

Teaching Evidence-Based Medicine with an Asynchronous Web Module: Measuring Student Preferences and Outcomes

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Background: Evidence-based medicine (EBM) is considered an integral element of health care today, and an essential component of a physician assistant (PA) educational curriculum. Using a Web-based tutorial may be an effective and efficient way to introduce EBM to students. The purposes of this study were to demonstrate that EBM principles could be effectively taught to PA students via a Web-based tutorial and to identify student preference for delivery format. **Methods:** A first-year cohort (N = 42) of PA students was enrolled in a self-paced, Web-based EBM tutorial consisting of five modules. Each module was presented in both an enhanced interactive format and a text-based format, and students could choose either or both formats. EBM knowledge acquisition was measured by content completion, final exam scores, and self-report; student preference was measured by student choice of module type and pre/post survey results. **Results:** All students completed the course and passed the final exam questions with a score of more than 80%, indicating mastery of foundational knowledge. Self-reported confidence in EBM principles showed a significant improvement. Most students preferred having both enhanced interactive and text formats available rather than just one type. A post hoc question revealed that 78% would have preferred having live lectures in addition to or instead of online instruction. **Conclusion:** Introductory EBM principles can be taught to PA students effectively via a Web-based tutorial. Students preferred having a variety of instructional formats, including lecture, instead of just one online format.

INTRODUCTION

Evidence-based medicine (EBM) is defined as the convergence of the best clinical evidence with clinical expertise and individual patient preferences.¹ EBM is considered an essential aspect of any health care professional program today, and the Accreditation Review Commission on Education for the Physician Assistant (ARC-PA) requires physician assistant (PA) programs to teach EBM.²

Coniglio et al³ described how EBM was successfully integrated into a PA curriculum with face-to-face coursework. With the expanding use of technology in education, increasingly crowded curricula, and the growing importance of educating off-site clinical preceptors in EBM, alternative delivery methods must be considered. Web-based education in health care has

emerged as a method of disseminating information in an effective, efficient format that is comparable in outcomes to classroom learning.⁴⁻⁶ In addition to providing a flexible format for offering EBM training to students on campus, a Web-based course would also allow schools to provide clinical preceptors in remote locations with updated information in EBM. Furthermore, an asynchronous, Web-based course could be archived and would allow students on clinical rotations to access and review EBM materials while engaging in patient care. Studies have found Web-based EBM education to be a viable teaching medium for both students⁷ and clinicians.⁸

Yet there is much we don't know about the most effective way to teach online. Cook has noted that we should not continue to compare computer-

Feature Editor's Note:

To mark the third anniversary of the Evidence-Based Medicine (EBM) feature, we are pleased to present this submission from York, Nordengren, and Stumbo. Their study of a Web-based tutorial shows that EBM principles can be taught to PA students via the Web and advances the body of literature on methods of teaching EBM principles to first-year PA students.

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The intent of this feature is to present a forum for PA educators to share their approaches to teaching EBM. Areas of interest might include reviews of EBM resources; mini-tutorials in areas such as statistics, epidemiology, and study design; ethical, historical, or philosophical perspectives of EBM; and discussion of practice or technological tools that enhance application of EBM. Prospective authors are encouraged to contact the feature editors to receive approval of topics in advance.

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Figure 1. Screen Shot of Flash-Based Slide from Module 1



In this example, students must click through all buttons on screen to explore each concept. They could also access additional learning materials by clicking on drop-down resources in the upper right corner, and could navigate by clicking on slides on the left border. Each slide must be completed before moving on. Auditory feedback and music was embedded in slides.

Figure 2. Screen Shot of PDF Text Slide from Module 1



This presents the same content as shown in Figure 1, reformatted in a linear text. Note that scrolling is necessary in order to see the entire document. This PDF can be printed. There is no music or auditory feedback.

based to classroom learning due to confounding variables and the lack of definitive evidence showing any difference in outcomes between the two

methods.⁹ Rather, future research should look at the most effective way to deliver online content by comparing various computer-mediated methods.¹⁰

In a pilot study, the authors developed a text-based EBM tutorial that was delivered through Blackboard and shown to be effective with doctor of physical therapy students.¹¹ Successful learning outcomes were demonstrated by using a pre/post test based on the validated Fresno test of competence in evidence-based medicine.^{12,13} For the current study, the text-based tutorial from the pilot study was adapted by changing case examples to be more appropriate to PA students. Otherwise, the content remained essentially the same and was presented in a Web-based Blackboard tutorial consisting of five modules. Each module was available in two delivery methods: (1) enhanced, interactive Flash-based slides created with Articulate software (Fig. 1), and (2) text-based documents attractively formatted in Adobe PDF with graphics (Fig. 2). Students were able to choose either or both formats as they progressed through the modules.

The purpose of the study was twofold: (1) to demonstrate that EBM principles could be effectively taught to PA students via a Web-based tutorial, and (2) to identify student preference for delivery format. We hypothesized: (1) that students would demonstrate mastery of EBM concepts after completing the tutorial as measured by a final exam and a self-report survey, and (2) that students would prefer the enhanced interactive Flash-based delivery method to the PDF text-based delivery.

METHODS

Subjects

A convenience sample of first-year PA students taking a required one credit-hour research and epidemiology course in a master's program at a Midwestern osteopathic medical school were enrolled in the study (N = 42). IRB approval and informed consent were obtained prior to the study. Mean age

Table 1. Subject Demographics

Number	42
Gender	83% female, 17% male
Age mean	25.9 years
Age median	24 years
Age SD	5.9 years
Age range	22-47 years

of the students was 25.9 with a range of 22 to 47 years; 83% were female. Additional demographic information is presented in Table 1. Within the research and epidemiology course, all students had just completed an epidemiology and statistical overview before EBM was introduced to them through this tutorial. Undergraduate exposure to EBM, epidemiology, and statistics could not be controlled.

Tutorial

The content for the EBM tutorial was culled from peer-reviewed EBM sources^{1,14} and was demonstrated to be effective in a basic text format.¹¹ The same content was then used to create two types of online presentations. Content experts (AY, TS) designed the learning flow. An educational technologist (FRN) designed the tutorial presentation in two different formats. Students were allowed to choose their format preference: an interactive slide-based format with music, a text-based PDF format, or both.

The interactive format consisted of Flash-based slides created using Articulate software. This format had several distinct characteristics: (1) it allowed the student to see all the content of the slide within the computer screen without scrolling, (2) additional content could be accessed by the student by clicking and interacting with the graphics and links embedded in each slide, (3) slides contained music and auditory “click” feedback as the students interacted with the slide, (4) each element of each slide had to be

viewed before the student was allowed to move to the next slide, (5) all slides within a module had to be viewed prior to accessing the module quiz, and (6) the slides could not be printed out so all reading had to occur on screen. See Figure 1 for an example of an interactive slide. The authors anticipated that this format would appeal to students who were computer competent and who preferred to interact with the learning materials online.

The text-format modules were created with the same content and photos developed for the interactive modules. This content was placed in a simple but attractive PDF format with columns, color, and graphics. The text modules differed from the interactive modules in several ways: (1) these documents could not be viewed on one screen without scrolling, (2) there was no music or auditory feedback, (3) students could not interact with the documents, (4) there was no completion requirement before moving on to the next document or to the module quiz, and (5) text documents could be printed out. See Figure 2 for an example of a PDF text module; note that this is the same content as shown in Figure 1. The authors anticipated that this format would appeal to students who like to read a straightforward text and/or who like to print out the information.

The EBM tutorial was presented using Blackboard course management software version 7.1. The five modules were designed to teach the five basic steps of EBM in a systematic way. The modules and learning objectives are presented in Table 2. The first module introduced EBM, the major components and basic steps. The second module taught students how to understand background and foreground questions and how to create well-formed clinical questions based on clinical scenarios. The third module gave strategies for how to prioritize

searches, locate useable sources, and conduct PICO intervention searches efficiently. The fourth module presented how to appraise a journal article, including a preliminary assessment of the validity and importance of the findings. The last module introduced patient applications, and allowed for student reflection on the EBM process.

Also included in the tutorial were clinical discussion board cases, three videos from a medical librarian on searching for clinical evidence, Internet resource links, and practice quizzes following Modules 1-4. These supplemental elements were available to all students no matter which format was chosen. Students were able to take the quizzes as many times as necessary to achieve a satisfactory score of 80%. The quizzes could be saved and returned to at a later time.

The students were instructed that the course was self-paced and could be completed at any time on or off campus within a designated 2-week time frame. Each module took approximately 1 to 3 hours to complete. Students were told they could choose either one or both of the module formats at any time and could switch between the two as desired. All students had access to all of the supplemental materials such as resource links and library tutorials at any time. Both the interactive and text modules were self-contained units. The students were able to stop a unit at any time and return to it later. When they returned, they had the option to pick up where they left off or to start at the beginning of the module. Finally, students were told that they would continue to have access to both formats of the EBM tutorial until graduation, so they could return to it at any time after the course had ended.

Data Collection

The primary data collection was done with a qualitative pre/post survey

Table 2. EBM Tutorial Learning Objectives

Module	Content	Objectives
1	EBM overview	<ol style="list-style-type: none"> 1. Define evidence-based medicine (EBM) 2. List the 3 major components of EBM 3. State why learning about EBM is important in today's health care arena 4. Understand the basic steps involved in pursuing EBM
2	Asking clinical questions	<p>Module 2, Part 1: Formulating a Clinical Question</p> <ol style="list-style-type: none"> 1. Define the difference between background and foreground questions 2. Identify the components of a well-built clinical question 3. Create a well-formed clinical question based on a clinical scenario <p>Module 2, Part 2: Types of Clinical Questions</p> <ol style="list-style-type: none"> 1. Differentiate and construct clinical questions about: <ol style="list-style-type: none"> a. Intervention b. Diagnosis c. Prognosis d. Etiology/harm
3	Searching for evidence	<p>Module 3, Part 1: Types of Evidence</p> <ol style="list-style-type: none"> 1. Complete the levels of the evidence pyramid 2. Define and identify types of studies shown on the pyramid 3. State which type of research is best to answer each type of clinical question <p>Module 3, Part 2: Searching for the Evidence</p> <ol style="list-style-type: none"> 1. Create a search strategy for researching clinical questions 2. Identify databases that would be most appropriate for different types of questions 3. Conduct a search for a clinical scenario
4	Appraising the evidence	<p>Module 4, Part 1: Screening:</p> <ol style="list-style-type: none"> 1. Read the abstract and ask several basic screening questions 2. Answer the question: Is this article worth my time? <p>Module 4, Part 2: Appraising a Therapy Article:</p> <ol style="list-style-type: none"> 1. Determine the validity of the study 2. Estimate the importance of the findings <p>Module 4, Part 3: Appraising a Diagnosis Article</p> <ol style="list-style-type: none"> 1. Determine the validity of study 2. Estimate the importance of the findings
5	Applying to patient assessing outcome	<ol style="list-style-type: none"> 1. Determine if the findings are applicable to your patient(s)

design. The surveys were administered through Blackboard as part of the EBM tutorial. The pre-survey asked for demographic information plus several questions rating their understanding of specific EBM concepts. The exit survey asked about their understanding of specific EBM concepts and format preference for media delivery, and provided ample room for comments.

To assess student self-perception of

understanding of EBM concepts, a short series of questions was adapted from a pilot study conducted with physical therapists¹¹ and based on the Fresno test¹³ of competence in evidence-based medicine. These surveys were not meant to be comprehensive; rather, they were meant to capture a snapshot of student confidence in a few concepts frequently associated with EBM. For example, the students had

just finished a class on statistics in which *p* values were covered. Though these are important, we did not include *p* values in the survey. Instead, we chose to ask about relative risk reduction and confidence intervals, two concepts that are often referred to in EBM. Students were asked to rate their understanding of each as “understand well,” “understand a little,” or “do not understand.” They were asked

how well they understood:

- The steps of EBM
- How to write PICO questions
- How to search for research literature
- The concept of validity
- What is a systematic review or meta-analysis
- The statistic of relative risk reduction
- The concept of a confidence interval

Upon completion of the tutorial, the Blackboard software calculated and displayed the surveys results, which were not linked with student names.

Tutorial completion rate was 100%, and presurvey response rate was 100%. Postsurvey response rate was 95% for format preference questions and 55% for concept comprehension questions. Additional data analysis was conducted with Excel software.

Finally, additional data on content mastery was obtained by administering a series of 12 multiple-choice questions as part of an exam in the course, for which we received a response rate of 100%. These questions were derived from tutorial content and were modeled on the Fresno test¹³ of competence in evidence-based medicine.

RESULTS

The first purpose of the study was to demonstrate that EBM principles could be effectively taught to PA students via a Web-based tutorial. As this was an introductory EBM course, the authors believed that the critical element was to move the students from “do not understand” to some level of understanding; therefore, “understand well” and “understand a little” were grouped together for this initial phase of analysis. As shown in Table 3, all students reported ($p < .001$) that they had moved out of the “do not under-

stand” category to some level of understanding of selected EBM concepts.

Next, the authors looked more closely at the final level of understanding to see how many students reported that they “understood well.” Significant changes ($p < .05$) in the post survey results of students who “understood well” were noted in the following: steps of EBM (2% to 57%, $p < .001$); writing PICO questions (0% to 78%, $p < .001$); validity (24% to 65%, $p = < .001$); what is a meta-analysis or systematic review (2% to 35%, $p < .001$); and relative risk-reduction (21% to 48%, $p = .04$). The following concepts did not show a significant change into the “understand well” category: search for evidence (17% to 26%, $p = .39$); confidence interval (43% to 65%, $p = .08$).

Finally, exam results showed that all students achieved 85% or higher on the EBM content posttest, indicating a satisfactory understanding of EBM principles. These findings indicated that the first purpose of teaching PA students EBM principles via a Web-based tutorial was successful.

The second purpose of the study was to identify what delivery format the students preferred. Survey results as shown in Table 4 indicated that students preferred having both the Flash-based slides and PDF text formats available (65%) as opposed to Flash slides only (28%), PDFs only (2%), or no preference (5%). Of the seven students (17%) of who reported using the PDFs all or some of the time, five of them (12% of the total) reported printing them out all or some of the time.

Students were able to make comments on the post-tutorial survey. The authors were surprised that so many students commented that they wished they could have face-to-face lectures. Therefore, a short post hoc questionnaire on that topic was sent out with a 55% response rate. When asked if they would prefer a live lecture, 78% said

that would definitely attend such lectures, while 13% were not sure, and 9% would not attend. Students were less positive about adding “talking head” lecture videos (9% would definitely watch them, 43% were unsure, and 48% said they would not watch them) or audio only lectures with slides (13% would definitely watch them, 39% not sure, and 48% would definitely not watch them).

DISCUSSION

The first hypothesis, that this tutorial would be effective at teaching fundamental EBM skills, was upheld. Based on the self-reported knowledge of EBM concepts, all students who completed the survey moved from “do not understand” to some level of understanding. In fact, in all categories, a significant number moved to the “understand well” category, with two exceptions: searching for evidence and the concept of confidence intervals. Regarding searching for evidence, understanding appeared lower than any other category, which indicates that more instructional material and learning experiences would be needed to boost this score. Regarding confidence intervals, those percentages were high to start with as students had just completed a statistics module. All students passed the final exam with 85% or higher indicating test mastery on these concepts.

As noted, EBM consists of the best evidence combined with clinical expertise and patient preference. Because students have limited clinical expertise and patient exposure at this point in their careers, this tutorial focused on the element of evidence and, by necessity, measured knowledge acquisition in an academic environment. Ideally, this tutorial is only an introduction that will continue to be integrated during clinical rotations and beyond in order to have an impact on patient care¹⁵ and become an element

Table 3. PA Student Self-Reported Level of Understanding Before and After EBM Tutorial

		Understand Well	Understand a Little	Do Not Understand
The steps of EBM	Pre	2% (1/42)	64% (27/42)	33% (14/42)
	Post	57% (13/23) $p = .001$	43% (10/23) $p = .11$	0% (0/23) $p < .001$
How to write PICO questions	Pre	0% (0/42)	5% (2/42)	95% (40/42)
	Post	78% (18/23) $p < .001$	22% (5/23) $p = .08$	0% (0/23) $p < .001$
Search the literature	Pre	17% (7/42)	69% (29/42)	14% (6/42)
	Post	26% (6/23) $p = .39$	74% (17/23) $p = .67$	0% (0/23) $p < .001$
Systematic review and meta-analysis	Pre	2% (1/42)	48% (20/42)	50% (21/42)
	Post	35% (8/23) $p < .001$	65% (15/23) $p < .001$	0% (0/23) $p < .001$
Concept of validity	Pre	24% (10/42)	69% (29/42)	7% (3/42)
	Post	65% (15/23) $p < .001$	35% (8/23) $p = .007$	0% (0/23) $p < .001$
Relative risk reduction	Pre	21% (9/42)	52% (22/42)	26% (11/42)
	Post	48% (11/23) $p = .04$	48% (11/23) $p = .72$	4% (1/23) $p < .001$
Concept of confidence interval	Pre	43% (18/42)	52% (22/42)	4% (2/42)
	Post	65% (15/23) $p = .08$	35% (8/23) $p = .16$	0% (0/23) $p < .001$

of a lifelong learning plan.

Nevertheless, the results indicate that a foundational knowledge of the principles of EBM was laid.

Our second hypothesis that students would prefer the enhanced Flash-based modules was partially upheld and the results turned out to be more complex than anticipated. Regarding preference, the majority of students wanted both PDF and Flash-based content available rather than one or the other. This was surprising because Blackboard data revealed that few students even used the PDFs and even fewer printed them out. This suggests students liked having the choice of formats even if they didn't use them all.

More surprisingly, a significant majority wanted lecture delivery. This was evidenced by numerous comments on the postsurvey and the post hoc

questionnaire results. The fact that this group of students preferred lectures could be attributed to lectures being the model of delivery with which they are most familiar. The students in this study have received the vast majority of their PA educational material through lectures, with some Blackboard supplementation, so this tutorial was their first experience with completely online learning. Therefore, one could speculate that these students may not have had the experience or self-directed skills necessary for Web-based learning, and that this may need to be addressed prior to launching Web modules in the future.

While the authors hesitate to report on the post hoc results as they are limited in their generalizability, the results are provocative and similar to what others have reported.¹⁶ This suggests that the use of a blended learning for-

Table 4. Preference for Module Delivery

Flash-based format only	28%	(11/40)
PDF-text format only	2%	(1/40)
Both Flash and PDF formats	65%	(26/40)
No preference	5%	(2/40)

mat combining live lecture with online components may be more effective, at least initially, prior to a completely asynchronous learning experience. More study is needed in this area of when and how to provide online learning.⁴

Limitations

Perhaps the largest drawback of this study is one found in many education-

al studies — that quizzes and surveys measure knowledge acquisition, but not application. Also, while self-report and qualitative surveys may provide insight and correlation, they are not definitive and cannot show causation.

This study is also limited by a small sample and by the selection of a PA class that is predominantly young and female and from one Midwestern school, so generalizing to other health professions in other geographic areas is difficult. Also, while we did ask for a self-report on the pretutorial survey, we could not control for previous exposure to EBM. The response rates were somewhat inconsistent: while the presurvey response rate was 100%, the postsurvey rate dropped to 55%. There was no EBM content pretest, only a posttest. Finally, the follow-up period was short so longer term effects are unknown.

CONCLUSION

Fundamental EBM skills can be taught via asynchronous, Web-based modules. Students prefer having a choice of delivery options, though they may not use all of them. Inclusion of a face-to-face component along with the Web-based component to create a blended learning environment might improve student satisfaction.

Future research is needed in the area of Web-based EBM learning. A similar study with clinicians would reveal if similar results are true for that group, and the authors are currently conducting such a study. Additional research is needed to drill down to the specific effectiveness of various methods of Web-content delivery. As EBM continues to become a powerful force in health care, it is imperative that students and clinicians know how to access and learn new material online. A geographically dispersed clinical workforce and the need for lifelong learning suggest that online learning will become even more important in

the future. Knowing the most effective way to provide this information can have an impact on learning, and ultimately, on patient care.

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