INTRODUCTION

E-learning is defined as the use of computer or other electronic devices and internet technologies to provide educational interventions aiming at enabling learning and improving performance (Ghirardini 2011, Sinclair et al., 2016). E-learning is an effective teaching method in health professions: two systematic reviews with meta-analysis demonstrated that e-learning is associated with large positive effects compared with no intervention and e-learning's effectiveness is similar to traditional instructional methods (Cook et al., 2008). E-learning is used in a range of learning contexts such as higher education (Lahti et al., 2014, Lee and Lin, 2013) and Continuing Professional Development (CPD) (Sinclair et al., 2016, Richmond et al., 2016). Many publications describe how e-learning programmes were developed but few do it thoroughly; studies assessing the effectiveness of e-learning programmes rarely describe how their interventions were developed limiting the extent to which their pedagogical veracity or trustworthiness can be judged (Sinclair et al., 2016). This commentary profiles how an e-learning programme on the biopsychosocial (BPS) model for non-specific low back pain (NSLBP) was developed in response to a need for osteopaths to learn about the current evidence for the management of low back pain (Kent et al., 2009, Formica et al., 2017, Zangoni and Thomson, 2017). The programme was designed in the form of CPD for osteopaths with more than 15 years of experience as these osteopaths qualified prior to the introduction of the BPS model in Osteopathic Educational Institution's (OEI) curricula in the UK. The e-learning was intended to be used as CPD independent to any other program of study.

E-learning courses offer access to all practitioners, including those in remote areas and allow access to the course around participants' schedule rather than the other way round (Harden and Laidlaw, 2012). There are two general approaches to e-learning (Ghirardini, 2011). The first one is *synchronous* where content delivery occurs at the same time as receipt by participants (e.g. webinars) and the second one is *asynchronous* where content delivery occurs at different times than receipt by participants (e.g. a lectured module delivered via e-mail link) (Ruggeri et al., 2013).

The design and development of the e-learning programme was informed by the ADDIE model (Ghirardini, 2011) and this commentary follows the five stages of the ADDIE model described in sequence below. The ADDIE model is an instructional model that provides guidance on the development and design of e-learning programmes. It is one of the main models used in the development of e-learning programmes in healthcare and has been advocated as a useful tool for developing curricula and improving educational and practice performance (Robinson and Dearmon, 2013). The model has not been formally tested and lacks guidance on which strategies should be implemented to evaluate the e-learning programme and its outcomes. In addition there is little guidance about costing the e-learning development using an ADDIE approach. An alternative model has been developed following a review of postgraduate medical e-learning programmes (De Leeuw et al., 2016). However, this newer model also does not appear to have been formally evaluated. The content of the De Leeuw model and ADDIE model have considerable overlap in terms of operational development stages; the De Leeuw model describes the stages in more detail, and the ADDIE is one of the most commonly used frameworks.

1. Analysis

Prior to developing an e-learning programme, analysis of the aims of the e-learning programme is required (Raymond and Iliffe, 2012). This includes identifying the gap in professional knowledge that requires training (needs analysis), who the target audience is, and the content that should be included in the programme (Ghirardini, 2011, Nagarajan and Wiselin Jiji, 2010, Raymond and Iliffe, 2012).

Needs analysis

The BPS model has been recommended in a number of clinical guidelines, most recently in the updated guidelines for the management of LBP and sciatica (NICE, 2016). However, previous research has shown that therapists do not consistently use the model (Rainville et al., 2000, Pincus et al., 2007, Houben et al., 2005). Manual therapists commonly assess physical impairment and pain but less frequently factors such as activity limitation and psychosocial function (Kent et al., 2009). When measuring manual therapists' attitudes to back pain, they demonstrate more a biomedical approach to back pain than a biopsychosocial one (Pincus et al., 2007, Innes et al., 2015). This has been explored qualitatively and similar findings have been found across different manual therapy professions including osteopathy (Formica et al.,

2017, Zangoni and Thomson, 2017). Consequently, a need exists to close the theory-practice gap, requiring specific training to change manual therapists' attitudes to back pain, knowledge, skills and confidence to assess and manage patients within a BPS framework.

Target audience analysis

There is some evidence that osteopaths may be less willing than physiotherapists and chiropractors to engage in psychological issues with their patients with back pain, recommend restricting daily activities, and tend to believe there is an underlying structural cause to back pain (Pincus et al., 2007). Recent studies demonstrate that collectively, manual therapists report a lack of training on BPS assessment and management and express a need for training in this field (Singla et al., 2015, Synnott et al., 2015, Formica et al., 2017, Zangoni and Thomson, 2017).

Content analysis

Content analysis is arguably the most critical step in the instructional design process (Ghirardini, 2011). If content is not contemporaneous then there is little value in finding the best instructional methods and media to use in training participants. Prior to developing this e-learning programme, the authors performed a scoping review (Draper-Rodi et al., 2016) to identify key elements that should be included in an evidence-based e-learning programme on the assessment of NSLBP in a BPS environment in a manual therapy context . Content analysis can take other forms including use of existing curricular material or recent guidelines.

2. Design

The design stage provides the curriculum structure, it also defines the learning objectives (LO) associated with each unit and lesson and the order in which the LO should be achieved, also known as sequencing. This stage defines the delivery methods and formats for each unit and lesson. It is also recommended that the evaluation strategy for the e-learning programme should be determined at this stage (Ghirardini, 2011, Molenda, 2003).

The aim of the set of LO listed (see supplementary material, Table 1 – learning outcomes) was to achieve the overall course objective: To understand how to assess a patient with NSLBP using the BPS model and to understand the management options available.

Content development

Learning interventions related to clinical practice commonly aim to have an impact on clinical behaviours. Changing behaviour is challenging and several models have been developed to enhance intervention outcomes. A metamodel, the Behaviour Change Wheel, was specifically developed to characterise and design behaviour change interventions (Michie et al., 2011). This metamodel was used to enhance the focus and effectiveness of the e-learning programme and informed the content of the programme by highlighting the conditions (both internal to the participants and in their social and physical environment) needed for the adoption of a BPS approach to NSLBP (e.g. willingness to look beyond biomechanical/structural causes to back pain, or interest in updating their knowledge on pain). To enhance the likelihood of behaviour change, these conditions informed the LO of the course. Guidance from the framework was also used to decide how the intervention should approach the different conditions (e.g. with the use of education, persuasion or modelling).

Sequencing

Three different principles were used to inform the sequencing of the units and learning of the e-learning programme to maximise the learners' experience in terms of the logical flow and the pragmatic access to the learning (Ghirardini, 2011). One method, known as the prerequisite method, was used to introduce content from the general towards the specific, in this instance, Unit 1 included general information on NSLBP and the BPS model before more specific content was presented. The content was also organised following a job-context principle where information was organised in the order of a consultation. Unit 2 was designed around the first part of an osteopathic consultation (history-taking); and Unit 3 around the following part of the consultation (examination). Another principle, known as the spiral principle, was to blend different concepts presented earlier in the programme together, for example, Unit 4 integrated the content of the previous units on case history and examination around three different clinical scenarios. Unit 5 then discussed management considerations for patients with NSLBP. The LO and sequencing were entered into a course plan to map the

unit/lessons to the LOs (see supplementary material, Table 2– Lesson construct and content for details on the content of each lesson).

Instructional strategy

A systematic review found that the use of practice exercises, feedback, and repetition of study material in e-learning programmes offer greater learning (Cook et al., 2010b) and a related systematic review and meta-analysis found that including interactive components increases learning time which enhances learning outcomes and satisfaction with e-learning programmes (Cook et al., 2010a). Drawing on this evidence our e-learning programme used a combination of lectures and quizzes with specific feedback on participants' answers that included information about where in the e-learning programme participants could review content when they had incorrect answers, and exercises centred on clinical scenarios. These were organised using two instructional methods: expositive methods and application methods. Expositive methods were mainly used as they are ideal for teaching new information with the aim of changing participants' attitudes (Ghirardini, 2011). They were used through the medium of case-studies and presentations. Application methods were used when the LO was to develop job-specific cognitive skills. This was achieved by providing worksheets with information and guidance that could be easily accessed and used by practitioners in the treatment room with patients, and mainly by using scenario-based exercises.

Delivery strategy

Although many practising osteopaths are likely to be fully computer literate we wanted to ensure all participants could easily access the content. The interface of the e-learning course was designed to be very simple with few options, menus or buttons to minimise the risk of confusing participants when logging onto the website and ensure minimal barriers to take up of the e-learning.

Evaluation strategy

Evaluation strategies are important to in all educational programmes including in e-learning (Ruggeri et al., 2013, Molenda, 2003). They can be conducted at different stages of the development of e-learning programmes depending on their aims. Content evaluation is important to assess that the content in the e-learning programme corresponds to the content analysis findings; quality evaluation is a key aspect before implementing an e-learning

programme; formative evaluation ensures that participants' learning journeys will not be troublesome; confirmative evaluation measures the effectiveness of the e-learning programme and finally summative evaluation evaluates if an old course is still valid or needs updating (Ghirardini, 2011). Four evaluation strategies were used (the first three are described in this commentary, the last one will be published separately to this commentary): a content evaluation, a quality evaluation, a formative evaluation, and a confirmative evaluation (with an explanatory mixed methods feasibility study) to assess the feasibility and acceptability of the e-learning programme.

3. Development

The development stage is first informed by creating a storyboard. This produces a visual representation of the different screens the e-learning will have and the different learning experiences that will be included (Ghirardini, 2011, Jantke and Knauf, 2005). Then courseware is produced, consisting of developing media, producing the course online and integrating the content elements into a learning platform that learners can access.

Storyboard development

The storyboard was created with Microsoft PowerPoint 2010 (Microsoft Corp., Washington, USA). Diverse teaching methods (both inductive and deductive methods using lectures, clinical scenarios and reading material) and quizzes (using a combination of multiple choice, true/false and matching questions) were included as this is considered good practice in medical education to foster deep and durable learning (Cutting and Saks 2012). Feedback and information in quizzes was included when answers were incorrect and, when possible, where information on each specific topic could be found in the e-learning programme. Extra content material was also listed in the storyboard, and consisted of downloadable documents, or links to websites where extra information related to the e-learning programme content was accessible (see Figure 1 – Example of a storyboard page).

INSERT FIGURE 1 HERE

Courseware development

Lessons were either theoretical, used case-scenarios or were quiz-based. A combination of audio tracks, videos and graphics (illustrations or pictures) were used. Audio tracks and

videos were uploaded on YouTube (YouTube LLC., CA, USA) to allow access from any device connected on the internet. Pictures used in the programme were either royalty-free or referenced when they were sourced from a published article.

A variety of software products was used to develop the e-learning programme. An online presentation application (Prezi, Prezi Inc., CA, USA) was used for the development of the theoretical lessons, and screen capture software (Camtasia, Techsmith Corp., Michigan, USA). was then used to record Prezi presentations while adding an audio recording to it. Finally, YouTube was used to upload videos. All videos were 'unlisted' to prevent people not enrolled in the course from readily accessing these videos.

4. Implementation

The implementation stage consists of the installation and the distribution of the e-learning programme.

Installation

The programme was installed on Moodle, an open-source learning management platform (https://moodle.org). Installation of the e-learning programme was supported by the Information Technology (IT) team of the University College of Osteopathy. Conditional activity was enabled to ensure the sequencing would be respected: participants could access a lesson only when the previous one had been completed.

Distribution of the e-learning programme

The programme was a self-paced e-learning programme with some instructor-led course components to promote participants' motivation (Ghirardini, 2011). A *kick-off event* was used to invite participants to start the course. An *initial learning activity* was then sent in an email with their username and password to access the e-learning programme. The email included a direct link to the first lesson that introduced the course goals and agenda and a short video of the developer explaining why he decided to develop this programme and how it will be evaluated. The course ended with a *conclusion,* and *feedback* was gathered from the participant.

5. Evaluation

Different aspects of e-learning programmes should be assessed and evaluation can be done during their development (e.g. content evaluation), just after their development (e.g. quality evaluation) or after their distribution (e.g. effectiveness evaluation).

Content evaluation

The conditions (see *Content development*) required for participants to change their behaviours, informed by the behavioural change model (described above), were used to verify that the content of the e-learning aligned with our behavioural change aims. Content was checked by the authors to ensure all important conditions identified had designed elements in the e-learning programme.

Quality evaluation

The ECBCheck tool was used to assess the quality of the e-learning programme using the online version of the tool (http://www.ecb-check.net/). ECBCheck is a quality assessment scheme designed for e-learning programmes. Each criterion of the tool checklist required a description of the component of the appropriate e-learning programme and supporting documents to evidence it. The e-learning programme scored 93% of the maximal score. The results of the ECBCheck tool utilisation, although high, suggested opportunities for enhancing the learning through the provision of a more flexible approach to facilitate different learning pathways to improve the e-learning programme. This would have compromised the sequencing, which was informed by a job-context principle for organising the content and was therefore not implemented.

Formative evaluation

A formative evaluation of the e-learning programme was performed before distribution. As participants were going to have a minimum of 15 years previous clinical practice, it was decided to test the e-learning programme on a person who did not use informatics during their education and had a limited use of it in their professional work. To ensure that the e-learning programme was easily accessible to those with a limited experience of technology, a person with basic skills in IT was asked to test the e-learning programme functionality. The problems they reported related to: video sizes; YouTube offering other videos when lessons

were finished; lack of instructions in some lessons; automatic subtitles added by YouTube that were incoherent; and difficulty in accessing some lessons. All of these issues were addressed before distributing the e-learning programme.

Confirmative evaluation

A mixed methods feasibility study was undertaken to evaluate the feasibility and acceptability of the e-learning programme on participants' attitudes to back pain. This will be published separately.

CONCLUSION

E-learning programmes can be useful pedagogical tools to provide CPD (Sinclair et al., 2016). In this commentary we describe the development of an e-learning programme as an example, following the different phases of the ADDIE model. The content of the e-learning programme was informed by the results of a scoping review and by a behavioural change model that enabled us to list the conditions required from the participants to implement a BPS approach when managing patients with NSLBP. A content evaluation demonstrated that there were designed elements for all important conditions identified. The quality of the e-learning was highly rated using the ECBCheck tool. Some changes were implemented to the e-learning programme following a formative evaluation. A confirmative evaluation was conducted to evaluate the feasibility and acceptability of the e-learning programme on the participants' attitudes to back pain and will be published separately. This commentary provides a clear description of how an e-learning programme was developed, permitting external assessment of the pedagogical underpinning of our intervention, and hopefully it will be followed by other authors describing their interventions as contributions to pedagogical scholarship in this field.

List of references

COOK, D. A., LEVINSON, A. J. & GARSIDE, S. 2010a. Time and learning efficiency in Internet-based learning: a systematic review and meta-analysis. *Adv Health Sci Educ Theory Pract,* 15**,** 755-70.

COOK, D. A., LEVINSON, A. J., GARSIDE, S., DUPRAS, D. M., ERWIN, P. J. & MONTORI, V. M. 2008. Internet-based learning in the health professions: a meta-analysis. *Journal of the American Medical Association,* 300**,** 1181-96.

COOK, D. A., LEVINSON, A. J., GARSIDE, S., DUPRAS, D. M., ERWIN, P. J. & MONTORI, V. M. 2010b. Instructional design variations in internet-based learning for health professions education: a systematic review and meta-analysis. *Academic medicine,* 85**,** 909-922.

DE LEEUW, R. A., WESTERMAN, M., NELSON, E., KET, J. C. & SCHEELE, F. 2016. Quality specifications in postgraduate medical e-learning: an integrative literature review leading to a postgraduate medical e-learning model. *BMC Med Educ,* 16**,** 168.

DRAPER-RODI, J., VOGEL, S. & BISHOP, A. 2016. What are the biopsychosocial obstacles to recovery for non-specific low back pain? Results of a scoping review. *Orthopaedic Proceedings,* 98-B**,** 14-14.

FORMICA, A., THOMSON, O. P. & ESTEVES, J. E. 2017. 'I just don't have the tools' - Italian osteopaths' attitudes and beliefs about the management of patients with chronic pain: A qualitative study. *International Journal of Osteopathic Medicine*.

GHIRARDINI, B. 2011. E-learning methodologies: A guide for designing and developing e-learning courses. Rome: Food and Agriculture Organisation for the United Nations.

HARDEN, R. M. & LAIDLAW, J. M. 2012. *Essential Skills for a Medical Teacher: An Introduction to Teaching and Learning in Medicine*, Elsevier Health Sciences UK.

HOUBEN, R. M., OSTELO, R. W., VLAEYEN, J. W., WOLTERS, P. M., PETERS, M. & STOMP-VAN DEN BERG, S. G. 2005. Health care providers' orientations towards common low back pain predict perceived harmfulness of physical activities and recommendations regarding return to normal activity. *European Journal of Pain,* 9**,** 173-83.

INNES, S. I., WERTH, P. D., TUCHIN, P. J. & GRAHAM, P. L. 2015. Attitudes and beliefs of Australian chiropractors' about managing back pain: a cross-sectional study. *Chiropractic & manual therapies,* 23**,** [Online] Available at: http://chiromt.biomedcentral.com/articles/10.1186/s12998-015-0062-y.

JANTKE, K. & KNAUF, R. 2005. Didactic design through storyboarding: Standard concepts for standard tools. *4th international symposium on Information and communication technologies.* Trinity College Dublin.

KENT, P. M., KEATING, J. L. & TAYLOR, N. F. 2009. Primary care clinicians use variable methods to assess acute nonspecific low back pain and usually focus on impairments. *Manual Therapy,* 14**,** 88-100.

LAHTI, M., HATONEN, H. & VALIMAKI, M. 2014. Impact of e-learning on nurses' and student nurses knowledge, skills, and satisfaction: A systematic review and meta-analysis. *International Journal of Nursing Studies,* 51**,** 136-149.

LEE, T. Y. & LIN, F. Y. 2013. The effectiveness of an e-learning program on pediatric medication safety for undergraduate students: A pretest-post-test intervention study. *Nurse Education Today,* 33**,** 378-383.

MICHIE, S., VAN STRALEN, M. M. & WEST, R. 2011. The behaviour change wheel: A new method for characterising and designing behaviour change interventions.

Implementation Science, 6**,** [Online] Available at:
http://implementationscience.biomedcentral.com/articles/10.1186/1748-5908-6-42.

MOLENDA, M. 2003. In search of the elusive ADDIE model. *Performance Improvement,* 42**,** 34-36.

NAGARAJAN, P. & WISELIN JIJI, G. 2010. Online educational system (e-learning). *International Journal of u- and e-Service, Science and Technology,* 3**,** 37-48.

NICE 2016. Low back pain and sciatica: management of non-specific low back pain and sciatica. *In:* NATIONAL CLINICAL GUIDELINE CENTRE (ed.). London: National Institute for Health and Clinical Excellence.

PINCUS, T., FOSTER, N. E., VOGEL, S., SANTOS, R., BREEN, A. & UNDERWOOD, M. 2007. Attitudes to back pain amongst musculoskeletal practitioners: a comparison of professional groups and practice settings using the ABS-mp. *Manual Therapy,* 12**,** 167-75.

RAINVILLE, J., CARLSON, N., POLATIN, P., GATCHEL, R. J. & INDAHL, A. 2000. Exploration of physicians' recommendations for activities in chronic low back pain. *Spine,* 25**,** 2210-2220.

RAYMOND, M. & ILIFFE, S. 2012. Technology-enhanced learning - checklists to evaluate an e-learning resource. *Education for Primary Care,* 23**,** 458-9.

RICHMOND, H., HALL, A. M., HANSEN, Z., WILLIAMSON, E., DAVIES, D. & LAMB, S. E. 2016. Using mixed methods evaluation to assess the feasibility of online clinical training in evidence based interventions: a case study of cognitive behavioural treatment for low back pain. *BMC Medical Education,* 16.

ROBINSON, B. K. & DEARMON, V. 2013. Evidence-based nursing education: effective use of instructional design and simulated learning environments to enhance knowledge transfer in undergraduate nursing students. *J Prof Nurs,* 29**,** 203-9.

RUGGERI, K., FARRINGTON, C. & BRAYNE, C. 2013. A global model for effective use and evaluation of e-learning in health. *Telemed J E Health,* 19**,** 312-21.

SINCLAIR, P. M., KABLE, A., LEVETT-JONES, T. & BOOTH, D. 2016. The effectiveness of Internet-based e-learning on clinician behaviour and patient outcomes: A systematic review. *International Journal of Nursing Studies,* 57**,** 70-81.

SINGLA, M., JONES, M., EDWARDS, I. & KUMAR, S. 2015. Physiotherapists' assessment of patients' psychosocial status: Are we standing on thin ice? A qualitative descriptive study. *Manual Therapy,* 20**,** 328-334.

SYNNOTT, A., O'KEEFFE, M., BUNZLI, S., DANKAERTS, W., O'SULLIVAN, P. & O'SULLIVAN, K. 2015. Physiotherapists may stigmatise or feel unprepared to treat people with low back pain and psychosocial factors that influence recovery: a systematic review. *J Physiother,* 61**,** 68-76.

ZANGONI, G. & THOMSON, O. P. 2017. 'I need to do another course' - Italian physiotherapists' knowledge and beliefs when assessing psychosocial factors in patients presenting with chronic low back pain. *Musculoskelet Sci Pract,* 27**,** 71-77.