

Web-based learning: pros, cons and controversies

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ABSTRACT – Advantages of web-based learning (WBL) in medical education include overcoming barriers of distance and time, economies of scale, and novel instructional methods, while disadvantages include social isolation, up-front costs, and technical problems. Web-based learning is purported to facilitate individualised instruction, but this is currently more vision than reality. More importantly, many WBL instructional designs fail to incorporate principles of effective learning, and WBL is often used for the wrong reasons (eg for the sake of technology). Rather than trying to decide whether WBL is superior to or equivalent to other instructional media (research addressing this question will always be confounded), we should accept it as a potentially powerful instructional tool, and focus on learning when and how to use it. Educators should recognise that high fidelity, multimedia, simulations, and even WBL itself will not always be necessary to effectively facilitate learning.

KEY WORDS: distance learning, e-learning, instructional design, instructional method, internet, medical education

Introduction

The internet is more frequently becoming a part of our daily lives, and its presence in medical education is unmistakable. Web-based courses seem to dominate the attention of educators and students. If presentations at international conferences are any indication, the interest in this new instructional medium is indeed commanding. At the 2005 meeting of the Association for Medical Education in Europe, for example, at least 104 presentations dealt with various aspects of web-based learning (WBL).¹ But is all this hype warranted? Is WBL really all it is cracked up to be, or is it just a fad? This article will attempt to answer that question.

What is web-based learning?

Web-based learning encompasses all educational interventions that make use of the internet (or a local intranet). There are currently three broad classifications or configurations within WBL: tutorials, online

discussion groups, and virtual patients. The distinctions between these configurations are often blurred, and in fact a given WBL intervention might use a combination of two or three, but the implications for teaching warrant a conceptual, albeit at times arbitrary, separation.

Online tutorials are similar to face-to-face lectures. They generally consist of information structured by the teacher in a way that will (hopefully) facilitate learning. Tutorials are often enhanced by features such as multimedia (sound, pictures, movies, and animations), links to online resources (full-text journal articles or related websites) and other areas within the course, and self-assessment tools. Effective online tutorials often also make use of patient cases.

Online discussion is similar to the face-to-face small group session. As with any small group, there may be an element of didactic teaching from the instructor (eg a brief tutorial) but the heart of the teaching lies in group discussion. Teachers take on the role of facilitators – defining the scope of the discussion, monitoring and guiding the discussion as needed, and providing or helping students to find additional resources. Communication among group members can be asynchronous (delay between sending a message and receiving the response) or synchronous (live).

Virtual patients are computer-based simulations of patient encounters. Depending on the scenario students might query the computerised ‘patient’ to obtain a history, request information about the findings of physical examinations, order and interpret laboratory results and other tests, and/or institute therapy.

It is also worth noting what WBL is *not*. The internet has found many functions in medical education in which the primary intent is not an educational intervention designed for web-based delivery. These include archives of face-to-face lectures (eg PowerPoint slides or videotaped lectures) and course syllabi, online administration of tests and course evaluations, and administrative communications. While certainly useful, these functions do not constitute WBL.

Advantages of web-based learning

Any advantages and disadvantages of WBL are contingent upon at least two conditions: the nature of

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the WBL intervention, and the intended setting including the prospective learners. The advantages of a pencil depend on the kind of pencil (wood or mechanical, black lead or coloured, etc) and the use to which the pencil is applied (writing a test, marking a piece of wood, drawing a poster, etc). It is also important (but unfortunately not always considered) that the WBL intervention must be well designed. The elements of well-designed WBL are beyond the scope of this article, but have been discussed previously.²⁻⁵ With these caveats, there exist numerous *potential* advantages of WBL.

Distance learning, economies of scale and consistent message

Perhaps the most obvious advantage of WBL is that it overcomes physical distances. This is the cardinal feature separating WBL from other computer-assisted instructional methods, and enables WBL to facilitate the teaching of students scattered across different practice sites in the same city,⁶ different cities,⁷ and even different countries.^{8,9} The result of distance independence is that learners have the opportunity to participate in the same instructional activities regardless of physical location.¹⁰ For teaching settings in which faculty expertise varies across sites this can be an important advantage.

Distance learning also permits the possibility of economies of scale. Once a WBL tutorial or virtual patient has been developed, class size is limited only by server capacity and bandwidth. Viewed another way, it is possible for schools to share resources and thus avoid redundancy in developing course materials.¹¹ Individual components of a course (for example, a paragraph of text, an animation, or a video clip) can be indexed and made available for use in other courses (reusable learning objects).¹² Note that economy of scale is less apparent in online discussion settings, where demands on faculty facilitator time usually increase with each additional learner.

Flexible scheduling

Along with flexibility in physical location, WBL offers flexibility in timing of participation.¹⁰ In contrast to lectures given at a fixed time, learners can access a WBL tutorial or virtual patient at any time day or night. Participating in an asynchronous online discussion group also offers flexibility, but it is tempered by the need to respond to communications from other group members in a timely manner and adhere to agreed schedules.

Easily updated perpetual resource

Changes in medical practice and feedback from students often prompt teachers to update or alter their course. With WBL, such changes can be made quickly and easily, and avoid the expense of reprinting the course syllabus. Other faculty, and even students, can also be involved in the process of updating the course. Web-based learning products persist long after the course ends. Learners may thus return to access the tutorial as a reference when seeing patients or studying for a test, the text of a rich

online discussion when writing a final paper, or the virtual patient simulator for additional practice.

Individualised learning

Web-based learning offers the promise of individualised learning.¹³ Learners can be given greater control over the learning environment by allowing them to select from among multiple different learning opportunities within a given course and move at their own pace. Learners struggling to learn a topic can pursue remedial work, those interested in learning more can do so, and those already familiar with the topic can move quickly to the next. Likewise, asynchronous communication in an online discussion group allows learners to tailor participation to their needs; those desiring or requiring more time for study and reflection can use it.

Another way to individualise instruction involves adaptive instruction in which the computer uses information about the learner to alter and thus optimise the learning experience.^{14,15} Adaptation has been suggested in response to various individual differences including baseline knowledge of the subject matter, motivation, attitudes toward computers, and learning and cognitive styles.¹⁶

Novel instructional methods

Web-based learning facilitates several instructional methods that would be infeasible or at least difficult in traditional settings. For example, virtual patient simulators can present medical students with a wide variety of patients and medical contexts to supplement classroom learning. This provides the opportunity to 'experience' uncommon scenarios, facilitates the repetition (deliberate practice¹⁷) and temporal spacing (distributed practice) required for enduring learning, and allows communication of detailed performance-based feedback. Other learning exercises, such as interactive models and games, or using the internet to search for and assimilate information from multiple sources, can engage learners. Multimedia (colour, sound, video, photographs, graphics, and animations) can enrich a course in ways that would be difficult, if not impossible, using a textbook. The asynchronous nature of many online discussion groups allows time to think deeply about the issues at hand and spend time constructing a thoughtful response. This is in contrast to a face-to-face setting where the conversation may move on before a learner has had time to grasp the concepts let alone formulate a question or comment.

Assessment and documentation

Finally, WBL facilitates assessment and documentation of educational objectives.⁶ Online assessment has the same flexibility in distance and timing as the WBL intervention, and also allows immediate customised feedback. Furthermore, in an age when documentation of learning tasks and competence is increasingly expected, WBL can serve a useful administrative purpose. Automated record-keeping can verify exactly what content

learners reviewed and can also document successful completion of a summative assessment.

Disadvantages of web-based learning

However, WBL is not without its disadvantages. In fact, many of these are related to the very advantages listed above – the other side of the coin, if you will.

Social isolation

Flexibility in time and location means that the learner using WBL tutorials and virtual patients is often studying alone, which over time may lead to a perception of social isolation. Online discussion groups have a distinct social organisation which differs to that of a face-to-face small group. In an era when teamwork and team learning is increasingly valued, will WBL build or detract from critical interpersonal relationships and communication skills? Alternatively, will interactions with a virtual patient satisfactorily mimic a real patient encounter, and will the associated learning transfer to the bedside?

De-individualised instruction

Despite the promise of individualised instruction noted above, it has yet to be clearly shown that these theoretical promises bear fruit as hoped. On the contrary, more often WBL fails to respond to the individual needs of the learner. Whereas a good teacher can monitor the group and adapt instruction to accommodate various learning needs, adaptive WBL interventions must be explicitly programmed to monitor, recognise, and respond appropriately to individual needs. This is not as easy as it sounds,^{14,18} and only a handful of WBL interventions (for the most part outside of medical education) have done this successfully – and only at a very rudimentary level. It remains to be seen whether the potential advantage of individualised instruction can be realised,¹⁹ but for the moment adaptive WBL appears to be more vision than reality, and instruction is more often predetermined than personalised.

Cost

Offsetting the potential economies of scale are the large up-front costs associated with developing WBL. While it is a simple matter to convert an existing textbook, syllabus, or lecture to a web-based format, such conversions rarely if ever constitute effective instruction. In contrast, the development of an effective online tutorial or virtual patient can be very expensive – ranging from thousands to hundreds of thousands of dollars when time and opportunity costs are accounted. Also, ongoing faculty time commitments to an online discussion group can be significant.^{20,21} Finally, each WBL experience comes at the expense of learner time that might have been devoted to other purposes. Educators often capitalise on the flexible scheduling of WBL activities without taking into account the cumulative time required to complete all assignments.⁶

Technical problems

Despite best intentions, technical problems are inevitable with virtually all instructional media (for example, running out of chalk when teaching with a blackboard). However, as instructional media become more dependent upon technology the impact of technical problems becomes greater. In the absence of chalk a good teacher could improvise and teach, but serious computer problems will completely disrupt a WBL course. Even minor problems (which in my experience are far too common) can be a serious impediment, decreasing satisfaction and course participation⁶ while increasing cognitive load,²² which in turn impede learning.

Poor instructional design

The quality of instructional design varies in all teaching settings. However, in WBL this is more obvious because once complete a website can be viewed and critiqued by all users. Furthermore, in contrast to a face-to-face course in which a talented instructor can teach with minimal preparation, instruction in WBL must be explicitly planned and implemented. Research shows that many – perhaps most – WBL courses have an inferior instructional design.^{23,24} A classic example is the ‘textbook on the web’ – publishing the text of an existing syllabus or book on the internet and calling it a course. Such courses offer little if any advantage over the previous format while incurring the disadvantages listed here, and hardly qualify as ‘instruction’. While poor instructional design is certainly not unique to WBL, the challenge of implementing effective designs on the internet and the absence of an instructor for needed clarification may make WBL more sensitive to flawed designs.

Technology for technology's sake

Perhaps not so much a disadvantage as a potential error, many educators and administrators are seeking out WBL and other education technologies for the sake of technology, rather than to achieve an educational goal. It is as though the technology train is leaving the station and no one wants to be left behind. Unfortunately, this has often led to poor instructional design (as noted above) or, worse yet, the use of WBL in situations in which other instructional methods or media would be more effective. For example, using WBL to teach medical interviewing may be less effective than other modalities. It is important to remember that, like chalk, PowerPoint slides, and calculators, WBL is just a tool – a powerful tool, perhaps, but one that may not be appropriate in all situations.

Areas of controversy

Is web-based learning better than face-to-face?

It is natural, when faced with a new technology, to ask, ‘Is this better than what we had before?’ Thus, researchers have compared WBL to written course materials,^{25–27} practice guidelines,^{6,28} face-to-face lectures,^{9,29} workshops,^{21,30} self-guided

slideshows,³¹ and small group sessions.³² Unfortunately, it is impossible to derive meaningful interpretations from these studies, which are collectively termed media-comparative research. While many media-comparative studies are limited by methodological flaws, even the best-designed studies are invariably confounded or open to multiple interpretations. The problem is that the term 'web-based learning' does not refer to a single entity any more than do the terms 'lecture' or 'textbook'. In face-to-face lectures there is wide variation not only in the quality, but also in the specific instructional methods (analysis of patient cases, audience discussion, etc) and course enhancements (slides, photographs, video clips, etc) used. Likewise, WBL interventions vary in the instructional methods (self-assessment questions, simulated patients, etc.) and course enhancements (colour, sound, video, etc). These variations make it impossible, in a media-comparative study, to know whether it was the medium (eg WBL versus face-to-face) or some other component of the course, or some combination thereof, that produced the observed results – regardless of effect size or statistical significance. Thus, as much as we might like to answer the question, 'Is WBL better than face-to-face?', it is unfortunately impossible to collect the required evidence.^{16,33–36} This is true regardless of whether one defines the criterion 'better' as higher test scores, higher efficiency (test score per time), satisfaction, motivation, or some other way.

Furthermore, it is quite likely that the appropriateness of WBL as a learning tool will vary upon the instructional context and objectives. WBL may be a great way to teach neuroanatomy, but only moderately effective for teaching examination of the cranial nerves, and entirely ineffective for teaching a student how to tell a patient that he has cancer. The bottom line is that it is not possible to make a global statement comparing WBL to face-to-face, or any other instructional medium.

Some point to media-comparative studies showing improved learning outcomes with WBL,^{6,25,28,30} but in each case the differences can be attributed to simultaneous changes in instructional methods and/or course enhancements such as multimedia. Results suggesting enhanced motivation in WBL settings can likely be attributed to infatuation with new technologies (similar claims were made with the advent of other instructional technologies such as television, filmstrips, and video³³) or improvements in instructional design. It is interesting to note a recent study in which learners actually found WBL *less* motivating than other formats.³⁷ Of course, as noted above, WBL facilitates the use of instructional methods or enhancements that might otherwise be impossible or impractical, and WBL can certainly enhance learning to the extent that it enables more effective instructional designs.³⁸ It is important, however, to distinguish the tool (the blackboard, slide projector, or computer) from the instructional methods it is used to support.

What do multimedia and high fidelity add to learning?

One advantage of WBL is the ability to include multimedia – sound, animations, photos and video clips – and sophisticated virtual reality as part of the learning experience. However, such

features can be prohibitively expensive and it is not clear that the benefit always warrants the investment. Evidence suggests that well-designed graphics and animations improve learning and that narration enhances learning from graphics.⁴ However, non-essential multimedia act to distract learners and actually decrease learning. Furthermore, video clip frame rate and colour do not seem to impact satisfaction or understanding,³⁹ suggesting that high visual fidelity may not be needed. While evidence is lacking, it seems likely that the realism required for effective virtual patients will vary according to the learner level and the learning task.⁴⁰ Much remains to be learned in this regard, but the bottom line is that more sound, graphics, and visual fidelity may not always be better.

This being said, the novel methods available in WBL present an opportunity for new, powerful instructional designs. For example, evidence shows that narrated explanations of graphics are more effective than written explanations.⁵ The realisation of this and other instructional designs may be *easier* in WBL than in many traditional learning settings.

Can web-based learning be individualised?

As noted above, WBL has the potential to adapt to the characteristics of individual learners such as cognitive and learning styles, motivation, and prior knowledge.¹⁶ Little research has been conducted along these lines in medical education. Research from other fields suggests that adaptation to prior knowledge^{41–44} and to certain cognitive styles⁴⁵ may indeed be fruitful. Adaptation to learning styles, on the other hand, has not been found to be effective.^{36,45} Only time and additional research will tell what attributes, if any, will prove useful as a basis for adaptation. However, a few points should be kept in mind by those undertaking such studies. First, before considering possible adaptations, care should be taken to establish a foundation of effective instructional methods appropriate for the course learning objectives.⁴⁶ In my own experience, once I have identified effective instructional methods it is often difficult to come up with adaptations! Second, adaptation requires scores that provide a reliable and valid assessment⁴⁷ of the individual characteristic upon which adaptation decisions will be made (this is rarely as easy as it might seem). Third, adaptation is only warranted if aptitude-treatment interaction has been demonstrated.^{16,48} Aptitude-treatment interaction research entails methodological considerations beyond the scope of this document.^{48,49}

Is there a role for automated instructional design?

Since the early days of computers educators have hoped to use them for the design as well as the delivery of instruction.^{50–52} The dream is that computers can assist in the design of effective instruction, making the process more efficient and enabling less expert teachers to develop high-quality instructional activities. While much progress has been made, this field remains in its infancy.⁵³ However, at least one prototype for medical education has been described.⁵⁴ Uniform standards will facilitate the widespread use of such technology.^{12,55}

What should we do?

So, should we be using WBL? Perhaps this is not the right question. The internet is here to stay, and in all likelihood so is WBL. As with other instructional media (books, blackboards, television, etc), WBL will continue to find a role in medical education. However, this role is as-yet unclear. Perhaps instead of asking 'if' we should use WBL, we should ask 'when' and 'how' to use this potentially powerful tool. 'When?' encompasses selection of WBL versus other formats for achieving specific learning objectives, integration of WBL with other instructional designs, timing of instruction, and cost-effectiveness, while 'how?' will help to determine features of the technology (instructional methods, enhancements, adaptation, etc) that will make this tool more effective.

Existing research in medical education provides little direct evidence to guide responses to these questions. Hopefully the next few years will see an accumulation of empiric data to support and inform decisions. Until then, what do we do? Regarding 'when', educators should avoid developing a WBL course for the sake of having a course on the internet. Rather, WBL should be used only when the advantages listed above outweigh the disadvantages. Regarding 'how', there is substantial (but by no means definitive) evidence from WBL research outside of medical education to inform our practice.⁵ Also, instructional methods that have proven effective in other media may well translate to WBL applications. These principles can guide our practice until more definitive evidence is available, and will also provide a starting point for future research. However, educators should not replicate a face-to-face course or written instructional materials on the internet. Rather, adapting an existing course to a WBL format may require substantial revision to minimise the disadvantages of WBL and fully capitalise on the potential advantages.^{2,4,5}

To summarise, WBL is here to stay. It offers many advantages over traditional instructional formats, but also entails many disadvantages. Decisions regarding the use of WBL in a particular course should weigh these advantages and disadvantages, and keep in mind that there is nothing inherently better about WBL compared to other instructional media and methods. Like blackboards and slides, WBL is a powerful tool – but only a tool – that if used wisely can greatly facilitate learning.

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