The development of an exemplar e-module for the continuing professional development of European dentists

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Abstract

Aim: To present the development of an exemplar e-module for dental continuing professional development (CPD) provided by dental schools and other dental educational providers.

Materials and methods: The exemplar e-module covered the topic of 'Sterilisation and cross-infection control in the dental practice' as this is one of the most recommended topics for dental CPD in Europe. It was developed by a group of topic experts, adult learning and distance learning experts and a technical developer. Major concerns were pedagogy, interoperability, usability and cost reduction. Open-source material was used to reduce the cost of development.

Results: The e-module was pre-piloted in dental practitioners for usability and then evaluated by experts in the field and dental academics through an electronic questionnaire and an online presentation and discussion at the ADEE 2012 Special Interest Group on DentCPD-Lifelong learning. This facilitated refinement before final production. A Creative Commons License was implemented to ensure the developers' rights and facilitate wider distribution and access to CPD providers.

Discussion and conclusions: The e-module was developed according to well-defined pedagogical and technical guidelines for developing e-learning material for adult learners. It was structured to promote self-study by directing learners through their study, promoting interaction with the material, offering explanation and providing feedback. Content validity was ensured by extensive review by experts. The next step would be to expand the evaluation to practising dentists in various countries after relevant translations, and adaptations to local policies have been made.

Introduction

Electronic educational material has a significant and growing potential in dental continuing professional development (CPD), and there are a number of publications discussing its application, strengths and weaknesses (1–4). A previous study in the UK based on a post-impact evaluation analysis of an e-learning cross-infection control course, using a CD-ROM provided to

all general dental practitioners in England in 2004, showed that its use was popular amongst dentists and the development of relevant online material was recommended (5). In that study, the dentists commented that studying at their own pace and time was very important, but a minority of users believed that CD learning was dry, uninteresting and time-consuming (5).

As the use of computers increases rapidly and information and communication technology (ICT) further develops, a wider dissemination of e-learning in dental CPD is anticipated (2). This trend stresses the need for the development of high-quality e-learning material. Important issues have been raised: quality of content, technical quality, pedagogical efficiency, usability, interoperability in the technology used, low cost (6, 7).

The design of electronic educational material for CPD is based on adult and e-learning principles. In this case, the dental professionals are adult learners with set intentions, different set patterns of learning, different pre-existing knowledge and clear expectations for the learning outcomes (8). The particular needs of the adult learners should be assessed before developing the educational material (9). Several educational approaches can be reflected in the design of electronic educational material: teacher-directed vs. learner-directed learning, individual vs. collaborative learning, instructional vs. discovery learning (10). The electronic educational material should be learning-centred; it should guide, support, motivate, interact with the learner, be self-explanatory, user-friendly, flexible, scientifically correct, up-to-date, clearly targeted, relevant to practice, providing opportunities for critical thinking and self-evaluation (6, 7, 10, 11). Various teaching components and clear navigation tools can serve the individual learning styles of the adult learners and support conversational learning (10). Feedback should be fed back to the providers who should regularly update the material (6).

On the other hand, technical considerations include usability (effective and efficient use by the learners), interoperability and low cost. Usability and interoperability are major concerns for the developers of e-modules particularly when the learners' computer literacy or access to IT infrastructure varies (7, 12). Low cost is also becoming very important for both the providers and the learners, and open-source material is recommended (7, 9). It is important that the e-learning educational material is tested, before the final development, to investigate pedagogical and technical issues (7, 13).

One of the deliverables/products of the 'Dent*CPD*' project co-funded by the European Commission (509961-LLP-1-2010-1-UK-ERASMUS-EMHE) was to develop an exemplar e-module for dental CPD, designed to be offered by European dental schools and other dental CPD providers. This article sets out the e-module development process and the testing procedures before finalising the design and content.

Materials and methods

The topic that was selected by the DentCPD project partners covered the topic of 'Sterilisation and cross-infection control in the dental practice' as this is one of the compulsory or recommended dental CPD topics in most European countries (14, 15).

The e-module was developed by a team at the University of Athens dental school, including experts in the field of decontamination and cross-infection control for dental practice, adult learning and distance learning, and technological development. The team agreed on (i) the educational content and (ii) the design of the web pages. During the whole development process, there was continuous discussion and review of the e-module by the DentCPD project partners using e-mail, teleconferences and face-to-face meetings. A preliminary review was undertaken by practising dentists in Greece to investigate the technical aspects. A further evaluation was then undertaken, by European experts in the topic and dental educators, before finalising the module design and content. An online demonstration and discussion took place during the Lifelong Learning Special Interest Group (SIG) meeting of the Association for Dental Education in Europe (ADEE) conference in 2012.

Results

Development of the content

The content was developed by an expert in the module topic and was based on published guidelines by international organisations including the Council of European Dentists/CED (16) and the Centers for Disease Control and Prevention/ CDC (17). The content specialists and the distance learning experts worked closely together to adapt conventionally written documents to e-learning material. The initial framework incorporated subunits on protection measures prior to beginning treatment for a patient, hand washing, gloves, mask and glasses, appropriate dental clothing and surface coverings, sterilisation of dental instruments, sterilisation of handpieces and burs, preparing impressions for the laboratory, management in the case of accident and/or exposure to infected material and post-exposure prophylaxis (PEP) and taking protection measures after completing treatment for a patient. A chapter on the management of dental unit waterlines was added after the European experts' evaluation. Based on the distance learning experts' opinion, videos were developed and images were added to support or replace the content.

As this e-module aimed primarily to serve as an exemplar electronic educational facility in support of dental CPD, the team of experts decided that the content should not be too exhaustive and over prescriptive in covering all aspects of sterilisation and cross-infection control, but should include major points that could be later adapted and modified by the local providers to meet their particular needs and protocols.

Design development

Major concerns, whilst developing this e-module, were interoperability, usability and low cost. The target group of learners (all European dentists) may use different electronic devices and systems and have different levels of computer literacy and attitudes towards e-learning and different levels of knowledge on the topic. Further, the European dental schools and other dental CPD providers may have different resources for IT development. Therefore, it was deemed necessary to develop a website suitable to meet the needs of the vast majority of users and providers.

Technical aspects

Open-source material was used in most cases to reduce the cost of development and the cost of later adaptations and modifications, which would be undertaken by various European dental schools.

The e-module was based on HTML5 and JavaScript technologies. Web pages were written in Adobe Dreamweaver CS5 (18), and graphical illustrations were optimised for the web by using Adobe Photoshop CS5 (18). To handle cross-browser inconsistencies, video footage was encoded to three different versions (MP4, WebM, Ogg) (19) using the open-source application Miro Video Converter (20). Flash fallback was also provided for when the HTML5 video is not supported by the user's browser. Video.js (21), an open-source JavaScript and CSS library, was embedded in the web pages for video playback, providing cross-browser consistency and additional features such as full screen and subtitles. JQuizme (22), licensed under the MIT licence, a webpage quiz application made with jQuery was used as a generator plug-in for the quizzes. FancyBox2 (23), licensed under Creative Commons Attribution NonCommercial 3.0 license, was used for displaying images that float over the top of the web page and grouped related items, adding navigation and zooming functionality.

Various designs were tested to ensure proper display before the final decision on the design was agreed.

Preliminary review of technical aspects

After the initial framework was developed including images, videos and self-assessment questions, a preliminary online evaluation was performed to investigate technical aspects. At this stage, it was important to record any problems related to the use of different electronic devices and different internet connections. An anonymous electronic questionnaire was developed including 10 closed and open-ended questions on the structure, design and navigation aspects. The questionnaire recorded comments about colours, fonts, readability and use of images, videos and self-assessment questions and about technical problems encountered during navigation. The rating of the quantitative evaluation ranged from 1 (very negative) to 10 (very positive). The respondents were also invited to add free comments in specific text boxes.

The survey link was e-mailed to 25 dentists in Greece with experience in using e-learning material, with a link to the e-module. A reminder e-mail was sent to non-respondents 10 days later. Twenty dentists responded to the questionnaire. The mean rating of all items ranged from 6.7 to 10. The highest rate was recorded for the absence of any technical problems ($x = 10.0$) and the lowest for the colours being used ($x = 6.7$).

The open-text questions provided very useful comments, which helped improve the e-module. Comments were made about the size of the images, the presentation and type of the self-assessment questions, the colours used and the use of videos on particular topics.

Final design

The definitive web page was divided into three sections: the main (larger) middle section contained the study material, the left-hand bar contained the menu area and the right-hand bar the related information (Figs 1 and 2).

The menu area displayed the introduction, including detailed reading instructions for the users, the aims and expected outcomes, the different subunits of the content, each one referring to a specific procedure (chapters). The menu enabled navigation to the various subunits. The subunits could be read sequentially or in random order, according to the individual needs of the reader.

The right-hand bar displayed related information such as internet sites (for example, the Centre for Disease Control and Prevention) and documents providing further information.

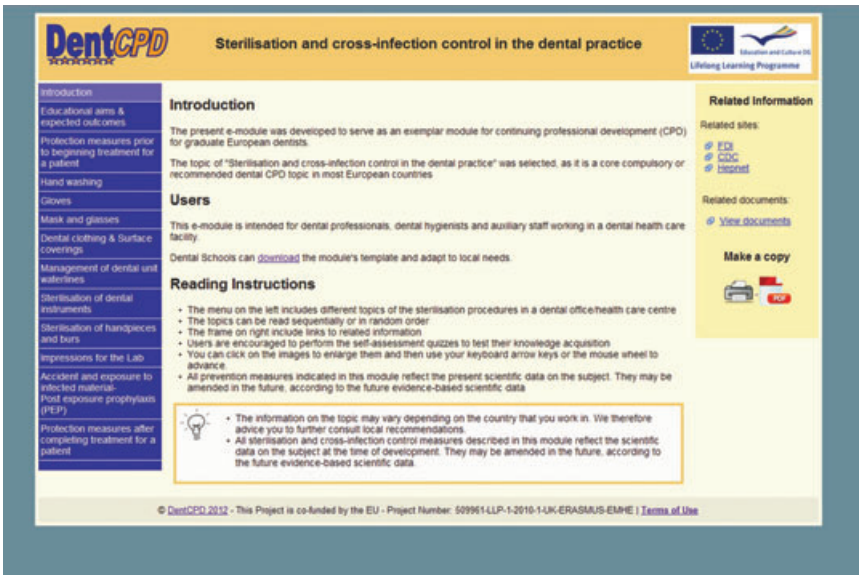

Fig. 1. The design of the webpage.

Fig. 2. Videos and images supported the study material. Pop-up windows were used to add further information. Continuous feedback was provided by a series of self-assessment questions.

Links to PubMed or the online versions of documents were offered. Printing options and text downloading as a PDF version were also available (Figs 1 and 2).

The e-module included elements enhancing effective visual learning as described in other DentCPD reports and relevant publications (10, 13, 24, 25).

- Colours, frames and navigation symbols were used to direct the reader and to organise the content in a clear, standardised and user-friendly way.
- Different, but consistent colours, were used for the different webpage areas to provide a general sense of direction (blue for the menu, light yellow for the study area, yellow orange for related information).
- The colour and contrast choices (black on a yellow background, white on blue) were chosen to increase text legibility.
- Visual cues were inserted to point to specific actions ('info sign' for further information, 'printer image' for printing options and so forth).
- The main points in each topic were summarised in a framed bulleted text.
- The fonts and the density of lines were designed to enhance readability.
- A page format was preferred to facilitate reading the content, avoiding scrolling whenever possible.
- The text was short so that the reader could remain focused, and links to more information were provided. To enable the addition of further information, pop-up windows were used (Fig. 2). In addition, further information was included in the feedback to the self-assessment questions when necessary.
- Videos and images were used to support, accompany or replace the study material (Fig. 2).
- Images were displayed as thumbnails (Fig. 2) and could be clicked to enlarge and advanced by use of the mouse wheel, or the keyboard arrow keys or by clicking on a forward or backward button. The information related to the images could be obtained in the thumbnail format by simply placing the mouse on the image. Specific instructions on the use of images were included in the text.
- Clinical procedures were presented in steps.
- Chapter titles, subtitles and important concepts were highlighted in bold.
- Hyperlinks were used linking different chapters.
- Continuous feedback was provided to the learner by means of a series of self-assessment tests integrated into the text (Fig. 2). The self-assessment tests were multiple choice or true–false questions. Immediate feedback was provided, and the total score was presented after completing each series of quizzes.
- A link to download and print the content was provided, as an additional study option.

Evaluation from experts in the topic and dental educators

As this electronic material will be offered to European dental schools to serve as an exemplar e-module for dental CPD, it was important to record the opinion of the educators before finalising the product. The e-module was forwarded to the members of the DentCPD project team for comment. The

web-link was also forwarded by the project partners to experts in sterilisation and cross-infection control in their host institutions for additional comment on the content and design.

To obtain feedback from a wider sample of European dental educators in the field, the DentCPD project partners introduced the e-module to the Lifelong Learning SIG at the ADEE 2012 meeting in Lyon, France, by (i) performing an online evaluation before the meeting and (ii) an online demonstration and discussion during the meeting.

Online evaluation

All registered participants for the ADEE SIG meeting received an e-mail with the electronic link for the e-module and an anonymous electronic questionnaire 2 weeks before the conference and were asked to respond to the questionnaire before the meeting so that the findings could be analysed in advance and used to inform further discussion.

The questionnaire investigated content and usability. It included 31 questions. Closed questions used a rating scale from 1 (strongly disagree) to 5 (strongly agree). Demographic characteristics of the respondents were collected (country, age, gender, employment status), as well as questions about the time needed to complete the e-module, technical aspects, structure, design and pedagogy (including browser used, speed of downloading, media function, text readability, overall organisation, links consistency, adequacy of feedback provided, clarity of instructions, use of multimedia) and content (whether it was sufficiently up-to-date, self-explanatory, relevant to practice, the level of difficulty and whether it added to pre-existing knowledge). A free text option was offered to report on any technical problems encountered and an 'any other comments' box included for further suggestions.

There were 17 responses to the electronic questionnaire. Some of the respondents were experts in the subject and responsible for teaching the topic of this module at their host institution. There was wide country distribution (Netherlands, Finland, Poland, France, Spain, Czech Republic, Ireland, Italy, UK). The respondents used different browsers (Internet Explorer, Firefox, Opera) and 80% needed less than 1 h to complete the module. The general impression about the e-module was very good ($x = 4.1$ on a 5-point scale).

The highest rates were recorded for the statements: 'it was a convenient way to learn' ($x = 4.6$), 'the module is learner-friendly' ($x = 4.5$), 'links are consistent and easy to identify' ($x = 4.5$), 'the pages load quickly' ($x = 4.5$). Lower evaluation ratings were recorded for the statements 'after studying the module, my practice will change' ($x = 2.4$), 'the material added to my pre-existing knowledge' ($x = 3.1$), 'the level of content was advanced' ($x = 3.3$). The low values relating to changes in knowledge and practice were expected, as the respondents were dental academics, many of them were experts in this particular field.

Feedback was provided in the open-ended questions where respondents were asked to add their comments. There were a few but limited technical problems with the use of videos and this tended to be associated with the speed of the local internet connection. Specific comments were very helpful for the module's further development. These included suggestions on improving the clarity of some self-assessment questions, edits and additions in some areas such as the management of the dental units' waterlines and post-exposure prophylaxis (PEP).

Online demonstration and discussion

The e-module was also presented online and discussed during the Lifelong Learning SIG meeting at the ADEE 2012 conference. A very fruitful discussion took place based on the evaluation results and on other issues raised. The SIG attendees included 22 dental educators from 13 countries (Greece, UK, Finland, the Netherlands, Latvia, Denmark, France, Italy, Poland, Serbia, Spain, Turkey).

An important issue, raised in the evaluation process, was the variation in local policies in different European countries in relation to sterilisation and cross-infection control (including hand washing, type of dental clothing, one-use burs, etc).

The evaluation results were analysed and discussed at the DentCPD project team meetings in Lyon before and after the SIG meeting. Based on all these discussions, further additions and edits were performed.

DentCPD e-module licensing and dissemination policy

Newly developed electronic pedagogical material must ensure that all providers and users know exactly how it should be utilised.

The DentCPD project team implemented a Creative Commons License (CCL) (26).

Two versions have been made available on the DentCPD site (www.DentCPD.org): (i) a 'read only' version of the original module bearing the parties' logos licensed using the 'Attribution Non-Commercial No Derivatives' CC licence, which permits copying, distributing and transmitting the work but does not permit commercial use or altering, transforming or building upon the work. Further, the licensee should acknowledge the original source and (ii) an editable version licensed using the 'Attribution Non-Commercial-ShareAlike' CC licence, which requires the licensee to acknowledge the original source and permits editing, non-commercial use and sublicensing on the same terms. The second option offers free downloading of the e-module framework at any local dental school, with the original text presented as dummy text, easy to translate, edit and adapt to different local needs. This option could be downloaded from the menu area (subunit: introduction/users).

Discussion

The development of an exemplar e-module for practising dentists in the European countries was a challenge, considering the diversity in the providers (dental schools) and the target group in terms of policies, resources, knowledge and attitudes.

The topic and the educational objectives were defined and based on current dental CPD needs' assessments, and the content was developed and reviewed by European experts in the field. Distance learning experts advised on pedagogical efficacy. Technical considerations on usability, interoperability and low cost were applied, and consecutive evaluations were performed before final production.

When developing e-material for dental CPD, content validity, accuracy and currency must be ensured (7). The content was initially prepared by a European expert in the field, based on published international recommendations [CED (16), CDC (17)], and was further peer-reviewed by other European experts. The discussions and evaluations have shown that there are many common policies regarding sterilisation and cross-infection control for dental practice in European countries. However, occasional variation was recorded (for example, in hand washing, use of blouses, sterilisation of handpieces, single use of burs). The content of the e-module must adapt to local needs. Thus, a statement was inserted in the introduction advising users to further consult local guidelines on best practice.

Distance learning experts assisted dental academics in transforming traditional material into e-learning material. E-learning content development would be a further task for dental faculties. Some would resist but others would see this as an exciting challenge, which should be promoted and rewarded (27).

Usability is an important component in e-modules design. An early usability testing and a participatory design approach (13) including potential users were applied in the development process.

E-material must be flexible and adaptable to the users' needs. Over complexity of educational software and inflexible platforms can be barriers to the implementation of e-learning in dental education (7). It is essential to develop an adaptive interface suitable for all user categories when the learners come from a variety of different backgrounds and levels of expertise (12). Electronic material should be user-friendly (6).The e-module framework, described here, is simple and easy to adapt. A technical developer in the local institution could easily modify the material with low cost. In addition, as cost is also a significant barrier for the learner (7), the DentCPD project team agreed to offer free access to the e-module framework for CPD providers, under a non-commercial use licence.

This e-module has been structured to promote self-study by directing learners through their study, promoting interaction with the material, offering explanation, providing feedback, encouraging, supporting and motivating the reader. Instructional design strategies were included (28) such as video clips of demonstrations, links to internet sites, references to guidelines and tests. Self-assessment has been provided throughout the module to increase interaction. Medical students' evaluation of e-learning resources has indicated that important interactive activities include video demonstrations, self-assessment exercises and internet links for further study (28). Basic rules of graphic design were followed, such as defining the functional regions of the page and grouping related elements, retaining consistency in the basic framework, using colours and contrast to increase text legibility (10, 25). Technical developers insist that all information should be immediately visible (24). The learner can easily adjust the size of the text, but as the target audience varies, in terms of age and computer literacy, the display page has been designed to be as readable as possible at a glance. Choosing a page format instead of scrolling has been shown to facilitate reading and revising text performance (29). Thumbnail pictures were used to keep graphic files as small as possible (24) providing instructions for further display. 'White space' was used to produce visual relief for the webpage (25).

It is not within the aim of this manuscript to dictate the teaching methodology applied when using this e-learning module. This e-module was based on a learner-directed, individual learning approach (10) but the CPD provider has to choose the most appropriate educational techniques to meet the defined learning objectives, considering the available resources and the local needs. A blended learning method, combining face-to face and distance learning elements, presents many advantages (4, 30) and could enable conversation and collaborative learning whilst using the e-module.

A system of credit points was not included, as this is an exemplar module not aligned to any particular CPD provider. A dental school could provide a proof of participation by confirming the CPD credits after the module's completion. This could be easily performed by including a registration mechanism and a centralised assessment system connected to each registrant. A pre- and a post-course electronic questionnaire could be added to identify any improvements in knowledge and skills (31). Use of the pre- and post-test offers providers, as well as the learners, data on learning gains. Further, feedback to the provider should be added by means of a centralised collection and evaluation mechanism, which will enable improvements of the e-module itself, the total course (if any) or both (30).

Conclusion

This exemplar e-module was developed according to guidelines for developing e-learning material for adult learners. Efforts were made to ensure interoperability, usability, content validity and pedagogy achieved at a low cost.

The next step would be to translate the e-module into different European languages and expand the evaluation amongst groups of practising dentists in various countries to further investigate usability and the effect on learning. Adaptations to local policies and local teaching methods will be necessary.

Further research is also required to evaluate whether studying the module makes a difference to workplace practice. In addition, it would be useful to compare the use of the e-module alone in comparison with the use of a blended approach to learning.

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Conflicts of interest

The authors report no conflicts of interest.

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