for a better response, other surveys of HCPs also have tended to generate low response rates [28,29].

Using a mixed-methods approach that balances both quantitative and qualitative data as equally valuable in evaluation is consistent with using a realist approach to identify the contextual factors of successful training programs, since these factors are intimately connected to the success or failure of a training [6]. The quantitative results from our evaluation, are aligned with objectivist epistemology in valuing numerical outcomes to clearly define program outcomes at various time points and demonstrate overall impact of the training program. Similar to many other evaluation approaches, quantitative results can be used to guide evaluators, managers, planners, and participants in distinguishing worthwhile training programs [30] from ineffective ones. One of our evaluation goals will be to improve the response rates to these surveys administered post course. The qualitative results from the TEACH project's evaluation approach are aligned with subjectivist epistemology in valuing participant feedback in determining program success and impact. Qualitative results can also be used to distinguish worthwhile training programs from ineffective ones and are helpful in guiding program modifications. Our future research will incorporate this more fulsomely through the inclusion of qualitative questions in the 3- and 6-month follow-up surveys and through semistructured in-depth interviews with HCPs, their administrators, and their patients post training.

Implementation models for dynamic human behaviors (ie, practice change), such as the KTA cycle, require a comprehensive evaluation framework with different approaches that can inform future decision making. Some evaluators have lamented the proliferation of evaluation models and urged that an effort be made to synthesize existing models [31]. Conversely, some studies demonstrated that the goal of attaining uniformity in evaluation methods and measures cannot be attained without prematurely inhibiting crucial developments in the field of evaluation [32].

Conclusions

In this evaluation study, different approaches helped us to comprehend the wide range of needs related to evaluating the Web-based TEACH Core Course. Our predispositions and preferences on philosophical and methodological dimensions led us to choose different models, methodologies, data collection tools, analysis methods, and interpretive techniques. As we move forward, we must identify what is useful in each approach when faced with a specific evaluation need. This study also helped to demonstrate that the aggregate model can detect the effects and impact of Web-based courses because of the richness of data collected in each approach impacting different stakeholders. This comprehensive evaluation approach appears compatible and applicable to other programs based on implementation frameworks (eg, KTA). Some of the key features and major characteristics of the aggregate model are as follows:

- When developing an evaluation model, one must consider paradigm, theoretical framework, methodological approach, and data collection methods.
- A comprehensive evaluation model should include qualitative (deductive or inductive) and quantitative approaches for data collection, analysis, and interpretation.
- Utilitarian approaches to evaluation can be helpful in identifying impact through a more objective lens. However, an intuitionist approach, through a subjectivist lens, can uncover information to guide program improvements, beyond what may have been originally expected.

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Conflicts of Interest

Dr. Selby reports grants/research support from Pfizer Inc., Pfizer Canada Inc., Shoppers Drug Mart, Bhasin Consulting Fund Inc., and Patient-Centered Outcomes Research Institute. Dr. Selby has received honorariums for speaking engagements from Pfizer Canada Inc., ABBVie, and Bristol-Myers Squibb. In addition, Dr. Selby has received consulting fees from Pfizer Inc./Canada, Evidera Inc., Johnson & Johnson Group of Companies, Medcan Clinic, Inflexxion Inc., V-CC Systems Inc., Kataka Medical Communications, Miller Medical Communications, NVision Insight Group, and Sun Life Financial. Furthermore, through an open tender process, Johnson & Johnson, Novartis, and Pfizer Inc. are vendors of record for providing nicotine replacement therapy and varenicline, free/discounted, for research studies in which Dr. Selby is the principal investigator or a co-investigator.

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Abbreviations

ANOVA: analysis of variance
CAMH: Centre for Addiction and Mental Health
CPD: continuing professional development
HCPs: health care providers
KTA: Knowledge-to-Action
TEACH: Training Enhancement in Applied Cessation Counselling and Health

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Original Paper

An E-Learning Module to Improve Nongenetic Health Professionals' Assessment of Colorectal Cancer Genetic Risk: Feasibility Study

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Abstract

Background: Nongenetic health providers may lack the relevant knowledge, experience, and communication skills to adequately detect familial colorectal cancer (CRC), despite a positive attitude toward the assessment of history of cancer in a family. Specific training may enable them to more optimally refer patients to genetic counseling.

Objective: The aim of this study was to develop an e-learning module for gastroenterologists and surgeons (in training) aimed at improving attitudes, knowledge, and comprehension of communication skills, and to assess the feasibility of the e-learning module for continued medical education of these specialists.

Methods: A focus group helped to inform the development of a training framework. The e-learning module was then developed, followed by a feasibility test among a group of surgeons-in-training (3rd- and 4th-year residents) and then among gastroenterologists, using pre- and posttest questionnaires.

Results: A total of 124 surgeons-in-training and 14 gastroenterologists participated. The e-learning was positively received (7.5 on a scale of 1 to 10). Between pre- and posttest, attitude increased significantly on 6 out of the 10 items. Mean test score showed that knowledge and comprehension of communication skills improved significantly from 49% to 72% correct at pretest to 67% to 87% correct at posttest.

Conclusions: This study shows the feasibility of a problem-based e-learning module to help surgeons-in-training and gastroenterologists in recognizing a hereditary predisposition in patients with CRC. The e-learning led to improvements in attitude toward the assessment of cancer family history, knowledge on criteria for referral to genetic counseling for CRC, and comprehension of communication skills.

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KEYWORDS

colorectal neoplasms; colorectal, neoplasms, hereditary nonpolyposis; adenomatous polyposis coli; genetic testing; gastroenterology; health communication; feasibility studies; education; professional

Introduction

Colorectal cancer (CRC) is one of the most common forms of cancer worldwide. Mortality can be reduced if individuals at risk are detected and treated early [1]. Patients with a familial or hereditary risk (eg, Lynch syndrome and familial adenomatous polyposis) comprise about 10% to 30% of all patients with CRC [2,3]. Recognition of hereditary CRC syndromes helps to identify high-risk patients, provide them with appropriate surveillance, and offer surgical options. Despite the relatively high frequency of familial and hereditary CRC syndromes and the proven benefit of screening high-risk individuals, referral for genetic counseling appears to be suboptimal, leading to under-diagnosis of hereditary CRC [4].

Adequate referral may be hampered by the clinician's lack of *knowledge* on who and when to refer, and on lack of *experience and training* [4,5]. Indeed, some health professionals (such as gastroenterologists and surgeons) are not specifically trained in genetics and may lack the experience to adequately discuss genetic issues with their patients [6]. In the Netherlands, gastroenterologists and surgeons (rather than primary care physicians) function as gatekeepers for patients with CRC, identifying most patients at risk and providing them with initial information on heredity and genetic testing [6]. Hereafter, we refer to these health professionals as nongenetic health professionals.

It is reported that, in 80% of consultations, the oncologists, surgeons, and gastroenterologists have discussed the family history [6-8]. This suggests a positive *attitude* toward the assessment of a family history. However, 1 study showed that the quality of these discussions on family history of cancer may be inadequate (58%) [6]. The limited quality was mainly attributed to inadequate *communication skills*, for example, the clinicians asked vague, incomplete, overly general, and steering questions, or multiple questions at one time. In addition, when clinicians addressed patients' family history, an increased risk for CRC was only discussed in 57% of those patients for whom such a discussion was warranted [7]. As a consequence, patients with an indication for genetic counseling may have been missed.

These studies suggest that nongenetic health providers may lack relevant knowledge, experience, and communication skills to adequately detect familial CRC, despite a possibly positive attitude toward family history assessment [4-7]. Dedicated training may enable them to adequately refer patients for genetic counseling [6]. Thus, training for nongenetic health care professionals should not only increase factual knowledge but also improve knowledge on effective communication with regard to genetics [9,10].

For gastroenterologists and surgeons (residents as well as specialists), (continued) medical education is traditionally organized through conferences, courses, workshops, and educational meetings. However, as specialists (in training) have limited time and the skill of discussing hereditary risks is a relatively small part of daily care, e-learning may be of practical value.

E-learning can be defined as a training, education, or instruction that occurs on a digital medium, such as a computer or mobile device [11]. The advantages of e-learning are that it is flexible, inexpensive, easy to adapt to individual needs and newest insights, and can be completed at any self-chosen time and location; moreover, e-learning can be adapted to the newest technological advances [11-13]. However, a disadvantage is that the translation of the skills learned into clinical practice may be less obvious. Only a few studies have investigated the effect of e-learning on communication skills. For example, McCarthy et al showed an improvement of skills in knowing when and how to complete incident forms and disclosing errors [14]. Daetwyler et al showed that their e-learning module improved the skill of breaking "bad news" in a setting with a simulated patient [15]. Another study that aimed to improve clinicians' behavior during genetic testing for ovarian cancer showed that a change in knowledge through Web-based learning can drive behavior change [16].

This study addresses the feasibility of e-learning aimed at the improvement of attitude, knowledge, and communication skills in health professionals. Specifically, the aims were as follows: (1) to develop an e-learning module for gastroenterologists and surgeons (in training) aimed at improving *attitudes* toward assessment of a cancer family history, *knowledge* on hereditary CRC and criteria for referral to genetic counseling, and *comprehension of communication skills* (ie, insight into the need to assess a cancer family history in a structured, nonsteering way); and (2) assess the feasibility of this e-learning module for continued medical education of these specialists.

This test of feasibility includes the perception of gastroenterologists and surgeons on the timing, time constraints, technical problems, fulfillment of expectations, clinical usability, and usefulness, as well as the design and technical usability of the e-learning module.

Methods

This study consisted of development of the e-learning module and measurement of the feasibility of the e-learning module to allow improvements (if required).

Stage 1: Development

Focus Group

First, as the target group is difficult to recruit, an online asynchronous focus group was organized. The purpose of this focus group was to investigate the attitudes of gastroenterologists and surgeons-in-training toward collecting a cancer family history and discussing genetic testing, and their need for an e-learning module to connect to their preferences and needs. Using purposeful sampling, the aim was to approach 6-12 gastroenterologists and surgeons-in-training of varying gender and experience.

The focus group discussion addressed the following: oncogenetic knowledge, attitude, perceived communication skills in and competencies and barriers toward collecting a cancer family history and discussing genetic testing, knowledge on information sources about hereditary CRC, organizational aspects associated

with either investigating or not investigating a cancer family history and discussing genetic testing, available tools for discussing a cancer family history, and educational preferences (ie, what educational elements should e-learning entail).

The focus group discussion was carried out by means of the free Web tool FocusGroupIt, LLC (Matt Foley, Rochester, NY, USA) [17]. Focus group participants were invited to join the discussion at several times during a 10-day period. They were instructed to answer the moderator's (KD) open questions in a predefined order and were encouraged to react to each other's answers. The moderator asked questions to further stimulate the discussion. An inductive approach, based on the questions addressed, allows to summarize what the health professionals said. The summary of the transcript of the discussion was shared with the participants to enable their feedback.

Framework Development

On the basis of the input of the focus group, a framework for the e-learning module was developed by the study coordinator (KD) in close collaboration with a clinical geneticist (CA), surgeon (PT), gastroenterologist (ED), medical psychologist (ES), educational expert (EtP), and an e-learning developer (PD). The framework comprised descriptions of the content (*what?*), learning goals (*why?*), and method (*how?*) for each step of the e-learning module. The learning goals were formulated using the taxonomy of Bloom [18], which consists of six levels of learning in the cognitive domain (evaluation, synthesis, analysis, application, comprehension, and knowledge). On the basis of this framework, a script was written.

E-Learning Module Development

In the next step, the e-learning module itself was developed. In this phase, choices and decisions regarding the medical content and the configuration of the e-learning module were made. Technical decisions were made regarding navigation (learner or program-controlled), use of multimedia (verbal, visual, or audio), use of game elements, and which software to use. After the development of the e-learning module, 8 professionals (including medical experts such as a gastroenterologist, surgeon, and clinical geneticist) and researchers specialized in medical communication tested the first version of the e-learning module. They critically commented on the content (depending on their expertise), the language used, and the ease of use of the module.

Stage 2: Feasibility

Study Participants

Feasibility testing of the module was first performed among a group of surgeons-in-training (3rd- and 4th-year residents; hereafter called surgeons) and then among gastroenterologists. For feasibility studies, a sample size of at least 55 participants has been recommended [19].

Procedure

Separate procedures were followed for each of the two groups. In spring 2016, the surgeons participated in an obligatory national training day on oncology. In addition, 1 week before the training, they were invited via an email from the organizers of the oncology training, strongly recommending their participation in the e-learning module. Surgeons were asked to fill in a brief online questionnaire both before (T0) and directly after (T1) the e-learning module. The email contained a link to the first questionnaire. At the end of the questionnaire, a link to a website with the e-learning module was provided. Participants were able to access the e-learning module at a time and place of their own convenience but were asked to complete it before their national training day. The link to the second questionnaire was provided at the end of the e-learning module.

On the basis of the input from the surgeons, adaptations could be made (if required) to the e-learning module before submitting it to the gastroenterologists. Using a list of all gastroenterologists registered in the Netherlands, this group was directly approached by the principal researcher via email. The email contained a link to the first questionnaire. At the end of the questionnaire, a link to a website with the e-learning module was provided. Gastroenterologists were also able to access the e-learning module at a time and place of their own convenience but within a time limit of 2 weeks after the invitation. The link to the second questionnaire was provided at the end of the e-learning module. Participants could not enter the second questionnaire without having completed the prequestionnaire and the e-learning module.

All surgeons and gastroenterologists received a gift voucher of 30 euro for their participation to compensate for their time, owing to their busy schedules.

Measures

Table 1 shows the items included in the pre- and postquestionnaire. The prequestionnaire assessed the following: personal characteristics (age, gender, year of graduation, and experience with the patient population), attitude toward cancer family history assessment (Continuing Professional Development Reaction Questionnaire), and expectations regarding the e-learning module. A self-developed knowledge test on hereditary CRC and communication skills, consisting of a pre- and posttest, was part of the e-learning module.

In the postquestionnaire, participants were invited to evaluate the e-learning module on the timing, time constraints, technical problems, fulfillment of expectations, clinical usability and usefulness, design and technical usability, and attitude. Questions based on the study of other authors were translated by the study coordinator (KD) and checked for content validity by a clinical geneticist (CA), surgeon (PT), gastroenterologist (ED), and medical psychologist (ES). The questions regarding relevant knowledge were also checked for content validity by these experts. Participants were encouraged, but not obliged, to fill in the questionnaires directly before and after completing the e-learning module. Therefore, some time may have elapsed between the completion of the e-learning and the pre- and postquestionnaire.

Data Analyses

Descriptive statistics were used to analyze most aspects of feasibility. To determine a change in *attitude* and *knowledge* between T0 and T1 either a paired *t* test or Wilcoxon signed-rank test was used, depending on the distribution of the data. Data were analyzed using IBM SPSS Statistics 23 (IBM Corp).

Table 1. Measures included in the pre- and postquestionnaire.

Category	Number of items	Reference	Description of questions or response scale (if applicable)	Time point	
				Pre	Post
General characteristics	5	Self-developed	Age, gender, year of completion as physician, experience with patients with CRC[a] (5-point scale: very much to none), and estimation of number of patients with CRC seen in last 3 months	X[b]	
Attitude, beliefs, and intentions	10	Based on the CPD[c] Reaction Questionnaire [20]	Attitude, beliefs, and intentions toward collecting a cancer family history (different response scales depending on the item; see Table 4 for the items)	X	X
Knowledge					
Tested	8	Self-developed	Eight questions on knowledge about hereditary CRC and assessment of cancer family history		X
Self-evaluation	2	Based on Robinson et al 2015 [16]	Did your knowledge on hereditary CRC and investigating a cancer family history increase? (7-point scale: strongly disagree to strongly agree)		X
General evaluation of e-learning	4	Self-developed	Give a grade: 1 (low)-10 (high) Would you advise others to follow the e-learning module (yes or no or maybe)? Would you be willing to pay for such an e-learning module (none, 0-15, 15-30, or more than 30 euro)? Would you be interested in other modules (yes or no or maybe)?		X
Timing	1	Self-developed	Did the e-learning come at the right point in time during the educational track (only applicable for surgeons; 3-point scale: too early to too late)		X
Time constraints	2	Self-developed	How did you evaluate the length of the e-learning? (5-point scale: much too long to much too short) How long did it take you to complete the e-learning module? (0-15, 15-30, 30-45, 45-60, or more than 60 min)		X
Technical problems	4	Self-developed	On what device did you follow the e-learning? How many turns did you take to complete it? Did you encounter technical problems, and if so, what type of problems? (3 multiple choice and 1 open questions)		X
Design and technical usability	10	Based on Jacobs et al (personal communication, Ellen Smets, December 2016)	Did you think the e-learning was well-developed, user-friendly, nice, readable, and usable? Did you think the e-learning used understandable language, understandable instructions, clear instructions, useful instructions, and complete instructions? (5-point scale: not at all to very much)		X
Clinical usability and content					X
Expectations	3	Based on te Pas et al [21]	See Table 6 for the items. (7-point scale: strongly disagree to strongly agree)	X	X
Cases	4	Self-developed	Did you find the case examples used clear, helpful, complete and realistic? (7-point scale: not at all to very much)		X
Content of e-learning	3	Self-developed	Which two components of the e-learning did you find most and less useful? Did you miss anything, and if yes, what did you miss? (2 multiple choice and 1 open questions)		X

[a]CRC: colorectal cancer.

[b]X means that the questionnaire was used at that time point.

[c]CPD: Continuing Professional Development.

Results

Stage 1: Development

Focus Group

A total of 2 gastroenterologists-in-training (1 male and 1 female; 1 in the final year of training and 1 at the start of training) and 5 surgeons-in-training (3 females and 2 males; 1 at the start of training, 2 in the middle of their training, and 2 in the final year of their training) participated in the online focus group. In addition, 1 gastroenterologist-in-training (male, in the middle of his training) was interviewed individually.

The participants had a positive attitude toward *collecting a family history*; however, not all of them had actual experience. They acknowledged the added value of a cancer family history assessment, such as investigating a differential diagnosis, evaluating the need to refer for genetic counseling, and identifying the potential risk for family members. One of their main barriers in the current practice was lack of time; participants worried that discussing cancer family history was potentially time-consuming because of the possible emotional reactions of patients. Another reported barrier was lack of oncogenetic knowledge; participants suggested that patient checklists or physician training may help overcome this barrier.

A total of 5 participants had experience in *discussing genetic testing* with patients, and all had perceived this as important. Lack of time, unclear procedures, lack of knowledge on guidelines, and referral criteria were reported as the most important barriers in discussing genetic testing with patients. To overcome these barriers, the use of a clear protocol, feedback of the clinical geneticist, education, and a checklist were suggested.

When prompted, participants indicated wanting to improve the following communication skills: asking concrete open questions, following through with questions, signaling cues, and clearly formulating and structuring questions about cancer in the family. However, most participants thought that an e-learning module should focus mainly on oncogenetic knowledge and not on communication skills. Participants reported that they were not thoroughly educated about genetics during their curriculum or training. An e-learning module on this topic would need to be short and problem- or case-based, and also discuss useful information sources.

E-Learning

On the basis of the input of the focus group, a framework for the e-learning module was developed; then, a prototype of the e-learning module was developed. Articulate storyline version 2.1 was used because of the experience with this software within our hospital. During the development process, the study coordinator (KD) and the e-learning developer (PD) continuously discussed the technical decisions to be made. Subsequently, this prototype was tested among 8 professionals; this led to only small changes, for example, correction of spelling or grammatical errors and some errors in medical content.

Table 2 shows the content of the e-learning, and Multimedia Appendix 1 shows some screenshots of an English translation of the Dutch e-learning module.

Stage 2: Feasibility

Study Population

Surgical Residents

A total of 104 surgical residents were invited; however, 124 prequestionnaires (T0) were collected because several participants reentered the prequestionnaire after missing the link to the e-learning module. On the basis of a decision rule to distinguish those who had reentered the questionnaire from those who had not, we were able to exclude these questionnaires. The decision rule was formulated as follows: if gender, age, and Internet Protocol address were similar, answers on the remainder of the questionnaire differed on less than 6 variables, and year of graduation differed less than 2 years, then the last questionnaire filled in was removed. Unfortunately, because we were unable to identify all double entries, the final sample comprised 110 completed questionnaires at T0. At T1, 84 surgeons completed the questionnaire.

Gastroenterologists

Out of the 39 invited gastroenterologists, 14 participated (36% response rate) at T0 and 10 participated at T1. Reentry was not possible with this questionnaire. Pre- and postquestionnaires were mostly compared on a group level. However, for the pre- and posttest data, we paired the data for the 84 surgeons and the 10 gastroenterologists for which we had data at two points in time. Table 3 shows the sociodemographic characteristics of the study sample at T0.

Evaluation

Results of the 2 study groups are presented together, with the exception of differences between the versions of the e-learning module that could influence the results of the 2 groups, such as the game element.

On average, participants rated the e-learning module 7.5 (standard deviation [SD] 0.9) on a scale of 1 to 10. For the question “Would you recommend the e-learning to others like you?,” 75.5% (71/94) of the participants said yes, 16.1% maybe (15/94), and 7.5% (7/94) said no.

Out of the surgeons, 86% would be interested in e-learning modules about other hereditary cancers (eg, hereditary breast and ovarian cancer), 6% would not, and 8% “might be.” Out of the gastroenterologists, 44% would be interested in e-learning modules about other aspects of hereditary (eg, next generation sequencing or genomics), 22% would not, and 33% “might be.”

Out of all participants, 67% said they would not be willing to pay for the e-learning if they could get accreditation points for it, 26% would be willing to pay up to 15 euro, 7% would be willing to pay 15-30 euro, and 1% would be willing to pay more than 30 euros.

Table 2. Content of the e-learning module. For all questions, participants received standardized textual feedback based on their answers.

Topic	Explanation	Examples of questions within the topic
Entry test	The entry level of knowledge of the participant was tested with 8 multiple choice questions	Which advice is not relevant for adequately assessing a family history? Pick one. Response options were as follows: • Ask about second-degree family members • Ask for the age at which cancer in the family member was diagnosed • Ask if there were metastases in cancers in the family
Long cases using comics with questions	Two clinical scenarios (one with a mistake in medical content, and one with a communication mistake) in the form of a comic with questions (see screenshots)	Do you have enough information to decide if this patient should be referred for genetic counseling? Response options were as follows: • Yes, I have enough information. The patient should not be referred • No, I do not have enough information • Yes, I have enough information. The patient should be referred
Overview of helpful aids to assess cancer family history	Links to relevant information in apps, checklists, and questionnaires with 1 reflective question	Which method do you find most useful for clinical practice?
Four short cases	Case descriptions for which the participant needs to evaluate whether the patient needs to be referred for genetic counseling	A patient got bowel cancer at the age of 49 years and has a niece with endometrium cancer at the age of 60 years. Does this patient need to be referred for genetic counseling? yes or no
Communication examples	Examples of erroneous communication skills and reflective questions on how to improve questions (asking concrete open questions, following through with questions, signaling cues, and clearly formulating and structuring questions about cancer in the family) when investigating a cancer family history	*And something else. Nobody in your family has bowel cancer?*[a] How could you rephrase this question?
Misunderstandings in two comics	Two clinical scenarios in which misunderstandings arise and multiple-choice questions about these misunderstandings	*I am planning to buy a house. Is it wise to get a DNA test done? I have heard that it can have consequences for your insurance and that you would not be able to buy a house.* What would be an appropriate response to the reaction of the patient? • In most cases, genetic testing has no consequences for insurance. The clinical geneticist can discuss this with you and help you decide what is the most sensible thing to do • You can better wait until you have bought your house. I will refer you to a clinical geneticist after you have done that • DNA research has no consequences for your insurance. The clinical geneticist can tell you more about that
Misunderstanding in game or comics	Description of most common misunderstandings by patients about genetic testing, such as consequences for insurance, including the in-laws in the family history, etc. In the first version, participants had to click on rolling balls within a certain time frame to make the misunderstandings visible. This format was changed after the test among surgeons-in-training. In the second version, pictures of patients were shown with a text balloon reflecting their misunderstanding. An explanation of the misunderstanding and on how to deal with it was provided	Thinking balloon of patient: *"Cancer in the family she asks. Hmmm, what types of cancer do we have in my mother's family?"* Advice for health professional: You can explicitly say to the patient that she needs to consider both sides of the family

Topic	Explanation	Examples of questions within the topic
Barriers word cloud	Participants could click on words in a word cloud presenting the most common barriers clinicians experience in discussing a cancer family history and genetic testing and how to overcome these	Word in the word cloud: Timing Explanation: At the time of diagnosis, there is a lot that needs to be discussed with a patient. However, because in some cases the genetic test result can influence the treatment, it is important to address the cancer family history early in the trajectory. Experience shows that when the topic is not addressed in the first consultation, it will not be discussed in follow-up consultations
More information (overview of helpful aids)	A downloadable overview of the most important information sources, for example, websites with guidelines and informative websites, for patients and health professionals	N/A[b]
End test	With the end test, the level of knowledge after following the e-learning was evaluated with the same 8 multiple choice questions as in the entry test	Which tumors are associated to Lynch? Answering options were as follows: • Endometrium cancer • Cervical cancer • Biliary tract cancer • Sebaceous gland carcinoma • Hodgkin lymphoma

[a]Text in italics are expressions of hypothetical patients or doctors.

[b]N/A: not applicable.

Table 3. Characteristics of the respondents at T0.

Characteristics of the respondents (N=124)	Surgical residents (N=110)		Gastroenterologists (N=14)	
	Mean (range, SD[a])	n (%)	Mean (range, SD)	n (%)
Age in years[b]	31.6 (28-37, 1.8)		36.2 (26-60, 9.5)	
Gender [c]				
Male		65 (59.6)		6 (46.2)
Female		44 (40.4)		7 (53.8)
Years since completing medical degree[d]	7 (3-11, 1.7)		11 (0-35, 9.5)	
Experience with CRC [e]				
A lot or much		70 (63.6)		8 (57.1)
Not much or little		39 (35.4)		5 (35.7)
None		1 (0.9)		1 (7.1)
Number of patients seen with CRC in the last 3 months				
0-19		36 (32.7)		12 (85.7)
20-39		54 (49.1)		1 (7.1)
40-59		9 (8.2)		
60-79		4 (3.6)		1 (7.1)
80-99		1 (0.9)		
100 or more		6 (5.5)		

[a]SD: standard deviation.

[b]Missing values: 3

[c]Missing values: 2

[d]Missing values: 4

[e]CRC: colorectal cancer.

Attitude, Beliefs, and Intentions

Tables 4 and 5 show the attitude of participants toward asking for a cancer family history at T0 and T1.

Regarding participants' beliefs about their capabilities that they would find it easy to ask for a cancer family history (z=−2.90, P=.004), participants were significantly less positive at T1 compared with T0. No differences were reported for their capability to ask for a cancer family history or their confidence in asking for a cancer family history.

Regarding participants' perception of social influences that colleagues would ask for a cancer family history (z=−2.62, P=.009) and that persons who are important in their profession would ask for a cancer family history (z=−3.71, P=.000), participants were significantly more positive at T1 compared with T0. No significant differences were found with regard to whether the participants thought respected coworkers would ask for a cancer family history.

Concerning beliefs about consequences that asking for a cancer family history is useful from a medical point of view (z=−2.51, P=.012), participants were significantly more positive at T1 compared with T0.

Regarding moral norms, participants were significantly more positive that asking for a cancer family history is the right thing to do from a medical perspective (z=−2.73, P=.006) at T1 as compared with T0.

Concerning participants' intention to ask for a cancer family history (z=−2.82, P=.005) and to plan to ask for a cancer family history (z=−6.72, P=.001), participants were significantly more positive at T1 compared with T0.

Knowledge on Hereditary Cancer and Comprehension of Communication Skills

For surgeons, the mean test score significantly improved from 49% correct (SD 21, range 0-100) on the pretest to 67% correct (SD 20, range 10-100) on the posttest (t_{82}=−6.11, P<.01); 70% of the individual scores improved, 12% decreased, and 18% remained stable. For accredited e-learning modules, the posttest score should be at least 70% correct. Therefore, before inviting the gastroenterologists, we critically reviewed and slightly adapted the test and the content of the e-learning, so that they were better aligned.

For gastroenterologists, the mean test score significantly improved from 72% correct (SD 18, range 50-100) on the pretest to 87% correct (SD 11, range 70-100) on the posttest (z=−2.25, P=.02); 70% of the scores improved, 10% decreased, and 20% remained stable.

On average, participants self-rated their increase in knowledge (7-point Likert scale, strongly disagree to strongly agree) on hereditary CRC with a 3.7 (SD 2.0) and their comprehension on how to investigate a cancer family history with a 5.5 (SD 1.0).

Table 4. Attitude, beliefs, and intentions toward investigating a cancer family history.

Scale and item[a]	T0 (n=123) Mean (SD[b])	T1 (n=94) Mean (SD)
Beliefs about capabilities		
I have the ability to ask for a cancer family history (strongly disagree to strongly agree)	6.3 (0.7)	6.3 (0.6)
I am confident that I could ask for a cancer family history (strongly disagree to strongly agree)	6.1 (1.0)	6.2 (0.7)
For me, asking for a cancer family history would be (extremely difficult to extremely easy)	6.2 (0.8)	6.0 (0.7)
Social influences		
To the best of my knowledge, the proportion of colleagues who will ask for a cancer family history would be (0%-20% or 20%-40% or 40%-60% or 60%-80% or 80%-100%)[c]	5.0 (1.4)	5.4 (1.1)
Now think about a coworker who you respect as a professional. In your opinion, does he or she ask for a cancer family history (never to always)	5.7 (1.0)	5.8 (0.8)
Most persons who are important for me in the profession would ask for a cancer family history (strongly disagree to strongly agree)	5.5 (1.0)	5.8 (0.8)
Beliefs about consequences		
Overall, I think that asking for a cancer family history from a medical point of view is (useless to useful)	6.1 (0.9)	6.4 (0.6)
Moral norm		
Asking for a cancer family history is the right thing to do from a medical perspective (strongly disagree to strongly agree)	6.1 (1.0)	6.4 (0.6)
Intention		
I intend to ask for a cancer family history (strongly disagree to strongly agree)	5.9 (1.1)	6.2 (0.8)
I plan to ask for a cancer family history (strongly disagree to strongly agree)	5.3 (0.8)	6.3 (0.6)

[a]All items were answered on a 7-point scale with a higher score indicating a more positive attitude toward the described behavior.

[b]SD: standard deviation.

[c]Item has been rescored from a 5-point to a 7-point scale.

Table 5. Attitude, beliefs, and intentions toward investigating a cancer family history (change scores).

Scale and item[a]	Change[b]	*z*	*P* value
Beliefs about capabilities			
I have the ability to ask for a cancer family history (strongly disagree to strongly agree)	• Decrease: 15 • Increase: 14 • Ties: 46	−0.19	.85
I am confident that I could ask for a cancer family history (strongly disagree to strongly agree)	• Decrease: 17 • Increase: 15 • Ties: 43	−0.10	.92
For me, asking for a cancer family history would be (extremely difficult to extremely easy)[c]	• Decrease: 24 • Increase: 5 • Ties: 46	−2.90	.004
Social influences			
To the best of my knowledge, the proportion of colleagues who will ask for a cancer family history would be (0%-20%/ or 20%-40% or 40%-60% or 60%-80% or 80%-100%)[d]	• Decrease: 5 • Increase: 16 • Ties: 54	−2.62	.009
Now think about a coworker who you respect as a professional. In your opinion, does he or she ask for a cancer family history (never to always)	• Decrease: 13 • Increase: 14 • Ties: 48	−0.37	.72
Most persons who are important for me in the profession would ask for a cancer family history (strongly disagree to strongly agree)	• Decrease: 5 • Increase: 25 • Ties: 45	−3.71	.001
Beliefs about consequences			
Overall, I think that asking for a cancer family history from a medical point of view is (useless to useful)	• Decrease: 13 • Increase: 27 • Ties: 35	−2.51	.01
Moral norm			
Asking for a cancer family history is the right thing to do from a medical perspective (strongly disagree to strongly agree)	• Decrease: 11 • Increase: 26 • Ties: 37	−2.73	.006
Intention			
I intend to ask for a cancer family history (strongly disagree to strongly agree)	• Decrease: 15 • Increase: 27 • Ties: 33	−2.71	.007
I plan to ask for a cancer family history (strongly disagree to strongly agree)	• Decrease: 2 • Increase: 55 • Ties: 18	−6.60	.001

[a]All items were answered on a 7-point scale with a higher score indicating a more positive attitude towards the described behavior.

[b]number of individuals that decreased or increased or stayed the same from T0 to T1, n=74.

[c]in the other direction: significant decrease in attitude.

[d]Item has been rescored from a 5-point to a 7-point scale.

Table 6. Participants' expectations regarding the e-learning module.

Item[a]	T0 (n=123) Mean (SD[b])	T1[c] (n=93) Mean (SD)
I expect that the content of this e-learning is usable in clinical practice	5.3 (1.2)	5.7 (1.0)
I expect that the benefits of participating in this education via the Internet outweigh the disadvantages	5.4 (1.1)	5.7 (1.0)
I expect that participation in this education via the Internet will offer me the opportunity to organize my work more effectively	5.2 (1.1)	5.6 (1.1)

[a]7-point scale: strongly disagree (1) to strongly agree (7).

[b]SD: standard deviation.

[c]At T1, participants were asked if these expectations were fulfilled. For example, "I expected that participating in this education via the Internet would allow me to spend more time on other activities."

Perceived Timing and Time Constraints

Out of all participants, 64% thought that the e-learning came at the right point in time, whereas 34% thought it came too late, and 2% thought it came too early in their educational track. In addition, 51% participants took 15-30 min to complete the e-learning, 43% took 30-45 min, 5% took 45-60 min, and 1% took 0-15 min.

Furthermore, 86% participants reported that the length of the e-learning module was exactly right, whereas 9% thought it was too lengthy, and 5% thought it was too short.

Design, Technical Usability, and Technical Problems

Participants completed the e-learning module on a computer or laptop (83%), mobile phone (14%), or tablet computers (3%). The majority of participants (85%) completed the e-learning module in 1 session, whereas 15% took two or more turns to finish it.

On a 5-point scale, participants evaluated the e-learning module as well-developed (mean 3.9 [SD 0.6]), user-friendly (mean 4.1 [SD 0.6]), nice (mean 3.7 [SD 0.7]), readable (mean 3.9 [SD 0.6]), and usable (mean 4.0 [SD 0.6]). On a 7-point scale, participants evaluated the language in the e-learning module as understandable (mean 5.8 [SD 0.8]) and the instructions in the e-learning as understandable (mean 5.8 [SD 0.7]), clear (mean 5.8 [SD 0.8]), useful (mean 5.7 [SD 0.7]), and complete (mean 5.7 [SD 0.8]).

Out of all surgeons, 21% reported having encountered technical problems, which could be categorized as related to readability, display on the mobile phone, loading of pages, and the "game" element (see below) not working properly. On the basis of this information, we adapted the game before inviting the gastroenterologists; none of the participants in this latter group experienced any technical problems.

Evaluation of Clinical Usability and Content

Table 6 shows the participants' expectations regarding the e-learning module at T0 and, if these were fulfilled, at T1. At T0, participants had high expectations (mean 5.2-5.4 on a scale from 1-7) regarding the usability of the content, the benefits of education via Internet, and organizing their work more effectively. At T1, these expectations were fulfilled (mean 5.6-5.7 on scale 1-7) for all 3 items.

Case examples were evaluated as follows: clear 5.5 (SD 0.9), helpful 5.3 (SD 0.8), complete 5.2 (SD 1.1), and realistic 5.3 (SD 1.0) (7-point Likert scale, not at all to very much).

According to the surgeons, the most useful elements of the e-learning module were *short cases* (54%; ie, a case description in which the participant needs to judge if the patient needs to be referred for genetic counseling) and the *overview of helpful devices or aids* (45%; ie, links to relevant information in apps, checklists, and questionnaires with reflective questions). Least useful were the *game on misunderstandings* (70%; ie, a description of the most common misunderstandings that patients have about genetic testing, based on clicking on rolling balls within a certain time frame), and the *barriers* (56%; ie, participants could click on words in a word cloud presenting the most common barriers and how to overcome these). On the basis of this information, we changed the "misunderstandings" in the game component, that is, in the revised version; pictures of "patients" were shown with a text balloon reflecting their misunderstandings. Additionally, explanations about the misunderstandings and how to deal with them were provided. Furthermore, the word cloud with the "barriers" was made voluntary instead of being obligatory (Table 2).

According to gastroenterologists, the most useful elements of the e-learning module were the *short cases* (40%), *the overview of criteria for referral* (40%), *the long cases* (40%; ie, two clinical scenarios in the form of a comic with questions), and *the overview of helpful devices or aids* (30%). Least useful to gastroenterologists were the *barriers* (50%), the *pretest* (40%), the *misunderstanding cases* (30%), and the *misunderstanding pictures* (30%; ie, pictures of patients expressing misunderstandings).

Out of the surgeons, 21% indicated that they "missed" something: this was mainly categorized as more background information (eg, more in-depth information on the background of hereditary problems), more overviews (eg, overview of the Lynch criteria), or more information about referral (eg, more insight into when a referral is needed). On the basis of this information, an overview of helpful resources (eg, guidelines and assessment tools for cancer family history) was added. None of the gastroenterologists indicated that they missed something.

Discussion

Principal Findings

This study investigated the feasibility of an interactive problem-based e-learning module for gastroenterologists and surgeons (in training) aimed at improving *knowledge* of hereditary CRC, *attitude* toward, and *comprehension of communication skills* needed for a cancer family history assessment. The study provides relevant insights for researchers and teachers in the field of online learning. A unique innovative e-learning has been developed, using problem-based comics displaying realistic doctor-patient conversations, which activate participants to elaborate on what would be appropriate behavior.

The e-learning led to the intended improvements in attitude toward assessment of cancer family history, knowledge on CRC criteria for referral to genetic counseling, and comprehension of communication skills. *Attitude* toward a cancer family history assessment became more positive on 6 out of the 10 items. *Knowledge* on hereditary cancer and *comprehension* of communication skills showed significant improvement. Studies aimed at health professionals investigating the effect of e-learning modules on attitude and knowledge showed similar effects [14,22-26] in, for example, end-of-life care, reducing antibiotic prescribing, error reporting, behavior change psychology, and addressing unhealthy alcohol use. Studies investigating the effect of e-learning on communication skills or comprehension of skills are scarce. However, McCarthy et al showed that their program resulted in an improvement of skills in knowing when and how to complete incident forms and disclosing errors [14]. Daetwyler et al showed that their module improved the skill of breaking “bad news” in a setting with a simulated patient [15].

Participants in this study self-reported that they learned more about accurately assessing cancer family history than about hereditary CRC. Importantly, asking for a cancer family history was perceived as significantly less easy for participants after following the e-learning module than before the training. Thus, although the comprehension of communication skills increased, the participants felt more insecure about asking for a cancer family history. A better or increased understanding of what is needed for an accurate cancer family history assessment may have influenced the confidence in their own skills. In other words, participants may have become aware of the gaps in their skills (ie, consciously incompetent); a positive consequence of this may be an increased willingness to change behavior and learn from future experiences [27].

The evaluation of our e-learning module shows that the e-learning was well received and that participants were positive about both the design and content. The positive evaluation of the e-learning may be further increased by adding more problem-based cases to increase the variety of cases and to stimulate recall of the referral criteria. Most surgeons and gastroenterologists found the e-learning module attractive and useful, and would recommend it to others. However, the majority indicates that they are not willing to pay for the e-learning module, which may complicate the implementation of e-learning in continuing medical education. Therefore, it is important to incorporate the e-learning module in existing educational tracks. Moreover, as medical students and nurses may benefit from this e-learning, the module may be incorporated in their educational tracks. Furthermore, a blended learning (ie, adding a traditional communication training session to the e-learning module) may increase the application of the learned skills into clinical practice and incorporate the learned skills cognitively.

A limitation of this study is the restricted dataset, as some participants did not fill in the postquestionnaire. This may be because of lack of time or technical reasons, that is, not being able to complete the e-learning module. Therefore, the number of participants reporting technical problems may be lower than those actually experiencing technical problems. In addition, we did not test the actual impact of the e-learning module on communication skills (eg, using a simulated patient). Potentially, this e-learning should be integrated in a blended learning model to enable a greater effect on participant’s skills; in this way, participants can practice with the learned skills and thereby transfer their skills to daily practice.

A strength of the study is that we were able to demonstrate that (at least the basic) communication skills have the potential to be trained via an e-learning module. Another limitation is that the same test was used to assess knowledge before and after completing the e-learning module, which may have caused testing bias. However, as we did not provide feedback about the first (T0) test and the second test was (on average) about 30 min later, this effect is probably small. On the other hand, this short time frame may have led the test to function as a memory test rather than a test of their capacities. A test after a few weeks, following the e-learning module, would have given more insight in the learning effect.

Our problem-based e-learning on recognizing hereditary predisposition in patients with CRC was feasible for surgeons-in-training and gastroenterologists. The e-learning module is now ready for use and appears to be a useful tool to improve knowledge on hereditary CRC and attitudes toward and comprehension of a cancer family history assessment.

Future studies should evaluate whether the e-learning module has a beneficial effect on more adequate referral of at-risk patients to genetic counseling, resulting in more preventive screening, better prevention, and or timely diagnosis in patients and their family members. The results of this study are promising and warrant additional research on how communication skills can be further addressed in online learning.

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Conflicts of Interest

None declared.

Multimedia Appendix 1

Screenshots of a comic with questions.

[PDF File (Adobe PDF File), 547KB - mededu_v3i2e24_app1.pdf]

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Abbreviations

CRC: colorectal cancer
SD: standard deviation

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Original Paper

A Web-Based Lifestyle Medicine Curriculum: Facilitating Education About Lifestyle Medicine, Behavioral Change, and Health Care Outcomes

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Abstract

Background: Lifestyle medicine is the science and application of healthy lifestyles as interventions for the prevention and treatment of disease, and has gained significant momentum as a specialty in recent years. College is a critical time for maintenance and acquisition of healthy habits. Longer-term, more intensive web-based and in-person lifestyle medicine interventions can have a positive effect. Students who are exposed to components of lifestyle medicine in their education have improvements in their health behaviors. A semester-long undergraduate course focused on lifestyle medicine can be a useful intervention to help adopt and sustain healthy habits.

Objective: To describe a novel, evidence based curriculum for a course teaching the concepts of Lifestyle Medicine based on a web-based course offered at the Harvard Extension School.

Methods: The course was delivered in a web-based format. The Lifestyle Medicine course used evidence based principles to guide students toward a “coach approach” to behavior change, increasing their self-efficacy regarding various lifestyle-related preventive behaviors. Students are made to understand the cultural trends and national guidelines that have shaped lifestyle medicine recommendations relating to behaviors. They are encouraged to engage in behavior change. Course topics include physical activity, nutrition, addiction, sleep, stress, and lifestyle coaching and counseling. The course addressed all of the American College of Preventive Medicine/American College of Lifestyle Medicine competencies save for the competency of office systems and technologies to support lifestyle medicine counseling.

Results: The course was well-received, earning a ranking of 4.9/5 at the school.

Conclusions: A novel, semester-long course on Lifestyle Medicine at the Harvard Extension School is described. Student evaluations suggest the course was well-received. Further research is needed to evaluate whether such a course empowers students to adopt behavior changes.

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KEYWORDS

life style; health behavior; healthy lifestyle; health education; health promotion; wellness programs; curriculum; self efficacy; young adult; education, medical, undergraduate; health knowledge, attitudes, practice; universities; mental health; adolescent; risk reduction behavior; humans

Introduction

College Student Health and Lifestyle Medicine Interventions

College students are an important target audience for lifestyle medicine—a medical specialty focused on evidence-based interventions for improving healthy lifestyle behaviors encompassing diet, exercise, and wellness. College health is a major concern, especially around stress management, sleep deprivation, weight management, nutrition, physical activity, and alcohol use [1-4]. College is a critical time for experimenting, exerting autonomy, and determining how to make choices that result in happiness and productivity. College also marks a critical time for the acquisition and maintenance of healthy habits.

Researchers and educators have been investigating the lifestyle choices of college students for decades, and studies demonstrate that unhealthy habits such as physical inactivity and poor nutritional choices become exaggerated in college. In one study, researchers tracked individual college students' body weight and body composition and demonstrated an increased prevalence of student obesity from 17.5% (23/131) to 30.5% (40/131) between entering and graduating from college [5]. Given the obesity and diabetes epidemics in the United States and worldwide, teaching college students about healthy lifestyles can play an important role in preventing cardiovascular disease, cancer, and respiratory disease. In a different study examining the efficacy of a single 1-hour motivational intervention for college students on obesity, researchers found that students who participated in the intervention did not have significant body mass index (BMI) reductions at the 3-month follow-up when compared with control students [6]. They concluded that prolonged interventions may be necessary for a significant impact on student health. Addressing and undoing the unhealthy habits that prevail in college will take more than a 1-hour intervention.

Research on the health of college students has been completed by investigators around the world, including countries such as China [7,8], Ethiopia [9], Lebanon [10], Saudi Arabia [11], Qatar [12], Sudan [13], Serbia [14], Bahrain [15], Arab countries [16], Puerto Rico [17], Spain [18], and the United States [4,19,20]. College students' health and behaviors are of interest because of the mental stress and anxiety that many students experience [21,22], as well as the use of excessive alcohol [23-25], smoking habits [26], drug use [27], weight [28-30], sleep problems [31,32], lack of physical activity [4], poor diets [33-35], and overall unhealthy lifestyles of college students [36-38].

Many interventions to increase the health and well-being of college students have been investigated. A systematic review and recent meta-analysis of computer-delivered Web-based interventions to improve depression, anxiety, and psychological well-being of college students demonstrated that cognitive, behavioral, and mindfulness interventions were effective in reducing stress [39]. In a systematic review of dietary interventions in college students, the authors' analysis of 14 papers found that in-person interventions showed promise in improving students' dietary behaviors, but these changes were minimal [40]. Interventions that included self-monitoring and goal setting maximized outcomes. In this same review, Web-based interventions were less effective overall but seemed to show efficacy with students who resisted change or considered changing their eating habits. This review also looked at environmental approaches that could increase the visual cues to action for selecting healthy options. There is evidence that in-person and Web-based interventions can help college students address stress and can nudge students in the direction of making healthy dietary choices.

Impact of Lifestyle Related Coursework on College Health

Research has also focused on the effect that academic major selection and academic class selection have on the lifestyle behaviors of students. In one study, researchers examined the correlation between a college student's chosen major and his or her dietary choices. It revealed that female nutrition majors had healthier habits and made superior food choices compared with female non-nutrition majors [41]. It is not clear whether the students who chose nutrition as a major had healthier habits before going into college, whether their education helped to inform them about healthy eating, or whether it was a combination of factors that led female nutrition students to have healthier eating habits. An examination of self-reports of students in a health sciences university in Bahrain revealed that a high percentage of health science students had unhealthy dietary habits and sedentary behaviors, with 48% (43/90) of male students physically inactive and 84% (463/552) of female students physically inactive on a daily basis [42]. This study revealed that students who focused on health sciences and on taking classes in health were not necessarily following a healthy lifestyle. Health sciences is a broad topic, and there is a vast array of courses that could be included in the curricula. Research demonstrates that a student's interest in the topic of health does not mean that he or she adheres to a healthy lifestyle. The integration of nutrition education within the second year of medical school in the cardiovascular module was associated with improved heart-healthy eating habits [43].

A semester-long college course in lifestyle medicine could address many of the unhealthy habits that college students tend to adopt and sustain during college. Lifestyle medicine is the science and application of healthy lifestyles as interventions for the prevention and treatment of diseases such as heart disease, diabetes, stroke, obesity, dementia, and cancer, all of which are affected by lifestyle choices. It is the evidence-based specialty bridging the research and science of physical activity, nutrition,

stress management and resilience, smoking cessation, sleep hygiene, social support, and other healthy habits to individuals through clinical practice in health care [44]. Lifestyle interventions include exercise prescriptions, nutrition prescriptions, stress management and resilience training, smoking cessation programs, sleep evaluations and recommendations, identifying and encouraging social connections, harnessing individuals' strengths, and using positive emotions such as gratitude and laughter as medicine to empower individuals to reach their optimal state of health and well-being [45]. By providing a greater depth of knowledge concerning basic health information, guidelines, and research findings as well as prolonged exposure to lifestyle medicine tenets and by creating opportunities to practice healthy lifestyles throughout the semester, a lifestyle medicine class for undergraduates can empower students with the knowledge, skills, tools, and experiences necessary to adopt and sustain healthy habits for a lifetime.

With the American College of Lifestyle Medicine and the American College of Preventive Medicine working to create curricula for medical students, students in the health professions, and practicing physicians coupled with the newly formed American Board of Lifestyle Medicine creating a national board examination for certification in lifestyle medicine, lifestyle medicine is becoming mainstream for the treatment and prevention of chronic diseases such as diabetes, heart disease, obesity, stroke, and cancer. This paper aims to outline a curriculum for undergraduate- and graduate-level coursework that strives not only to impart an understanding of core lifestyle medicine concepts and skills as described in the existing literature but also to provide a place where students can reflect upon their own daily choices and work on their own behavior change project for a semester.

Methods

Course Goals

The overarching goal of the Introduction to Lifestyle Medicine Course was to demonstrate how lifestyle medicine principles and interventions apply to individual health behaviors, examining both short- and long-term health outcomes. Educational interventions on nutrition and exercise have been shown to improve student self-efficacy relating to various lifestyle-related preventive behaviors [46]. The Introduction to Lifestyle Medicine Course uses evidence-based principles that aim to increase student confidence, which enables students to co-create goals for themselves while progressing toward the adoption of healthy habits and completing their required behavior change project. By utilizing the coach approach, students are able to collaborate, negotiate, and partner with individuals to identify obstacles to change, strategies around the obstacles, character strengths, motivators, social supports, and methods of accountability that will enable lasting change. There is an emphasis on the student as both learner and teacher. All members of the course are acknowledged for their own life experience, and students share their wisdom during Web-based class discussions and discussion posts.

Introduction to Lifestyle Medicine Course students gain a solid understanding of the main components of lifestyle medicine. The history of the development of lifestyle medicine is the first focus of the course and provides the groundwork on which the rest of the material is built. Understanding cultural trends and national guidelines in lifestyle behaviors, such as exercise, diet, and stress management, encourages the students to consider the social ecological model of change, with a focus on how one's environment helps to shape one's behavior. The course brings the science from the medical literature and practical strategies from clinical experience to the students aspiring to instill healthful lifestyle behaviors in themselves, their family and friends, as well as future patients and clients. By the end of the 13-week course, the students have a solid understanding of the importance of practicing healthy habits.

Course Topics and Rationale for Inclusion

Physical Activity, Nutrition, and Addiction

The topics of exercise, nutrition, and addictions come from the data revealing that Americans do not reach the recommended levels of exercise [4], do not eat the recommended quantities of fruits and vegetables [47], and suffer from addictions to nicotine, alcohol, and drugs. In the *New England Journal of Medicine* paper by Mokdad and colleagues (entitled Actual Causes of Death in the United States), the bar graph included reveals that tobacco use, physical inactivity, poor diet, and drug use comprise the top actual causes of death [48]. In addition, research has demonstrated that the majority of cancers can be prevented by lifestyle-related factors, which include refraining from smoking and alcohol use, having a healthy BMI, and engaging in adequate physical activity [49]. These are the most common lifestyle behaviors researched in the medical literature, and they are all significant contributors to morbidity and mortality rates.

Sleep

The connection of sleep to memory and learning, the connection of poor sleep secondary to obstructive sleep apnea to stroke, the connection of inadequate sleep to obesity, and the statistics on sleep deprivation and motor vehicle accidents (from driving while drowsy) have led to the inclusion of sleep as a major topic in the curriculum [50,51].

Stress

Health care expenditures are consistently higher among individuals with psychological stress [52], and stress is associated with depression, cardiovascular disease, and human immunodeficiency virus and acquired immunodeficiency syndrome [53]. Tackling the topic of stress is essential to a college course on lifestyle medicine. Positivity, gratitude, and laughter are ways to manage stress and increase creativity. Therefore, these topics are included to shine a light on them and also to provide some enjoyment for the students as they learn about laughter yoga, flow, and resiliency. A strengths-based approach to life is a relatively new concept [54] but is one that is proving to be empowering. Stress management techniques, their evidence base, and their practical implementation are emphasized in the course.

Lifestyle Coaching and Counseling

Learning how to counsel people about lifestyle modification is the primary mode of delivery for lifestyle medicine. Motivational interviewing, appreciative inquiry, and other health coaching techniques are useful counseling methods in the clinical environment. Their use has been described in the medical literature as tools for patients to guide them to create and sustain behavioral change [55-57]. These concepts illustrate to college students that behavior change is not simply about "willpower" and "deciding to do it"—beliefs that all too often result in stigma toward self and others who need to change their behavior [58].

Alignment With Core Competencies

For lifestyle medicine, the core competencies for primary care physicians were recommendations by a blue ribbon panel, which comprised physicians from the American Medical Association, the American Osteopathic Association, the American Academy of Family Physicians, the American College of Physicians, the American Academy of Pediatrics, the American College of Preventive Medicine, and the American College of Lifestyle Medicine. They are outlined in Textbox 1 and were originally delineated in the *Journal of the American Medical Association* [59]. The Introduction to Lifestyle Medicine Course addresses all of the 15 core competencies except for application of office systems and technologies to support lifestyle medicine in the office setting. This competency was not relevant for students who were not currently practicing medicine and was not included in the course curriculum. A practicing lifestyle medicine physician should possess the following: knowledge, skills, attributes, and values.

The Web-based weekly class sections invite the students to apply the material discussed in class to themselves and their own lives (See Table 1). These periods of reflection allow the students to consider how they might make healthy changes while in college.

This Web-based, distance learning college lifestyle medicine course also includes a behavior change project because knowledge is powerful, but it is not powerful enough to instill lasting change. Thus, as part of the required work, the students examine and work on their own habits. Students are encouraged to focus on a behavior or healthy habit that they are seeking to adopt for themselves. They are asked to log their current activity and situation with that particular behavior, noting triggers, rewards, and emotions around it. Then, they are asked to create a behavior change plan with SMART (specific, measurable, achievable, results-focused and time-bound) goals and to establish a tracking and accountability methodology that works for them. At the end of the semester, the students write a brief (3-5 pages) report on their experience of trying to change a behavior. Review of these reports reveals that some students in the class quit smoking, lost weight, added exercise into their routines, sat for shorter periods of time, increased their ability to handle stress, added fruits and vegetables to their diets, and cut down on their alcohol intake.

Results

The Harvard Extension School has been offering a course in lifestyle medicine since 2014. The course was offered as a hybrid course in 2014 and 2015, meaning that students could either take the entire course from a distance or they could choose to attend lectures live. In 2016, the course was completely Web-based. In total, 75 students from across the United States and around the globe took the course during the first year; 2 years later, in 2016, there were 111 students enrolled in the course, which marked it as one of the most popular classes at the school that semester. The majority of the students were undergraduates, with the second largest cohort being masters graduate students, mostly in psychology. Practicing physicians, retired lawyers, engineers, investment bankers, rabbis, musicians, therapists, and nurses have completed the course. At its inception, the course was offered as a psychology course with psychology credits, but in the year 2016, it was also approved for biology credit, which encouraged more premedical students to enroll in the course. The course was well received, gaining one of the highest rankings at the school with a 4.9 out of 5 (5 being the highest possible rating) in all 3 years.

Discussion

There is a health care crisis in the United States and worldwide, with epidemics of obesity and diabetes. The new medical field of lifestyle medicine has the potential to help millions of adults to reverse common chronic conditions such as heart disease, high blood pressure, diabetes, obesity, back pain, and inflammatory arthritis and to help millions of children and adolescents to prevent the development of these chronic conditions. With a board certification process in place for 2017 and physicians lining up for training in this field, lifestyle medicine is sure to play an important role in the future of health care.

Of course, the pursuit of healthy lifestyles involves both individual choices and social/institutional pressures, which include, for example, easier access to vending machine snacks rather than produce and social support (or lack thereof) [2]. Although our curriculum focuses on individual progress and change, the knowledge gained may help empower students, patients, and consumers to push for institutional changes that can facilitate healthier lifestyle choices. As such, the education system can play an important role in solving our medical and health care crises. Teaching college students about healthy lifestyles can help inform them about the rationale behind national guidelines. Although readings and lectures can teach students about lifestyle medicine, the opportunity to practice healthful behaviors and to work on changing unhealthy behaviors truly allows students to appreciate the process, challenge, and rewards of change.

The Harvard Extension School's Web-based, distance learning course, Introduction to Lifestyle Medicine, provides a novel, evidence-based curriculum that teaches basic lifestyle medicine knowledge, skills, and tools to undergraduates at an established university that is available worldwide. A variety of lifestyle medicine guidelines are conveyed to undergraduates in a

Web-based class format and have been received favorably, which is evident by the official student evaluations and their rankings submitted to the school administrators. Textbox 1 demonstrates the core competencies for lifestyle medicine. As seen in Table 1, the college curriculum meets many of the core competencies for prescribing lifestyle medicine.

Over the past 3 years, the Lifestyle Medicine course has been completed during a semester block. The strength of the course lies in the breadth of its curriculum. Central to the success of the curriculum is the behavior change strategy using the coach approach, defined as communicating with the patient in a nonjudgmental way that evokes the wisdom within patients, respects their autonomy, builds their self-efficacy, honors them as the expert in their own lives, and provides realistic strategies to help them adopt and sustain healthy habits for a lifetime. Students in the course come away with tools for behavior change that can be applied within the context of their daily lives.

The medical literature demonstrates that providers who practice behavior change are more likely to be successful when delivering the advice to their patients [60,61]. Thus, if students who complete the course go on to become certified lifestyle medicine practitioners, they will have already experienced what it takes to change a behavior and will be able to relate to patients. If the students do not plan to be lifestyle medicine practitioners, they will have the tools to help loved ones who desire to make a change in their daily habits. Moreover, the students themselves will fully understand the change process and the power of healthy living. Providing this course to students of all ages, located all over the globe, fosters connections across generations and across oceans and continents. A research study examining the health behaviors of students completing this Lifestyle Medicine course will help to determine whether the course will empower students to adopt behavior changes years after the course is over.

Textbox 1. Lifestyle Medicine Competencies for primary care professionals.

1. Leadership (2 competencies)

- Promote healthy lifestyle behaviors (emphasized in week 1 and addressed in all other weeks).
- Practice healthy lifestyle behaviors (emphasized in week 1 and in the behavior change project due at the end of class).

2. Knowledge (2 competencies)

- Demonstrate knowledge that lifestyle can positively affect health outcomes (emphasized in all weeks, stressing specific behaviors during correlating weeks, such as exercise in week 4).
- Describe ways in which physicians can effect health behavior change (emphasized in all weeks, stressing specific behaviors during correlating weeks, such as nutrition in week 5).

3. Assessment skills (3 competencies)

- Assess social, psychological, and biologic predispositions (emphasized in all weeks).
- Assess readiness to change (emphasized in weeks 2 and 3 with behavior change, goals, and accountability and then addressed in each week thereafter. Case studies reinforce these principles).
- Perform lifestyle medicine focused history of present illness, physical exam and relevant anthropometric and laboratory testing (emphasized in week 1 and in each week thereafter).

4. Management skills (4 competencies)

- Use nationally recognized practice guidelines (completed for each week, such as exercise guidelines in week 4 and nutrition guidelines in week 5).
- Establish effective relationships with patients (emphasized in weeks 2 and 3 with behavior change, goals, and accountability and addressed in each week thereafter. Case studies reinforce these lessons).
- Collaborate with patients and their families to develop specific action plans such as lifestyle medicine prescriptions (emphasized in weeks 2 and 3 with behavior change, goals, and accountability and addressed in each week thereafter).
- Help patients manage and sustain healthy lifestyle practices, including referrals as necessary (emphasized in week 1 with team approach to lifestyle medicine and discussed in weeks thereafter).

5. Office and community support (4 competencies)

- Have the ability to practice in interdisciplinary and community teams (emphasized in week 1 and discussed in weeks thereafter).
- Apply office systems and technologies to support of lifestyle medicine (mentioned but not emphasized as office systems vary, and this competency is the one that is the least applicable to the college population).
- Measure processes and outcomes (emphasized in week 1, and research on outcomes is addressed in each week's material).
- 4. Use appropriate community referral resources to support implementation of healthy lifestyle (emphasized in week 1 and discussed throughout the course).

Table 1. Lifestyle Medicine Core Competencies met by the Lifestyle Medicine College Course syllabus.

Course Topic	Section Guiding Question and Topic Description	Competencies met by Course Topic
Week 1: Introduction and overview of lifestyle medicine	*Where am I now with healthy habits?* Discuss where students typically gain knowledge about healthy lifestyles and what are the preferred methods for gathering this important information. Have students reflect on their existing habits based on in-class assessment.	A1, A2, B1, B2, C1, C3, D4, E1, E3, and E4
Week 2: How to evoke behavior change for self and those you care for personally and professionally	*What motivates me and how do I respond when people try to help me?* Discussion centers around the coach approach. Have students compare and contrast their own experiences with health professionals using the expert and coach approaches.	A1, B1, B2, C1, C2, C3, D1, D2, D3, D4, EI, E3, and E4
Week 3: Goal setting, accountability, and tracking for lifestyle medicine	*What is a lifestyle goal that I want to work toward during this semester?* This section introduces the Health Behavior Change Project. Have students begin to consider how they will stay accountable and track progress.	A1, B1, B2, C1, C2, C3, D2, D3, D4, E1, E3, and E4
Week 4: Physical activity guidelines and prescription	*What is your level of physical activity?* Discussion centers on the development of an exercise prescription for ourselves and counseling others.	A1, B1, B2, C1, C2, C3, D1, D2, D3, D4, E1, E3, and E4
Week 5: Nutrition guidelines and prescription	*How can I eat a healthy diet while being a student this semester?* Introduces food tracking and food diaries. Discuss the Harvard Healthy Plate and compare/contrast with the recommendations of the US Department of Agriculture. Discuss cultural eating habits and other topics related to eating patterns (mindful eating, eating frequency, breakfast intake, etc).	A1, B1, B2, C1, C2, C3, D1, D2, D3, D4, E1, E3, and E4
Week 6: Sleep and its effect on health and well-being	*What is my sleep routine and how does it impact my body?* Discuss existing sleeping patterns in comparison with recommendations. Examine things that have an influence on sleep (emotions, nutrition, etc).	A1, B1, B2, C1, C2, C3, D1, D2, D3, D4, E1, E3, and E4
Week 7: Stress resilience	Sections: Guiding question— *How do I handle stress and what evidence-based techniques can I try to help me be more resilient?* Discussion of stress, eustress, the state of flow, and methods to combat stress reactions.	A1, B1, B2, C1, C2, C3, D1, D2, D3, D4, E1, E3, and E4
Week 8: Relaxation, mindfulness, and meditation	*How do I relax? What evidence-based techniques might I try in the future?* Review and introduce various relaxation techniques. Discuss techniques being used by students.	A1, B1, B2, C1, C2, C3, D1, D2, D3, D4, E1, E3, and E4
Week 9: The connection prescription	*What relationships do I cherish and why? How can I maintain social connections throughout my life?* Discuss benefits of connection and methods that can be used to increase and improve the level of connection.	A1, B1, B2, C1, C2, C3, D2, D3, D4, E1, E3, and E4
Week 10: Positive emotions: laughter, optimism, and gratitude	*What resonated most with you on the topic of positive emotions?* Practice expressing positive emotions in a group setting and create a plausible plan for fitting this into your daily routine.	A1, B1, B2, C1, C2, C3, D2, D3, D4, E1, E3, and E4
Week 11: Smoking, alcohol, and addiction	*How do you know when you are addicted?* Discuss how to help a person who smokes, drinks too much, or is addicted to drugs. Examine the controversial topic of "food addiction."	A1, B1, B2, C1, C2, C3, D1, D2, D3, D4, E1, E3, and E4
Week 12: Self-care	*What do you do for self-care at the moment and what do you plan to do differently going forward?* Discuss the prioritization of self-care and methods to use. Use self-care assessment.	A1, B1, B2, C1, C2, C3, D2, D3, D4, E1, E3, and E4
Week 13: Education reform around lifestyle medicine and existing state of practice for lifestyle medicine	*If you could make a policy change that would encourage healthy lifestyle habits, what would it be and why?* Discuss and answer questions about the existing state of lifestyle medicine education and practice. Examine practical steps students can take locally.	A1, B1, B2, C1, C2, C3, D2, D3, D4, E1, E3, and E4

Conflicts of Interest

None declared.

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Abbreviations

BMI: body mass index
SMART: specific, measurable, achievable, results-focused and time-bound

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Original Paper

Comparison of the Impact of Wikipedia, UpToDate, and a Digital Textbook on Short-Term Knowledge Acquisition Among Medical Students: Randomized Controlled Trial of Three Web-Based Resources

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Abstract

Background: Web-based resources are commonly used by medical students to supplement curricular material. Three commonly used resources are UpToDate (Wolters Kluwer Inc), digital textbooks, and Wikipedia; there are concerns, however, regarding Wikipedia's reliability and accuracy.

Objective: The aim of this study was to evaluate the impact of Wikipedia use on medical students' short-term knowledge acquisition compared with UpToDate and a digital textbook.

Methods: This was a prospective, nonblinded, three-arm randomized trial. The study was conducted from April 2014 to December 2016. Preclerkship medical students were recruited from four Canadian medical schools. Convenience sampling was used to recruit participants through word of mouth, social media, and email. Participants must have been enrolled in their first or second year of medical school at a Canadian medical school. After recruitment, participants were randomized to one of the three Web-based resources: Wikipedia, UpToDate, or a digital textbook. During testing, participants first completed a multiple-choice questionnaire (MCQ) of 25 questions emulating a Canadian medical licensing examination. During the MCQ, participants took notes on topics to research. Then, participants researched topics and took written notes using their assigned resource. They completed the same MCQ again while referencing their notes. Participants also rated the importance and availability of five factors pertinent to Web-based resources. The primary outcome measure was knowledge acquisition as measured by posttest scores. The secondary outcome measures were participants' perceptions of importance and availability of each resource factor.

Results: A total of 116 medical students were recruited. Analysis of variance of the MCQ scores demonstrated a significant interaction between time and group effects (P<.001, η_g^2=0.03), with the Wikipedia group scoring higher on the MCQ posttest compared with the textbook group (P<.001, d=0.86). Access to hyperlinks, search functions, and open-source editing were rated significantly higher by the Wikipedia group compared with the textbook group (P<.001). Additionally, the Wikipedia group rated open access editing significantly higher than the UpToDate group; expert editing and references were rated significantly higher by the UpToDate group compared with the Wikipedia group (P<.001).

Conclusions: Medical students who used Wikipedia had superior short-term knowledge acquisition compared with those who used a digital textbook. Additionally, the Wikipedia group trended toward better posttest performance compared with the UpToDate group, though this difference was not significant. There were no significant differences between the UpToDate group and the digital textbook group. This study challenges the view that Wikipedia should be discouraged among medical students, instead suggesting a potential role in medical education.

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KEYWORDS

medical education; medical students

Introduction

Health care professionals and trainees are challenged to keep pace with a rapidly growing knowledge base. By 2020, the estimated doubling time of medical knowledge will be 73 days [1]. Ubiquitous Internet accessibility has both mediated this rapid dissemination of research and allowed for increased access to information [2]. In particular, many medical trainees use Web-based resources to answer clinical questions and acquire medical knowledge [3-5]. Despite widespread use, there is a paucity of research on the impact of these resources on knowledge acquisition in medical education.

Among medical students, three commonly used Web-based resources are digital textbooks; UpToDate, a point-of-care online medical software; and Wikipedia, a freely editable encyclopedia. Previous studies have reported that a majority of medical students use UpToDate for clinical activities such as patient admissions and teaching rounds [6,7]. Textbooks, meanwhile, are more commonly used for preparation of tutorials and tests, as well as for in-depth reading [7,8]. Finally, up to 94% of medical students and 70% of junior physicians have reported using Wikipedia to supplement curricular learning and clinical practice, respectively [9,10].

Although commonly used, trainees are actively discouraged from using Wikipedia as an information source [11]. Critics argue that it is error-prone because of a lack of traditional editorial controls [12]. Moreover, studies of Wikipedia entries in cardiovascular sciences, gastroenterology, and pharmacology have found inaccuracies because of errors and omissions [11,13-15]. This skepticism, however, may be exaggerated [16-18]. A 2005 *Nature* investigation found similar error rates when comparing Wikipedia articles with their counterparts in the Encyclopedia Britannica, a trusted, expert-reviewed resource [19]. In addition, articles in gastroenterology and nephrology were shown to have moderate to fair reliability for patients [16,17]. Whereas previous reports have looked largely at the quality of Wikipedia content, there is no reported data on the direct impact of Wikipedia on knowledge acquisition.

The aim of this study was to evaluate the impact of Wikipedia on short-term knowledge acquisition among medical students compared with UpToDate and a digital textbook.

Methods

This parallel-arm, randomized controlled trial (RCT) was conducted from April 2014 to December 2016. Approval was granted by the University of Toronto Research Ethics Board (Protocol Reference # 30420). Written consent was obtained online from all participants. All authors reviewed and approved the final manuscript. No changes to methodology after trial commencement were made. This trial was not registered as it does not meet the International Committee of Medical Journal Editors' criteria for the definition of a clinical trial. Specifically, the outcomes tested are not patient-related outcomes.

Participants

Preclerkship medical students were recruited from four Canadian medical schools over 2 years from April 2014 to December 2016. Convenience sampling was used with informal recruitment through word of mouth, social media, and email by 2 authors (RK and DK). The primary inclusion criterion was that participants must be medical students in preclerkship training (ie, in their first or second year of medical school) at a Canadian medical school. After recruitment, participants were anonymized with a unique identifier and randomized in an allocation ratio of 1:1:1 to one of the three groups: (1) Wikipedia, (2) UpToDate, and (3) digital textbook. The random allocation sequence was created by one author (MAS) using a Web-based random number generator. Another author (CW) assigned participants to each of the three groups using sequentially numbered assignments. Participants were blinded to group assignment until they were required to use their intervention. Once they began using their Web-based resource, blinding was not possible. Data analysts were blinded to group assignment. Participants were not told which Web-based resource was the intervention of interest.

Study Design

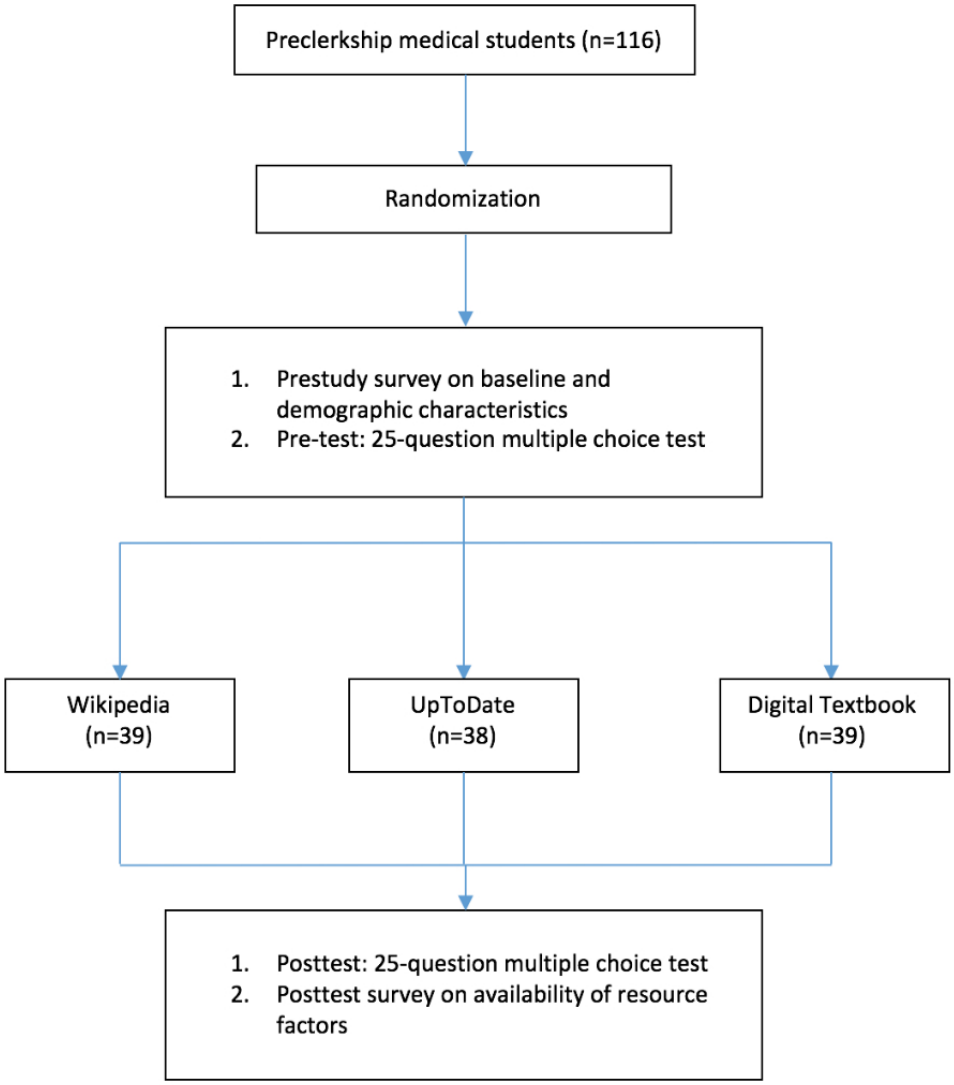
The study methodology is summarized in Figure 1**.** All participants completed a questionnaire of their demographics. Participants then had 30 min to complete a multiple-choice questionnaire (MCQ) pretest of 25 questions, wherein they could take written notes of questions they wanted to research further. After the pretest, participants had 30 min to research the questions using their assigned Web-based resources, during which they were allowed to create written notes. Finally, participants completed the same MCQ as a posttest, wherein they could use their written notes and general knowledge acquired from the intervention. They also completed a follow-up survey on the Web-based resources.

Data collection was done using two formats: in-person and online. Online administration was used to connect with remotely located participants and was conducted the same way as in-person collection. The two data collection methods differed only in degree of interactivity with the study coordinator. During

in-person data collection, a study coordinator was present throughout the entire administration, who assigned participants to individual computers and only interacted with participants for consent, initial test setup, and notification of time remaining on each section. During online collection, screen-sharing software was used to track participant completion of the tests and to indicate time remaining on each section. In both scenarios, participants completed surveys, tests, and intervention using a standard Web browser and Google Forms software.

Study coordinators only answered questions regarding logistics (eg, remaining time) and did not advise participants on test content or Web-based resource navigation. Coordinators also ensured that participants only used their assigned intervention through direct observation or screen-sharing.

Figure 1. Study design.



Pretest Assessment

Participants completed a MCQ of 25 questions that emulated questions on the Medical Council of Canada Evaluation Exam (MCCEE). The MCCEE is a standardized examination administered by the Medical Council of Canada (Ottawa, Canada) to assess basic medical knowledge and readiness for postgraduate medical training in Canada. The content of the MCCEE is aimed toward graduating Canadian medical students to ensure that participants (ie, preclerkship medical students) would not have considerable prior knowledge. Test questions were retrieved from an MCCEE site, which is freely available online [20]. These questions were imported into a Google Forms questionnaire and delivered online. Questions were reviewed by 2 academic physicians (SG and JH) to ensure broad coverage of topics and appropriateness.

Training Interventions

After recruitment, participants were randomized to one of three Web-based resources: (1) Wikipedia, (2) UpToDate, and (3) digital textbook. During the testing, participants each had 30 min to access the Web-based resource and could make notes using pencil and paper on any topics or questions on the test to research using the assigned intervention. Wikipedia and UpToDate were accessed using an Internet browser, with the participants logging into the latter using institutional accounts. The digital textbook, *Harrison's Principles of Internal Medicine, 18th edition*, was accessed through institutional accounts.

Participants were limited to only their assigned interventions and were not allowed to search for additional information online. Moreover, participants were not provided with guidelines or strategies on how to access information. Coordinators tracked participant progress to ensure adherence with the assigned interventions. Within the allotted time, participants used a self-directed approach to research topics relevant to the MCQ.

Posttest Assessment

To test for knowledge acquisition, participants completed the same MCQ administered at the beginning of the study. During this iteration, participants could refer to their written notes as a reference. After completing the test, participants answered a follow-up survey regarding five electronic resource factors: search functions, hyperlinks to other pages within the resource, references, open access editing, and expert editing. In the first section of the survey, participants rated the importance of each of the five factors in their learning. In the second section, participants then rated the availability of each of the factors within their assigned resource. For perceptions of importance, participants rated the five factors with respect to their general importance when using Web-based resources on a Likert-type scale of 1 to 5, where 1 represented *not important at all* and 5 represented *very important*. For perceptions of availability, participants rated the five factors with respect to only their assigned resource (Wikipedia, UpToDate, and digital textbook) on a Likert-type scale of 1 to 5, where 1 represented *not at all available* and 5 represented *very easy to access.*

Outcome Measures

The primary outcome of the study was the difference in knowledge acquisition between the three groups as indicated by percentage scores on the MCQ. The tests were graded using a scoring key on a scale of 0 to 25. Each correct answer was awarded one point; incorrect answers or omissions were not penalized. Secondary outcome measures were the participants' perceptions on availability of the five following factors: search functions, hyperlinks to other pages, references, open access editing, and expert editing.

Sample Size

On the basis of previous research on knowledge acquisition using Web-based resources among medical trainees, 28 participants per group have been sufficient to detect significant differences between four groups [21]. To account for potential dropout, 116 participants were recruited.

Statistical Analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 20 (IBM Corp). Demographic variables were represented using descriptive statistics. All quantitative data were represented using means with standard deviations or medians with interquartile range, where appropriate. Categorical data were represented by count with frequency.

Primary analysis was intention-to-treat. To determine a difference in the MCQ scores across the three groups, a two-way mixed-factorial analysis of variance (ANOVA) was completed with one within-group factor (test: pretest and posttest) and one between-group factor (group: Wikipedia, UpToDate, and digital textbook). To determine whether there were any differences in participants' perceptions of the importance and availability of the five resource factors for the resources (Wikipedia, UpToDate, and digital textbook), a Kruskal-Wallis test was used. Any significant effects on ANOVA or Kruskal-Wallis tests were further analyzed using Tukey honestly significant difference (HSD) and Mann Whitney *U* post hoc tests, respectively. Additionally, an exploratory analysis was conducted; two-way ANOVA was performed for posttest MCQ scores using highest level of education before medical school (group: masters, PhD, other professional degree) and assigned resource (group: Wikipedia, UpToDate, and digital textbook). The assumptions for the mixed ANOVA and two-way ANOVA were assessed and the appropriate corrections were applied for any violations [22]. Following statistical reporting recommendations, effect size was calculated using generalized eta squared (η_g^2) and Cohen measure (*d*) for ANOVA and Tukey HSD post hoc tests, respectively [23]. Alpha was set at .05 for all statistical tests.

Results

Demographics and Baseline Characteristics

A total of 116 preclerkship medical students were randomized and completed the study from April 2014 to December 2016. No participants were lost to follow-up. Participant demographics, prior resource use, and data collection format are provided in Table 1. Participants' perceptions of the importance of several resource factors with respect to general Web-based resources are shown in Table 2. There were no significant differences between the groups on any of the five factors ($P>.05$).

Primary Outcome

MCQ responses for each group are shown in Figure 2. There were no significant differences between the three groups at pretest (Table 3). The ANOVA of the MCQ scores indicated a significant interaction between time and group effects ($F_{2,113}=10.07$, $P<.001$, $\eta_g^2=0.03$). Post hoc analysis indicated that the Wikipedia group scored significantly higher on the posttest compared with the textbook ($P=.01$, $d=0.86$). There were no other significant post hoc pairwise comparisons between the other two groups. On the two-way ANOVA, there was no significant interaction between group assignment and highest education before medical school for posttest MCQ scores ($F_{4,106}=171.85$, $P=.51$).

Secondary Outcomes

Participants' perceptions of the availability of resource factors within their assigned resource are shown in Table 4. There were significant differences between the groups on all the five factors ($P<.001$).

Table 1. Baseline demographic characteristics, prior resource use, and data collection format of participants.

Characteristic	Textbook group, (N=39)	UpToDate group, (N=38)	Wikipedia group, (N=39)
Sex, female, n (%)	16 (41)	16 (42)	8 (21)
Age (years), median (interquartile range)	23 (3)	23 (3)	23 (2)
Highest level of training before medical school, n (%)			
Bachelor's degree	31 (80)	31 (82)	27 (69)
Master's degree	7 (18)	5 (13)	11 (28)
PhD	1 (3)	1 (3)	1 (3)
Other professional degree	0 (0)	1 (3)	0 (0)
Used before study as learning resource, yes, n (%)			
Wikipedia	35 (90)	32 (84)	35 (90)
UpToDate	29 (74)	28 (74)	29 (74)
Digital textbooks	32 (82)	34 (90)	35 (90)
Data collection format, n (%)			
In-person	26 (67)	24 (63)	24 (62)
Online	13 (33)	14 (37)	15 (39)

Table 2. Participants' perceptions of the importance of resource factors with respect to general Web-based resources in a poststudy survey. Values are median ratings with interquartile range in parentheses, where 1 is *not important at all* and 5 is *most important*.

Resource factor	Wikipedia group, median (IQR[a])	UpToDate group, median (IQR)	Textbook group, median (IQR)	*P* value
Search function	5.0 (1.0)	5.0 (0)	5.0 (0)	.06
Hyperlinks	4.0 (2.0)	4.0 (2.0)	4.0 (2.0)	.42
References	4.0 (1.0)	3.0 (2.0)	4.0 (2.0)	.44
Open access editing	2.0 (2.0)	2.0 (2.0)	2.0 (2.0)	.18
Expert editing	4.0 (1.0)	4.0 (1.0)	4.0 (1.0)	.82

[a]IQR: interquartile range.

Table 3. Multiple-choice questionnaire results for all three groups.

MCQ[a]score	Wikipedia group, mean % (SD)	UpToDate group, mean % (SD)	Textbook group, mean % (SD)	*P* value		
				Wikipedia-UpTo-Date	Wikipedia-text-book	UpToDate-text-book
Pretest	44.10 (11.70)	45.46 (15.43)	43.90 (12.26)	.65	.95	.60
Posttest	61.03 (15.29)	55.26 (15.31)	49.23 (11.94)	.08	<.001[b]	.07

[a]MCQ: multiple-choice questionnaire.

[b]Indicates statistically significant findings among pairwise comparisons (*P*<.05).

Figure 2. Bar graph of the mean percentage multiple-choice questionnaire (MCQ) test scores for the Wikipedia, UpToDate, and textbook groups at pretest and posttest. The bars indicate the standard deviation of the scores. Asterisks (*) indicate post hoc comparisons of $P<.05$.

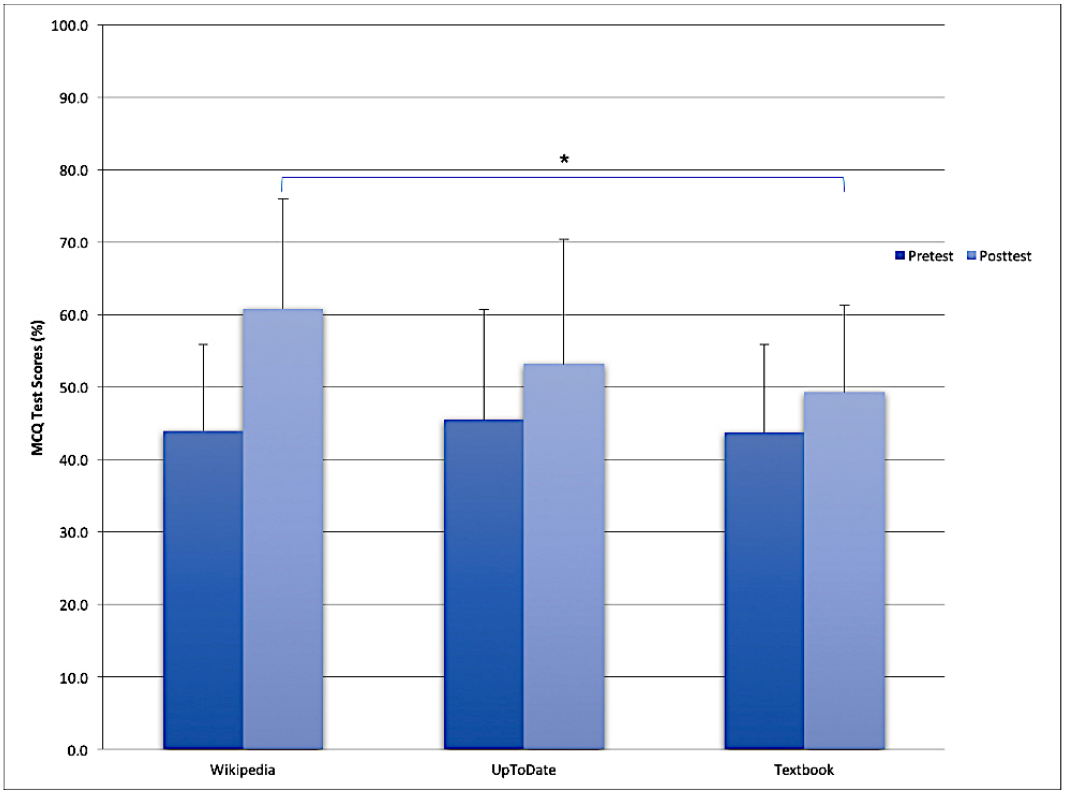


Table 4. Participants' perceptions of five resource factors with respect to their assigned resource (Wikipedia, UpToDate, and textbook) in a poststudy survey. Values are median ratings with interquartile range in parentheses, where 1 is *not at all available* and 5 is *very easy to access*.

Resource factor	Wikipedia group, median (IQR[a])	UpToDate group, median (IQR)	Textbook group, median (IQR)	*P* value		
				Wikipedia-UpToDate	Wikipedia-textbook	UpToDate-textbook
Search function	5.0 (1.0)	4.0 (2.0)	3.0 (2.0)	.25	<.001	<.001
Hyperlinks	4.0 (1.0)	4.0 (2.0)	2.0 (2.0)	>.99	<.001	<.001
References	4.0 (1.0)	5.0 (1.0)	4.0 (1.0)	<.001	>.99	<.001
Open access editing	4.0 (2.0)	1.0 (2.0)	1.0 (0)	<.001	<.001	.63
Expert editing	3.0 (2.0)	4.5 (2.0)	4.0 (2.0)	<.001	<.001	.69

[a]IQR: interquartile range.

Discussion

This study demonstrates that Wikipedia can be effectively used as a resource for short-term knowledge acquisition by medical students. Specifically, the Wikipedia group had significantly better posttest performance on an MCQ examination based on the MCCEE compared with the digital textbook group. Additionally, the Wikipedia group trended toward better posttest performance compared with the UpToDate group. Finally, the UpToDate group trended toward better posttest performance compared with the digital textbook group. These latter two comparisons, however, were not significant. This is the first trial directly evaluating the impact of Wikipedia on medical knowledge acquisition beginning to address a gap identified in a recent Cochrane Review [24].

These results may be explained by differences between the three resources with respect to the availability of certain resource functions and familiarity. First, Wikipedia's search functions and hyperlinks were rated significantly higher than the digital textbook (these factors were not significantly different between Wikipedia and UpToDate), suggesting that participants were able to find information more easily. In addition, more participants reported using Wikipedia as a learning resource at baseline compared with UpToDate and digital textbook. Increased familiarity with Wikipedia is supported by literature, underscoring the high prevalence of its use among medical students [3,9].

Ease of navigation, afforded by better search functions and hyperlinks and familiarity, may have placed a lower cognitive load on students using Wikipedia compared with a digital textbook. According to cognitive load theory, there are limitations or loads on the amount of novel information that the

brain can process [25]. We hypothesize that a lower cognitive load allowed students to more efficiently access and acquire knowledge. Our interpretation is commensurate with previous work exploring mental exertion in medical students. Using eye metrics such as task-evoked pupillary response and eye fixation, one group found that UpToDate was associated with higher levels of mental exertion compared with Wikipedia [26].

These findings suggest a potential role for Wikipedia in medical education. However, Wikipedia use is currently discouraged in the academic community because of concerns regarding its accuracy and reliability [11,12,15]. Additionally, participants in our study held negative attitudes toward Wikipedia, as they perceived it as having fewer references and less expert editing compared with UpToDate and a digital textbook.

Whereas some criticism is warranted, there is strong evidence supporting the use of Wikipedia in health care. A recent systematic review of Wikipedia found more studies reporting positive than negative evaluations of article quality [27]. Wikipedia has also been endorsed in patient and nursing education because of the reliability and accuracy of its health-related articles [17,18,28]. Furthermore, the claim that Wikipedia lacks sufficient editorial controls is tenuous, as it has its own editorial mechanisms. WikiProject Medicine, a user group founded in 2004, is a distributed expert review board dedicated to coordinating medical content on Wikipedia. They also publish a style manual with recommendations on how to write health-related articles and grade articles per quality measures [29]. Finally, Wikipedia offers an advantage that subscription-based resources cannot—free access. This feature makes it available to medical students who may not have subscriptions.

There are several strengths of this study. First, there was excellent integrity of study participation and data, as there was no participant dropout and no missing data. Second, the generalizability of the findings benefit from the inclusion of students from multiple medical schools. Finally, this is the first known study that investigated the impact of Wikipedia as an electronic resource using an RCT design.

Our findings must be framed within the context of the study limitations. First, participants who did not finish the pretest within 30 min would not have known which topics to search to answer missed questions. Second, posttest scores may have been inflated, as the participants who correctly answered select questions in the pretest would have had more time to answer the remaining questions. These two limitations, however, would have been uniform across the three groups, thereby, likely not having contributed to observed differences between the groups. Third, participants may only have enrolled in the study if they had experience in using electronic resources, which could have introduced selection bias. Although this bias could impair the generalizability of the findings, its impact is likely minimal, as there is evidence that up to 94% of medical students use Wikipedia [9] **.** In addition, the nonblinded nature of our study may have impacted study results. It is, however, not possible to conduct a truly blinded randomized trial for many educational interventions. Fourth, Wikipedia and UpToDate are dynamic resources that are edited as medical knowledge evolves. The replicability of this study may be compromised with time as the health-related entries on these dynamic resources change. Finally, our study was potentially underpowered as the Wikipedia group trended toward but did not have significantly better knowledge acquisition compared with the UpToDate group. As this is the first study of its kind, it is possible that our sample size calculation was inaccurate because of a dearth of appropriate comparative literature.

Although this study and others suggest there is educational value in Wikipedia, few medical schools have seriously explored its potential as a knowledge acquisition resource. This stance may be shortsighted, as many trainees use this resource and will likely continue as practicing physicians [5,10]. Medical schools may benefit from considering the use of Wikipedia in their curricula, such as enlisting students to create and edit medically focused articles. A recent study found that medical students who edited Wikipedia for course credit not only improved the quality of the articles but also enjoyed the editing experience [30]. Social-constructivist learning models theorize that participation in content development allows learners to become better acquainted with knowledge as active agents of learning [31]. Using this theoretical approach, future research could explore how trainee involvement with the creation and development of content on Wikipedia relates to their learning and knowledge acquisition.

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Conflicts of Interest

Dr James Heilman is a long-term volunteer editor and administrator of Wikipedia. He was a founder of Wikimedia Canada and Wiki Project Med Foundation. He currently sits on the board of trustees of the Wikimedia Foundation and is a special advisor to Wiki Project Med Foundation. He has never received financial compensation for any of these roles.
Dr Jacob de Wolff is a long-term volunteer editor and administrator of Wikipedia. He is a board member of the Wiki Project Med Foundation. He has never received financial compensation for any of these roles.

Dr Samir C Grover is a Wikipedia editor and administrator. He has never received financial compensation for either of these roles.

Authors' Contributions

MAS, CW, MB, JFdW, JH, and SCG were involved in the study conception and design. RK, DK, and SB were involved in the acquisition of data. MAS, RK, and SCG drafted the manuscript. MAS, RK, CW, DK, CT, AK, SB, KV, MB, JFdW, JH, and SCG were involved in the critical revision of the manuscript for important intellectual content. MAS, RK, CW, and CT managed statistical analysis. SCG was responsible for administrative, technical, or material support, as well as study supervision. MAS, RK, CW, DK, CT, AK, SB, KV, MB, JFdW, JH, and SCG approved the final manuscript.

Multimedia Appendix 1

CONSORT - EHEALTH checklist (V.1.6.1).

[PDF File (Adobe PDF File), 745KB - mededu_v3i2e20_app1.pdf]

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Abbreviations

ANOVA: analysis of variance
HSD: honestly significant difference
IQR: interquartile range
MCQ: multiple-choice questionnaire
MCCEE: Medical Council of Canada Evaluation Exam
RCT: randomized controlled trial
SD: standard deviation

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Original Paper

The Perceptions of Medical School Students and Faculty Toward Obesity Medicine Education: Survey and Needs Analysis

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Abstract

Background: Recent trends in obesity show that over two-thirds of US adults are considered at least overweight (body mass index, BMI≥25 kg/m^2) and of those, about one-third are categorized as obese (BMI≥30 kg/m^2). Physicians can address the health impacts of obesity; yet research has suggested that physicians-in-training frequently fail to recognize obesity, are not properly educated regarding treatment options, and spend relatively little clinic time treating obesity. Medical school is a unique opportunity to address this area of need so that the doctors of tomorrow are prepared to treat obesity appropriately.

Objectives: The objective of this study was to determine perceptions of where clinical training for medical students on the topic of obesity and its treatment should improve and expand so that we could address the needs identified in a computerized clinical simulation.

Methods: We conducted a literature review, as well as a needs analysis with medical school students (N=17) and faculty (N=12). Literature review provided an overview of the current state of the field. Students provided input on their current needs, learning preferences, and opinions. Faculty provided feedback on current training and their perceptions of future needs.

Results: Most students were familiar with obesity medicine from various courses where obesity medicine was a subtopic, most frequently in Biochemistry or Nutrition, Endocrinology, and Wellness courses. Student knowledge about basic skills, such as measuring waist circumference, varied widely. About half of the students did not feel knowledgeable about recommending weight loss treatments. Most students did not feel prepared to provide interventions for patients in various categories of overweight/obesity, patients with psychosocial issues, obesity-related comorbidities, or failed weight loss attempts. However, most students did feel that it was their role as health professionals to provide these interventions. Faculty rated the following topics as most important to supplement the curriculum: patient-centered treatment of weight, bringing up the topic of weight, discussing weight and well-being, discussing the relationship between weight and comorbidities, and physician role with overweight or obese patients.

Conclusions: A review of the literature as well as surveyed medical students and faculty identified a need for supplementation of the current obesity medicine curriculum in medical schools. Specific needed topics and skills were identified.

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KEYWORDS

obesity; weight loss; medical students; medical education; curriculum

Introduction

Extent of the Public Health Problem

The consequences of obesity are broad and severe, and a majority of the population is affected. Two-thirds of US adults are considered at least overweight (body mass index, BMI≥25 kg/m^2), and further categorization of that group shows that around one-third of adults are categorized as obese (BMI≥30 kg/m^2) [1,2]. Obesity is the second leading cause of preventable death in the United States [3,4]. As the rate of obesity continues

to rise, so does the rate of obesity's common comorbidities. For example, according to the Centers for Disease Control and Prevention, the rate of diagnosed diabetes mellitus has more than doubled in the past 24 years, and an estimated 90% to 95% of individuals with diabetes have type 2 diabetes [5]. Patients who are obese are also at increased risk for many other chronic diseases, including hypertension, heart disease, and cancer, as well as physical disabilities [6]. Direct costs for obesity-related illnesses in the United States have reached US $147 billion/year, of which 40% can be attributed to the 8% of patients who are severely obese (BMI≥35 kg/m^2) [6,7].

The Gap in Between Ideal Obesity Medicine and Actual Practice

The appropriate practice of obesity medicine could turn this epidemic around. However, some evidence shows a gap between the ideal scenario and what is actually happening in practice. Providing weight management tailored for each patient, including making appropriate referrals for comprehensive care, can be effective in producing lasting weight loss [7]. Unfortunately, few physicians routinely provide screening or intervention for weight problems for their patients [7,8]. Research has suggested that physicians-in-training frequently fail to recognize obesity, are not properly educated regarding treatment options, and spend relatively little clinic time treating obesity [9]. Some students also hold negative attitudes toward people who are obese or feel uncomfortable discussing the topic, which could interfere with effective treatment. There is a gap between ideal obesity medicine and actual practice that needs to be addressed.

Current Obesity Medicine Training in Medical Schools

It is widely recognized that medical students need to be adequately prepared to practice obesity medicine effectively. The Association of American Medical College (AAMC) recognizes the universal importance of weight management, including the prevention of overweight and obesity, and its guiding principles recommend that this be emphasized in the medical school curriculum [10]. Furthermore, the AAMC has concluded that, in addition to the disease-centered approach often taken, medical students need "easily accessible tools to focus students' and trainees' attention on urgent social and behavioral dimensions of patients' complex problems, such as obesity" [11].

Despite these recommendations, research shows that obesity is often neglected in the medical school curriculum. Survey results indicate that the average American medical school spends only 19.6 of the required 25 contact hours on nutrition instruction, and only 27% of medical schools meet AAMC curriculum recommendations [7,12]. Despite known negative bias by some medical students toward obese patients [7,13-15], little is being done to change student attitudes [4]. In a meta-analysis of literature about educating medical students on obesity, Vitolins et al found only 5 publications between 1966 and 2010 describing and evaluating educational interventions [4]. It is therefore not surprising that a majority of physicians surveyed in 2 studies reported a lack of training and competence in weight management [7,8].

Medical students who are better prepared to approach the subject of obesity may improve patient care as physicians and impact patient health positively through more effective screening, diagnosis, and treatment of obesity. More effective treatments will also reduce the prevalence of obesity-related comorbid conditions such as cardiovascular disease and type 2 diabetes. Regrettably, obesity is not adequately covered in many medical schools [6,7,12]. Medical students, residents, and practicing physicians need more training about obesity and treatment options. The current medical curriculum on obesity medicine appears to have deficits that need to be clearly identified so that medical student training in this area can be improved.

To develop an understanding of the specific needs for training in obesity management skills that could be addressed via a simulation application, we conducted a needs analysis with medical school students and faculty.

Methods

A thorough literature review was conducted, which identified possible topics for the skills training activity and common barriers that we should strive to overcome. The medical student survey responses provided an understanding of the medical students' perceived needs and the skills they should be taught related to obesity medicine and treating patients with obesity. Faculty at different institutions gave their opinions related to medical student training in obesity medicine.

Literature Review Methods

Before the needs analysis, we conducted a thorough literature review of the following terms in combinations to form search criteria and searched via Google Scholar, UNC Library, and PubMed: medical school, obesity, obesity medicine, education, curriculum, training, weight, and nutrition. These Web-based searches were filtered to access original research and review studies with abstracts dating from 2011 to 2015. A total of 35 study abstracts were reviewed for relevance, and 11 studies were selected for further reading. We collated topics and skills that had been identified in these studies as needing improvement or additional training, as well as common barriers to successful skills training. Our needs analysis survey for medical school faculty was designed to inform us of the subtopics and skills related to obesity medicine that were most needed to supplement medical school curricula.

Medical Student and Faculty Survey Methods

To balance the literature review, we conducted a short survey of current medical students and another of medical school faculty members. For this study, a convenience sample was used. Recruitment emails were sent to medical students who had previously taken a health professional student course provided by Clinical Tools, Inc. Recruitment was targeted at 2nd, 3rd, and 4th year medical school students, 1st year residents, and medical interns. Participants came from 4 medical schools and included 11 female and 6 male students. Out of the 17 medical students, 9 (53%) were 2nd year students, 7 (41%) were 3rd year students, and 1 (6%) was in the 4th year of medical school training. All major medical specialties were indicated as possible areas of interest for the students.

Faculty participants were course or clerkship directors, professors, or coordinators in Internal Medicine, Family Medicine, or Medical Biochemistry departments. Faculty emails were obtained from Web-based searches of reputable medical schools in the areas mentioned above. For a group total of 12 faculty, 7 participants were female and 5 were male.

Both groups were emailed a link to a screening and eligibility form. After completing the Web-based eligibility form, only eligible users were directed to complete the needs analysis survey via the same link.

The survey questions were presented in several formats, including Likert-style items, multiple-choice questions, and open-ended questions. The survey took approximately 15 min to complete.

The medical student survey questions were broken down into the following categories:

1. Obesity medicine: Survey questions in this section assessed students' familiarity with obesity medicine in their medical school and what courses on obesity medicine were included.
2. Medical education on obesity: In this set of questions, students provided feedback about their current training in topics related to assessing and treating overweight and obesity. In addition, they rated their knowledge or preparation and how they perceived their roles in providing interventions for patients with overweight or obesity.
3. Further information and thoughts: Students were asked to provide additional feedback about what they viewed as the most challenging aspect of treating overweight and obese patients.

Faculty were asked specifically about the need for training on obesity, barriers to such training, and the specific skills that should be taught, such as interviewing, motivating patients, documenting weight, assessing for appropriateness of medication or surgical intervention, developing a weight management plan, and implementing that plan.

The survey questions were broken down into the following categories:

1. Obesity medicine and curriculum: Questions were designed to assess how obesity medicine was currently taught in medical school and to assess faculty confidence in student clinical skills as they related to assessing and treating patients with overweight or obesity.
2. Topics for supplemental educational outcomes: Questions rated the importance of topics for our curriculum. Questions were divided into (1) core concepts and patient data collection, (2) patient assessment, (3) treatment approaches, (4) treatment implementation, and (5) additional topics.
3. Supplemental resource use: Questions assessed how the planned educational simulation would be integrated into the medical school curriculum in terms of where within the curriculum it would be included, how it would be used, time spent, and its usefulness.

Results

Literature Review Results

Through the various studies, gaps were identified in our Web-based literature review, which indicated a need for the following:

- Primary care providers to improve efficacy in helping patients lose weight [16,17]
- A stronger physician background in the biologic and pathophysiological foundations of obesity [9,18]
- Navigating the complexity and heterogeneity of overweight and obesity [18]
- Overcoming attitudes and bias toward patients with obesity and positive attitudes toward the actual management of obesity [4,19]
- Recognition of modest weight reduction as substantial (for comorbidity prevention)
- Access to resources
- Effective role models in a clinical setting as well as engagement in training [6]
- Training regarding obesity counseling [20]

Student Survey Results

Student Survey: Obesity Medicine Courses

We asked students how obesity medicine was taught in their medical schools currently (Table 1), whether in its own course, within another course, or not at all. Of the respondents, 76% (13/17) were familiar with obesity medicine through a course where obesity medicine was a topic. Students reported obesity medicine being covered in multiple courses (Table 2), most frequently Biochemistry or Nutrition (94%; 16/17) and Endocrinology (82%; 14/17).

Table 1. Students' descriptions of their obesity medicine training (N=17).

Description	n (%)
I am familiar with obesity medicine through:	
A course where obesity medicine was a topic.	13 (76)
A specific course on obesity medicine.	2 (12)
I am not familiar with obesity medicine in my coursework yet.	2 (12)

Table 2. System or disease topics associated with obesity medicine (N=17).

System or disease topics	n (%)
Obesity medicine is included with these system or disease topics (choose as many as apply):	
Biochemistry or Nutrition	16 (94)
Endocrinology	14 (82)
Wellness	12 (70)
Cardiovascular	11 (65)
Clinical Foundations of Medicine	5 (29)

Student Survey: Current Training

Students were asked whether they had received training in particular topics related to assessing and treating overweight or obese patients. A majority agreed or strongly agreed that they had studied or received training to:

- Assess overweight or obese patients (65%; 11/17)
- Use behavioral counseling in clinical interviews (71%; 12/17)
- Recommend treatment for overweight or obesity (65%; 11/17)

Students agreed least often that they had studied or received training on "monitoring overweight or obesity treatment" (53%; 9/17).

Student Survey: Knowledge/Preparation

Students were asked to rate their knowledge about measuring and interpreting body mass assessments and treatments for overweight or obesity (Table 3). Students' knowledge varied with the topic. The topics where students most frequently rated their knowledge as good or excellent were "calculating BMI" (82%, 14/17) and "interpreting BMI" (71%, 12/17). The topics for which students most frequently rated their knowledge the lowest (very poor or poor) were "interpreting waist circumference" (35%, 6/17) and "measuring waist circumference" (35%, 6/17).

Student Survey: Self-Efficacy

Students were asked how prepared they felt for interventions with patients having various stages of obesity and obesity-related problems (Table 4). A majority of students felt they were not prepared or only somewhat prepared for providing weight-related interventions to all categories of patients surveyed. On a 4-point Likert-type scale, 88% (14/16) rated their preparation the lowest for providing interventions to overweight to stage III obesity (not prepared at all or somewhat prepared), and 69% (11/16) rated low preparation for providing interventions to patients with psychosocial issues (not prepared at all or somewhat prepared). A not applicable (N/A) option was available for students to choose if they were not aware of interventions at the various stages of obesity. N/A results were not included in the question totals as noted in Table 4.

Student Survey: Future Role as a Health Professional

Students were asked about how they viewed their future roles in obesity management. All students (N=17) agreed or strongly agreed that they see the following as their role as a health professional:

- Recommending dietary changes
- Recommending physical activity changes
- Assessing for weight-related comorbidities

Students mostly agreed or strongly agreed that their other roles in obesity management as a health professional included:

- Selecting patients for surgical treatment (82%, 14/17)
- Selecting patients for use of pharmacotherapy (82%, 14/17)
- Providing behavioral counseling (76%, 13/17)

Student Survey: Experience With Overweight or Obese Patients

Students were asked a conditional question about whether they had any experience with overweight or obese patients in their case studies or clinical experiences (N=17). Additionally, when they responded that weight was addressed, they were asked about the nature of the interaction, and 71% (11/17) of the respondents said they have had adult patient encounters in which weight was addressed and the data suggested the following:

Many or most interactions involved:

- Weight as a contributing factor to a current medical condition (67%, 7/11)
- Discussions of weight initiated by the provider (45%, 5/11)
- A current medical condition exacerbated by weight problems (55%, 6/11)

Few or some interactions involved:

- Discussions of weight initiated by the patients (91%, 10/11)
- Weight as the primary focus of the appointment (91%, 10/11)
- Discussions of weight initiated by the provider (55%, 6/11)

Additionally, 59% (10/17) reported that they have encountered overweight or obese patients (or case studies) where they thought weight should have been addressed and it was not. When asked to select the reason why they thought weight was not addressed:

- 70% (7/10) selected a lack of time to discuss weight problems
- 60% (6/10) said there were more important items to discuss in the situation
- 30% (3/10) said the patient had a history of not following lifestyle change advice

Table 3. Students' rating of obesity medicine knowledge (N=17).

Student knowledge	Mean (standard deviation)	Good or excellent, n (%)
Please rate your knowledge about the following:		
Calculating body mass index (BMI)	4.18 (0.728)	14 (82)
Interpreting BMI	3.88 (0.857)	12 (71)
Recommending appropriate weight loss treatments	3.24 (0.903)	8 (47)
Measuring waist circumference as an obesity assessment	3.18 (1.24)	6 (35)
Interpreting waist circumference as an obesity assessment	3 (1.06)	4 (24)
Average	3.49 (0.957)	8.8 (52)

Table 4. Students' rating of their obesity medicine self-efficacy (N=17).

Student self-efficacy	Mean (standard deviation)	Prepared or very prepared, n (%)
I feel prepared for interventions with the following adult populations:		
Patients with obesity-related comorbidities	2.47 (0.717)	8 (47)
Patients with psychosocial issues	1.94 (0.929)	5 (31)[a]
Overweight or obese patients with a history of failed weight loss attempts	1.76 (0.970)	4 (24)
Overweight to stage III obese patients	1.88 (0.619)	2 (12)[a]

[a]n=16.

Student Survey: Patient Communication

In round 1 of the survey, students were asked whether they were comfortable discussing weight issues with overweight or obese patients. Of the respondents, students agreed or strongly agreed they were slightly more comfortable discussing weight with obese patients (57%, 4/7) than with overweight patients (43%, 3/7).

In round 2 of the survey, students were asked about their interest in learning more about effective ways to address weight-related issues with overweight or obese patients. Of the 10 respondents, most students agreed or strongly agreed that they were interested in:

- Learning how to effectively address weight issues with obese patients (100%, 10/10)
- Learning how to effectively address weight issues alongside issues perceived as more important (90%, 9/10)
- Learning how to effectively address weight issues with overweight patients (80%, 8/10)

Faculty Survey

Faculty Description of Obesity Medicine Topics Currently Covered

Obesity medicine was most often incorporated into courses on other topics according to a majority of the 12 faculty respondents (83%, 10/12) as opposed to a course focused on only obesity (8%, 1/12) or not being included in the curriculum (8%, 1/12). From the 12 universities represented, courses that faculty reported covering obesity most often were as follows: Endocrinology (58%, 7/12), Cardiovascular (50%, 6/12), and Biochemistry and/or Nutrition (42%, 5/12). Other courses covering obesity were Wellness, Gastrointestinal, and Family Medicine and Psychiatry clerkships.

BMI and physical activity guidelines were the most frequently covered of the curriculum subtopics surveyed, with 83% (10/12) of faculty agreeing or strongly agreeing. The least commonly covered subtopic was motivational counseling or interviewing techniques; only 67% (8/12) of faculty agreed or strongly agreed that this topic was included in their school's standard curriculum.

Faculty Perception of Importance of Supplemental Obesity Medicine Topics

Faculty rated a list of 27 topics on their importance for inclusion in a curriculum supplement. The topics that they rated highest, using a 5-point Likert-type scale, were as follows: "patient-centered treatment of weight" (4.7), "bringing up the topic of weight" (4.6), "discussing weight and well-being" (4.6), "discussing the relationship between weight and comorbidities" (4.6), "physician role with overweight or obese patients" (4.6), "confronting personal bias against overweight or obese patients" (4.5), "referring patients for dietary guidance" (4.5), and "developing a long-term plan" (4.5).

Topics rated the lowest were "effectiveness of weight-loss surgery" (4.0), "assessing body mass" (3.9), "using the body mass assessment to guide treatment" (3.9), "referring patients for surgery" (3.8), and "personal weight struggles" (3.4).

Faculty Assessment of Student Clinical Skills

Faculty participants reported confidence in student skills related to evaluation and assessment of patient weight or obesity but less confidence in student ability to recommend weight loss treatments or treatment planning for weight loss (Table 5). In contrast, of the majority of faculty respondents who were aware

of their students' preparedness, 100% (8/8) rated students as only "somewhat prepared" or "not prepared at all" to follow guidelines for treating obese patients or for overweight or obese patients who had tried and failed to lose weight (Table 6).

Faculty confidence in their students' clinical skills in obesity medicine varied according to the specific skill. For each of these questions, there was an N/A answer available; *I don't know* in Table 5 and *Unsure* in Table 6. N/A results are not included in the question totals, varying the N=12 and given no weight in the data table. We found that faculty agreed or strongly agreed with the following:

Faculty were *confident* in their students' ability to (see Table 5):

- Evaluate patient with overweight or obesity (64%, 7/11)
- Assess patients with overweight or obesity (82%, 9/11)

Faculty were less confident in their students' ability to (see Table 5):

- Recommend appropriate weight loss treatments (18%, 2/11)
- Develop a long-term plan for patient weight loss (18%, 2/11)
- Implement a long-term plan for patient weight loss (10%, 1/10)

Faculty rating of student preparedness also varied with the patient category:

Faculty rated students as *not prepared* or only *somewhat* prepared to follow weight loss guidelines for treating (see Table 6):

- Overweight patients (73%, 8/11)
- Stage I-II obese patients (67%, 6/9)
- Stage III obese patients (89%, 8/9)
- Patients with psychological issues (100%, 10/10)
- Overweight or obese patients with a history of failed weight loss attempts (100%, 8/8)

Faculty rated student preparation to treat patients having weight-related comorbidities using weight loss guidelines as moderate: 55% (6/11) of faculty rated students as *prepared*, and 45% (5/11) of faculty rated students as only *somewhat prepared*.

Faculty Survey: Key Findings Summary

Most of the faculty reported that obesity medicine is covered within more than one course, most often Endocrinology, Cardiology, and Biochemistry or Nutrition. For obesity medicine topics, a majority of the faculty agreed or strongly agreed that body mass evaluation, dietary guidelines, and physical activity guidelines were already covered in their curriculum. Many topics were identified as important for inclusion in a supplement to the existing curriculum, with the highest rated of these topics in terms of importance involving the doctor-patient relationship and counseling the patient. Faculty were most confident in their students' weight assessment skills and least confident in students' ability to develop a long-range weight loss plan. Faculty rated student preparedness highest for following guidelines with patients having weight-related comorbidities and overweight patients and lowest for treating patients having failed weight loss attempts.

Table 5. Faculty's assessment of students' confidence (N=12).

Confidence in students' skills[a]	I don't know, n (%)	Strongly disagree, n (%)	Disagree, n (%)	Neither disagree nor agree, n (%)	Agree, n (%)	Strongly agree, n (%)	Mean (SD)
I am confident in my matriculating students' clinical skills to:							
Evaluate patients with overweight or obesity	1 (–[b])	0 (0)	0 (0)	4 (36)	6 (55)	1 (9)	3.72 (0.647)
Assess patients with overweight or obesity	1 (−)	0 (0)	0 (0)	2 (18)	7 (64)	2 (18)	4 (0.632)
Recommend appropriate weight loss treatments	1 (−)	0 (0)	4 (36)	5 (45)	2 (18)	0 (0)	2.82 (0.751)
Develop a long-term plan for patient weight loss	1 (−)	1 (9)	3 (27)	5 (45)	2 (18)	0 (0)	2.73 (0.905)
Implement a long-term plan for patient weight loss	2 (−)	1 (10)	3 (30)	5 (50)	1 (10)	0 (0)	2.6 (0.843)

[a]Likert rating: I don't know=N/A; Strongly disagree=1; Disagree=2; Neither disagree nor agree=3; Agree=4; Strongly agree=5.

[b]The N/A options are not given any weight.

Table 6. Faculty's rating of students' preparedness (N=12).

Faculty perceptions of students' preparedness[a]	Unsure, n (%)	Not prepared at all, n (%)	Somewhat prepared, n (%)	Prepared, n (%)	Very prepared, n (%)	Mean (SD)
How prepared are your matriculating medical students to follow weight loss guidelines to treat the following?						
Overweight patients	1 (–[b])	0 (0)	8 (73)	3 (27)	0 (0)	2.27 (0.467)
Stage I obese patients	3 (–)	0 (0)	6 (67)	3 (33)	0 (0)	2.33 (0.5)
Stage II obese patients	3 (–)	1 (11)	5 (56)	3 (33)	0 (0)	2.22 (0.667)
Stage III obese patients	3 (–)	1 (11)	7 (78)	1 (11)	0 (0)	2 (0.5)
Patients with psychological or psychosocial issues	2 (–)	2 (20)	8 (80)	0 (0)	0 (0)	1.8 (0.422)
Overweight or obese patients with weight-related comorbidities	1 (–)	0 (0)	5 (45)	6 (55)	0 (0)	2.55 (0.522)
Overweight or obese patients with a history of failed weight loss attempts	4 (–)	4 (50)	4 (50)	0 (0)	0 (0)	1.5 (0.535)

[a]Likert rating: Unsure=N/A; Not prepared at all=1; Somewhat prepared=2; Prepared=3; Very prepared=4.

[b]The N/A options are not given any weight.

Discussion

Principal Findings

On the basis of the student and faculty responses, a medical school curriculum should stress on patient interviewing or counseling skills to address weight issues with all patients and associated weight-related problems. Specific areas of need in current medical school curricula include providing real or simulation-based opportunities for students to practice clinical skills while interacting with patients, such as discussing weight-related issues with patients in a patient-centered way, to increase quality and effectiveness of these interactions, and to decrease discomfort with these measures. Furthermore, students need experience with a variety of patients needing weight interventions, including those with extreme obesity and psychological problems. Simulations would also offer the opportunity to become comfortable with skills, such as bringing up the topic of weight or measuring waist circumference.

Currently, obesity-related topics are primarily integrated into traditional basic science and systems–oriented courses, from Biochemistry or Nutrition to Endocrinology and Cardiovascular Systems. This approach may not be the most effective way to teach students about this public health threat. Although most students were familiar with the topics, few reported case studies or clinical simulations that focused on obesity and developed the necessary patient interaction skills.

Faculty and students identified several similar deficits in obesity medicine training. Only around half of both faculty and students felt that students were prepared to follow weight loss treatment guidelines. Students were not confident of their interviewing and motivational skills, and faculty saw this as an important skill area to supplement. Both students and faculty saw a deficit in being able to help patients who have many failed weight loss attempts.

Faculty and students differed on their perception of how well prepared they are in obesity medicine in a few areas. Faculty rated students as being prepared to treat weight-related comorbidities more frequently than students did. Faculty believed that students were being appropriately prepared in the evaluation and assessment of patients with overweight or obesity, but students rated their preparation in some related skills low, such as measuring waist circumference.

Most students in round 1 reported interest in learning more about obesity and saw treatment as part of their role as a health care provider, including covering areas such as diet and lifestyle. In the follow-up round, however, students indicated that they see treating obesity as frequently secondary to "more important health problems."

More emphasis is needed on evidence-based guidelines for treating all stages of excess weight, as well as developing and implementing long-term plans for patient weight loss. Motivational interviewing and other counseling techniques need to be incorporated more into the medical school experience, as both students and faculty agree that this is an area where there is room for improvement. Students overwhelmingly indicated interest in this topic and other topics related to patient communication.

All 3 lines of inquiry (literature review, medical student, and faculty feedback) support the inclusion of more training for students related to weight biases and the implications for patient care.

Limitations

The sample size of our student and faculty populations was small, and therefore the findings could be seen as not necessarily representative of the populations as a whole. Although all attempts were made to expand our sampling through direct email recruitment, we were limited in our access to medical school contact information and therefore had to rely on convenience sampling of those users who made their contact information public, visited our site, and took our survey.

Analyzing the originating university of each participant as well as their current year or position, our study did include 2 distinct subsets of each population that could be seen as a representative sample of both students and faculty. The majority of student respondents were from Kansas University Medical School (11), but our sample covered a range of medical student years and therefore can be seen as representative of the medical school population as a whole. Additionally, our faculty sample had representatives from 12 different universities with no duplicates and therefore could be used as a representative sample of the medical school faculty population overall.

Conclusions

Most students and faculty agreed that medical school curricula are preparing the students appropriately to discuss medical comorbidities and assess weight. A troubling finding was that the medical students surveyed did not feel *adequately prepared* to interview, assess, or treat a patient with overweight or obesity, particularly given that this is an audience with generally high confidence. Faculty should consider supplementing and changing curricula to address this concern. As medicine as a whole moves toward the realization that obesity is itself a health condition, not just a symptom or sign of other medical problems, these students will not be ready to assist their future patients unless changes are made in their training.

Acknowledgments

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Conflicts of Interest

The authors are employees of Clinical Tools, Inc.

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Abbreviations

AAMC: Association of American Medical College
BMI: body mass index

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Original Paper

Log In to Experiential Learning Theory: Supporting Web-Based Faculty Development

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Abstract

Background: For an increasingly busy and geographically dispersed faculty, the Faculty of Medicine at the University of Southampton, United Kingdom, developed a range of Web-based faculty development modules, based on Kolb's experiential learning cycle, to complement the faculty's face-to-face workshops.

Objective: The objective of this study was to assess users' views and perceptions of the effectiveness of Web-based faculty development modules based on Kolb's experiential learning cycle. We explored (1) users' satisfaction with the modules, (2) whether Kolb's design framework supported users' learning, and (3) whether the design principle impacts their work as educators.

Methods: We gathered data from users over a 3-year period using evaluation surveys built into each of the seven modules. Quantitative data were analyzed using descriptive statistics, and responses to open-ended questions were analyzed using content analysis.

Results: Out of the 409 module users, 283 completed the survey (69.1% response rate). Over 80% of the users reported being satisfied or very satisfied with seven individual aspects of the modules. The findings suggest a strong synergy between the design features that users rated most highly and the key stages of Kolb's learning cycle. The use of simulations and videos to give the users an initial experience as well as the opportunity to "Have a go" and receive feedback in a safe environment were both considered particularly useful. In addition to providing an opportunity for reflection, many participants considered that the modules would enhance their roles as educators through: increasing their knowledge on various education topics and the required standards for medical training, and improving their skills in teaching and assessing students through practice and feedback and ultimately increasing their confidence.

Conclusions: Kolb's theory-based design principle used for Web-based faculty development can support faculty to improve their skills and has impact on their role as educators. Grounding Web-based training in learning theory offers an effective and flexible approach for faculty development.

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KEYWORDS

computer-assisted instruction; models, educational; staff development; education, medical; computer simulation

Introduction

Background

Faculty development is essential for academic staff to develop the pedagogical knowledge and skills that they need to succeed in their teaching roles. Faculty development initiatives can take many forms. Approaches include face-to-face workshops, seminars, short courses, fellowships, and formal qualifications such as postgraduate certificates or master's degrees [1]. Advances in educational technologies allow learners instantaneous access to resources and tools. Web-based training is rapidly expanding as an approach to faculty development [2]. Options include open-access faculty development resources for clinical teachers in the form of short modules, such as at the London Deanery [3], and online master's degrees to support physicians to develop skills in education [4]. These demonstrate that Web-based approaches offer several advantages, including convenience and flexibility of learning, access across multiple countries, lower cost, and more time to reflect and learn concepts.

Steinert et al [5] highlighted the need to ground faculty development in theoretical models and principles of teaching and learning to plan, guide, and develop faculty development interventions. Sandars et al [6] also emphasized the importance of grounding work in theoretical models as well as explicitly describing the learning theory when designing technology-supported interactions because this gives an indication of how the technology is intended to facilitate learning and can explain why some e-learning interventions work better than others. Dabbagh [7] wrote about a theory-based design framework to provide a basis for designing e-learning instruction where a pedagogical model (eg, applied learning theory) leads to the specification of instructional strategies (ie, describes techniques that the designer uses to facilitate learning). Technology-enhanced learning or training solutions can then be customized to operationalize the identified instructional strategies.

A limited number of studies described the use of learning theory to guide the design of Web-based resources for professional development. Vrasidas and Zembylas [8] applied a constructivist approach to the development of online resources for teachers' training. Zhu et al [9] described how a framework can guide the design of augmented reality apps for professional development of general practitioners around the use of antibiotics. These studies showed how learning theory may be used to create the learning environment or to guide learning activities as a substitute for traditional instruction. We did not find a published design framework used for professional development that actually maps the learning activities to a theoretical model or evaluates how the theory-based approach can facilitate meaningful learning and knowledge building.

The University of Southampton's Faculty of Medicine runs a successful faculty development program designed to meet the needs of the more than 2000 medical teachers who teach basic science and clinical subjects to both undergraduate and graduate entry students. The medical teachers are based in Southampton, across the South of the United Kingdom, the Channel Islands, and more recently in Kassel, central Germany, following the addition of a European bachelor of medicine program. It is therefore difficult for clinicians, especially those based at the more distant hospitals, to attend face-to-face workshops. To improve faculty development opportunities, we developed a blended approach of face-to-face training events and interactive, self-directed, Web-based training, described further in a separate publication [10]. The medical teachers can freely access these modules through a portal called Medical Education Staff Access (MEDUSA). These modules are commonly known as MEDUSA modules.

A total of 10 MEDUSA modules have been developed to date, covering a variety of topics ranging from teaching practices (eg, lecturing, giving feedback, supervising student assistantships, and supervising student projects) to assessment (Assessment of Clinical Competence, ACC—formerly the undergraduate mini-CEX—Observed Structured Clinical Exams, OSCEs), raising awareness in issues related to diversity, the student transition from classroom to clinical learning, and the role of the Pastoral Academic Tutor. To ensure maximum flexibility and to enable anytime-anywhere use, the modules were designed to engage learners and to facilitate learning without facilitator inputs. The design of the modules was underpinned by Kolb's experiential learning cycle [10]. Kolb's model [11] draws from situated cognition and emphasizes that learning occurs though a four-stage cycle, in which "immediate or concrete experiences" provide a basis for "observations and reflections." These observations and reflections are distilled into "abstract concepts," which can be "actively tested," in turn creating new experiences. The design of "the role of the OSCE examiner" module illustrates this (summarized in Figure 1 and a screen shot from the module in Figure 2).

Figure 1. The design of "The role of the OSCE examiner" Medical Education Staff Access (MEDUSA) module based on Kolb's experiential learning cycle.

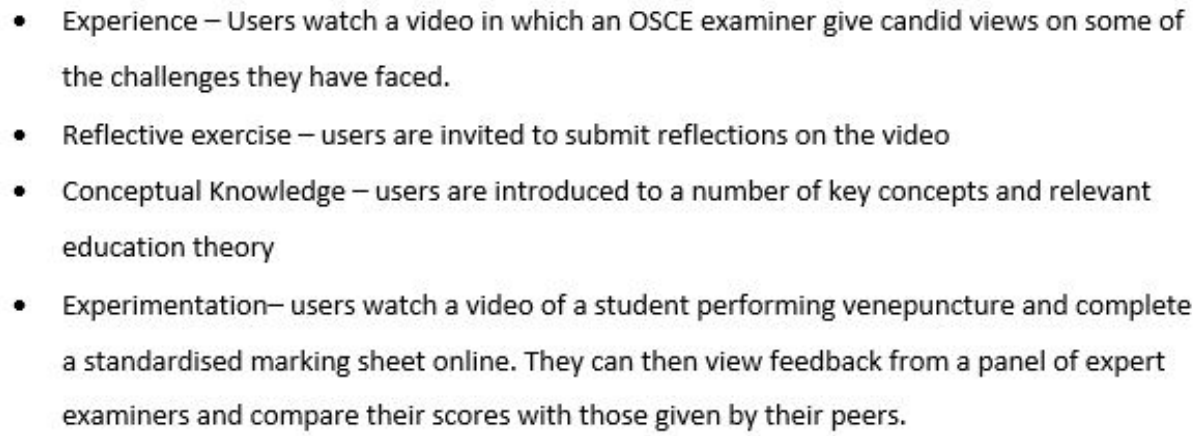
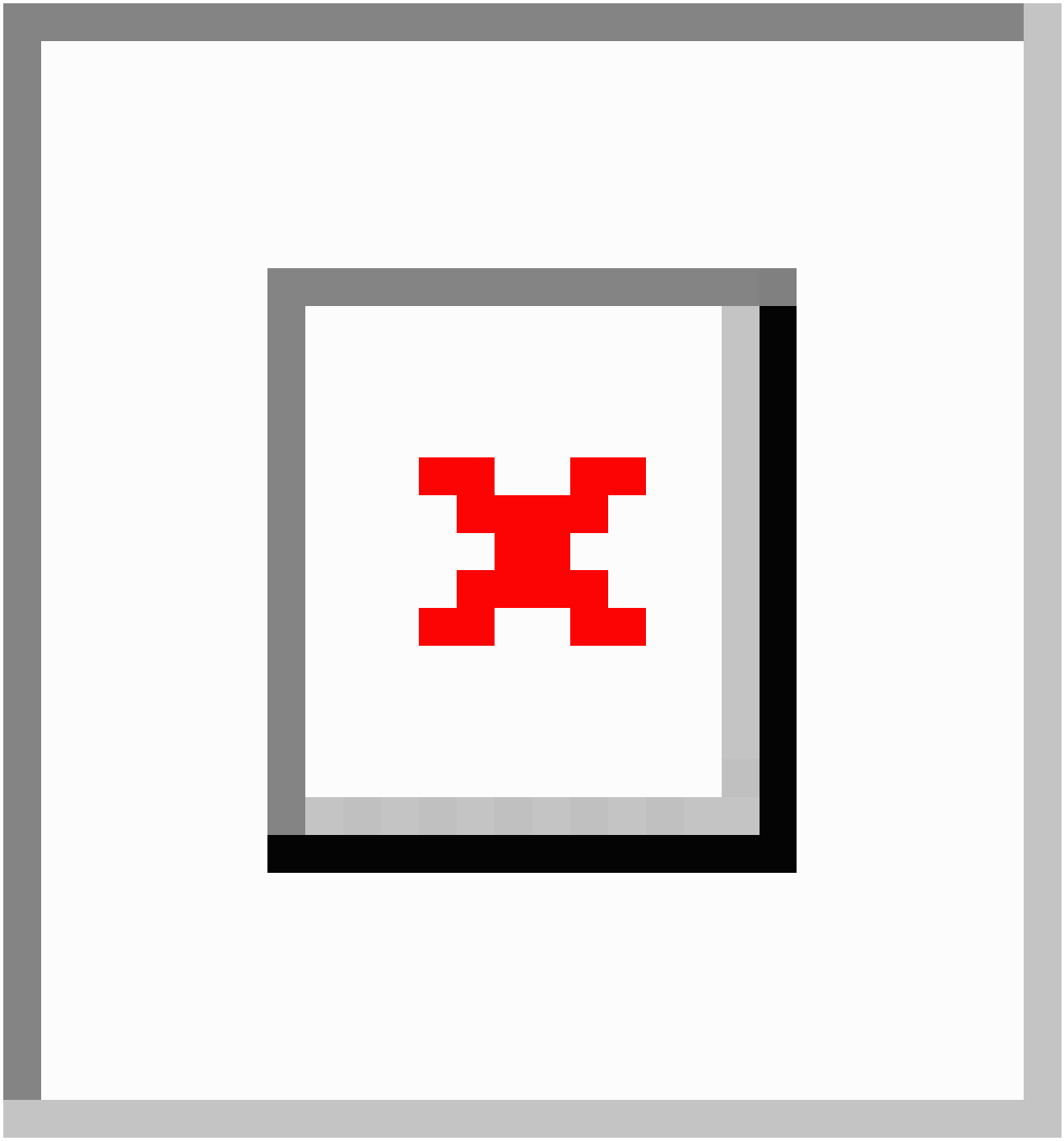


Figure 2. Screenshot from the "Have a go" activity in the module showing a video of a student undergoing an OSCE and the online marking sheet that users complete with the activity feedback that compares their score with expert examiners and peers.



Objective

The aim of this paper was to present an educational innovation to emphasize the value of grounding faculty development in theory. We describe a theory-based design approach that we used to guide the design of interactive self-directed e-learning modules for faculty development. On the basis of Kolb's experiential learning cycle, we created virtual learning environments for feeling, thinking, reflecting, and acting in the modules and evaluated their effectiveness. We studied whether the implemented module design promoted learning through supporting the learning cycle of experience, reflection, conceptualization, and experimentation. Here, we report our findings relating to (1) the users' satisfaction with the MEDUSA modules and their key design features, (2) how the design features support the users' ability to learn, and (3) whether the modules affected their work as educators, based on their perceptions after completing the modules. Therefore, the overall aim of this study was to assess users' views on the effectiveness of designing Web-based faculty development modules based on Kolb's experiential learning cycle.

Methods

Data Collection

Evaluation data were collected from seven MEDUSA modules between March 2010 and July 2013. Ethical approval was

waived, as this was an evaluation of an ongoing educational service by a member of staff.

Each module had a built-in evaluation survey that users were invited to complete once they had undertaken the module. The evaluation survey contained a mix of open and closed questions. In the closed questions, users rated each module with regard to its relevance, meeting of learning outcomes, maintenance of interest, amount of interaction, type of interaction, ease of navigation, and overall structure using a 5-point scale (where 1=very dissatisfied and 5=very satisfied). Three open-ended questions asked users to report design features that they found useful in helping them to learn and the features that were not useful and to report how the module had changed their role as educators.

The MEDUSA portal has a learning management function, "My MEDUSA", which captures the results of each activity to offer users the flexibility of learning at their own pace by allowing them to review previous attempts and to print a summary of their progress and a certificate of completion. Users rated the usefulness of this feature using a 3-point scale (where 1=not useful, 2=useful in parts, and 3=mostly useful).

Users also rated additional design features of fast-track option and discussion forum. Fast track, available in some modules, enables users to move through a briefer learning cycle, with the option to return later for deeper learning by working through the full module. A discussion forum provides opportunities for collaboration with other educators. Users were asked to report whether they used this feature and whether they would use it in other modules.

Analysis

The responses to closed questions were imported into SPSS, version 22 (IBM Corp, 2013) for analysis by SB. The data were analyzed using descriptive statistics to report the frequency and number of responses.

Responses to open-ended questions were imported into Excel (Windows 2010) for qualitative analysis. Data for each of the three questions were analyzed individually (by SO and SC) using the inductive qualitative approach of content analysis [12]. Responses were analyzed line by line using open coding to systematically develop categories, encapsulating all participants' views. In content analysis, words or phrases are deemed to reflect important views from participants' concerns [13]. Illustrative quotations are reported to describe the categories.

Results

MEDUSA modules were made available to 1365 academic staff and clinicians who teach medical students at the University of Southampton. The modules were promoted through the faculty's Website, faculty biannual newsletters, and paper leaflets distributed in face-to-face events. Between the period of data collection from March 2010 to July 2013, 284 medical educators (20.8% of total faculty; 50.8% female, 49.2% male) completed 409 modules. Out of the 402 module users with identified roles, 276 (68.6%) were clinical academics, 107 (26.6%) were nonclinical academics, and the remaining 19 users (4.8%) had nonteaching roles, including pastoral and research-only roles. Module evaluation survey was reported on 283 modules of the total 409 completed modules, giving a response rate of 69.1%.

Satisfaction With MEDUSA Modules

The modules were rated very highly for interactivity, navigation, interest, learning outcomes structure, and relevance with a median score of 4, with over 80% of participants reporting ratings ≥ 4 (satisfied and very satisfied), as shown in Table 1.

The usefulness of the My MEDUSA feature was rated by 255 users (90%). The majority, 161 of 255 users (56.9%), reported it as mostly useful, 84 (32.9%) found it partly useful, and only 10 users (4%) rated it as not useful at all. As the fast-track feature is only available in two modules, only 52 users (18.4%) reported using it, and only 24 users (46.2%) reported that they would recommend using the feature in future. None of the MEDUSA users used the discussion forum.

Does the Design Framework Support Learning?

Two hundred twenty-five participants made 368 comments about the features that they liked about MEDUSA modules. A total of three themes were identified: the module contents, the delivery modes and technologies, and the structure and presentation of the modules (Table 2).

The module content theme included comments relating to the cases and examples used, key concepts and models introduced, views of students and expert educators, and opportunities for practice and feedback. In the module delivery theme, participants liked the use of multimedia and the design of videos and animations.

We identified a synergy between the design features that the users liked and the four stages of Kolb's experiential learning cycle used to develop the modules (Table 3). We employed different design features to address the instructional strategies used to operationalize each stage of Kolb's learning cycle. Participants reflected on features they liked that mapped to the design features at each stage. Examples of some of their quotes are reported in the last column of Table 3.

We used simulations and videos to provide a base for an "experience," and the participants commented on the usefulness of seeing a video of an OSCE examination and providing them with a real-life example where they can see the interaction between the student and the examiner. We used reflection activities and thought-provoking questions to promote "reflection" in the learning cycle. Although MEDUSA was not designed to give feedback to users on their reflections, My MEDUSA provides a summary of completed activities, enabling users to look back at their reflections after completing the module. Participants generally engaged with reflective activities and commented that the modules provided them with space to think and reflect.

To generate new knowledge through "conceptualization," we presented theoretical models, video demonstrations for practical tips, and videos and case studies showcasing different perspectives. Participants learned not only from the theoretical models and practical tips presented but also through considering

different perspectives from expert educators and students. Participants found it useful to test concepts and experiment through tasks and activities with feedback in each module.

Using Kolb's theory-based design principle for Web-based faculty development enabled us to address our faculty members' learning needs and meet our organizational needs and constraints (Figure 3).

Table 1. Overall satisfaction ratings (evaluation data from seven Medical Education Staff Access (MEDUSA) modules: Assessment of Clinical Competence, Planning and Delivering Lectures, the Role of the OSCE Examiner, Giving Constructive Feedback, the Student Assistantship, Diversity and From Classroom to Clinical Learning. Satisfaction ratings completed by 283 MEDUSA users).

Item	Median rating (1-5 scale)	Rating ≥ 4[a]
Amount of interaction	4	86.7% (241/278)
Ease of navigation	4	82.8% (231/279)
Maintenance of interest	4	81.0% (226/279)
Meeting learning outcomes	4	76.5% (216/282)
Overall structure	4	84.9% (236/278)
Relevance	4	87.8 % (244/278)
Type of interaction	4	83.9% (234/279)

[a]% (n/N), where n reflects the number of rating reporting a score of ≥ 4; and N is the total number of rating (scored between 1-5) reported for that item.

Table 2. Themes identified from the Medical Education Staff Access (MEDUSA) features that participants liked (qualitative data from a total of 368 comments reported by 225 participants who completed the evaluation survey).

Themes	Codes
Content	Cases and examples used
	Opportunity to practice
	Feedback on activities
	Practical tips
	Key concepts and models
	Relevant, informative, and realistic
	Relates students and examiner views
	Thought provoking
	Resources and references
Delivery	Animations/video design
	Use of multimedia
	Ease of use, access, and navigate
Presentation	Engaging and interactive
	Appropriate length
	Clear
	Concise
	Simple language
	Organized

Table 3. Medical Education Staff Access (MEDUSA) features that were liked by users mapped to Kolb's experiential learning cycle (qualitative data from a total of 368 comments reported by 225 participants who completed the inbuilt evaluation survey).

Kolb's experiential learning cycle	Instructional strategies	Technologies/design solutions	Sample quotes
Experience	Building understanding through an experience	Simulations to showcase an experience	"...good to see a video of an examination."
	Engaging learners in meaningful and relevant tasks so they can apply knowledge in real-world situations	Videos and graphics to bring a case to life or to demonstrate a situation	"...simulated student."
		Case scenarios describing challenging situations	"...seeing student patient interaction."
			"...real life example shown."
Reflection	Promoting reflection	Reflection activities and thought-provoking questions	"...space to consider as well as do."
			"...it made me think."
			"...could relate to other examiners description of problems they encountered."
Conceptualization	Generating new knowledge and concepts	Presenting knowledge and theoretical models though engaging animations	"...animation of Millar's pyramid."
	Promoting authentic learning tasks	Interactive case scenarios, video demonstrations for practical tips and guidance	"...examples of constructive feedback."
	Supporting multiple perspectives	Videos showcasing different perspectives	"...trouble shooting strategies."
			"...the views of a variety of very experienced lecturers on how to prepare for them and deal with stress involved."
			"...good to get students views and experiences of feedback."
			"...video recordings of difficult situations people have encountered."
Experimentation	Testing concepts through active experimentation	Performing tasks and receiving feedback on task	"...being able to score an actual ACC and compare with peers and experienced examiners."
	Promoting collaboration and encourage dialogue between teachers and other learners	Discussion forum	"...opportunity to upload my lecture for review."

Figure 3. Kolb's based design framework showing applied in MEDUSA modules showing; instructional strategies and design solutions used (Blue), learning management functions used to meet learner needs (Brown) and reporting functions used to meet the needs of faculty developers/administrators (pink).

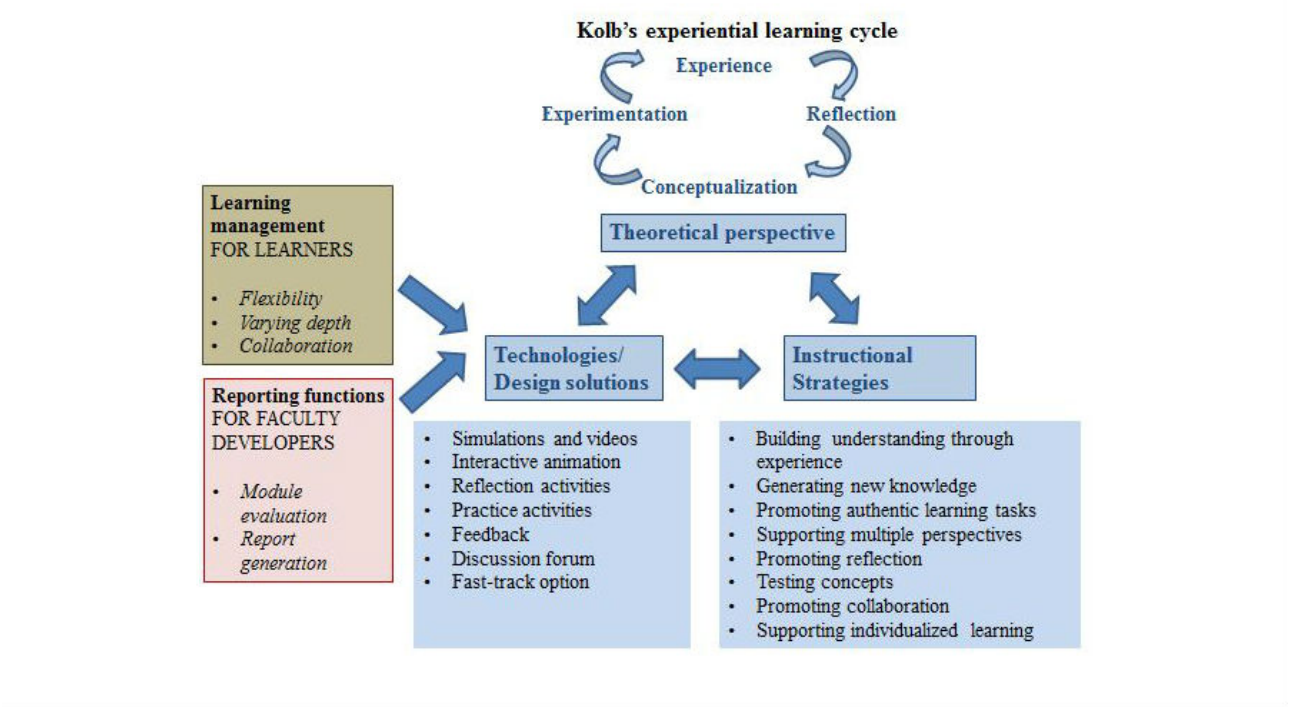


Table 4. The users reported the various ways in which Medical Education Staff Access (MEDUSA) modules will change their work as educators (Qualitative data from a total of 189 comments reported by 174 participants who completed the inbuilt evaluation survey).

Category	Description (percentage of comments)	Sample quotes	Kolb's experiential learning cycle
Awareness	Raising awareness, reminding and reinforcing concepts (18%)	"Reinforced some things I knew but do not always focus on and a good opportunity to reflect on own skills and course design."	Reflection
Knowledge	Gaining knowledge; improved understanding (17%)	"I feel more informed, and have a better idea of standard required."	Conceptualization
Change	Changing practices—shifting in the focus or method (13%)	"Encouraged me to get students to discuss with each other their feedback after they get it and to offer more opportunity to discuss feedback they get on an assignment."	Experimentation
Reflection	Making the user reflect on their practice (12%)	"I think it will help me to consider again how I present things to students, to enable as wide an inclusion as possible."	Reflection
Performance	Building skill, improving performance (11%)	"It will improve how I deliver lectures and help me to keep my audience engaged throughout so that I can maximize how much the students get out of it."	Experimentation
Confidence	Improving confidence (8%)	"I have more confidence that I'm on the right track!"	Conceptualization
Application	Applying learning into practice (8%)	"I took away some useful ideas to try out with my next student..."	Experimentation

Do Users Perceive That MEDUSA Will Change Their Work as Educators?

Participants reported the ways in which they anticipated the module would change their work as educators. A total of 174 participants provided 189 open-ended comments. These were categorized thematically into seven categories as shown in Table 4 with illustrative quotes. Participants commented that the modules will enhance their roles as educators by increasing their awareness and knowledge; they also commented that completing the modules helped to improve their confidence and their performance and encourage more reflection in their own practice as well as to consider applying their learning in planning of new teaching practices. Some participants had reported to have even started to implement some changes in their practices.

Discussion

Principal Findings

Web-based faculty development was previously shown to be pedagogically promising [2]. Our evaluation shows that the provision of MEDUSA modules in our institution is acceptable to faculty staff with very high rates of satisfaction reported for the modules and with suggestions to improve design features. The findings also provide evidence that the Kolb-based design principle used for Web-based faculty development can support users' ability to learn and has an impact on their role as educators.

Dabbagh outlined instructional strategies that embody the characteristics of the constructivist views, including activities that promote authentic learning activities, collaboration and social negotiation, promoting articulation and reflection, supporting multiple perspectives, and providing scaffolding [5]. In our theory-based design framework, we embraced these characteristics in the module design and described how to operationalize them through the technologies or design solutions we adopted.

In experiential learning theory, learning is defined as the processing of transformative experiences, which includes concrete experience and abstract conceptualization. The recipients of faculty development are independent autonomous learners who engage in experiences relating to their educational roles. We anticipated that applying Kolb's learning cycle in the training design would enable them to reflect on these experiences, as well as conceptualize and experiment to motivate behavioral change during the subsequent experiences in the next learning cycle.

Each MEDUSA module was designed based on Kolb's learning cycle. The module evaluation data suggested that the implemented design features that the users liked in MEDUSA modules directly relate to Kolb's learning cycle. For example, our users liked design features such as videos that brought cases to life to simulate a relevant *experience* based on Kolb's model. Similarly, users found the content to be thought provoking, as it stimulated *reflection*. The key concepts and models are related to *conceptualization*. Also among the top ranked were the activities and, in particular, opportunities to practice and get feedback on performance. These promoted active *experimentation* according to Kolb's model. Our faculty found activities that enabled them to rate student performances and compare their scores with others' scores particularly helpful. Janick et al used similar Web-based approaches to train faculty to give feedback to students on their performances during small group exercises. They reported that using video clips of student performances and enabling faculty to rate and benchmark their scores increased their ability to assess students and give feedback [14].

Our faculty indicated that completing MEDUSA modules helped them to be better educators through raising their awareness and promoting reflection, increasing their knowledge, and understanding and improving their performance and confidence. Our findings suggest that not only do the stages of Kolb's learning cycle support learning but different aspects of the learning cycle also become more relevant to individual faculty members for improving their practice and becoming better educators.

We designed our faculty development program to cater to multidisciplinary faculty with diverse backgrounds and with different learning needs. Computer-generated content, such as graphics and videos, can be used to extend and simulate the real-world environment [15]. Therefore, we used simulations in MEDUSA modules to offer those with little or no experience the opportunity to experience authentic tasks, gain knowledge, and practice in a safe environment to prepare them for when they have to do it in real life. Those who have more experience can benefit from improving their performance through reinforcing concepts, gaining different perspectives, and having additional opportunities for practice and feedback. Additionally, we customized some of our modules to acknowledge varying depths of engagement in e-learning through a fast-track option.

With a large portion of our users based at different geographical locations, including overseas, increasing flexibility and access was critical. The learning management function, "My MEDUSA," enabled flexible learning by enabling users to monitor and review their progress in each module, and the discussion forums provided opportunities for dialogue and collaboration with other educators. Studies have emphasized that one of the benefits of participation in discussion forums is access to an online community of practice [16,17], a network of individuals who share and develop knowledge, values, and experiences and are focused on a common practice and/or mutual goal [18]. Our learners did not take advantage of discussion forums. They accessed modules in their time over 3 years, and they were not likely to return to the module to see whether anyone had commented. Thus, a sense of community did not develop from this feature. Fox et al [19] has suggested that active moderation of discussion groups may be important in increasing communication among participants, but we designed our program to minimize moderation.

On the basis of our experience after implementing Web-based modules for faculty development, we encourage the use of approaches that are grounded in learning theory and that can address their participants' learning needs and meet their organizational needs and constraints. Future research, using qualitative methodology, could further explore how and why the use of theoretically designed Web-based training enables learning and influences educators in their teaching roles and how to maximize possible features of a learning management system.

Conclusions

Web-based staff development can provide an effective alternative to traditional face-to-face programs to offer flexibility to geographically dispersed faculty. We have kept educational principles at the core in the development of these e-learning modules for faculty development and based their design on Kolb's experiential learning cycle. Evaluation of the effectiveness of these modules shows that there is a link between the theoretically informed designed features and what users reported as effective learning. To our knowledge, our approach

for mapping learning to different stages of Kolb's experiential learning cycle is the first of its kind, and our exploratory evaluation supports grounding Web-based faculty development in learning theory.

Limitations

Further research is required to explore more holistic outcome evaluation of intervention. According to Kirkpatrick's classification of learning outcomes for educational evaluations [20], our study focused on the level 1 learning outcomes relating to participant satisfaction. Level 2 outcomes relate to testing knowledge, and although participants practiced and applied their learning through activities in each module, we did not test whether the users still retained learning after a certain time had elapsed after the completion of the Web-based training. Future research can address level 3 learning outcomes, that is, whether completing the module can improve teaching.

Although the qualitative findings in this study do provide insight into both what works and what does not, as well as how it can change behavior, there are limitations to open-ended survey questions. A next step could be to conduct an in-depth qualitative study using face-to-face or telephone interviews from a selected sample of participants, which would elicit a more in-depth understanding of how Web-based training can improve educators' practice.

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Conflicts of Interest

None declared.

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Abbreviations

ACC: Assessment of Clinical Competence
MEDUSA: Medical Education Staff Access
OSCE: Observed Structured Clinical Exams

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Original Paper

A Survey of Medical Oncology Training in Australian Medical Schools: Pilot Study

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Abstract

Background: Oncology is a rapidly evolving field with continuous advancements in the diagnosis and treatment of cancer. Therefore, it is important that medical students are provided with the knowledge and experience required to care for oncology patients and enable them to diagnose and manage toxicities of novel therapeutic agents.

Objective: This study was performed to understand the medical students' perspective of the oncology education provided in universities across Australia and identify areas of education that could potentially be modified or improved to ultimately attract more students to a career in oncology.

Methods: This pilot cross-sectional study consisted of an 18-question survey that was submitted online to medical students in their final year and interns rotating to the Tamworth Hospital.

Results: The survey was completed by 94 fifth-year medical students and interns. Oncology was taught both theoretically and clinically for 68% (63/93) of participants, and 48% (44/92) had an exclusive oncology rotation. Both theoretical and clinical oncology assessments were conducted for only 21% (19/92) of participants. Overall, 42% (38/91) of participants were satisfied with their oncology education, and 78% (40/51) were dissatisfied with the number of oncology teaching hours. The importance of a career in oncology was rated as low by 46% (41/90) of participants.

Conclusions: This pilot study indicates that there are potential areas to improve oncology teaching in Australian universities. The majority of surveyed students were dissatisfied with the number of teaching hours they receive in oncology. More global assessment of students and/or interns from other Australian institutes may yield further useful information.

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KEYWORDS

medical; oncology; training; Australia

Introduction

Oncology is a rapidly advancing field with novel treatment options and methods of diagnosis being continuously developed for many types of cancer. These put a significant burden on junior and senior clinicians as they are required to maintain an up-to-date understanding of novel treatments and modes of diagnosis to provide patients with a high standard of care. To suitably prepare junior doctors, a tertiary education is required that provides them with the capability to not only diagnose and treat patients but also to detect, as early as possible, the symptoms of the acute toxicities associated with both novel and conventional treatments. Furthermore, clinicians need the skill required to continuously incorporate the latest developments in the field into their repertoire. Currently, there is no standard method to ensure that the oncology curriculum in medical schools is of a quality that sufficiently prepares medical students to care for oncology patients.

Worldwide, there is considerable variation in the content and structure of the oncology education taught in medical schools. For many universities, medical oncology rotations are often not mandatory [1,2]. In 2007, a survey of recently graduated interns

from the United Kingdom revealed only 40% of participants felt prepared to diagnose cancer, 15% felt that they had sufficient knowledge of radiotherapy and chemotherapy, and 11% felt prepared to treat an oncological emergency [3]. Similar results were obtained from a 2013 survey of 82 interns in India, with only 32% of interns being aware of the role of radiotherapy, only 37.5% of interns being aware of the role of chemotherapy, and only 12.5% of interns being confident caring for terminal and late stage patients [4].

There is evidence that oncology is underrepresented in the curricula of Australian medical schools, and concern has been raised regarding the extent of the exposure of students to oncology [5]. McRae et al [5] compared the cancer knowledge and skills of interns graduating from graduate medical program courses with those from non–general medical program courses and also compared the cancer knowledge and skills of interns in 2001 with those who completed a similar survey in 1990 [6] and concluded that graduates from 2001 had less exposure to specific cancers such as melanoma, rectal cancer, and mouth cancer than those who trained in 1991. The study was guided by the Australian Cancer Society's Ideal Oncology Curriculum for Medical Schools, which was established in 1999 and has been regularly updated, with the last revision in 2014. Findings from McRae et al [5] suggested that the oncology education provided to medical students could be structured more effectively to provide students with a greater appreciation of the field, which may generate more interest in oncology as a future career. Hence, we believed another study to understand the knowledge and skills of medical students and interns for medical oncology was in order. The aim of this pilot cross-sectional study was to gain an understanding of medical students' perspectives of the oncology education provided in universities across Australia and identify potential areas of the tertiary education that could be modified or improved to ultimately attract more students to a career in oncology.

Methods

Study Design

This pilot cross-sectional study consisted of an online questionnaire developed by the investigators (see Multimedia Appendix 1). The survey was completed between August 2013 and August 2015 and consisted of 18 questions. Participation was offered to all fifth-year medical students and interns rotating through North West Cancer Centre and Tamworth Rural Referral Hospital (Tamworth, New South Wales, Australia). The questions were separated into 5 categories: institutions, exposure to oncology, oncology curriculum and teaching, students' perceptions of the curriculum, and interest in pursuing oncology as a career. This study was approved by the human research ethics committee at the University of New England, New South Wales, Australia. All participants provided written informed consent.

Participants

The study population consisted of medical students in their final year of study or first-year postgraduate students (interns) from Australian medical schools. An open invitation was submitted to the students and interns who rotated through North West Cancer Centre and Tamworth Rural Referral Hospital during the survey period.

Statistical Analysis

Statistical analysis was performed using SAS version 9.4 (SAS Institute Inc). Data were presented in the form of numerical values, transformed into percentile values, classified into 3 categories of variables with 2 sets of values, and inference obtained on direct or inverse proportionality of the variables.

Results

Participant Population

A total of 94 medical students or interns were recruited and completed the questionnaire. The universities represented are displayed in Table 1.

Exposure to Oncology During Medical School

When asked which year of medical school participants were first introduced to oncology, the majority of participants who responded to the question reported that it was introduced to them in their fifth year of study (53/93, 57%) (Table 2). Eleven, 10, 8, and 9 participants reported that they were introduced to oncology in first, second, third, and fourth years, respectively. One participant was not introduced to oncology until their sixth year, and one reported to have never received oncology education in medical school.

Table 1. Participating universities.

University	Number of participants (N=94)
University of Newcastle	37
University of New England	18
University of New South Wales	13
University of Wollongong	3
Sydney University	7
Other	12
Did not respond	4

Table 2. Year of introduction to oncology.

Year of medical school	Number of respondents N=93, n (%)
One	11 (12)
Two	10 (11)
Three	8 (9)
Four	9 (10)
Five	53 (57)
Six	1 (1)
Never	1 (1)

Oncology Education

Participants were asked whether they were taught oncology in theory only, whether they were taught during clinical rotations only, or if both teaching methods were employed. Out of the 93 responding participants, 3 (3%) were taught the theory only, 25 (27%) were taught during clinical rotations only, and 63 (68%) were taught with both methods. Two (2%) participants stated that they were not taught medical oncology or did not respond. Most participants received between 1 and 5 weeks of education (78/93, 84%), 11 (12%) received 5 to 10 weeks, and no participants received 10 weeks or more.

Rotations were not always exclusively dedicated to a single specialty and may have been used to teach multiple topics. Out of 92 responding participants, 44 (48%) had an exclusive oncology rotation and 44 (48%) had oncology combined with another specialty (Table 3). Four participants were unsure. The oncology rotation was mandatory for 75% (70/92) of participants and elective for 17% (16/92) of participants; 9% (8/92) of participants were unsure.

When asked if there was knowledge testing in oncology, 49% (45/92) of participants reported that they were not assessed, while 21% (19/92) of participants reported undergoing both theoretical and clinical examinations; 24% (22/92) had only written assessment, and 7% (6/92) had only clinical examination.

To determine why participants may have limited oncology education, participants were asked if any medical oncologists were involved in teaching at their university. Half (45/94, 50%) stated that medical oncologists were involved in teaching at their university, 9% (8/94) reported that they did not receive any teaching from a medical oncologist, 41% (37/94) were unsure, and 4 did not answer the question. These data suggest that half of all medical students either did not have access to or were not aware that they had access to a teaching medical oncologist at their university.

Student Assessment of Their Oncology Education

When participants were asked to grade the quality of their oncology education as either satisfactory, average, or unsatisfactory, 42% (38/91) participants rated their oncology education as satisfactory, 48% (44/91) rated this at average, and 10% (9/91) reported that it was unsatisfactory. When participants were asked to indicate reasons why they were dissatisfied with their oncology education, 78% (40/51) of responding participants indicated that they were dissatisfied with the limited number of teaching hours, 65% (33/51) of participants attributed this to a lack of clinical exposure, 29% (15/51) of participants believed there was a lack of consultant training sessions, and 26% (13/51) stated that they had limited resources.

Conversely, of the participants that identified aspects of their medical oncology training that they found satisfactory, 78% (57/73) of participants attributed this to oncology consultant teaching, 66% (48/73) of responders attributed this to adequate teaching exposure, 48% (35/73) to adequate teaching hours, and 38% (28/73) to adequate access to resources.

When asked which were the medical oncology topics the participants felt needed more attention in medical school, 49% (44/89) suggested clinical application, while 17% (15/89) recommended that more attention be given to treatment approaches (Table 4).

Oncology as a Career

When participants were asked to rate their view of the importance of a future career in medical oncology as either low or high, 54% (49/90) rated the importance as high and 46% (41/90) reported the importance as low.

Table 3. Methods by which students were taught oncology.

Teaching method	Number of respondents N=93, n (%)
Theory only	3 (3)
Clinical rotations only	25 (27)
Both methods	63 (68)
Not taught	2 (2)

Table 4. Oncology topics medical students believed should be given more attention.

Areas of oncology	Number of respondents N=89, n (%)
Molecular biology	2 (2)
Pathophysiology	7 (6)
Pathology	0 (0)
Clinical applications	44 (49)
Diagnostic investigations	10 (11)
Treatment approaches	15 (17)
Psychosocial aspects	4 (5)
Other	7 (8)

The 2 main reasons why the medical students and interns would not choose medical oncology as a career were lack of sufficient understanding or awareness of the topic (47/72, 65%) and lack of sufficient exposure at the undergraduate level (25/72, 35%). No participant stated that they would not specialize in oncology due to a lack of career prospects.

Discussion

Principal Findings

This cross-sectional pilot study investigating medical students' perspectives on oncology education highlights potentially significant differences in teaching methods and students' understanding and exposure to oncology across Australian universities.

The supply of medical oncologists is currently insufficient for the incidence of cancer in Australia, and the demand for oncologists is expected to increase as the aging population continues to develop [7]. Therefore, it is important that a sufficient number of medical students choose to specialize in oncology. However, in this study, 46% of medical students graded the importance of a career in medical oncology as low.

Previous studies indicate that the quality and quantity of the education provided in a subject is an important factor in student decisions to specialize in that field [8,9]. A study completed by French oncology residents found that exposure to oncology as a medical student was a factor involved in 83% of student decisions to choose oncology as a specialty [8]. Furthermore, a survey completed by 488 participants from 14 medical schools in the United Kingdom found that students were more likely to choose urology as a specialty if they had more hours of urology teaching, if they attended urology theater sessions, and if they had confidence in performing urological procedures [10]. This may in part explain the lack of interest in oncology by Australian medical students, as only 68% were taught oncology theoretically and clinically, 79% were dissatisfied with the number of teaching hours, and 68% were dissatisfied with their level of clinical exposure. A study that found that Australian medical interns in 2006 had less opportunity to examine cancer patients than interns did in 1990 [5,6]. These data raise a question whether the oncology education provided by Australian universities is of sufficient quality and quantity to gain the interest of students and to make them feel confident that they have the knowledge and skills required to enter the specialty. Our participants were not the true representation of nationwide universities and their medical oncology teaching program. We think structured and collaborative future studies in this direction would be essential to address these important aspects.

The development of a standardized curriculum to improve student education in the rapidly changing field of oncology is crucial to ensuring that medical graduates are well equipped to care for oncology patients. Therefore, we propose the development of a centralized body to standardize the oncology curriculum across Australian medical schools by updating the Ideal Oncology Curriculum or starting a new process altogether, thereby ensuring a high-quality oncology education for all medical students.

Results from this pilot study suggest that an exclusive oncology rotation may be of value in improving students' confidence and interest in the field. Indeed, this result is supported by another survey where a brief 2-week rotation was found to have significant value in improving student's confidence to care for patients in an oncology clinic [11]. The oncology curriculum could also be improved by making it mandatory for all medical students to complete an exclusive oncology rotation. This is evident as students who complete exclusive rotations are more likely to choose to specialize in that field [11-13]. A survey completed by 36 medical students before and after an oncology clinical rotation found that students were more confident in an oncology clinic after the rotation [11]. In our study, only 43% of the participants completed an exclusive oncology rotation, and 64% stated that they would not specialize in oncology because they lacked a sufficient understanding of the field. Therefore, by making it mandatory for all medical students to complete an exclusive oncology rotation, students are more likely to gain confidence and subsequently choose oncology as a specialty.

Limitations

The limitations of this pilot study include the low number of participants recruited and the enrollment of only medical students and interns rotating through a rural Australian center. These factors limit its generalizability and the ability to draw meaningful conclusions. Furthermore, some participants were medical oncology interns on oncology rotations, who may have been biased because of their oncology experience. The lack of

participant demographics, while ensuring anonymity and encouraging participants to speak freely, is also a weakness.

Conclusions

Nevertheless, this small pilot study indicates that this group of Australian medical students is receiving education in medical oncology that could be improved. The lack of satisfaction with the quality of the education may be influencing the low numbers of students choosing to specialize in medical oncology. The area identified as requiring additional emphasis in this survey is the clinical application. A more detailed and broader survey may further delineate potential areas of priority in improving oncology education in tertiary institutions.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Online survey questions.

[PDF File (Adobe PDF File), 24KB - mededu_v3i2e23_app1.pdf]

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Original Paper

Systems-Based Training in Graduate Medical Education for Service Learning in the State Legislature in the United States: Pilot Study

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Abstract

Background: There is a dearth of advocacy training in graduate medical education in the United States. To address this void, the Legislative Education and Advocacy Development (LEAD) course was developed as an interprofessional experience, partnering a cohort of pediatrics residents, fourth-year medical students, and public health students to be trained in evidence-informed health policy making.

Objective: The objective of our study was to evaluate the usefulness and acceptability of a service-based legislative advocacy course.

Methods: We conducted a pilot study using a single-arm pre-post study design with 10 participants in the LEAD course. The course's didactic portion taught learners how to define policy problems, research the background of the situation, brainstorm solutions, determine evaluation criteria, develop communication strategies, and formulate policy recommendations for state legislators. Learners worked in teams to create and present policy briefs addressing issues submitted by participating Illinois State legislators. We compared knowledge and attitudes of learners from pre- and postcourse surveys. We obtained qualitative feedback from legislators and pediatric residency directors.

Results: Self-reported understanding of the health care system increased (mean score from 4 to 3.3, *P*=.01), with answers scored from 1=highly agree to 5=completely disagree. Mean knowledge-based scores improved (6.8/15 to 12.0/15 correct). Pediatric residency program directors and state legislators provided positive feedback about the LEAD course.

Conclusions: Promising results were demonstrated for the LEAD approach to incorporate advocacy training into graduate medical education.

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KEYWORDS

health policy; education, public health professional; education, medical; legislation, medical; problem-based learning; knowledge management; interdisciplinary communication

Introduction

Since the 1970s, both US legislators and the public have shown diminished confidence in physician leadership [1,2]. In contrast, national health care and policy leaders are calling upon physicians to be trained in policy and advocacy in order to provide optimal care for their patients [3-5]. This shift in physician practice is emphasized by the American College of Graduate Medical Education. Milestones were implemented in 2015 as evaluation criteria for graduate medical education. For example, pediatric residents are expected to develop the ability to "advocate for quality patient care and optimal patient care systems" [6] and to "work in interprofessional teams to enhance patient safety and improve patient care quality" throughout their course of training [7].

There are very few published studies of curricula that train health care professionals in advocacy to provide optimal patient care [5,8,9]. Studies of these curricula conclude that involvement in an advocacy course increased the learner's likelihood of pursuing future advocacy and that involvement of legislators led to more meaningful policy results [8,9]. However, we found no curricular descriptions of learners partaking in a dialogic process with legislators to understand values and issues and then using knowledge brokering to arrive at policy solutions and recommendations.

To address this void in health professional education, a multidisciplinary faculty committee at the University of Illinois at Chicago, USA, created the Legislative Education and Advocacy Development (LEAD) course to train pediatrics residents, public health students, and fourth-year medical students to think critically about health care, analyze policy, and communicate effectively about policy through the method of legislative briefing. The LEAD course sought to help learners to discern the actors and institutions involved in the policy-making process; critically examine the context of policy developments; appreciate how issues are placed on the policy-making agenda; understand the process of policy development, implementation, and modification; and apply dominant conceptual theories of the policy-making process to a critical health issue.

The LEAD curriculum therefore drew from previously established advocacy training programs to provide learners with the tools to understand and engage in health policy making [8,9]. The LEAD course incorporated project-based learning to enhance the learner experience and cultivate competencies outside of the traditional classroom setting [10,11]. Advanced organizers, which have been shown time and again to reduce cognitive load by providing methodological scaffolding, were an important addition to the course [12,13]. However, the LEAD course's key innovation was the incorporation of knowledge brokering: bringing health science professionals, state legislators, and other stakeholders together to facilitate knowledge interaction and intermediation in the service-based learning process [14,15]. This approach went beyond the traditional linear knowledge-deliverance model because it was iterative and invoked active participation from all involved parties to develop new ideas and foster meaningful legislative action [16]. Our first aim with the LEAD curriculum was to measure learners' demographics and changes in knowledge. We hypothesized that there would be significant improvement in our learners' knowledge. Since there are very high correlations between symbolic political attitudes and political behaviors [17-19], our second aim was to measure learners' attitudes before and after the course. We hypothesized that attitudes, which are symbolic in nature and thus resistant to change, would not shift significantly, but might change slightly [18-20]. Our final aim was to gather feedback from all invested parties: learners, pediatric residency program directors, and state legislators. We hypothesized that our program would be well received and considered a valuable addition.

Methods

We used a single-arm pre-post study design to study the feasibility of the LEAD course and its impact on attitudes and knowledge among learners.

Setting

We purposively invited pediatrics residents, fourth-year medical students, and public health students by email to participate in the 2-week LEAD course. A pediatrics faculty member with 3 years of policy experience and a public health faculty member with 20 years of policy experience were the instructors for the course. The course and study were conducted in February 2016. We expected learners to spend about 40 hours per week on their work. This time was divided thusly: 30 hours per week spent on modules and preparation with the group, and 10 hours per week on lectures and mock panels. Learners' pre- and postcourse surveys were printed, self-administered, and anonymous to ensure privacy, and therefore completion of the surveys did not affect learners' grades in the course. Additionally, only approved members of the research team had access to the surveys to ensure confidentiality.

We received ethical approval from the Institutional Review Board of the University of Illinois at Chicago (December 21, 2015, Research Protocol # 2015-1084). The study was consistent with the ethical standards of the Declaration of Helsinki. All learners provided verbal informed consent to participate in the study; this was obtained by the lead author and not recorded.

Curriculum

The curriculum had two parts: didactics and experiential learning.

Learners participated in didactics, largely grounded in the works of Bardach, concerning background and landscape discovery, reiterative formulation of problem statements, and decision-making criteria [12]. Learners were instructed in the

use of an advanced organizer that contained the core elements of a policy brief: issue statement, background, landscape, options and analysis, and final recommendation. Multimedia Appendix 1 shows this advanced organizer. The course objectives (Multimedia Appendix 2) were based on the advanced organizer. The curriculum focused on training learners to support recommendations with evidence and to use the advanced organizer for structure. Emphasis was also placed on developing legislator-derived, value-based criteria to evaluate each option and produce a final recommendation. An interactive overview of the state-level policy-formulation process was also provided. Learners participated in the policy-formulation process with extensive faculty mentorship and discussion. Beyond guidance on creating policy brief documents, participants also honed their oral presentation skills.

Concurrently, learners worked in 4 independent interdisciplinary teams to create briefs based on specific child health queries submitted directly from the state legislators. Learners discoursed both in live groups and virtually by cocreating briefs through Google Docs (Google Inc). Some examples of queries are lead abatement, gun control, access to home care services for disabled children, and licensure of professional midwives. In creating these briefs, learners used legislator values to create decision-making criteria, which guided research and policy analysis. Multimedia Appendix 3 shows an example of a decision-making chart. Learners presented their briefs during guided role play involving a panel of LEAD faculty and guest experts from the Department of Pediatrics and the School of Public Health, University of Illinois at Chicago. Additionally, participants identified and resolved common pitfalls encountered during the policy brief creation process [20]. The final product was a polished presentation with accompanying full-length and summarized policy briefs. Finally, learners formally presented their policy analysis and recommendations to state legislators and received feedback.

Measures

Knowledge

We assessed knowledge with 15 questions on the pre- and postcourse surveys. These questions tested learners on factual data such as major US health care policies, components of a policy brief, and identification of state legislators and their governmental roles. Of these 15 questions, 13 were multiple choice questions with 4 to 12 answer choices, and 2 were free-response questions: “Who is your district’s state Senator?” and “Who is your district’s state Representative?” The highest possible correct total score was 15.

Attitudes

The pre- and postcourse surveys gave 13 attitude questions with possible answers ranging from 1=strongly agree to 5=strongly disagree. We analyzed each question separately. Content was adapted from 2 previously reported questionnaires on medical students’ and residents’ attitudes [21,22]. The 13 questions are tabulated below. Questions 1 and 2 were adapted from Stafford et al [22], questions 3 through 5, 7, 8, and 10 through 13 were from Emil et al [21], and questions 6 and 9 are original to this study.

Program Feedback

Learners were asked questions concerning quantity, quality, and engagement in past and present health policy instruction via the pre- and postcourse surveys. Questions 1 and 2 were rated from 1=excellent to 4=poor, questions 3 and 4 were rated from 1=excellent to 4=N/A (ie, not applicable), and questions 5 and 6 were rated from 1=strongly agree to 5=strongly disagree. To further measure feasibility and gauge interest among pediatric residency program directors, we presented the curriculum as a workshop at the Association of Pediatric Program Directors 2016 annual meeting and collected feedback. In addition to open-ended feedback, the 9 pediatric residency program directors who viewed the presentation were asked “Would you want this type of experience at your institution?” State legislators were queried in an open-ended format regarding their experience.

Analysis

Due to an insufficient number of paired responses, we did not perform inferential statistical tests for the knowledge and attitudes questions. As applicable, we assessed program feedback data with a Wilcoxon signed rank test and otherwise assessed the feedback qualitatively for themes. We conducted statistical analyses using SAS version 9.4 (SAS Institute). All *P* values were 2-tailed. Thematic analysis of legislator and pediatric residency program director feedback was performed by 2 independent raters who evaluated all themes. Discrepancies were resolved by consensus.

Results

A total of 10 learners provided pre- and postcourse surveys. We received 9 responses for demographic data (90% response rate), 5 precourse knowledge surveys (50% response rate), 7 postcourse knowledge surveys (70% response rate), 8 precourse attitude surveys (80% response rate), 7 postcourse attitude surveys (70%), and 10 sets of program feedback data (100% response rate). However, many of the pre- and postcourse attitude surveys were incompletely filled out by learners, and on further inspection it appeared this was partly due to secretarial issues, with some questions printed on the back of the page. We received qualitative feedback from 4 state legislators and 9 pediatric residency directors. Table 1 shows the demographics and characteristics of responders.

Table 1. Demographics and characteristics of participants in the Legislative Education and Advocacy Development course (n=10).

Characteristics	n	%
Sex		
Male	6	60
Female	2	20
No response	2	20
Age (years)		
22-25	1	10
26-29	2	20
30-33	2	20
>34	3	30
No response	2	20
Race/ethnicity		
White (non-Hispanic)	1	10
Black (non-Hispanic)	3	30
Hispanic or Latino	2	20
Asian or Pacific Islander	1	10
Other	1	10
No response	2	20
Degrees earned		
MD/DO	5	50
Bachelor's degree	8	80
Master's degree	2	20
PhD	0	0
MPH	2	20
No response	2	20

Knowledge

Learners' scores improved from a mean of 6.8 out of 15 to 12.0 out of 15 by the end of the course (Figure 1). Given the lack of overlap between the pre- and postcourse 95% confidence intervals, we noted a pattern toward improved knowledge. The lower limit of the postcourse knowledge score (10.49) did not include the upper limit of the precourse knowledge score (9.89). As there were only 3 sets of paired responses, we could not conduct an analysis with *P* values.

Attitudes

Table 2 highlights the pre- and postcourse mean attitude scores. Attitudes were generally consistent from the pre- to postcourse surveys. Of the 13 items, 2 showed changes of 0.50 or more, toward greater recognition of the importance of health policy (question 6) and that the health care system should be government controlled rather than free market (question 9).

Program Feedback

Table 3 shows the pre- and postcourse means for feedback measures of the LEAD course. Self-reported understanding of the health care system significantly improved, with mean Likert scores improved from 3.0 (fair) to 2.3 (good) (*P*=.01). Additionally, learners reported that health care policy instruction *prior* to the LEAD course was "little" in quantity and only "fair" in quality. Learners agreed they would be more likely to engage in health policy, and more likely to recommend to a colleague to engage in health policy learning, than they would have been 1 month prior to the end of the course.

Figure 1. Mean and 95% CIs of pre- and postcourse knowledge scores.

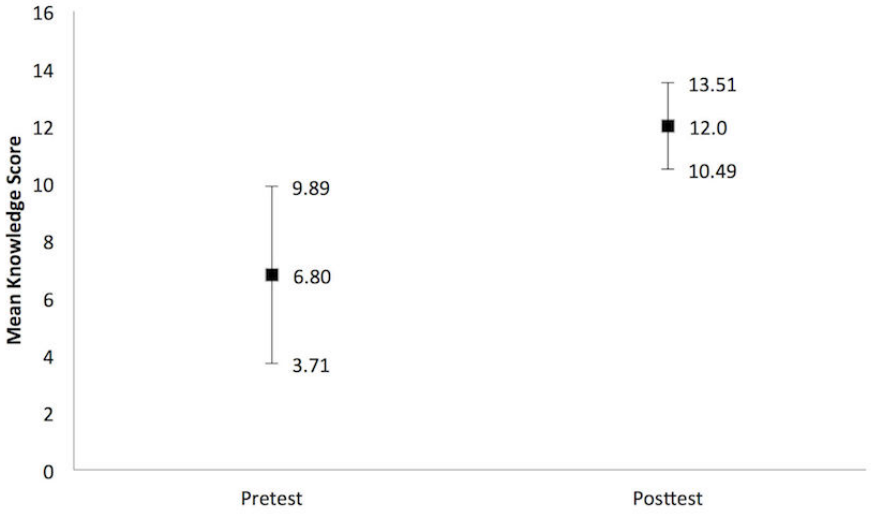

Table 2. Mean pre- and postcourse attitude scores[a], with number of responders.

	Statement	Pretest mean (SD)	Posttest mean (SD)
1	It is part of my job as a physician to advocate for policy change on behalf of children.	1.38 (0.74) (n=8)	1.29 (0.49) (n=7)
2	I feel that my role as a health advocate extends beyond the individual patient(s) I am treating.	1.25 (0.46) (n=8)	1.14 (0.39) (n=7)
3	I plan to take leadership in health care policy issues as a physician.	1.75 (0.71) (n=8)	1.57 (0.54) (n=7)
4	I plan to support universal health care coverage as a physician.	1.50 (0.54) (n=8)	1.29 (0.49) (n=7)
5	I don’t expect to have any time to be active politically as a physician.	3.75 (0.89) (n=8)	3.86 (0.90) (n=7)
6	Health policy will have no effect on how I care for my patients.	4.50 (0.58) (n=4)	5.00 (0.00) (n=7)
7	The government should guarantee health care access for all citizens.	1.25 (0.50) (n=4)	1.29 (0.49) (n=7)
8	The government should provide health care access for all citizens, even if higher taxation is needed to generate sufficient revenue.	2.00 (1.41) (n=4)	1.57 (0.54) (n=7)
9	I would prefer my health care system to be “free market” rather than government controlled.	3.00 (0.00) (n=4)	3.57 (0.79) (n=7)
10	The government should regulate the prices of health care services.	2.50 (1.00) (n=4)	2.29 (0.49) (n=7)
11	Health care services would improve if the government had no involvement in health care.	4.25 (0.50) (n=4)	4.29 (0.95) (n=7)
12	All citizens should have access to the same standard of medical care without regard to their financial means.	1.50 (0.58) (n=4)	1.71 (1.50) (n=7)
13	All children should have access to the same standard of medical care without regard to their financial means.	1.00 (0.00) (n=4)	1.43 (1.13) (n=7)

[a]Answers ranged from 1=strongly agree to 5=strongly disagree.

Table 3.

Questions	Precourse mean (SD)	Postcourse mean (SD)	*P* value
1. How would you rate your understanding of your health care system?	3.00 (0.67)	2.30 (0.48)	.01
2. How would you rate your understanding of health care systems in other "advanced/developed" countries?	3.30 (0.05)	3.00 (0.67)	.05
3. How would you rate the quantity of instruction on health care policy received in your current training program?	2.70 (0.67)	N/A[b]	N/A
4. How would you rate the quality of instruction on health care policy received in your current training program?	2.89 (1.27)	N/A	N/A
5. The current likelihood of my engaging in health policy activity/activities has increased compared to 1 month ago.	N/A	2.29 (0.82) (n=7)	N/A
6. The current likelihood of my recommending that my colleagues engage in health policy learning has increased compared to 1 month ago.	N/A	2.43 (1.41) n=7	N/A

[a]Questions 1 and 2 were rated from 1=excellent to 4=poor, questions 3 and 4 were rated from 1=excellent to 4=N/A, and questions 5 and 6 were rated from 1=strongly agree to 5=strongly disagree.

[b]N/A: not applicable.

We queried 4 state legislators about their experience with the LEAD course, and their responses were positive. Specifically, 2 state legislators expressed themes of efficacy. For example, 1 legislator wrote that this was "a thoughtful and well-researched brief that greatly improved my understanding in the area." All state legislators expressed a desire to continue participating. For example, 1 legislator wrote, "I look forward to working with the learners again next year." Of 9 pediatric residency program directors queried at the national conference, 8 (89%) said yes and 1 (11%) said maybe, regarding their desire for this type of course at their institution. Qualitatively, they found the experience insightful, were interested in viewing the didactics, and would like to incorporate LEAD into their training program.

Discussion

Principal Findings

The hypotheses for our LEAD course pilot study were all supported. We found that knowledge improved from pre- to postprogram. We found that attitudes were generally consistent from pre- to postprogram. We found that the pilot was well received by learners who took the course, pediatric residency program directors who may choose to implement the course, and the state legislators who participated in the course.

Knowledge improved meaningfully when learners' scores improved (6.8/15 to 12.0/15) on the postsurvey questionnaire. Knowledge outcomes among health policy training programs for medical students and residents to date have been self-assessed [5,9]. One study using learners' self-assessed knowledge improvement found a statistically significant increase in 5 areas of knowledge [9]. A previous study asked learners to self-assess their knowledge before and after course completion across several topics, including quality of and access to care, Medicaid and Medicare, and the role of government in health policy [9]. Both methods of evaluation have shown improvement in knowledge. Our findings within the LEAD program were consistent with other approaches demonstrating improved knowledge.

As hypothesized, scores on attitude questions for LEAD learners did not generally change between pre- and postcourse. This was likely a product of the already extreme Likert responses at baseline and the small sample, which self-selected into a policy course. Categorically stable attitudes that are held over time tend to better predict behavior than attitudes that change [23]. Two questions demonstrated variation: question 6 (greater recognition of the importance of health policy) and question 9 (health care system should be government controlled rather than free market), which both moved 0.50 points along the scale. While the cohort of learners who partook in the LEAD course generally displayed categorically stable attitudes, one potential caveat to this stability and general trend toward "progressive" attitudes was an apparent internal inconsistency between learners' signaled general support for universal health care and their support for financial means testing. Scores for question 12 showed that learners were more likely to consider "financial means testing" after the course. Although this may reflect a dichotomy between principles and the means of achieving principled goals, policy "targeting" (eg, financial means testing) is not necessarily juxtaposed to universalism [24]. It is possible that these learners were signaling greater nuance in their understanding of redistributive policy, a product of engaging with contradictory forces in a highly complex system [25].

Measuring attitudes is important, since attitudes may correlate closely with long-term behavioral outcomes in general [17-19], and specifically are thought to be indicators of health professional behaviors [26]. A previous study gauged the attitudes of learners in California, USA and Ontario, Canada [23]. The LEAD cohort of learners more closely reflected the participants of the Ontario than of the California cohort, but the LEAD learners were more agreeable than both the Ontario and California cohorts. For instance, both Ontario and California learners "agreed" while LEAD learners "strongly agreed" that they planned to become involved and take leadership in health care policy issues as a physician. We suggest that demography and self-selection into a policy course are possible reasons for attitudes discrepant with those previously reported [23].

Another focus of our study was to measure feedback from the 3 key types of players in the LEAD course: learners who took the course, pediatric residency program directors who may choose to implement the course, and the state legislators who participated in the course. There was broadly positive feedback from learners, pediatric residency program directors, and state legislators. More specifically, evaluative data from learners suggested that their understanding of the health care system improved, and prior to our course, their health care policy training was quite limited. In addition, the learners indicated a "good" likelihood of both engaging in health policy activities and recommending that a colleague engage in health policy learning. This is important because we know that learners' subjective opinions about a course directly translate to both their long-term behavioral changes and their underlying satisfaction with their education [27]. These feedback data from pediatric residency program directors is a measure of external validation, as these program directors were from different academic centers and therefore may have provided greater objectivity concerning programmatic strengths [28]. As demonstrated by responses from the pediatric residency program directors, LEAD would be a desirable addition to other pediatric residency programs. The LEAD curriculum can be easily exported to diverse residency programs, as it has no specific geographical or institutional requirements.

Although legislators have previously signaled a desire to work with undergraduates, none have been surveyed in the context of graduate medical education [29]. As demonstrated by the positive response of the state legislators, it is reasonable to assume that we brokered a meaningful interaction between the learners and legislators. Therefore, it is likely that state legislators who are interested in improving the health of their communities would be willing to participate with future iterations of LEAD. To further institutionalize this approach, educational leaders can work with legislative leaders and their staff to strengthen the didactic and formative learning approach. For instance, in Illinois, the LEAD leadership team worked closely with the leaders of the legislative caucuses—House and Senate Democrats and Republicans—to identify issues and active bills that might serve as centerpieces for engaged interprofessional service-based learning.

Limitations

This study has several limitations. First, the sample size was small. Second, we did not use a control group. This limited the ability to assess attitudes and knowledge of those medical students, residents, or public health students not participating in an intensive advocacy experience. Third, the lack of responses limited the ability to perform certain inferential statistical tests. Fourth, we did not collect data on how learners used their time; this would have been valuable to examine and perhaps compare with other advocacy training programs. Future research should study this topic with a larger sample and a control group.

Conclusion

There were promising results from the LEAD course as an acceptable and useful tool incorporating advocacy training into graduate medical education in the United States. The LEAD curriculum should be considered by institutions and programs seeking to help generate a new cadre of policy leaders from within the health professions.

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Conflicts of Interest

None declared.

Multimedia Appendix 1

Advanced organizer.

[PDF File (Adobe PDF File), 38KB - mededu_v3i2e18_app1.pdf]

Multimedia Appendix 2

Course objectives.

[PDF File (Adobe PDF File), 11KB - mededu_v3i2e18_app2.pdf]

Multimedia Appendix 3

Decision-making chart.

[PDF File (Adobe PDF File), 17KB - mededu_v3i2e18_app3.pdf]

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Abbreviations

LEAD: Legislative Education and Advocacy Development

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Original Paper

Selection and Use of Online Learning Resources by First-Year Medical Students: Cross-Sectional Study

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Abstract

Background: Medical students have access to a wide range of learning resources, many of which have been specifically developed for or identified and recommended to them by curriculum developers or teaching staff. There is an expectation that students will access and use these resources to support their self-directed learning. However, medical educators lack detailed and reliable data about which of these resources students use to support their learning and how this use relates to key learning events or activities.

Objective: The purpose of this study was to comprehensively document first-year medical student selection and use of online learning resources to support their bioscience learning within a case-based curriculum and assess these data in relation to our expectations of student learning resource requirements and use.

Methods: Study data were drawn from 2 sources: a survey of student learning resource selection and use (2013 cohort; n=326) and access logs from the medical school learning platform (2012 cohort; n=337). The paper-based survey, which was distributed to all first-year students, was designed to assess the frequency and types of online learning resources accessed by students and included items about their perceptions of the usefulness, quality, and reliability of various resource types and sources. Of 237 surveys returned, 118 complete responses were analyzed (36.2% response rate). Usage logs from the learning platform for an entire semester were processed to provide estimates of first-year student resource use on an individual and cohort-wide basis according to method of access, resource type, and learning event.

Results: According to the survey data, students accessed learning resources via the learning platform several times per week on average, slightly more often than they did for resources from other online sources. Google and Wikipedia were the most frequently used nonuniversity sites, while scholarly information sites (eg, online journals and scholarly databases) were accessed relatively infrequently. Students were more likely to select learning resources based on the recommendation of peers than of teaching staff. The overwhelming majority of the approximately 70,000 resources accessed by students via the learning platform were lecture notes, with each accessed an average of 167 times. By comparison, recommended journal articles and (online) textbook chapters were accessed only 49 and 31 times, respectively. The number and type of learning resources accessed by students through the learning platform was highly variable, with a cluster analysis revealing that a quarter of students accessed very few resources in this way.

Conclusions: Medical students have easy access to a wide range of quality learning resources, and while some make good use of the learning resources recommended to them, many ignore most and access the remaining ones infrequently. Learning analytics can provide useful measures of student resource access through university learning platforms but fails to account for resources accessed via external online sources or sharing of resources using social media.

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KEYWORDS

information-seeking behaviors; educational technologies; e-learning; learning analytics

Introduction

Background

Medical students routinely turn and are directed toward online information sources and services [1-2]. Course-related learning activities are typically well-supported with resources delivered through institutional learning platforms, while university libraries provide access to online collections of reliable and authoritative biomedical science and clinical resources. The ready accessibility of these resources drives educator expectations that students will locate, access, and assimilate them to support their learning. However, medicine is one of the most time-poor and information-rich professions, and when faced with too much information, too many choices, and not enough time, students may resort to superficial information seeking and retrieval strategies [3-4].

The first year of the medical curriculum often emphasizes biosciences over clinical learning. Students draw on a range of information to support their bioscience learning, although lectures and lecture materials continue to play a central role. Knowledge gained through lectures is often assimilated or applied to the clinical context through problem- or case-based learning approaches. One of the key assumptions underpinning these approaches is that students will self-direct their learning. That is, they will independently locate, access, and assimilate appropriate information to build their knowledge base and develop the necessary understanding and experience to apply and transfer this knowledge. Previous generations of medical students would have relied heavily on their own lecture notes, key textbooks, and physical access to their library. This scenario has clearly changed over the past 20 or more years as online resources have grown in number, quality, and availability. While data on the decline in student use of their own notes and textbooks is scant and largely anecdotal, the decline in physical use of academic libraries is clearly documented. Martell [5], for example, describes changing usage patterns among the 124 North American Association of Research Libraries (ARL) libraries between 1995 and 2006, documenting an overall decline in circulation of 26%—and 58% for specialist medical libraries—over that time. More recent data from ARL libraries [6] and from our own university library suggest that this trend is continuing, with a 70% fall in print circulation in our own biomedical library between 2006 and 2015. However, the number, variety, and academic use of electronic library resources has increased dramatically over the same period. Again, reliable usage data are somewhat hard to come by although Martell [5] reports an approximately 440% increase in electronic transactions (to approximately 5.7 million per year) for Harvard University's library from 2001 to 2006. Our own university experienced a more than doubling of accesses of key eBook collections (to around 1.5 million) between 2013 and 2015. While the number and scope of scholarly articles or documents available to students will vary somewhat from institution to institution, recent estimates put the number of documents indexed by Google Scholar at around 160 million [7].

Despite students having ready access to such a broad range of scholarly resources (eg, online journals and databases), including many high-quality biomedical science and clinical resources, previous studies suggest that many medical students tend to rely on a limited number of resources and resource types [8-9]. While not specifically referring to medical students, Head [10] talks about student use of "tried and true" resources, which typically include course readings, Google, Wikipedia, and—less frequently—library databases. Not all of these resources necessarily meet expected standards, leading to concerns that medical student information-seeking strategies may favor convenience and expediency over quality and reliability [2,11-13].

Against such concerns, current students are also more likely to be explicitly provided with or at least directed to key learning resources. Detailed lecture notes and lecture recordings are routinely provided through institutional learning platforms, and the provision of links to recommended texts, websites, and scholarly articles means that access is usually only a click away. Increasingly, there is an expectation on the part of students that these resources will be provided to them. This feeds an expectation by teaching staff that the resources will be used by students, ensuring that key curriculum content is delivered and that student self-directed learning activities are supported. It also helps to justify the additional demands and costs associated with the production and delivery of quality online learning materials. Yet, despite the widespread adoption of online learning platforms, most of which can produce detailed information about their access and use (ie, learning analytics), we still know relatively little about the number, type, and sources of learning resources that medical students routinely select and access. Moreover, learning analytics can only provide part of the picture as they often only capture resource access and use that occurs through institutional learning platforms, ignoring student use of favored sites and tools like Google, Wikipedia, and, increasingly, social media for sharing information and resources [2,14].

The primary aim of this study then was, where practical, to document and analyze medical students' selection and use of (primarily online) learning resources. This should help us to identify which types of learning resources are most used and most useful, and conversely, those that are underused or less useful. In addition, we sought to assess whether student selection and use of the resources aligned with medical educator and information specialist expectations. That is, to what extent does the identification, provision, and recommendation (either explicit or implied) of learning resources to students drive their use. Such findings should be of considerable interest to medical educators and scholarly information specialists (librarians), whose responsibility it is to identify, develop, and deliver effective learning resources to support medical students' learning.

Study Context

The purpose of this section is to provide context for the measurement, analysis, and interpretation of resource selection and use by first-year medical students. While it describes key elements of a specific medical curriculum, most of these elements, and the learning and teaching approaches they embody, are not unique.

The Melbourne Doctor of Medicine (MD) is a full-time, masters-level course. The first year takes place on campus and delivers biomedical science-oriented lectures and practicals within a framework of small group tutorials focused around weekly clinical cases. A supplementary series of small group tutorials is designed to prepare students for the clinical phase of the course (years 2 to 4).

The first-year curriculum is designed to consolidate student biomedical science knowledge and prepare them for clinical placements. Most learning activities and content are embedded within 2 year-long subjects. Foundations of Biomedical Science (FBS) comprises a mix of biomedical science lectures, clinical cases, and practical classes and is designed to develop and consolidate student knowledge across the main bioscience and biomedical disciplines. Concepts and content are taught using an integrated body systems approach with an emphasis on the application of bioscience knowledge in a clinical context. Principles of Clinical Practice (PCP) introduces and develops a series of core clinical skills, including the medical interview, physical examination, and diagnostic reasoning. Delivered through a series of weekly small group tutorials, PCP topics and activities are aligned with the body systems framework of FBS and are designed to emphasize the links between student biomedical science knowledge and clinical practice.

Clinical cases within FBS are delivered using a case-supported learning (CSL) approach. CSL encourages hypothetical reasoning and is designed to help students construct mechanistic representations of normal and abnormal processes based on their developing bioscience knowledge. CSL is delivered via small group tutorials at the beginning and end of each week. Tutors introduce the case during the first tutorial and assist students to identify salient learning issues and how these might be investigated. Students carry out these investigations during the week through a combination of self-directed and collaborative learning, which takes place around a program of lectures and tutorials. Students share their findings during the second tutorial and with the tutor's assistance develop a comprehensive pathophysiological mechanism to explain the case.

Delivery of the first-year curriculum is supported by MD Connect, a bespoke learning platform developed within our medical school, that has over 3000 users comprising students, teaching staff, clinicians, and administrative support staff. It provides full curriculum mapping and timetabling within which learning events such as lectures, tutorials, and practicals are linked to curriculum resources. First-year students interact with the learning platform via a series of activity- and resource-based interfaces including the following:

- Timetable: a personalized weekly timetable/calendar with embedded links to activity-based learning resources
- Curriculum: a navigable curriculum map with embedded links to activity-based learning resources
- Search: simple searching of curriculum resources
- Library: a curated selection of open and subscription-based scholarly resources

Online Resources

The learning platform mediates access to a comprehensive set of high-quality bioscience, biomedical, and clinical resources. These are drawn from an extensive curriculum database plus a selection of scholarly information sources and repositories. The curriculum database contains a detailed map of the formal curriculum with extensive linking between learning activities and supporting resources. All resources are tagged based on a series of contextual criteria. Key resource types are outlined in Table A of Multimedia Appendix 1.

Students access learning resources through the learning platform in a variety of ways. Curriculum resources (ie, resources that are explicitly mapped to formal learning activities) are typically accessed via the Timetable or Curriculum interfaces. Timetabled activities provide links to any associated learning resources, allowing for direct access. The Curriculum interface provides a navigable map of the curriculum down to the level of individual learning activities. Resources are linked to these activities as in the Timetable interface. The Library interface aggregates key bioscience, biomedical, and clinical resources and services, including academic journals, online textbooks, scholarly databases (eg, PubMed, Web of Knowledge), and clinical resources (eg, Clinical Key, BMJ Best Practice). Individual library resources are also linked to specific learning events within the curriculum database and can be accessed via the Timetable and Curriculum interfaces.

Methods

The study draws on 2 main sources of data: a detailed survey of MD student selection and use of learning resources and learning analytics based on log file analysis of student use of the learning platform.

Resource Use Survey

A paper-based survey of MD student selection and use of (primarily online) learning resources was administered to all first-year students in October 2013. Permission to administer the survey was granted by the human ethics committee of our university, and participation in the survey was optional and anonymous. The full survey contained 28 items (most of which contained a series of subitems) organized into 5 distinct sections covering student demographics, resource and information seeking, resource sharing, resource types, and the timing of resource use. Only data relating to items from the resource and information seeking section are relevant to this study and presented here. The items in that section were primarily designed to assess the frequency with which students access learning resources through the learning platform and from other sources. However, they also queried student perceptions of the usefulness, quality, and reliability of these resources; their

sources; and their motivation for selecting particular resources or resource types. All items required participants to respond by selecting an option on a 5-point Likert scale. Frequency of use items were scored according to: 1=less than monthly, 2=less than weekly, 3=once or twice a week, 4=on most days, and 5=more than once per day. Usefulness items were scored from 1=not at all useful to 5=extremely useful. The quality and reliability items were scored from 1=very low to 5=very high, and agreement items were scored from 1=strongly disagree to 5=strongly agree. A total of 72.7% (237/326) of first-year students returned survey responses of which 36.2% (118/326) were complete for the resource and information seeking section. Only those 118 survey responses were analyzed for this study.

Learning Platform Analytics

Detailed logs of first-year student use of the learning platform were captured over an entire semester (July to December 2012; 325 of 337 enrolled students used the learning platform during this period). Logs were captured on a per user per session basis and consisted of a detailed sequence of user actions or data requests (events), with each event described by a type, context, and timestamp. It is important to note that the survey and the log data are drawn from successive first-year student cohorts rather than the same cohort as, due to technical changes in the learning platform, detailed usage data were not available for 2013.

Data Analysis

The survey data were analyzed using a combination of descriptive and comparative statistics and exploratory cluster analysis. Likert responses were interpreted as interval rather than ordinal data [15] allowing comparisons of related groups of items to be carried out using 1-way repeated measures analyses of variance. Comparisons of individual items within these groups were conducted using pairwise *t* tests applying the Bonferroni correction to reduce the likelihood of type I errors. Variation between individual responses was explored using k-means cluster analysis. Determination of an appropriate number of clusters was informed by plotting the percentage variation in the within-groups sum of squares values for a range of k (where k equals the number of clusters) values and identifying the k value beyond which further reduction in the within-group sum of squares was reduced [16]. All analyses were carried out using the R Studio software package (The R Foundation).

Analysis of the learning platform log data was also descriptive and exploratory. Raw log data was processed, abstracted, and analyzed using custom parsing routines to produce a series of simple measures of resource use based on which students accessed them, how they were accessed (ie, which interface within the learning platform was used to access them), and the type of learning activity they were associated with.

Variation in access patterns between users was again explored through k-means cluster analysis. The data matrix for this analysis consisted of a binary access value for every learning resource accessed by at least 1 first-year student during the target semester.

Results

Resource Use Survey

The results of the survey items are presented in Tables 1-3. These 3 tables contain abbreviated descriptions of the items rather than the actual wording of the item. The values are means of the item responses (based on a 5-point Likert scale), and in each case the 1-way repeated measures analyses of variance conducted on these groups of items revealed highly significant differences between them ($P<.001$).

Students reported accessing resources through the learning platform several times a week on average, slightly more frequently than they did for other online sources. Only 11 of the 118 students reported accessing learning resources from the learning platform less often than weekly, and only 2 reported that the resources they accessed through it were not useful. Physical textbooks were used less frequently (approximately weekly). When using the learning platform, students reported they were more likely to access resources through the Timetable interface (approximately daily) than through the Curriculum, Search, or Library interfaces (once or twice a week). When finding and accessing online resources from outside the learning platform, students most often turned to general search engines and Wikipedia (approximately daily) and Facebook (several times per week). The university library and Google Scholar were used less often (approximately weekly). Students also regularly sought advice on their learning from their peers—up to several times a week versus less than weekly from teaching staff.

In line with the responses to the frequency of use items, students reported the learning platform as being more useful than other online sources for locating and accessing learning resources (Table 2). The learning platform's Timetable interface was particularly highly rated (useful to extremely useful). When seeking resources from outside the learning platform, students rated general search engines and Wikipedia as being slightly less useful than the learning platform's Timetable interface but significantly more useful than either Facebook, Google Scholar, or the university library (Table 2). In terms of the quality and reliability of learning resources located and accessed via the various sources, students again rated the learning platform most highly (Table 3). This was followed by other online sources generally, the learning platform's Library interface, and general search engines. Wikipedia was rated the lowest for both quality and reliability.

Table 1. Means of responses (5-point Likert scale to indicate less than monthly to more than daily) for survey items relating to the frequency of use of different learning resources or information sources.

Survey item	Mean[a]
Frequency of locating/accessing resources using...	
Learning platform generally	3.9 BC
Other online sources generally	3.5 C
Physical textbooks	2.8 D
Learning platform's Timetable interface	4.5 A
Learning platform's Curriculum interface	3.4 C
Learning platform's Search interface	2.9 D
Learning platform's Library interface	2.9 D
General search engines (including Google)	4.5 AB
Wikipedia	4.3 AB
Facebook	3.6 C
University library	2.9 DE
Google Scholar	2.6 EF
Frequency of seeking advice from...	
Peers	3.7 C
Teaching staff	2.0 F

[a]Means with nonoverlapping letter codes are significantly different ($P<.05$).

Table 2. Means of responses (5-point Likert scale to indicate not at all useful to extremely useful) for survey items relating to the usefulness of learning resources or information sources.

Survey item	Mean[a]
Usefulness for finding/accessing resources of...	
Learning platform generally	4.0 B
Other online sources generally	3.7 C
Learning platform's Timetable interface	4.4 A
Learning platform's Library interface	3.4 B
General search engines	4.3 BC
Wikipedia	4.2 BC
Facebook	3.0 DE
University library	3.3 D
Google Scholar	2.9 E

[a]Means with nonoverlapping letter codes are significantly different ($P<.05$).

Table 3. Means of responses (5-point Likert scale to indicate very low to very high) for survey items relating to quality and reliability of learning resources from different sources.

survey item	Mean[a]	
	Quality	Reliability
Resources available through...		
Learning platform generally	4.2 A	4.0 AB
Learning platform's Library interface	3.7 BCD	3.8 BCD
Other online sources generally	3.9 AB	3.7 CD
General search engines	3.7 BCD	3.6 CD
Wikipedia	3.6 CD	3.3 D

[a]Means with nonoverlapping letter codes are significantly different (P<.05).

Cluster Analysis

Inspection of the within-group sum of squares data suggested a 4-cluster solution. Membership and descriptions of these 4 clusters (groups) were as follows, with the text in parentheses indicating the approximate frequency of use or level of usefulness, quality, or reliability of the mentioned type of resource or method of accessing it.

Membership of all 4 groups was characterized by regular access of resources through the learning platform (on most days) and attribution of considerable value (useful to extremely useful) to the learning platform for locating resources and to the resources accessed through it. The median frequency of access of online resources from sources other than the learning platform varied between once or twice a week (groups 2 and 4) and on most days (groups 1 and 3).

Members of group 1 (n=22) were less likely than those in all other groups to agree that their selection of learning resources was influenced by external factors (eg, available time, convenience, recommendation by others). They were also most likely to access learning resources through the university library (on most days). Membership of group 2 (n=29) was characterized by less frequent searching for resources using either Google (on most days; all other groups reported using it more than daily) or the learning platform's Search function (less than weekly). They were also much less likely to use or find Facebook useful for accessing learning resources (less than weekly and not at all useful). Group 3 members (n=35) were the most likely to use Google, Wikipedia, and Facebook for accessing learning resources (more than daily). They were also more likely to find these sites useful and to rate the quality and reliability of resources they accessed through these sites highly. Members of group 4 (n=32) were the least likely to use physical textbooks or seek advice from teaching staff (less than monthly). They were also much less likely to access learning resources through the university library, either directly, through the learning platform, or via Google Scholar (less than weekly) or to find these sources of information useful.

Learning Platform Analytics

A total of 44,222 discrete sessions on the learning platform (per user median 118, maximum 577) with a median cumulative session time of 73.9 hours were logged and analyzed. That equates to an average of 4.5 sessions and 2.8 hours per user per week. Of the almost 1 million individual user actions or events that were captured, just over half were associated with use of the platform's Timetable interface. Users accessed 71,101 curriculum resources during the target semester, with most (90.99%) being accessed through the platform's Timetable interface.

Resource Use by Learning Platform Interface, Event, and Resource Type

Table B of Multimedia Appendix 1 lists the types and number of timetabled learning events and the number of resources linked to each through the Timetable and Curriculum interfaces. Table C provides a breakdown of the number and use of resources linked to timetabled learning events by resource type (see Table A also).

A total of 264 unique learning activities and 1079 linked resources were timetabled during the target semester. The most common timetabled learning activities were lecture (170/264), CSL tutorial (36/264), practical (24/264), and PCP tutorial (18/264). Almost two-thirds of all linked resources (685/1079, 63.48%) were directly associated with or derived from lectures (eg, lecture notes, lecture videos, or audio recordings), with the next most common resource types being journal articles (87/1079, 8.06%), websites (51/1079, 4.73%), and CSL case notes (36/1079, 3.36%).

Of those resources linked directly to lectures, 95.0% (685/721) were either lecture notes or lecture recordings. Lecture notes attracted the highest level of use, with each set being downloaded an average of 168.8 times and each user downloading an average of 93.7 different lecture note resources. Downloads of other resource types linked to lectures ranged from extremely low (eg, lecture audio: 2.9 downloads per resource) to moderately high (eg, textbook: 140 downloads per resource).

A further 358 resources were linked to timetabled events other than lectures, including CSL tutorials, PCP tutorials, and practicals. The more common resource types linked to these events included journal articles (72/358, 20.1%), websites (51/358, 14.2%), PCP roleplays (36/358, 10.1%), case notes (36/358, 10.1%) and textbooks (29/358, 8.1%).

Table 4. Proportions of users accessing resources via the learning platform's Timetable interface.

Resource type	Activity type	Resources	% Usage I[a]	% Usage II[b]
All	All	1079	100	98.2
Lecture notes	FBS[c] lecture	187	95.4	50.6
Lecture video[d]	FBS lecture	166	74.2	10.4
Journal article	FBS lecture	15	23.1	6.5
	CSL tutorial	69	71.1	15.1
CSL case notes	CSL tutorial	36	48.3	7.6
CSL video	CSL tutorial	16	42.5	6.9
Website	CSL tutorial	46	56.6	7.1
	FBS tutorial	4	11.1	5.8
Image	CSL tutorial	15	58.5	17.2
Textbook	CSL tutorial	29	52.0	7.9
PCP video	PCP tutorial	30	50.8	15.3
PCP roleplay	PCP tutorial	36	37.2	16.5
Tutorial notes	FBS tutorial	6	52.9	15.2
Reading	FBS practical	10	79.7	35.4
	FBS tutorial	9	70.8	48.9
Extras	FBS lecture	17	75.1	25.4
	CSL tutorial	3	14.5	6.7
	FBS practical	9	51.4	10.8

[a]Percentage of students who accessed at least 1 resource.

[b]Average number of those resources accessed per student as a percentage of the number of resources.

[c]FBS: Foundations of Biomedical Science.

[d]Downloadable videos only.

Access of resources via the learning platform's other interfaces was comparatively low and variable. For example, of the 34 resources available via the Library interface, 32 were accessed by at least 1 user. However, of these, only 7 of 23 recommended textbooks and 1 of 4 resource collections (MD Consult) were accessed on more than 50 occasions.

Resource Access by User

Table 4 details the proportion of users accessing different types of learning resources through the learning platform's Timetable interface by learning activity.

All users viewed at least 1 timetabled activity and virtually all (319/325, 98.2%) accessed at least 1 resource via the learning platform's Timetable interface. Lecture notes were accessed by almost all users (310/325, 95.4%), with each accessing just over one-half (94.3/187, 50.4%) of the available lecture notes resources. Almost three-quarters of users (241/325, 74.2%) also accessed lecture videos but they did so much more selectively, accessing only 10.4% (17.3/166) of the available recordings on average (Table 4). Readings also attracted comparatively high levels of access, with a clear majority of users viewing at least 1 reading associated with an FBS tutorial (230/325, 70.8%) or practical (259/325, 79.7%). Access rates for most other resource types and activity combinations were much more selective. Less than one-quarter of users (75/325, 23.1%) accessed any journal articles that were linked to lectures and, on average, each user accessed only 1 of these resources. Users were much more likely (231/325, 71.1%) to access journal articles associated with CSL tutorials, however.

Access rates for resources via other interfaces were low by comparison. Around half (159/325, 48.9%) of users accessed at least 1 resource by the Search or Curriculum interfaces and by the Library interface (183/325, 56.3%), and two-thirds (216/325, 66.5%) accessed at least 1 software resource. However, only around 1 in 3 users (119/325, 36.6%) accessed 10 or more resources via an interface other than the Timetable.

Cluster Analysis

Examination of the within-group sum of squares data suggested a 5-cluster solution. Membership and characteristics of the 5 clusters (groups) are described below according to the following usage level categories, where usage level refers to the proportion of members accessing a particular type of learning resource: very low≤5%, low=6% to 10%, moderately low=11% to 20%, moderate=21% to 40%, moderately high=41% to 60%, high=61% to 80%, and very high=81% to 100%.

Group 1 (n=42) was characterized by high use of lecture notes, moderately high use of downloadable lecture videos, moderately low use of journal articles, and low to moderately low use of

case notes, textbooks, and websites. Group 2 (n=91) was characterized by moderately high use of lecture notes and low to very low use of all other resource types. Group 3 (n=25) was characterized by very high use of lecture notes and low to very low use of other resource types. Group 4 (n=95) was characterized by very high use of lecture notes, moderately low to moderately high use of journal articles, and low to moderate use of lecture videos, CSL case notes, textbooks, and websites. Group 5 (n=84) was characterized by low use of lecture notes and very low use of all other resource types.

Discussion

Principal Findings

Despite clear areas of overlap, the survey and analytics data paint somewhat different pictures of student selection and use of resources. Analysis of the survey data suggests a pattern of regular access (on most days) by students of resources via the learning platform and from other online sources only slightly less frequently. Google and Wikipedia were also frequently used as sources of information or as starting points for locating information. This is despite students rating them significantly lower than the learning platform for quality and reliability, which is consistent with recent studies of first-year medical student information-seeking behavior [11,13]. Access of scholarly information sources, whether via the learning platform, university library, or Google Scholar, was typically infrequent.

The analytics data, on the other hand, reveal a pattern of variable access and use of resources via the learning platform, with most use concentrated around specific resource types and users. Lecture notes and readings aside, many learning resources only appear to be used by a small percentage of users (see Table 4). In addition, the cluster analysis of the analytics data reveals a surprisingly large subset of users (group 5) who accessed very few resources, including lecture notes, via the learning platform. This group accounted for approximately 25% of students within the 2012 first-year MD cohort. The cluster analysis of the survey data provides a different perspective again. There is no clear low usage group in this case; the approximately 9.3% of respondents (11/118) who reported accessing resources through the learning platform least often (less than weekly) being spread throughout the 4 groups, with groups differentiated largely on the basis of lower or higher use of or preference for particular resource types or access methods (eg, low use of textbooks by group 4; more frequent use of Google, Wikipedia, and Facebook by group 3).

If we accept that the analytics data are reliable and representative of student information-seeking behavior, then for those students who accessed the recommended resources infrequently (group 5 in the cluster analysis of the analytics data), a possible consequence of their behavior is that they are less well prepared and informed than their peers. This could impact their academic performance. Evidence linking or even comparing general resource use and academic performance appears to be limited, however. Goodall and Pattern [17] suggest the existence of positive relationships between library use and academic performance among undergraduate students at their university but failed to test these relationships statistically. Huon and colleagues [18] describe weak but significant correlations between resource use and academic performance among a group of first-year psychology students for some resource types—textbooks (r^2=0.21) and discussion forums (r^2=0.15)—but found no relationship for other common resources including lecture notes or tutorial materials. Further investigation of such relationships, and for medical students specifically, seems warranted given the limited and equivocal nature of these studies.

With respect to the majority of students who regularly used learning resources, their strong reliance on lecture notes confirms previous findings that these continue to form a key part of student learning strategies [10]. While students appeared to rate lecture notes highly (based on their assessments of the usefulness, quality, and reliability of resources accessed via the learning platform, see Tables 2 and 3), they are neither designed nor intended to meet all of our medical students' expected learning needs. Huon and colleagues [18] argue that student resource selection and use is driven much more by assessment needs than by exploring for understanding. Despite the learning and teaching approaches underpinning our and many other medical curricula (ie, case-based and self-directed learning), this is likely true for our students as well. If a deep knowledge and understanding of the curriculum is reflected in the breadth and depth of learning resources investigated, then based on the data presented here perhaps only a minority of students (best represented by group 4 in the cluster analysis of the analytics data) might be well placed to achieve this.

Limitations

While each of the general findings described above are potentially important and likely to have wider implications, there are some clear limitations to the study that need to be acknowledged. These include our focus on a single curriculum and the implementation of a specific (and specialized) learning platform, although both would appear to be representative of other medical curricula and sorts of learning platforms they employ. As with similar surveys, there are questions of accuracy and reliability of the questionnaire data, given the reliance on student perceptions and recollections of past resource use. The analytics data, on the other hand, has a high level of accuracy but is limited in its scope. It reliably captures when, what, and how students access resources from within the learning environment but reveals little about their discovery and use of other online learning resources.

Student use of social media is a case in point here. Just under a quarter of students who responded to the survey reported using Facebook on an approximately daily basis for accessing learning resources. In a related study [14], more than half of the surveyed medical students reported using Facebook and other technologies (primarily email and cloud-based file storage and sharing services) to share learning resources with their peers on most days. This includes resources that were originally sourced through the learning platform, which could in part explain the low usage rates of some learning resources (eg, lecture video recordings) in this study. The importance of these sharing networks in medical student learning practices is poorly

understood, probably underestimated, and warrants further investigation.

Conclusion

As previously mentioned, the relationships between resource discovery and use, learning, and academic performance are yet to be properly explored. Assessing these relationships in a way that accurately and reliably captures typical student study practices and controls for past performance appears challenging but could provide valuable insights into medical student learning behavior and the effectiveness of various types of resources to inform and support their learning.

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Conflicts of Interest

None declared.

Multimedia Appendix 1

Resource types and usage.

[PDF File (Adobe PDF File), 71KB - mededu_v3i2e17_app1.pdf]

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Abbreviations

ARL: Association of Research Libraries
CSL: case-supported learning
FBS: Foundations of Biomedical Science
MD: Melbourne Doctor of Medicine
PCP: Principles of Clinical Practice

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Original Paper

Mobile Apps for Teaching Intubation: Scoping Review and Critical Analysis in eLearning

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Abstract

Background: Airway management is a core skill in anesthesia ensuring adequate oxygenation and delivery of inhalational agents for the patient.

Objective: The goals of this study were to critically evaluate the quality of airway management apps and target revised Bloom's Taxonomy cognitive levels.

Methods: An electronic search using the keywords “airway” and “airway management” was conducted in May 2015 across the App Store, Google Play, BlackBerry World, and Windows Store. Apps were included in the study if their content was related to airway management. App content and characteristics were extracted into a standard form and evaluated.

Results: A total of 65 apps met the inclusion criteria, and 73% (47/65) of apps were developed by companies or industry. Anesthesiology trainees were the target audience in only 20% (13/65) of apps. Bag mask ventilation and laryngeal mask airways were covered in only 20% (13/65) of apps. Only 2 apps were supported in the scientific literature. For Bloom’s Taxonomy, 37% (24/65) of apps targeted knowledge, 5% (3/65) comprehension, 22% (14/65) application, 28% (18/65) analysis, 9% (6/65) evaluation, and 0% synthesis. Multivariate analysis identified cost of apps, size of apps (MB), and apps targeting trainees and paramedics to be associated with higher levels of cognitive processing of revised Bloom’s Taxonomy.

Conclusions: Apps developed for teaching intubation target lower levels of cognitive processing and are largely not validated by research. Cost, app size, and targeted user are associated with higher cognitive levels. Trainees and all users should be aware of the paucity of the published evidence behind the efficacy of some of these apps.

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KEYWORDS

anesthesia; apps; eLearning; mLearning; intubation; difficult airway; residents; anesthesiology

Introduction

Airway management is a core skill in medicine, important for the maintenance of adequate gas-exchange while enabling the delivery of inhalational medications. Various methods have been used to teach airway management including didactic lectures, seminars, simulation techniques, and workshops. Teaching modalities that are based on cognitive learning theory, mental practice, and simulation are known to be highly effective for both the acquisition of new knowledge and retention [1,2].

mLearning (learning via a mobile device usually through downloadable apps) may be useful for repeated exposure and just-in-time learning [3-5]. Ensuring the quality of mLearning tools is important, particularly with smartphone ownership by health care workers and app use at an all-time high [6,7]. A number of apps have been developed that teach airway

management. However, currently there is limited data on how these tools incorporate teaching theory.

The purpose of this study was to (1) characterize the current scope of apps used to teach airway management; (2) critically evaluate their content, use of teaching theory, level of cognitive processing targeted, and scientific validation; and (3) identify gaps in the field to further guide airway app development.

Methods

Overview

An electronic search was conducted in May 2015 across the 4 major smartphone operating system app stores: iOS (App Store), Android (Google Play), BlackBerry OS (BlackBerry World), and Windows Phone (Windows Store). Each store was searched separately using the terms "airway" and "airway management." No date of app publication was used to restrict search results.

Selection of Apps

Apps were included in the study if the goal of the app was to teach airway management. Apps were excluded if they were not patient-related (advertisements, airline industry-related, etc). Two authors (JW, CM) performed app selection independently. All discrepancies regarding selection were resolved through discussion. There was greater than 90% agreement between app store reviewers across all app stores before meeting for consensus agreement. Data from apps were abstracted into a standard Excel spreadsheet (Microsoft Corp). Abstracted data included app name, developer, country of origin, app description, price, and app size (MB).

Educational Content and Modalities Assessment

We developed a list of factors to assess educational content and teaching modalities used. This list was based on current literature review and experts who are trained in medical education, eLearning, and app development. We set up a priori criteria for assessing and evaluating apps. Published literature was reviewed and following an iterative process, criteria for data extraction were agreed upon. To assess the comprehensiveness of each app, the following criteria were used: (1) airway topics covered by the app, (2) type of airway devices discussed in the app, and (3) teaching modality used by the app (eg, book, guideline, quiz, journal, video, games, simulation).

Review of Theoretical Frameworks, Higher Order Cognitive Processing, and Scientific Validation of Apps

App description and its corresponding developer website were used to determine whether a specific theoretical framework had been used to guide app development. To evaluate the highest level of cognitive processing targeted in the app, we used the revised Bloom's taxonomy [8]. Two reviewers (CM, AL) independently reviewed each app's description using a standardized revised Bloom's taxonomy list, and all discrepancies regarding selection were resolved through discussion. Descriptions provided by the app store were examined for evidence of app inclusion in formal scientific research (eg, National Center for Biotechnology Information PubMed and Google Scholar).

Data Analysis

Descriptive analysis was used to summarize the data. Correlation coefficients between the revised Bloom's taxonomy and independent variables were determined by Pearson product-moment correlation if independent variables were continuous or by Spearman rank-order correlation if they were categorical or ordinal. Univariate generalized linear model with an identity link and normal distribution was used to identify factors associated with revised Bloom's taxonomy rankings. Following the univariate analysis, multivariate normal regressions were constructed with revised Bloom's taxonomy ranking as the dependent variable. Independent variables from significance at the 0.05 level in the univariate analysis were entered simultaneously into the multivariate model. Stepwise selection of covariates was performed with model inclusion and exclusion criteria of P=.15 and P=.2, respectively. JMP version 12 (SAS Institute Inc) was used to analyze the data.

Results

Overview

A total of 65 apps were identified for data extraction and analysis (Figure 1). The majority of apps were from Google Play (49/65, 75%), followed by the App Store (28/65, 43%), and the Windows Store (6/65, 9%). Blackberry World did not have any apps relating to airway management.

Figure 1. Flow chart of app selection process.

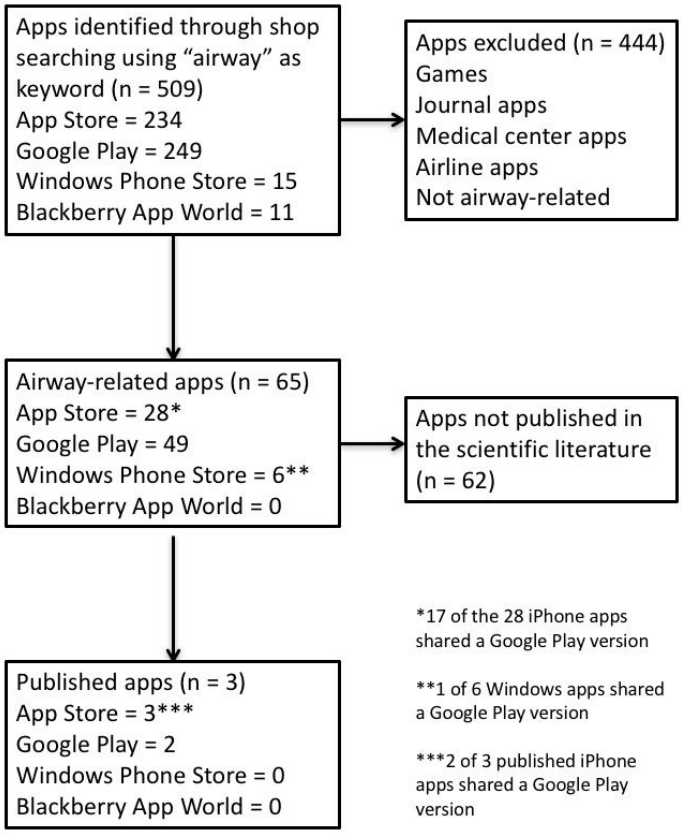
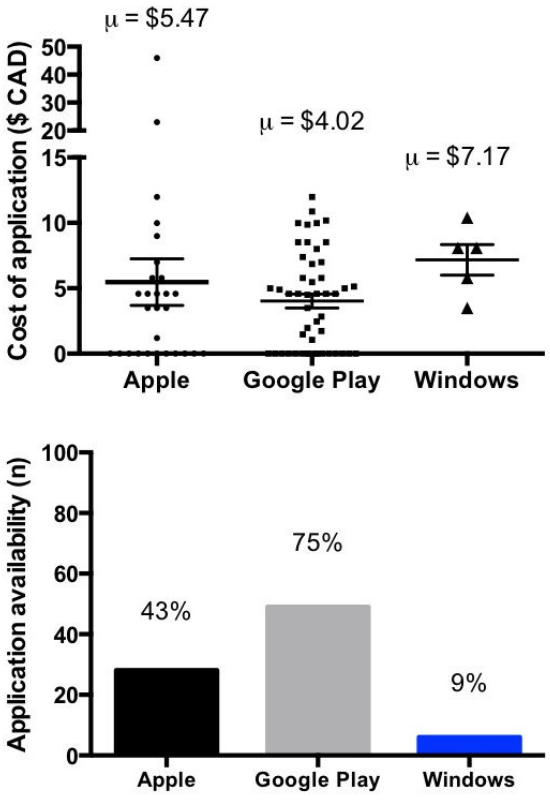


Figure 2. Costs (top) and availability (bottom) of airway management apps.



Cost

The average cost of an app was Can $4.02 (SD $3.71) from Google Play, Can $5.47 (SD $9.41) from the App Store, and Can $6.79 (SD $2.53) from the Windows Store (Figure 2). A total of 11 apps were free to download from the App Store and 16 from Google Play.

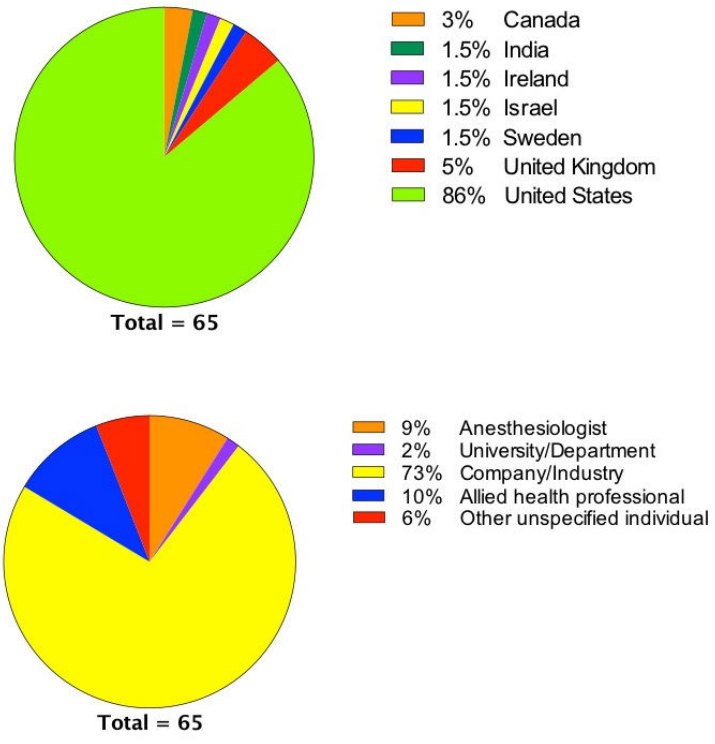
Developer

The majority of airway apps (47/65, 73%) were developed by companies, meaning that no associated identifiable educational department or authors could be identified; 9% (5/65) of apps were developed by anesthesiologists, 2% (2/65) by university departments, and 90% (58/65) of apps were developed in the United States (86%) (Figure 3). Emergency medical technicians were the most frequent target audience of apps (21/65, 32%) with anesthesiologists the primary target audience in 14% (22/65) (Table 1).

Table 1. Intended target audience of airway apps.

Target audience of app	n (%)
Emergency medical technicians	21 (32)
Health care professionals	20 (31)
Paramedics	19 (29)
Trainees	16 (25)
Nurses	14 (22)
Anesthesiologists	9 (14)
Emergency physicians	9 (14)
Critical care physicians	7 (11)
Military medics	4 (6)
Medical students	4 (6)
Family medicine physicians	3 (5)
Lifeguards	2 (3)
Firefighters	2 (3)
Respiratory therapists	1 (2)

Figure 3. Country of origin (top), identity of app developer (bottom).



Educational Content

Topics covered in the 65 included apps were quite varied. The most commonly covered topics were oropharyngeal airways (52/65, 80%), difficult airways (33/65, 51%), and endotracheal tubes (24/65, 37%) (Table 2). Bag mask ventilation and laryngeal mask airways were covered by 20% (13/65) of apps. Other topics such as airway equipment, fiberoptic bronchoscopy, cricothyroidotomy, and tracheostomy were each covered in 8% (5/65) of apps.

Teaching Modality

Apps most often incorporated guidelines as a teaching modality (55/65, 85%). Only 11% (7/65) of apps incorporated interactive or simulation exercises (Table 3).

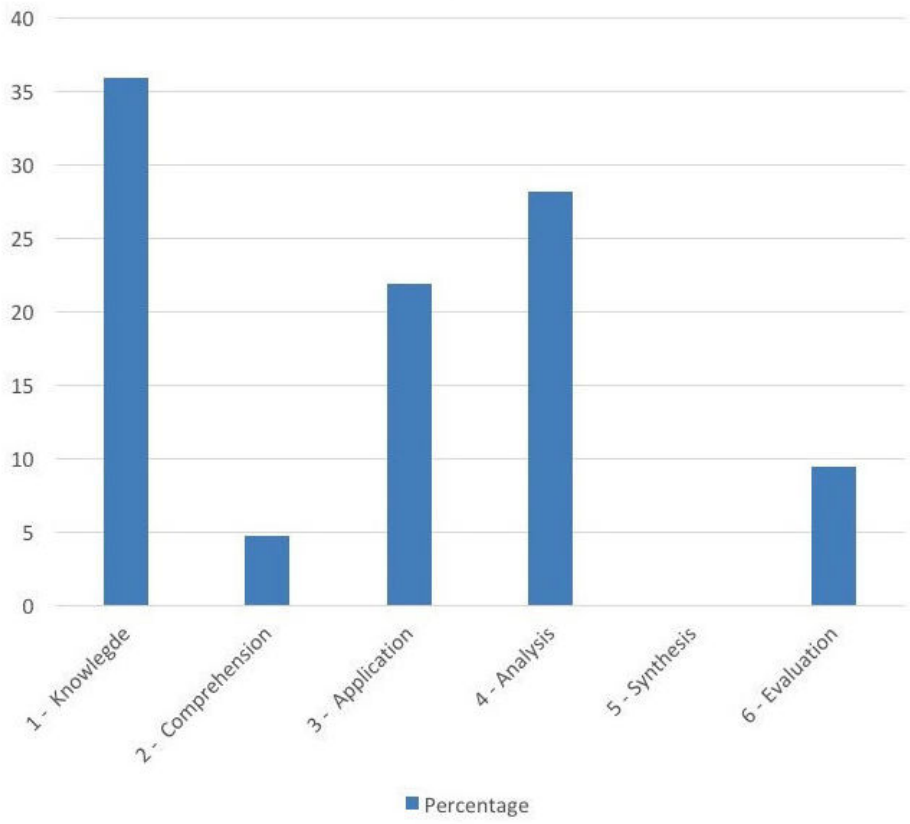
Table 2. Airway management topic covered by app.

Airway management component	n (%)
Oropharyngeal airway	52 (80)
Difficult airway	33 (51)
Endotracheal tube	24 (37)
Bag mask ventilation	13 (20)
Laryngeal mask airway	13 (20)
Rapid sequence induction	10 (15)
Resuscitation protocol	6 (9)
Cricothyroidotomy	5 (8)
Nasal prongs	3 (5)
Oxygen administration	3 (5)
Ventilator settings	3 (5)
Fiberoptic bronchoscopy intubation	2 (3)
Airway equipment	2 (3)
Preoperative assessment	2 (3)
Tracheostomy	1 (2)

Table 3. Function of the app.

Function of the app	n (%)
Guidelines	55 (85)
Reference lists	22 (34)
Quizzes with answers	22 (34)
Videos	14 (22)
Games	13 (20)
Books	9 (14)
Algorithms	9 (14)
Interactive/simulation exercises	7 (11)

Figure 4. Levels of higher order cognitive processing targeted by identified apps.



Theoretical Framework

None of the apps included educational theory in their description or on the developer websites.

Higher Order Cognitive Processing

Figure 4 demonstrates the levels of higher order cognitive processing targeted by included apps. The majority of apps (33/65, 51%) targeted the lowest level of revised Bloom's taxonomy (Remembering), with 18% (11/65) of apps targeting the higher cognitive processing levels Evaluation and Synthesis.

Scientific Validation

Only 2 of 65 included apps had associated published literature reporting on the app as a teaching tool. These were the iLarynx and NeoTube apps [9,10]. A third app, LuboCollar, also had published literature [11]; however, the literature associated with LuboCollar focused on the efficacy of the airway device rather than on the educational aspect of the app and therefore was excluded from further analysis.

Factors Associated With Higher Cognitive Processing

Multivariate analysis demonstrated that the cost of apps, app size (MB), and apps targeting trainees and paramedics were associated with higher levels of cognitive processing (Analysis, Evaluation, Synthesis) in the revised Bloom's taxonomy (Table 4).

Table 4. Factors associated with higher cognitive processing.

Source	Chi-square value	*P* value
Cost of app in Can ($)	4.0	.04
App file size (MB)	3.9	.04
Where is the app available? (App Store)	1.6	.21
Where is the app available? (Windows Store)	0.1	.78
Who developed the app? (company/industry)	0.1	.80
How many versions of app are there in the store? (App Store)	0.0	.97
How many versions of app are there in the store? (Google Play)	0.3	.58
Target audience? (trainees)	14.2	<.001
Target audience? (paramedics)	7.3	<.001

Discussion

Principal Findings

This is the first study to examine smartphone apps that teach airway management. We identified 65 apps, covering a range of airway topics that incorporate various teaching modalities. Our findings reveal that none of the apps used any formal advanced educational theory frameworks. We also found that few apps targeted higher order cognitive processing. In addition, a minimal number of apps were validated through scientific research.

The average cost of an app was Can $4.90 (SD $6.76). This suggests that there is scope to increase this charge when one compares this to the average cost of a medical textbook, particularly if quality and efficacy of learning from an app can be demonstrated. The majority of apps were developed by companies (49/65, 76%) without publishing inventor credential information. This contrasts with educational books and courses where an educator's background is commonly detailed allowing the consumer to make an assessment on the content quality prior to purchase. The authors therefore recommend that developers consider providing author information in app descriptions to better facilitate the selection process for the user and additionally to encourage user investment.

Leadership in App Development

Our results highlight a gap in the market in relation to developers and target users for airway apps. For example, anesthesiologists are targeted in 14% of available apps and are the developers of only 9%. Anesthesiologists provide expertise in airway management and are well positioned to provide leadership in the development of educational apps pertaining to teaching safe airway management. Our results additionally highlight a paucity of apps targeting anesthesiologists in training, a large population that requires airway management education.

Education Content and Modalities

While various professions may be involved in the airway management of a patient, the depth of knowledge required can vary between the specialties. Bag mask ventilation was found in only 20% (13/65) of identified apps and, while most apps do not claim to cover all airway topics but rather focus on a particular task, bag mask ventilation is a basic airway skill and as such consumers should be aware that many airway apps do not have broad scope of content. We suggest that consumers be cognizant of app content and target audience in addition to suggesting that app developers offer a trial version for users to evaluate before they decide to purchase.

The modalities used in the identified apps also reflect the levels of cognitive processing targeted, with the majority of apps providing simple guidelines (55/65, 85%), and fewer apps using games (13/65, 20%), quizzes (22/65, 34%), and simulation (7/65, 11%), which provide more complicated teaching modalities.

Learning Theory and the Revised Bloom's Taxonomy

In 1956, Bloom's taxonomy provided a template upon which educational objectives could be built, advancing the processes of curriculum development and student evaluation [8]. In 2001, the revised Bloom's taxonomy further expanded these learning objective descriptors, developing the cognitive domain and also adding a knowledge domain [8]. When compared to this revised cognitive domain, the majority of apps in this study targeted the lowest level of Bloom's taxonomy (Remembering) with only 18% (11/65) of apps targeting the 2 highest of the domains. Nevertheless, the authors highlight that this does not necessarily mean that apps classified as targeting the highest domains were of a better quality. For example, some apps allowed for the creation of flashcards and were therefore deemed as targeting the highest level of learning (Synthesis). However, the content of information placed in a flashcard could potentially be inferior to that found in a well-developed, evidence-based, highly researched and referenced app targeting Remembering. These differences may have been better discerned by assessing each app according to the knowledge domain of the revised taxonomy. However, this was not performed in our study and is a limitation to consider. The authors also note that it was often unclear what level of learning was targeted in an app, suggesting that learning objectives may not necessarily have been to the forefront of developers' minds during app development. This finding should caution users seeking high-quality educational apps in addition to identifying an area for app developers to target. If an app can demonstrate that high levels of learning are targeted, this could translate to higher app earning potential.

Regarding use of theoretical frameworks in the 65 identified apps, we were unable to identify any explicit mention of teaching theory. However, assessment of apps was based on the app descriptor and not on the actual app itself. Nonetheless, it appears that some apps did use multimedia, segmenting, and learner control principles, and it would be interesting to assess apps going forward, looking for use of common eLearning principles, whether intentional or not [9]. It may be possible that apps that include simulation and other tasks that target high-order thinking may require more programming content resulting in larger file sizes (Table 4).

Proof of App Efficacy

At the time of analysis, only 2 out of the 65 available apps had supporting research published in the scientific literature. The first publication focused on the free to download app iLarynx, which serves as a simulator for fiberoptic intubation using the accelerometer properties of the iPhone and iPad [9]. Using a repeat measures design, 20 trainees, and a power of 87%, the authors demonstrated a difference in time to visualize the carina between students who attended a lecture on fiberoptic intubation and students who received additional iLarynx training. The authors reported that 8 out of 10 participants in the standard training group had at least 1 failed (>120 second) attempt at intubation compared with 2 out of 10 in the iLarynx group (P=.01). There were a total of 24 failed attempts in the standard training group, but only 4 in the iLarynx group (P<.005). While intubation skill was tested on a manikin, these results suggest that an app using simulation may be a means through which medical technical skills can be taught.

The second available publication examined the effect of a free to download app, NeoTube, teaching neonatal intubation through

text, images, and video [10]. The published study was small, examining the effects of the app on 20 trainees. Nonetheless, the findings were promising, demonstrating an improvement in knowledge, skills, and a decrease in duration of intubation attempt (on a manikin) following use of the app.

These 2 publications suggest that apps may be a useful medium through which airway management may be taught. However, the fact that only 2 of 65 studies had associated published literature highlights the current lack of evidence regarding this new mode of learning. The authors recommend that app developers consider formally investigating the educational impact of their apps not only to improve app quality and development but also to add to the marketability of their product [8,9,12]. If developers can prove that their app positively affects learning then developers can consider charging more for their app, and consumers will be more likely to invest [13].

Limitations

The authors recognize that this study is not without limitations. First, this study identified apps using the keywords “airway” and “airway management.” If an app did not identify these keywords for search purposes, then it will not have been selected for inclusion. Additionally, information on an app was gleaned from the freely available text description of the app and not from examining the actual app itself. However, this search method simulates a typical consumer search and therefore was chosen as the most suitable search method for this study.

A second limitation is that this study did not examine adherence of app contents to current best practice. In view of a recent report that the majority of medical apps don’t adhere to current evidence-based guidelines, this reinforces our recommendations that developers consider employing the appropriate medical and educational experts in order to develop apps for educational purposes [13]. A third study limitation is that only PubMed and Google Scholar were used to identify associated publications. It is possible that if other databases were used, more articles may have been identified. Finally, it is important to mention that mLearning in medical education is a rapidly growing industry and therefore results of this study only pertain to apps available in May 2015 and may not be applicable to the cohort of apps currently available for use.

Conclusion

Smartphone apps are a new educational medium. As their use develops, it is expected that a more formal approach to app development will be taken. Our study demonstrates that the majority of the currently available apps teaching airway management have been developed by companies, do not cover basic airway management skills, do not target anesthesiologists, and do not target the higher levels of the revised Bloom’s taxonomy cognitive domain. The authors conclude that there is a role for experts in airway management to develop high-quality educational apps in order to serve the purpose of professionals who require attainment of such knowledge and skills. From the available literature examining these apps, there is some evidence to suggest that smartphone apps may be useful educational tools through which airway management skills may be learned. However, apps are a relatively new educational medium and, as such, further research is required in order to investigate the degree to which they may positively augment the learning process. We are only seeing the beginnings of pedagogical concerns regarding the development of apps for educational purposes. The authors highlight this area of research for medical educators going forward.

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Conflicts of Interest

None declared.

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Original Paper

Attitudes of Health Professional Educators Toward the Use of Social Media as a Teaching Tool: Global Cross-Sectional Study

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Abstract

Background: The use of social media in health education has witnessed a revolution within the past decade. Students have already adopted social media informally to share information and supplement their lecture-based learning. Although studies show comparable efficacy and improved engagement when social media is used as a teaching tool, broad-based adoption has been slow and the data on barriers to uptake have not been well documented.

Objective: The objective of this study was to assess attitudes of health educators toward social media use in education, examine differences between faculty members who do and do not use social media in teaching practice, and determine contributing factors for an increase in the uptake of social media.

Methods: A cross-sectional Web-based survey was disseminated to the faculty of health professional education departments at 8 global institutions. Respondents were categorized based on the frequency of social media use in teaching as “users” and “nonusers.” Users sometimes, often, or always used social media, whereas nonusers never or rarely used social media.

Results: A total of 270 health educators (52.9%, n=143 users and 47.0%, n=127 nonusers) were included in the survey. Users and nonusers demonstrated significant differences on perceived barriers and potential benefits to the use of social media. Users were more motivated by learner satisfaction and deterred by lack of technology compatibility, whereas nonusers reported the need for departmental and skill development support. Both shared concerns of professionalism and lack of evidence showing enhanced learning.

Conclusions: The majority of educators are open-minded to incorporating social media into their teaching practice. However, both users and nonusers have unique perceived challenges and needs, and engaging them to adapt social media into their educational practice will require previously unreported approaches. Identification of these differences and areas of overlap presents opportunities to determine a strategy to increase adoption.

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KEYWORDS

health education; health survey; teaching; health knowledge, attitudes, practice; interdisciplinary studies, social media; faculty development

Introduction

Social media is an inexpensive, powerful, and influential way of using Internet-based tools to facilitate easy and broad communication and the sharing of information and opinions [1,2]. Given the requirement of strong communication skills to provide excellence in health care and the rapid growth of social media usage as a medium of communication, health providers need to understand and adapt to social media use as a potential method of interacting with patients to provide care that meets the public's needs and expectations [1-3].

Currently, up to 70% of the general public seeks health care information and advice from Internet sources, and they continue to use Web-based resources to strengthen their capacity to communicate about their health needs [4]. Whereas penetration in North America, Europe, and Australia has been well documented [5], the rapid rise in Internet access through mobile devices has resulted in widespread growth in emerging market economies [5,6]. Although members of the general public were the early adopters of using the Internet and social media for their health care needs, health professional students have expressed a similar interest [7-10]. Globally, over 90% of university students actively use social media informally to create and share learning resources and to seek and provide moral support to one another [3,7-12]. However, given that 82% of patients around the world are interested in using Web-based mediums for health care purposes in the future [6], it highlights the importance of health care professional trainees learning to use these platforms to communicate professionally, academically, and clinically. So, how should academic institutions then prepare their students to have the skills and experience necessary to use social media to engage the public in the future?

A recent study demonstrated that medical students engaged in a course about social media and e-professionalism aided in the awareness of positive and negative uses of social media in a professional and educational environment [13]. Additionally, the majority of students made immediate changes to their social media use and reported that it would impact future Web-based behavior [13]. The use of social media in health care education has mainly been an area of increasing interest as a means of better engaging and enhancing the learning of students through methods outside the traditional didactic methodology, which relies on instructive teaching and passive learning. A number of studies have been conducted to investigate the ways in which the health care students informally use social media for educational purposes [14]. The results identify efficient communication with educators, peer collaboration, and small-group learning and sharing resources as key strengths [3,10]. Learners also use social media platforms to supplement their learning outside class, revisit key concepts, and view examples of physical exam skills [15,16]. Meanwhile, some health educators are starting to use social media formally as a method of delivering curricula and building student workplace competencies, including virtual journal clubs, reflective blogging, and microblogging platforms to enhance clinical decision making in a critical-care and team-learning setting [17-20]. Although the body of evidence investigating the effectiveness of using social media formally as a teaching tool is small, results show that social media use tends to lead to greater engagement, more active participation, and increased opportunities for feedback [7,12,14,15,17,18,21,22].

Adapting to new technologies and demands on time were identified as challenges to social media integration into education by educators and students [2,14,23-25]. Despite some integration of social media as an educational tool, broad-based adoption among educators has been slow. Apparent additional risks and challenges such as introducing a distraction during lectures or tutorials, difficulties with maintaining professionalism and patient confidentiality, legal implications of sharing information, and student exposure to low-quality health care information have been postulated as the reasons for the lag in adoption [2,7]. However, there have been a few studies that quantify these issues on a global scale. Hence, the purpose of this survey was to compare and contrast attitudes toward the use of social media as an educational tool with faculty who do and do not currently use social media in their teaching practice to determine the levels of awareness of social media policies and guidelines and to discern whether the various barriers articulated in the literature actually apply in practice for these international faculty members.

Methods

Study Design and Instrument Development

We conducted a global cross-sectional Web-based survey of 8 member institutions (see Table 1) from the Universitas 21 (U21) Health Sciences Consortium. U21 Health Sciences is a group of universities collaborating to explore health science education, research opportunities, and social transformation. The 8 participating institutions self-selected to take part in the "Social Media for Education in Health" project.

The research team included a faculty and student representative from each participating university, and they jointly developed a 24-question survey. Content for the first draft of the survey instrument was derived from the existing literature [26-30] and discussions among the research team. Furthermore, the draft was sent to global representatives from diverse health care disciplines, and feedback from experts in the health informatics/communications field and a statistician with experience in survey design was gathered before finalizing the survey. The final survey was constructed using FluidSurveys (Survey Monkey), a Freedom of Information and Protection of Privacy Act-compliant software, and ethical approval was obtained from research ethics boards of all participating institutions.

The site-specific faculty representative disseminated the survey to the members of their university community through electronic mailing lists targeting faculty, staff, and students. Although this survey was distributed to students and faculty, given the purpose of this study, only faculty responses were used. Response to the survey was accepted as informed consent, and responses were anonymous. Respondents were allowed to select more than one choice for nondemographic questions, where applicable. The survey was administered from July to December 2014. Inclusion

criteria for the study required respondents to have identified as educators and reported their frequency of social media use. Respondents who only filled out demographic data were excluded.

Data and Statistical Analysis

Data were downloaded from the Fluid Surveys platform into a Microsoft Excel spreadsheet and transferred to Stata/SE version 13 for analysis. Survey questions with an option for open text responses were coded into existing categories where applicable, or a new category was created as needed. Descriptive statistics were conducted on demographic data with continuous variables (age) expressed as a mean and standard deviation and categorical variables (gender and university affiliation) expressed as frequencies and percentages. Differences in the distributions of demographic variables were examined using a chi-square test (or Fisher exact test) for categorical variables or a *t*-test for age.

The chi-square test (or Fisher exact test where appropriate) was also applied and a *P* value of <.05 was considered to be statistically significant to examine the relationship between the frequency of social media use and barriers to the use of social media for health education, factors influencing decisions to use social media in teaching practice, capacity of social media to improve interactions among students/educators, and the type of social media currently used. The distribution of responses was similar on most questions for those who selected never and rarely as their frequency of social media use for educational purposes and similarly, for those who selected sometimes, often, and almost always. As such, the data were collapsed into two groups for all analyses, which were “nonuser” (never/rarely) and “user” (sometimes/often/almost always) for ease of interpretation.

Results

Health educators from 8 global institutions and a variety of health disciplines, including nursing, public health, medicine, pharmacy, dentistry, and physiotherapy, responded to the survey. The survey response rate was reported individually by each university and ranged from 4% to 46%, with data from some institutions missing. Respondents were divided into two groups, users and nonusers, based on the frequency of social media use in educational practice. Of the 270 respondents, 143 (52.9%) were users, and 127 (47.0%) were nonusers. There was a statistically significant difference in the mean age of users compared with nonusers (43.8 vs 46.3 years; *P*=.045; Table 1).

Perceived Barriers and Influencing Factors

Table 2 shows that among nonusers, the greatest perceived barriers to the use of social media in health professional education were a lack of understanding of how to integrate social media in their teaching practice (91/127, 71.7%), lack of departmental support (69/127, 54.3%), uncertainty on department policies (71/127, 55.9%), and lack of technical skills to use social media (71/127, 55.9%). Additionally, 41 out of 127 nonusers (32.3%) did not see the value of using social media in health education, which considerably differed in the proportion of users (7/143, 4.9%; *P* ≤.001). The two groups significantly differed on their attitudes to all barriers, except on concerns about professionalism (73/127, 57.5% vs 70/143, 49.0%; *P*=.18).

Table 1. Demographics.

Demographics	Users	Nonusers	Total	*P* value
Age, mean (SD)	**N=138** [a]	**N=121** [a]	**N=259** [a]	.045
Age in years	43.8 (9.3)	46.3 (10.3)	45.0 (9.8)	
Gender, n (%)	**N=141** [a]	**N=125** [a]	**N=266** [a]	.07
Male	44 (31.2)	53 (42.4)	97 (36.5)	
Female	97 (68.8)	72 (57.6)	169 (63.5)	
University affiliation, n (%)	**N=142** [a]	**N=126** [a]	**N=268** [a]	<.001
Fudan University, Shanghai, China	27 (67.5)	13 (32.5)	40 (14.9)	
Instituto Tecnológico de Monterrey, Nuevo Leon, Mexico	17 (85.0)	3 (15.0)	20 (7.5)	
University of Birmingham, West Midlands, United Kingdom	9 (26.5)	25 (73.5)	34 (12.7)	
University of British Columbia, Vancouver, Canada	23 (62.2)	14 (37.9)	37 (13.8)	
University College of Dublin, Dublin, Ireland	5 (71.4)	2 (28.6)	7 (2.6)	
University of Hong Kong, Pokfulam, Hong Kong	18 (75.0)	6 (25.0)	24 (9.0)	
University of Melbourne, Victoria, Australia	8 (38.1)	13 (61.9)	21 (7.8)	
University of Nottingham, Nottingham, United Kingdom	35 (41.2)	50 (58.8)	85 (31.7)	

[a]Note: Denominator varies slightly because of missing data.

[b]SD: standard deviation.

Table 2. Barriers to the use of social media for health professionals' education (in descending order of "Nonuser" group responses).

Factors	Users (N=143) n (%)	Nonusers (N=127) n (%)	*P* value
Do not understand how to incorporate social media into teaching/ learning	35 (24.5)	91 (71.7)	<.001
Concerns about professionalism	70 (49.0)	73 (57.5)	.18
Unsure about department's policies related to the use of social media	54 (37.8)	71 (55.9)	.005
Lack the technical skills to use social media tools	42 (29.4)	71 (55.9)	<.001
Department does not offer support for the use of social media in health education	59 (41.3)	69 (54.3)	.01
Do not see the value of using social media in health education	7 (4.9)	41 (32.3)	<.001
Department prohibits or actively discourages the use of social media in health education	5 (3.5)	14 (11.0)	.02

Table 3. Factors influencing decisions to use social media in teaching/learning practice (in descending order of "Nonuser" group responses).

Influencing factor	Users (N=143) n (%)	Nonusers (N=127) n (%)	*P* value
Evidence that learning is enhanced through the use of social media tools	96 (67.1)	73 (57.5)	.13
Ability and knowledge in the use of social media tools	78 (54.5)	65 (51.2)	.63
Support from experts in the use of social media to design teaching strategies/modules	52 (36.4)	62 (48.8)	.048
Fit of social media tools to the style of teaching/learning	65 (45.5)	61 (48.0)	.72
Improved learner satisfaction with the course	97 (67.8)	50 (39.4)	<.001
Peers using social media technologies in their classrooms	65 (45.5)	47 (37.0)	.18
Improved student evaluations of the course	56 (39.2)	44 (34.6)	.45
Course/Department coordinator suggesting the use of social media technologies in the classroom	45 (31.5)	40 (31.5)	>.99
Compatibility of social media technologies with the devices in use within classroom	65 (45.5)	33 (26.0)	.001

Table 3 describes the factors most likely to influence a nonuser to use social media in their teaching practice, which include (1) evidence demonstrating that learning is enhanced through the use of social media (73/127, 57.5%) and (2) their own ability and knowledge in using the associated technology (65/127, 51.2%). Additionally, support from the experts in the field of using social media for educational purposes to help design teaching strategies was a factor that was significantly more important for nonusers (62/127, 48.8% vs 52/143, 36.4%; *P*=.048).

Meanwhile, users have also rated supportive evidence to illustrate the enhanced learning from the use of social media as an important influencing factor (96/143, 67.1%). However, in stark contrast to nonusers, they were significantly more likely to be influenced by improved learner satisfaction (97/143, 67.8% vs 50 out of 127, 39.4%; *P* ≤.001).

Finally, users agreed that social media has the capacity to positively impact educational practices, whereas nonusers were significantly more skeptical of its ability to improve student learning (116/136, 85.3% vs 70/125, 56.0%; *P* ≤.001) and increase faculty-to-student interactions (127/140, 90.8% vs 81/126, 64.3%; *P* ≤.001). However, nonusers tended to agree with the users on social media's use in health education in increasing interactions among the student population, although there was still a significant difference (122/137, 89.1% vs 96/125, 76.8%; *P*=.02)—Data not shown in the table.

Knowledge of Policies and Guidelines

Both users and nonusers reported not being trained on social media–related policies and guidelines, with only 11.5% (16/139) and 5.8% (7/120), respectively, having been provided prior training (*P*=.18). Educators from both groups who did receive training reported having increased confidence in using social media for educational purposes (14/16 users, 87.5% and 5/7 nonusers, 71.4%; *P*=.56). Of those educators who had not been trained, 85.5% of users (106/124) and 73.5% of nonusers (83/113) would like to be provided with training on social media use; however, users were significantly more likely to want training compared with nonusers (*P*=.03).

Discussion

Principal Findings

Our survey found that almost three-quarters of educators only used social media as an educational tool "sometimes" or less often. Students' use of social media for health education is overwhelmingly higher, with almost the same proportion using social media often or always [31-35]. There is a clear discrepancy as students' usage of social media to enhance their education informally is growing disproportionally faster [31,32].

Creating categories of users and nonusers provided a means of comparing the attitudes of educators and understanding the factors that contribute to the differences in adoption.

Our findings suggest that the differences in mean age of the user and nonuser groups are statistically significant. In practicality, the 2.6-year difference in mean age and range of ages in each group may not be contextually relevant. Hence, unlike previous studies that suggested age and gender as major factors for the lack of broad-based adoption, our sample does not demonstrate strong demographic differences between users and nonusers [36,37]. However, the data from our study does suggest that the two groups have unique perceived challenges and needs and engaging them to adapt social media into their educational approaches will require very different approaches, which are previously unreported in the literature.

Nonusers perceived their greatest barrier to be a lack of comfort and technical skills. Therefore, evidence-based recommendations on principles, best practices, and successful strategies can be helpful to nonusers who are not confident in educational social media usage [31,36,38]. Although the rapid evolution of social media platforms could make the technological aspect more approachable, which would improve nonuser adoption, the growing number of competing tools could make the process of choosing a platform daunting and overwhelming [39,40]. Hence, greater foundational support from experienced peers, information technology departments, and industry experts on the basics of integrating social media tools in the delivery of content may improve uptake among nonusers. However, some nonusers may still not see the value of social media; consequently, institutions may want to recognize differences in opinions and encourage open debate and discussion among their faculty about the strengths and weaknesses of social media usage.

By comparison, users strongly believe in the capacity of social media to improve student learning and faculty and peer interactions with students, highlighting the importance of providing them with new evidence-based ways to increase engagement and supporting their efforts to incorporate innovative methods into their educational practice [41]. Unsurprisingly, users were more influenced to increase social media use in the academic setting by student-centric factors such as improved learner satisfaction and student evaluation, suggesting that feedback and active participation from students when educators do integrate social media into their content delivery could encourage more frequent use, and potentially more innovative or adventurous usages.

The users and nonusers did share commonalities; both were greatly influenced by evidence that learning is enhanced through social media integration and resources to aid educators increase their abilities and knowledge of social media–based teaching tools. As the body of evidence is continuously growing, the need for further high-quality literature is underscored by the need for effective dissemination of results [14,42]. Additionally, given that less than 11% of educators from both groups have received training on the policies and guidelines of social media use in the academic setting, institutions may focus on making their policies and guidelines clear and accessible through training and open forums for discussion at faculty development sessions [36,43].

We also found that both groups shared similar concerns on the impact that integrating social media in health education would have on professionalism. In the new media age, the distinction between personal and professional Web-based content is blurry, and the definition of appropriate behavior remains uncertain. Within the health care context, patients are likely to judge health professionals on their Web-based persona, which may in turn affect trust and adherence to advice [44]. Simultaneously, societal uptake of social media and general patient interest in connecting and engaging with health care professionals over social media is growing rapidly [45,46]. Thus, concern over the professional identity of a health care professional is a complex issue. However, engaging with these tools early, and in the "safer" educational context, will give educators and students the opportunity to experiment, experience, and reflect on how best to meet their professions' standard and public expectations [43,47].

Compared with the existing literature that largely comprises postulated barriers, our study substantiated some but not others. Although, professionalism, legal implications, and time investment are all important issues, they are of secondary importance to technological support, learner engagement, and clarity of institutional policies and guidelines. Hence, our study demonstrates an unreported set of issues to consider and the practical nature of educators' priorities when approaching social media in health education.

Limitations

This study has several limitations. As with most survey-based studies, our results may be subject to construct bias. However, an extensive review process was carried out a priori to minimize risk. Additionally, because faculty representatives at each institution disseminated the survey, there may have been inconsistencies leading to difficulties in determining the response rate and introducing potential bias.

The sample size was small and derived from voluntary participation; hence, it may have been limited by faculty population size, institutional stance on social media use, and strength of interest or opinion, thereby leading to potential type 2 error or insufficient power. Finally, the institutions self-selected to be participants; hence, our results are likely not generalizable to all health professional programs.

Conclusions

In conclusion, our survey results have demonstrated that adoption of social media as a teaching tool is not uniform for all faculty members but necessitates targeted strategies for current users and nonusers. The two groups have unique attitudes, needs, and motivations that need to be addressed. Furthermore, both groups need clear evidence that demonstrate effectiveness of social media as an educational strategy and thorough understanding of the institutional boundaries of social media use. Therefore, institutions need to discern the mix of users and nonusers that exists in their faculty population before instituting change management strategies to engage them in social media use in health professional education.

With health education moving away from the conventional approach of didactic knowledge transmission, social media could be an effective modality to employ a Socratic methodology where students and educators jointly collaborate to facilitate enhanced learning. Our findings suggest that the majority of users and nonusers are open-minded to incorporating social media into their teaching practice, and so they should be encouraged to do so, in accordance to their respective needs.

Ethical Approval

The ethics application was submitted to the University of British Columbia, and each of the other 7 participating institutions (Fudan University, China; Instituto Tecnológico de Monterrey, Mexico; University of Birmingham, the United Kingdom; University College of Dublin, Ireland; University of Hong Kong, Hong Kong; University of Melbourne, Australia; and University of Nottingham, the United Kingdom) used the approval to receive institutional departmental authorization before the administration of the survey.

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Authors' Contributions

Drs Ho and Last had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. All authors were involved in the study concept and design. D'Souza, O'Sullivan, Last, and Ho worked on the acquisition, analysis, or interpretation of data. D'Souza, Henningham, Zou, Huang, and Ho were involved in the drafting of the manuscript, whereas all the authors were involved in the critical revision of the manuscript for important intellectual content. D'Souza, Last, and Ho were involved in statistical analysis. Administrative, technical, or material support was provided by D'Souza and Ho. D'Souza, O'Sullivan, Last, and Ho were involved in study supervision. D'Souza and Ho were involved in the final approval of the version to be published.

Conflicts of Interest

None declared.

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Abbreviations

SD: standard deviation

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