Development and evaluation of the use of the Internet as an educational tool in occupational and environmental health and medicine

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The Internet, and specifically the World Wide Web (WWW), has an important role as a method of learning in occupational and environmental health and medicine. This paper provides a systematic overview of the demands and merits of this approach to learning in a range of higher education courses in these disciplines. Drawing on a relevant theoretical framework for understanding how students learn, it describes the design and evaluation of specific resources developed for students to learn using the WWW. The occupational and environmental health or medicine components of two undergraduate degree courses and of two postgraduate courses were reviewed to determine what learning objectives would be achievable by adapting extant conventional material, or by developing new teaching and learning resources for the WWW. Depending on the objectives, various learning resource formats were developed including descriptive, interactive (such as case study or data-based), reference and self-assessment. One WWW based tutorial consisting of an interactive resource with defined objectives, linked to constantly updated, in-house information and external links, was chosen as a representative for detailed evaluation. Process evaluation was based on student feedback, and outcome evaluation on group reports submitted on completion of the tutorial. Twelve of the 13 students who completed the tutorial returned the feedback questionnaire. All but one student rated it as 'good' or 'very good', with the majority of students reporting that it was easy to follow. Open-ended comments suggested that students valued the flexibility, timeliness, efficiency and breadth of access to relevant information offered by the WWW. The outcome evaluation showed that all the main learning objectives had been achieved. This work indicates that the WWW can be a valuable learning resource for occupational and environmental health and medicine.

Key words: Education; environmental; health; Internet; medicine; occupational; World Wide Web (WWW).

INTRODUCTION

The vast potential for using the Internet as a resource for learning is already widely recognized, with many secondary and tertiary education institutions actively involved in the development of such materials (see for example the review by Owston1). The Internet is being increasingly used as a vehicle for professional information in a wide range of subjects including occupational and environmental health and medicine,2,3 and therefore education must reflect the use and value of this medium. However, few systematic assessments are available of its role in achieving and maintaining quality as well as efficiency of learning when applied to these areas. Additionally, to be able to fulfil its potential and find its right place, such
learning needs to be evaluated adequately. Besides the place of conventional ‘face-to-face’ delivery of higher education, there may be increasingly important demands for web-based approaches as the nature of the student population changes, pressures in the workplace increase, and needs for continuing professional development are recognized. These require part-time or ‘open’ study and lifelong learning with adequate access and flexibility and opportunities for professional accreditation.

The World Wide Web (WWW) offers a constructive approach to these changing requirements. As in other higher education institutions, some Departments in Edinburgh University already recognize the importance of the WWW as a medium for supporting teaching and learning at undergraduate and postgraduate levels. This paper refers to specific developments in the Medical Faculty in the Department of Public Health Sciences, starting in the academic year 1995/96, when the World Wide Web began to be piloted, and subsequently embedded as a mode of teaching on several occupational and environmental health courses. This paper describes the role of the WWW, and its application as an educational tool in undergraduate and postgraduate courses in occupational and environmental health and medicine, through a systematic evaluation of the application of WWW-based learning both in existing and in new courses. Specific detail is included of an evaluation of process and outcome of a representative part of the educational material. The paper concludes with a discussion of the future role and prospects for this mode of learning.

The rationale underpinning the developments described here is rooted in educational theory. Offering students a resource-based approach to learning emphasizes learner autonomy, while the opportunity to explore additional Internet links exemplifies learning by discovery, as characterized in Bruner’s ‘hypothetical’ approach. The WWW provides an excellent opportunity to incorporate the various styles of learning required to address knowledge, attitudes and skills outcomes, and clearly identified by Kolb and Fry as concrete experience, reflective observations, abstract conceptualization and active experimentation.

METHODS

General review

The learning objectives relating to occupational and environmental health and medicine in existing or planned courses were reviewed to identify those parts with a high content in these subject areas. These courses comprised two undergraduate courses, namely the Medical Undergraduate course (MBChB) and the BSc (Honours) Degree course in Environmental Health, and two postgraduate courses (MSc in Environmental Health, and a professional development programme on Health Promotion in the Workplace). The course content that was addressed by virtue of its high content of occupational and environmental health, medicine and epidemiology consisted of the following: In the MB ChB (medical undergraduate) curriculum, the Special Study Module in Occupational Medicine was selected out of existing teaching, along with the core components in these subject areas in the new planned integrated undergraduate medical teaching curriculum (in Edinburgh this is termed ‘Vision 2000’). In the BSc (Honours) Environmental Health course approximately one-third of the teaching in years one and two, and all the planned teaching for years three and four was chosen for consideration. At postgraduate level, the three modules (out of a total of eight) with the highest content of occupational and environmental health and epidemiology teaching were chosen, together with a planned re-development of a professional development programme on Workplace Health Promotion. Learning objectives were chosen to reflect attitude, skill and knowledge outcomes in both the existing, and in the planned teaching. For each of the learning objectives to be piloted for Internet teaching, decisions were reached as to whether this could be achieved simply by the adaptation of existing teaching material or whether new material should be developed specifically for the WWW. These decisions were based on two main criteria. The existence of adequate and satisfactory textual and graphical material, argued in favour of existing material. On the other hand if fulfilment of the learning objectives required timely, i.e., frequently updated, sources or substantial interaction with the source (which might previously have been achieved through a face-to-face tutorial), new Internet-based material was derived to fulfil at least part of the learning outcome.

Empirical observations as well as the systematic evaluation described below permitted conclusions to be drawn regarding the merits and disadvantages of WWW-based learning in relation to learning outcomes, ease of development (or otherwise) of teaching materials and ease of use. Teaching was based on material developed primarily by academic staff in the department, but supplemented by critically vetted links to other WWW sites. In so doing various types of approaches became manifest and these are described with some examples below. The software packages used included WordPerfect Internet Publisher, Netscape Navigator and Microsoft Front Page, but it is not the purpose of this paper to discuss the technical aspects of the software or their respective merits.

Specific examples

In the academic year 1996/97 the use of the Internet as a learning resource was extended to several modules, including a postgraduate level module on Occupational Health and Workplace Health Promotion. This module included a tutorial based entirely on the WWW, encouraging students to explore issues around workplace health promotion, and relevant government and
media reports. It primarily addressed 'skills' objectives, but also significantly 'attitudes' and 'knowledge'. It provided a limited formative assessment and was exclusively developed de novo for the WWW. It was supplemented by WWW-based sources of information. This tutorial can be found on the following Uniform Resource Locator (URL):

http://www.med.ed.ac.uk/hew/hwgm.html

The objectives of the tutorial were that on completion of the tasks on the WWW, students would:

- be aware of current topical issues in health promotion in the workplace;
- be able to find out more about these using the World Wide Web as a resource;
- be able to critically appraise the purpose, contents and form of relevant governmental media (press) releases and
- have gained an insight into Government policy and how Government communicates important issues through the media.

The index tutorial began by inviting students to select a recent Government press release relating to their particular field of interest. In order to achieve the above outcomes, the tutorial was designed to give students the opportunity to explore relevant information on the WWW. One of the major strengths of using this medium for the tutorial is that it ensures up-to-date access to all Government press releases (and therefore a wide and contemporaneous choice for students) as well as up-to-date access to relevant resources in the field. The tutorial provided students with hypertext links to press releases from the Health and Safety Executive and the Department of Health. It was also linked to a 'directory' of relevant sites on the WWW, vetted by staff, and appropriate search facilities and on-line guidance on critical appraisal of Internet information to permit individual exploration of valid information. Thus while the basic tutorial format can remain unchanged, the hypertext links within this lead students to databases on the Internet which are automatically updated. Supplementary (optional) features included facilities for students to link to press releases of their own choice (for example overseas students could access those from their own country), and to access resources and/or press releases such as those from the Health Education Board for Scotland, the Trade Union Movement or national newspapers. This flexible approach clearly offered students the opportunity to direct their learning in line with their own professional and personal needs and interests, as recommended above. The nature of the tasks also emphasizes the constructivist approach to learning currently emphasized as an important component of higher education. In view of the diversity of outcomes and of teaching methods, this tutorial was deemed to be representative and therefore selected for more detailed formal evaluation.

Evaluation of specific example

For the purposes of this pilot study, students completed the index tutorial in small groups with each group submitting a report structured around the tutorial objectives. Process was evaluated by student feedback questionnaires, and the outcome in terms of the group reports. Process evaluation questionnaires were designed to enable collation of feedback from students. The following main areas were addressed:

- personal confidence and previous experience of using the WWW (a set of closed questions)
- individual reactions to working through the tutorial:
  - (a) closed questions (with responses rated on a 5-point scale) focusing on time spent, ease of getting started and of following instructions and hypertext links;
  - (b) perceived advantages/disadvantages of doing this tutorial on the WWW, specific weaknesses and strengths, and suggestions for future improvements.

After students had completed the tutorial, they were each given a personal copy of the evaluation form, to be filled in privately and anonymously, and returned in a sealed envelope. The short questionnaire was designed to take a maximum of 10 minutes to complete, with students being reassured of confidentiality, and urged to provide feedback on this new teaching resource, including any suggestions which would improve the tutorial for subsequent students. (On-line evaluation forms for future evaluation and feedback have since been introduced).

RESULTS

General review of types of formats that materialized

In reviewing the above courses, it was evident that a number of complementary formats were applicable, depending on the type of objective (attitude, skill, knowledge), the subject, the particular student audience and technical feasibility.

The 'descriptive' format: This is the easiest approach to adopt or adapt and consists of text, with an appropriate hierarchical structure, images and internal and external hypertext links. It must, however, be more than a simple transformation of a textual handout into hypertext mark-up language, as this would not take advantage of WWW and students would be reluctant to read large extracts of text on screen. 'Descriptive'
material was therefore divided into sections, punctuated by headings or other keys, such as questions, with a balance of images, blank space and some cross-referencing within and outside the page. This format is most likely to help fulfil ‘knowledge’ objectives and provide a source of easy reference but should not constitute the dominant teaching format. An example which deals with occupational asthma, and has been linked by various authorities can be found at:

http://www.med.ed.ac.uk/hew/work/ocasthma.html

Directories/indices, pointing through hypertext links to other sources: These were relatively easy to establish de novo but were not educationally adequate on their own, since it was not possible to fulfil learning outcomes in the subject areas solely by pointing to extant information elsewhere on the WWW. However, the directory served as a useful supplement to specially developed material, and permitted students to undertake their own searches of WWW sites vetted by staff and which complied broadly with published guidelines. The directory is available on:

http://www.med.ed.ac.uk/hew/links/

An added advantage of the directory format is that it helps students to develop skills to search elsewhere and, most importantly, to be able to critically appraise the WWW information from other sites. To guide students in this, a resource was specifically developed:

http://www.med.ed.ac.uk/hew/searchap.html

The remaining interactive learning formats described below encourage students to engage with the learning material and relate to learning objectives concerning attitudes and skills as well as knowledge. These formats also address the different categories of learning styles discussed in the Introduction.

The staged format: This approach imparts knowledge and skills in sequential ‘layers’, encouraging students to stop, question and think from one page to the next. It thus addresses a ‘reflexive observation’ approach to learning. An example of this is a discussion relating to the under-recognition and under-reporting of occupational ill-health:

http://www.med.ed.ac.uk/hew/work/essay0.html

The case study: A great deal of our current face-to-face teaching currently follows this approach. This can be centred around an individual workplace or an individual worker’s problem, e.g.:

http://www.med.ed.ac.uk/hew/clin/1a.html

Alternatives include an ‘environmental case study’ dealing with a real environmental assessment problem, e.g.:

http://www.med.ed.ac.uk/hew/alpha.html

The case study on WWW, as a form of ‘virtual experience’ addresses the ‘concrete experience’ and ‘abstract conceptualization’ styles of learning.

‘Realtime’ information or data sets: One important interactive advantage exhibited by the WWW and which cannot be matched by CD-ROMs is the capacity to use ‘realtime’ information or data sets. This allows students to test hypotheses against real world and real time data, and thus relates to Kolb and Fry's ‘active experimentation’. These include tutorials (one of which has been evaluated in detail and reported on below) which deal with Government policy in relation to the media and the public on aspects of occupational and environmental health. Moreover, interactive tutorials can draw on real-time pollution data, for example using air pollution data no more than two hours old. An example can be found on:

http://www.med.ed.ac.uk/hew/tutorial/aqexc.html

Self-assessment: This is an important element of any educational programme allowing students to monitor their own learning, including personal reflection. The WWW can provide the facility for such self-assessment, with hypertext links provided to enable students to move on (or return) to address those areas where their objectives might not yet have been achieved:

http://www.med.ed.ac.uk/HEW/edac/exams/mcq/mmcq.html

The ‘supplementing’ format: Even where learning objectives could clearly not be achieved by using the WWW alone or predominantly, for example in conducting practical assessments of the risks to health in specific workplaces, the WWW provided a means of supplementing the learning. For example in relation to the programme of practical workplace visits and assessments, pages were set up to provide background information and help with preparing reports:

http://www.med.ed.ac.uk/hew/edac/tasks/viswork.html

In total the site teaching materials developed on the WWW currently consists of approximately 30 MB of server space, including about 200 text files, about 150 image files and other supporting files. The full listing of tutorials currently available can be accessed through the following URL.

http://www.med.ed.ac.uk/hew/alpha.html

It should be stressed that the WWW teaching and learning resources still constitute a minority, albeit an appreciable one, of the teaching on the courses reviewed and form part of an integrated approach to teaching and learning. Currently, the lowest proportion is within medical undergraduate teaching and the highest within the postgraduate Workplace Health
EVALUATION OF LEARNING ON WWW — A SPECIFIC EXAMPLE

In the detailed evaluation of the WWW tutorial on Health, Work, Government and the Media, forms were returned by 12 of the 13 students who completed the tutorial (all postgraduate students in the Department of Public Health Sciences Masters degree programme), offering a comprehensive range of comments from those who completed the tutorial. The students came from a range of nationalities and academic and professional backgrounds, including health promotion, nursing and environmental health.

Process evaluation

Experience and confidence in using the WWW: All students had used the WWW before, although only two reported more than occasional use. The more experienced users had used the WWW at work, and/or at home, but all had used it at least once on an earlier module on the MSc course. Only four students had ever been given personal instruction on how to access the WWW, mostly via friends or colleagues; the rest were ‘self-taught’ with written guidelines. Perhaps because of this prior, albeit limited, experience, only three students reported feeling ‘a little apprehensive’ about tackling a tutorial on the WWW, with most feeling ‘quite confident’.

Reactions to tutorial

Overall the tutorial was positively rated. On a five-point scale ranging from ‘excellent’ (1) to ‘poor’ (5), 11 out of 12 students rated the tutorial overall as ‘very good’ (n = 5) or good (n = 6). The lowest rating was ‘not very good’ from only one student. No serious difficulties were apparent, with the majority of students reporting that it was easy to get started, follow instructions, understand the objectives of the tutorial and follow up the hypertext links. Four students admitted that they had wasted some time exploring other WWW links not directly relevant to the tutorial. Only two students believed that they could have completed the tutorial just as well without using the WWW; this appeared to be related less to the tutorial content than to the distracting environment of the computer lab where the tutorial was accessed. Eight students believed that the WWW offers advantages in terms of rapid and easy access to a wide range of information, with the opportunity to focus on more specific details. When asked how they might have accessed the information necessary for the tutorial (press releases and similar topical documents) without having access to the WWW, most suggested the library, CD-ROM or newspaper offices. This reinforced the perceived efficiency of the WWW noted by the majority as reported above. Open-ended questions invited students to comment on what they liked least about the tutorial, what was its best feature, and to offer suggestions for future tutorials. Two students felt the tutorial task was too simple, and another found it too rigid. This could merely reflect personal background experience in the area of workplace health promotion. Several felt they did not have enough time, and one student was clearly frustrated by working in groups, believing this resulted in ‘too many ideas’.

Comments concerning the best features of the tutorial mostly related to gaining experience in using the WWW, specifically in terms of knowing how to get started, learning how to find their way around and how quickly and easily information could be accessed.

Outcome evaluation

The students submitted reports covering four different press releases (from the Department of Health and from the Health and Safety Executive). Three focused closely on the association between health and occupational exposures, while the fourth addressed the more general issue of health service resources. Review of the student reports indicated that each group had fulfilled all the main objectives of the tutorial. All agreed that the press releases were adequate as a means of informing the lay public on government policy decisions. However, to varying degrees they commented on the lack of further available information in an inexpensive and easily accessible way. The press releases were deemed insufficient in themselves in providing this. Moreover some made the comment that press releases lack specific criteria and/or evidence on which to judge the favourable outcome of the policy that was proposed. Three of the reports provided explicit references to further relevant information both on the Internet and on using non-electronic documentation.

Overall, therefore, in this small pilot study, students’ experience of completing the Web-based tutorial was very positive, in terms both of gains in technological expertise and in achieving the tutorial objectives in relation to occupational health and workplace health promotion.

DISCUSSION AND CONCLUSIONS

This paper shows that the Internet, specifically the World Wide Web, can help contribute to a wide range of learning objectives in occupational and environmental health and medicine, including knowledge, skill and attitude objectives. For these outcomes, material can be devised which is based on an adaptation of current teaching methods and media, but preferably as material developed de novo for the WWW. As in all approaches to teaching, learning and assessment, a continuing process of improvement through feedback...
and iteration is necessary when developing learning resources on the Internet. Our experience suggests that in relation to knowledge objectives, teaching material can sometimes be prepared using existing text and graphics as a starting point, but with substantial adaptation to achieve the format necessary to enhance student motivation. In this context, the use of hypertext pages on the WWW has the disadvantages of needing access to hardware, together with the attendant ergonomic risks if the teaching material and the study station are not adequately designed. However if these issues are adequately addressed, then the advantages of this educational medium include the ability to provide vetted links to a wide range of sources, and the facility to provide 'real time' constantly updating information sources. To develop such teaching materials, teaching staff will need support to acquire the skills necessary for the design, development and delivery of pages on the WWW, and for the critical appraisal of the materials made available to students through links to other sites.

Many skills objectives in relation to occupational and environmental health, epidemiology and health promotion can be effectively achieved through the appropriate use of the WWW. These must include first and foremost the skills necessary to appraise information on the WWW, especially where links to other 'sites' are provided or may be sought by the students through targeted or perhaps even indiscriminate searches. The American Medical Association has provided some guidance on this issue, and has discussed the implications for the Internet in relation to medicine. The case study approach is particularly well suited to this form of teaching, whether the case study is clinical or not (e.g., a workplace or another environmental setting). The use of real time data (e.g., in the tutorial on Urban Air Pollution and Health) ensures that on every occasion that the student attempts the tutorial, the data is different from that previously experienced (and indeed may differ from one part of the country to another). This helps to maintain student interest, and to provide alternative data sources from which to learn common lessons.

For the achievement of attitude objectives, we believe that the face-to-face encounter with students will still remain of fundamental importance, although email discussion groups also provide an opportunity for exploring attitudes with fellow students. Similarly, while many 'skills' objectives have to be acquired 'in the field' it is anticipated that some form of computer-mediated conferencing (perhaps involving role play) will become part of the teaching resource. Thus, the use of WWW can improve quality, efficiency and ease of access to the knowledge base, to improve awareness and enhance the development of attitudes and skills.

In a European-wide project the Internet has been described as a 'rich resource of materials that students can use to improve the quality and quantity of their learning'. In addition, learning from the Internet is seen to provide an opportunity for the development of a number of important personal transferable skills, including technological, information-seeking and communication skills. The rationale for the WWW-based tutorial specifically exemplified here follows closely the recommendations from a major European project on distance learning (the Socrates programme). These are relevant to developing WWW-based resources in environmental and occupational health and medicine, and reflect the styles of learning identified in the Introduction to this paper. The recommendations (Preliminary Report from MECPOL) include the following:

- learning should be rooted in the interests and needs of students;
- learners should take a lead in defining what they need to know;
- learners should have more control over HOW they study;
- learners can study at their own convenience.

The Internet in general (and the WWW in particular) is finding increasing application as an educational resource. Although Mayes argues that many 'new' learning technologies in the past have failed to produce the expected revolution in educational practice, he expresses greater optimism for current trends, given the widely accessible nature of developments such as the Internet and its ability to satisfy the changing needs of students. Nevertheless, educational technology should not be introduced simply because it is novel and fashionable, and new developments should always proceed with caution and be integrated with conventional methods. Although most educators would agree in principle with such advice, it is still the case that educational developments are often introduced without any real evidence that they are of value. Wherever possible, therefore, evaluation should be an integral component of course development. Evaluations with positive outcomes can also convince more sceptical colleagues of the value of incorporating new technologies into a more traditional teaching programme. The pilot evaluation study reported here shows that the WWW can be an excellent learning resource for students of occupational and environmental health and of workplace health promotion, for the breadth and ease of access it offers to current and regularly up-dated sources of relevant data. In addition it allows students to experience self-directed learning, and provides the opportunity to develop technological skills which are increasingly important in professional practice.

Although initially applied to academic teaching and learning initiatives, which have been the focus of this paper, by design or by circumstance the WWW site that we have described has had other benefits. It has been of value to students in other courses at this University (MSc degree courses in Environmental Chemistry, Public Health, Epidemiology, and Health...
Promotion/Health Education) and informal contacts suggest that some of the resources have been used by students from other higher education establishments such as the Universities of Glasgow and of Bradford (E. B. MacDonald and J. H. Dennis — personal communications). It has been of interest to the general public, as shown by electronic mail messages (emails) received. It has been used as a shop-window to advertise for potential students, or to publicize research in progress. Moreover, staff involved in setting up the site have developed or contributed to hosting WWW sites of various learned societies on the same or other servers. These include the British Occupational Hygiene Society, the International Federation of Environmental Health, the International Occupational Hygiene Association, the Society of Occupational Medicine, the Institute of Occupational Hygienists and the Royal Environmental Health Institute of Scotland.

The WWW is likely to be an increasingly important vehicle for continuing professional development, as well as for information, for organizations such as these and for further innovations. For example, to help students develop critical appraisal skills we have begun to select important publications" and provide a critical review for debate:

http://www.med.ed.ac.uk/hew/tutorial/gardcom.html

An interactive site to permit the on-line hazard prediction of novel chemical entities based on current research\(^a\) has also been developed. A summary of other WWW sites relevant to occupational and environmental health has recently been published.\(^b\) At the time of writing, the Web site discussed in this paper is probably the largest academic site in occupational and environmental health and medicine in the European Union and possibly world-wide. However, it is important to realize that the most efficient way forward will probably arise through the development of partnerships or consortia to be able to share in fulfilling the ever-increasing demand for education and information in these as in other subject areas through the Internet.

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Note: A seminar presentation based on this paper is also available on the following URL:
http://www.med.ed.ac.uk/hew/seminar/internet.html

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