Introduction

E-learning has become an integral and ubiquitous component of health professional education. It has many benefits, including the accommodation of multiple learning styles, asynchronicity and instructional design flexibility (Gerkin, Taylor, & Weatherby, 2009). Increased access to education, cost-effectiveness, and interactivity are also frequently cited advantages of e-learning (Ehlers and Pawlowski, 2006). Despite these benefits, and the potential that recent advances in computer-based instruction offer, there is great variation in e-learning quality. Indeed, too often, purported e-learning programs are no more than document repositories with limited interactivity (Sinclair, Kable, Levett-Jones, & Booth, 2016).

Health professional educators should be competent in the use of current web-based educational technologies so that learners are able to access relevant and engaging e-learning materials without restriction. Educators must also maintain a balance between the design and implementation of quality resources, ensuring cost-effectiveness, sustainability, and accessibility, irrespective of time or geographical location of learners (Button, Harrington & Belan, 2014). Consequently, in order to develop and deliver engaging and pedagogically sound e-learning programs, they must be informed by evidence-based instructional design principles.

This paper presents ten guiding principles for educators who want to develop empirically informed, engaging and effective asynchronous e-learning programs (See Table 1). An exemplar e-learning program, CKD DETECT, designed to improve opportunistic chronic kidney disease (CKD) screening practices in the Australian primary care setting, is presented to demonstrate the application of each principle. The e-learning program was developed in response to sub-optimal CKD screening practices in Australia (Razavian et al., 2011) in conjunction with the call for CKD education to be improved (Mathew & Corso, 2009). The program's target audience is general practice nurses, as they are ideally positioned to lead general practice based screening programs (Tracey, Cossich, Bennett, Wright, & Ockerby, 2013). Further details about the program are discussed throughout the paper.

While it would be naive to suggest that there is a single linear approach or model for instructional design that will suit all e-learning development needs, the principles identified

in this paper can be used as a guide for health care professional educators who aim to develop pedagogically sound, high quality asynchronous e-learning programs. Fundamental to these principles is the premise that e-learning development should predominantly focus on the process of learning rather than the process of instruction (Gagne, Wager, Golas and Keller 2005).

<<Insert Table 1 Here>>

1. Consider learner capabilities and existing knowledge

Educators who plan to implement e-learning resources must consider the capabilities of the target audience for whom the resource is being designed. Despite the increased use of e-learning in health professional education, not all learners will be competent or confident in its use (Levett-Jones et al., 2009). There is a need to consider learners' experiences, attitudes and preferences with regard to e-learning, as well as whether they have reliable internet and computer access (Sinclair, Schoch, Black, & Woods, 2011). Variations in bandwidth and streaming capabilities of the learner's internet connection can also affect the delivery of the resource and learner satisfaction with the experience. Consideration of learners' technical ability and their need for preparatory activities can prevent disappointing user experiences that can result in disengagement from e-learning resources.

New information should always be linked to, and build on existing knowledge (Knowles, 1980). E-learning designers should recognise that learners may possess pre-requisite knowledge and that to repeat content that is already known will create a barrier to engaging with new content. This challenge can be navigated in one of three ways. Firstly, a case study approach could be utilised that requires the learner to identify appropriate clinical assessments or actions, and then provides immediate feedback on their responses. Depending on the accuracy of the answers, learners can either bypass selected modules if they choose, or be directed to extension materials prior to progressing to the next module of the program. The second option is to deliver a pre-quiz to identify the learner's current level of knowledge. Depending on the grade attained, learners can then be directed, either to a foundational or to more advanced learning modules. These approaches ensure that all participants will have the same baseline level of knowledge before proceeding to additional content required to meet the new learning outcomes of the program. A third option

developers may wish to consider is the use of a 'choose your own learning pathway' approach whereby users can select which modules they choose to undertake. This approach promotes engagement with program content and is consistent with 'just-in-time' teaching that is becoming more prevalent in today's learning environment (Boese, 2016).

CKD DETECT was designed to be intuitive in nature so that learners were able to easily navigate through each step of the program (Section 3 discusses this in more detail). The program also administers a 12 item pre-quiz to assess the learner's level of knowledge regarding CKD risk factors and best practice screening methods. A grade of 80% was set as a minimum knowledge requirement, and attaining a grade equal or higher, enables the learner to bypass the knowledge based module (module one) and proceed to the more practically focused module (module two). Module two profiles general practice settings that have successfully implemented screening programs that are easily replicable. Further information regarding the learning outcomes for module two are available in Boxes 4 and 7.

Box 1: Learner capabilities and existing knowledge considerations in the development of CKD DETECT

2. Consider the programming to be utilised

Educators should be fluent with the e-learning authoring software and programing resources they intend to use, and whether they are appropriate to the desired outcomes of the learning experience (Watkins, 2005). Asynchronous e-learning design requires an understanding of educational pedagogies, multimedia content, resource publication, electronic technologies and international web standards (Brown & Voltz, 2005). While experience in these areas is beneficial it is not essential, and with appropriate guidance and support, designing e-learning resources does not have to be difficult or time consuming. As the internet has developed, proprietary technologies including internet browsers and animation plugins have become available. Traditionally, many stand-alone e-learning programs have been developed using Adobe Flash or Microsoft Silverlight, multimedia platforms that can be used to create rich, animated and interactive media. These approaches have made it relatively easy and cost-effective for subject matter experts to develop their

own e-learning resources. The benefit of having full control over e-learning content design and development is that it allows for seamless integration of current clinically relevant content, as it becomes available, without the need to rely on third party developers to assist with updates.

Advancements in smart phone and tablet technologies has rendered some e-learning programs, particularly those developed using Flash or Silverlight software, inaccessible on mobile devices that do not support these platforms, including the Apple iPhone® and iPad® (Bonderud, 2011). However, major technology firms including browsers such as Mozilla and Google Chrome have taken steps to limit or completely prevent the use of Adobe flash due to vulnerabilities within it being actively exploited by hackers (Burgess, 2016). These types of issues need to be considered during the design of e-learning resources.

Programing behind e-learning resources can provide device independent access if educators and web designers use international web standards. These established international standards (W3C, 2012) provide a worldwide framework of open technologies whose only requirements are an internet connection and the browser on a computer, tablet or smart phone. Unlike installations of new software, most internet browsers can also be kept up to date once installed, without the user needing 'administrator access' to a computer, which can be a common problem in clinical settings. An additional benefit of using a browser-only approach when developing e-learning resources is the ability to update the content and have the changes immediately reflected world-wide (Mikkonen & Taivalsaari, 2011).

The requirement for international standards compliance is incontrovertible and is considered to be best practice in e-learning development, as it maximizes accessibility and compatibility across all computers and mobile devices (Leacock & Nesbit, 2007). Adherence to the standards also assists in avoiding technical issues and maximises usability. A combination of Hyper Text Markup Language (HTML) and Questionmark Markup Language (QML) can be utilised for authoring questions (see Table 2 for an explanation of these programing languages). Alternatively, other e-learning programs including Adobe Captivate, Smart Sparrow, Articulate Storyline or Adapt Learning could be utilised for content development. To meet best practice standards, e-learning programs should also be Sharable Content Object Reference Model (SCORM) compliant. SCORM compliance is a

standards and specifications protocol that enables communication between the e-learning program and the learning management system (LMS) in which it is hosted (Gasston, 2013). Educators who do not have the skill set or access to personnel with these skills, may wish to consider utilising HTML rapid authoring e-learning tools such as Elucidat (www.elucidat.com) or Gomo (http://www.gomolearning.com/) which offer intuitive design and development functionality, including in-built features such as online peer review via password access.

<<Insert Table 2 Here>>

CKD DETECT was developed using international web programing standards to maximise accessibility and compatibility across all computers and mobile devices. HTML was used to lay out headings, text and links. A combination of HTML and QML were used to create questions. Cascading Style Sheets (CSS) were used to present and position visual components of the program including icons, charts, boxes and graphics and JavaScript was used to provide interactivity, such as the ability to assess vital signs and calculate body mass index (see Figure 1). The entire project was designed and delivered using Questionmark Perception®, a standards based, assessment creation, delivery and reporting application. Consequently, delivery is via a browser only approach. The e-learning program can be packaged using SCORM to enable it to be imported into any LMS.

Box 2: The programming utilised in the development of CKD DETECT

<<Insert Figure 1 Here>>

3. Provide learning guidance

Asynchronous e-learning resources do not have the benefit of immediate educator or technical support and guidance, and for this reason they must be self-explanatory in nature and intuitive to use. In designing e-learning resources the amount, timing and quality of guidance provided will influence learner engagement, achievement and mastery as well as overall satisfaction (Palmer & Holt, 2009). Conversely, inadequate or unclear guidance can lead to frustration, ambivalence and disengagement (Boling, Hough, Krinsky, Saleem, & Stevens, 2012; Dziuban, Moskal, Kramer, & Thompson, 2012). In e-learning, guidance,

prompts, advanced organisers, hints and redirection can be used to promote critical thinking, to keep the learner 'on track' and to contribute to efficiency of the learning process.

Guidance for learning should also be supported by scaffolding (Seale & Cooper, 2010). Scaffolding refers to the provision of sufficient support and coaching to promote learning when concepts and skills are first introduced, followed by a gradual withdrawal of support as the learner progresses and begins to assume an increasingly independent role. Scaffolding allows the learner to construct new knowledge by linking current knowledge with new learning. Within the context of e-learning, scaffolding enables learners to engage with more complex learning than they would ordinarily be able to independently pursue if left unsupported (Obikwelu, Read, & Sim, 2013).

CKD DETECT provides guidance in a number of ways. Each page contains concise but clear instructions and links to support in the form of a help page. Advanced organizers and specific icons are also provided at the top of each page to allow the learner to track their progress. A set of icons was designed exclusively for this purpose to enable learners to identify what was expected of them on each 'screen' of the e-learning program (see Figure 2).

Box 3: Providing learner guidance in CKD DETECT

<<Insert Figure 2 Here>>

4. Identify learning outcomes and ensure content will deliver on them

Effective e-learning resources introduce the learner to a set of clear learning outcomes and the resource is then developed to ensure those outcomes are achieved (Gagne et al., 2005). The outcomes, where possible, should situate the learning content within a broader curriculum and allow the learner to link current knowledge with what they are setting out to learn. Without the guidance provided by way of learning outcomes, learners are left to guess what it is they are expected to focus on. This has a direct impact on their confidence, persistence, satisfaction with, and quality of their learning experience (Palmer & Holt, 2009). Using learning outcomes to clearly outline the expectations, purpose and rationale for the learning experience provides the learner with the opportunity to develop their confidence as they learn new material. In turn, this acquired self-efficacy can assist in driving learner

motivation (Blaschke, 2012). Learning outcomes also provide a framework for the design team to ensure that the development of the e-learning resource remains focused and is not merely a compiled repository of resources.

CKD DETECT was designed and developed to meet two key learning outcomes derived from the Kidney Health Australia - Caring for Australians with Renal Insufficiency Guidelines (Johnson et al., 2013). A third outcome was developed from the findings of an elicitation study that identified the barriers and facilitators to opportunistic CKD screening by general practice nurses in an Australian primary care setting (Sinclair, Day, Levett-Jones, & Kable, in press). This study concluded that many of the participants were familiar with risk criteria indicating who should be targeted for opportunistic screening and how screening should be undertaken. However, despite this understanding, participants did not always undertake opportunistic CKD screening. The barriers to CKD screening were found to be complex, multifaceted and influenced by many inter-related variables that were socially and organisationally driven (Sinclair et al., in press). The major barriers for CKD screening may be overcome, if general practices can adopt strategies utilised by other practices that have successfully implemented chronic disease screening programs at minimal cost to the practice. Herein lies an important caveat for the developers of e-learning programs; simply acquiring the requisite knowledge will not necessarily lead to clinical application or motivate learners to put into practice what they have learned (potential solutions to this challenge will be discussed in Section 9).

The learning outcomes for CKD DETECT were consistent with Australia's kidney health priority areas (Kidney Health Australia, 2015), thereby reinforcing the clinical and contextual relevance of the learning activity. Resource limitations and rationalisation are a constant issue in healthcare education, and it is essential that investment in e-learning resources is justifiable. Making the link between learning outcomes and health priority areas is one way of providing a sound justification for such an investment.

Box 4: Ensuring content directly addresses learning outcomes in CKD DETECT

5. Conceptualise and create meaningful and engaging content

When designing e-learning resources it is tempting to focus on entertainment and interactivity to the detriment of quality content and facilitated learning. Figure 3 illustrates how meaningful e-learning resources can be achieved when there is a mixture of high and low interactivity (depending on content) and when pedagogical principles inform all content related decisions. Bloom's taxonomy is particularly useful here as this model helps the educator make informed instructional design decisions that move learners from knowledge recall to analysis and application of those facts, as well as evaluation, reflection and critical thinking (Krathwohl, 2002).

<<Insert Figure 3 Here>>

Using a paper or digitally based storyboard approach to conceptualise the design and delivery of content is vital. It affords the opportunity to clearly outline the approach the design team wants to take and will save considerable development time. Microsoft PowerPoint™ is an easily accessible tool that can be used to create storyboards and offers the benefit of being able to drag and rearrange storyboard frames if required. Ideally, each story board frame should include the following details (see figure 4):

- Frame (screen) title and number
- Branching (i.e. link to next screen/s) and/or additional resources option
- Visual descriptors/sketch/multimedia/content section
- Interactivity and programming notes
- Narrative/scripts notes
- Comments section

<<Insert Figure 4>>

E-learning interactivity allows the learner to be actively engaged rather than a passive recipient of information. CKD DETECT uses a range of different levels of interactivity, from those that promote conceptual understanding and basic knowledge recall, albeit in a visually stimulating way (see Figure 5: The Glomerulus video), to those that require learners to examine and interpret pathology results (see Figure 6: Cyril's blood results and CKD trajectory). To illustrate, one of the learning activities in CKD DETECT requires nurses to recognize the significance of physical assessment data. This design requires them to identify risk factors for CKD, utilise clinical decision making skills and draw conclusions about the patient's clinical condition.

Box 5: Utilising interactivity to create meaningful and engaging content in CKD DETECT

<<Insert Figure 5 here>>

<<Insert Figure 6 here>>

6. Present the stimulus material

The way in which the stimulus materials are presented is a key element of e-learning design success. New stimulus material must be directly aligned with the achievement of learning outcomes and serve to illustrate essential aspects of the content. The learner's working memory, the psychological construct that influences information processing, needs to be considered carefully during the pre-design phase. Working memory is the ability to hold and process a given piece of information in one's mind. An unrelated thought or interruption is likely to cause a disruption and consequently, a loss of information which will impact the process of learning (Gathercole & Alloway, 2004). The ideal approach to avoid overloading working memory is to deliver content over a series of small modules rather than providing too much information in one large stand-alone program. This process, known as chunking (Martin, 2015) maximises the chances that the learner will be able to read, process and absorb the content presented. It also provides the development team with a framework to design clear and easy to follow content (Murphy, Worswick, Pulman, Ford, & Jeffery, 2015).

Headings, images, tables, videos, colour, graphics, bold print and italics, should be used to emphasize key points and facilitate perception of essential features. Video and audio resources should be in MP4 and MP3 file format respectively in order to meet best practice standards and ensure content is available across all devices. Video and audio content should also include a written transcript to mitigate any potential audio playback problems or for learners who are in a 'quiet zone' and do not have headphones. Transcripts may also assist learners, particularly those from a non-English speaking background, to understand terminology and be able to seek further information if required. The use of underlining should be restricted to hyperlinks to minimise possible confusion. Colour pallets should be carefully considered in order to provide contrast and colour combinations that allow people who are colour-blind (or low vision in other educational contexts) to access the content, while making the resource attractive to retain the learner's attention (Mbipom & Harper, 2011).

Considered use of heading code in the HTML is important because most screen readers used by learners with visual impairments use HTML heading levels to summarise the document and mark out sections. In a similar way to the more familiar Microsoft Word application, web pages designate heading levels so that Heading 1 (or <h1> in HTML) is larger than a Heading 2 (<H2>) and so on. Guidelines exist that specify how these headings should be used to maximise accessibility (University of Washington, 2010). On the modern web, font size is controllable easily from the user perspective – both at system level and browser level. However, the use of well-styled headings will allow larger and smaller text to remain relatively similarly sized even if the learner increases or decreases the font size to their comfort level. The default font sizes should be within accepted ranges and be tested across all major platforms, devices and browsers.

Figures 1, 5 and 6 demonstrate the considered use of heading code and colour pallets to maximise learner comfort who undertake CKD DETECT. All file formats meet best practice standards including MP4 for video files and MP3 for audio files. Transcripts were made available for all relevant content.

Box 6: Presenting the stimulus material in CKD DETECT

7. Consider how you will capture and maintain the learner's attention

As with all adult education initiatives there needs to be an explicit reason or motivation for undertaking a learning activity (Knowles, 1980). There are many ways of providing the rationale for the e-learning activity and to capture the learner's attention. Gagne et al., (2005) advocate the use of novelty such as an animation, humour, demonstration of an unexpected event, or provision of a relevant patient safety statistic or a meaningful scenario to facilitate engagment. A brief 60 - 90 second video from a prominent authority figure can also be effective in gaining learner attention and establishing the context and benefits of the resource. The emphasis here is on 'brief', although the optimal length for video in e-learning will vary depending on the content, its purpose and presentation. No firm evidence exists to support the ideal length of e-learning video content, however for an e-learning introduction the maxim should be 'the shorter the better', with the video not lasting more than 90 seconds (Perry, 2011). An exception is the use of video content that demonstrates a particular skill.

Learner engagement is heightened when the learning is transferable to real world situations. This is facilitated by delivering authentic activities that enable learners to recognise the relevance of their learning to clinical practice (Brown & Voltz, 2005). In health professional education the introduction of the 'person' who is or will be the recipient of care, through the use of text, video or audio files, promotes a person-centred approach and enhances learner motivation. Beginning with a person's life history allows health professionals to view their practice as more than interactions linked to episodes of care but rather as meaningful engagement with a person during a time in their illness (or life) journey. Unfolding stories are known to provide adult learners with a powerful and effective way to retain information (Brown, Denning, Groh and Prusak, 2005). Patient stories enable exploration of reality from different perspectives and create an emotional resonance (Stone & Levett-Jones, 2014) and learners are more likely to exert effort if they find the scenarios compelling and meaningful (Gee, 2003).

CKD DETECT sought to gain the learner's attention in a number of ways. Firstly, a short 90 second introductory video, presented by a practice nurse, provides the stimulus for the e-learning program. It includes an emotional plea and explains how practice nurses can significantly influence patient outcomes through evidence-based screening practices. This is then followed by another video of a person on haemodialysis who was not screened early enough to regress their kidney disease. In this short video they explain the impact that not identifying kidney disease early enough has had on their lives. The learner is then presented with the pre-test to evaluate their existing knowledge regarding CKD risk factors and opportunistic screening processes and determine, as previously discussed, whether they need to complete the knowledge focussed module before proceeding to the more practically focused module.

Module one introduces the learner to Mr John Anderson, a 62 year old man who presents to their general practice. They are given insight into John's life history through a series of images overlaid with a narrated audio file. This is reinforced by the provision of 'John's Story' and an outline of his medical history. The learner continues in their usual role as a practice nurse who meets John at their local practice. This is followed with factual information about the prevalence and epidemiology of CKD. In this way, learners are left in no doubt about the significance of this learning to their current and future clinical practice. Module two presents learners with real-life case studies of award-winning general practices who have implemented processes to successfully screen people with recognised risk factors for CKD. The module is based on the premise of having conversations that matter and suggests strategies to improve volitional control of screening practices in their local GP surgery. This module is pragmatically focussed on change management at an organisational level.

Box 7: Capturing and maintaining learner attention in CKD DETECT

8. Design objective performance assessments and feedback

Assessment should be frequently undertaken throughout the e-learning program using a range of questions designed to assess the learner's achievement of the learning outcomes.

These can be formatted from traditional multiple choice, multiple response, numeric or select styles through to graphically rich drag and drop interfaces. Questions can be used to facilitate new learning, and extensive feedback on correct and incorrect responses should be provided to further assist in actively engaging learners.

The provision of feedback allows learners to gauge their performance; it also reinforces learning, corrects misconceptions and inspires confidence in the learner's understanding of the content (Hatziapostolou & Paraskakis, 2010). In e-learning, feedback is traditionally provided as notification of 'correct' or 'incorrect' responses, however this does little to remediate knowledge deficits. Feedback with e-learning should consider all the possible answers and be delivered to provide guidance, direction, encouragement and further information. The timing of feedback is essential; the immediacy that can be provided by e-learning programs embeds learning at the time of delivery and prevents learner frustration (Shute, 2008). Assessment feedback needs to be clear, specific and meaningful to facilitate further learning (Killen, 2005). Immediate feedback is more effective than delayed feedback in terms of both retaining correct information and correcting wrong answers (Dihoff, Brosvic, Epstein, & Cook, 2004). It also affords greater knowledge retention, confidence and the ability to identify and comprehend why responses may have been incorrect in the first instance. E-learning developers should consider providing tailored and specific feedback for each question, including common mistakes and learning caveats to facilitate further learning. Allowing multiple opportunities to reattempt questions also encourages learners to persist in learning without fear of failure.

CKD DETECT uses a range of multiple choice, multiple response, and drag and drop interfaces to both assess understanding of content and facilitate new learning. We utilised very specific feedback that linked both correct and incorrect answers to best practice guidelines regarding the detection of CKD. To illustrate, one formative question in module one asked users to identify what investigations should be ordered after identifying that Cyril possessed several risk factors for CKD. One of the multiple-choice distractors was a bladder scan. Rather than identifying it purely as incorrect. The learner was directed to the indications of a bladder scan and in what situations this would be an appropriate investigation to undertake. If the learner identified the correct investigations, their feedback would reiterate where the evidence for this investigation originated from.

Box 8: Performance assessment and specific feedback in CKD DETECT

9. Incorporate elements to enhance retention, transfer and behaviour change

Once the learner has worked their way through an e-learning resource and achieved the pre-determined learning outcomes, preventing knowledge degradation over time and enhancing the learner's ability to transfer their learning to new situations is vital. This is particularly relevant in health professional education where the goal is often clinical transfer and application. There should be provision for recall of learning, either by reattempting the e-learning resource at spaced intervals throughout future weeks and months (Gagne et al., 2005), or in other ways such as online tests or quizzes, or directing the learner to further reading such as guidelines or journal articles.

E-learning is not an educational panacea and will not achieve all educational outcomes. No evidence-based guidelines exist regarding ideal e-learning program size or duration, configuration or instructional design approach (Cook, Levinson, & Garside, 2010; Cook et al., 2010). If the outcome is to increase knowledge and participant self-efficacy, e-learning has been demonstrated to be at least as effective as face-to-face learning (Cook et al., 2008). What is less clear is whether e-learning can influence sustained behaviour change. If behaviour change is a desired outcome, further consideration is required by the development team to ensure content adequately addresses variables that affect participant

volitional control. Behaviour change is a complex and multifaceted phenomenon. If an e-learning program is focussed on skill development or behaviour change, educators must first recognise that the learner may not be able to undertake the learned behaviour or skill of their own volition, if external variables such as attitudes, perceived social pressures and behavioural control prevent them from doing so (Ajzen, 2002). Consequently, research may be required prior to the development of e-learning resources to identify any contextual or personal variables that may impede behavioural change.

Self-reported evaluation tools that measure confidence to perform a target behaviour do not necessarily guarantee actual behaviour change (Sinclair et al., 2016). These evaluation tools are inadequate because they do not determine whether the individual possesses the volitional control to carry out a desired practice (Chiou, 1999). Consequently, e-learning interventions that focus on behaviour change or skills development should be developed within a theoretical framework that considers the tenets of behaviour change (Webb et al., 2010). E-learning developers should develop reliable and validated instruments to objectively evaluate behavioural outcomes for asynchronous e-learning programs where it is impractical to conduct face-to-face evaluation.

With the growth of externally provided asynchronous e-learning programs, minimal attention has been directed to the rigorous evaluation of clinical skills and health professional behaviour. The majority of e-learning research to date has focused on user satisfaction, knowledge improvement or self-efficacy relating to clinical skills using subjective self-reported measures (Lahti, Hätönen, & Välimäki, 2014). Few studies have examined the effectiveness of e-learning programs on HCP behaviour using objectively administered evaluation criteria (Sinclair et al., in press). Those that do, have used Objective Structured Clinical Examination (OSCE) (Cantarero-Villanueva et al., 2012) or Objective Structured Assessment of Technical Skills (OSAT) (Pape-Koehler et al., 2013). These processes are impractical for evaluating clinical skills and behaviour change in the asynchronous e-learning environment. Consequently, alternate objective measures informed by sound theoretical constructs that have been psychometrically tested are required, to evaluate e-learning outcomes associated with behaviour change (Sinclair et al., 2016).

CKD DETECT was informed by the findings of an elicitation study which identified the barriers and facilitators to opportunistic CKD screening by Australian based general practice nurses. The findings of the study allowed the program's content to be tailored specifically to address the identified barriers. This is a substantial step forward from the traditional approach of delivering education that is focused on improving knowledge with the hope that knowledge will increase confidence and subsequently increase the probability that participants will engage in the target behaviour or practice. Developing an e-learning program that focuses on delivering solutions based on existing real world practice solutions may assist with behaviour change however this is yet to be supported by empirical evidence and further research in this area is required.

Box 9: Utilising evidence to create content to facilitate behaviour change in CKD DETECT.

10. Incorporate peer review of content and resource evaluation measures

The evaluation of the impact of any educational initiative is important but never more so than when implementing e-learning resources which require a significant investment of time and expertise (Marshall, 2012). During 'face-to face' education, educators can observe students level of engagement and involvement and utilise objective evaluation measures to assess clinical practice, however this opportunity is not available in an asynchronous online environment. Consequently, evaluation should be the final important design element considered by e-learning developers (Gagne et al., 2005; Ossiannilsson & Landgren, 2012).

The evaluation process should occur at two stages: prior to implementation peer review of the learning resource should be conducted, and on completion of the e-learning program, evaluation of achievement of the learning outcomes should be conducted. The development team should consider engaging a reference group to critique and provide advice on the design and content throughout the project. Preferably, the reference group will be comprised of experts in the content field, e-learning instructional design and evaluation methodology. A separate, and ideally blinded, peer review process should also be undertaken after the program has been developed. Peer review is well established as a primary mechanism for quality control in the discipline of health education. However it has also been criticized as being an arbitrary and subjective process prone to bias (Smith, 2006).

Due to the potentially subjective nature of peer review processes, e-learning resources should be rigorously evaluated by a group from the intended target audience as well as subject matter and instructional design experts. Peer reviewers should be instructed to complete the program and scrutinise aspects such as accuracy of content, navigation, interactivity, format, usability and currency (Ruiz et al., 2007). The review process can be strengthened by utilising objective evaluation instruments such as the Learning Object Review Instrument (LORI) (Nesbit, Belfer, & Leacock, 2003) as a framework to evaluate key domains from the veracity and accuracy of content, ease of navigation, and whether the e-learning program adheres to internationally accepted technical standards.

Education effectiveness from an end user perspective is traditionally evaluated using the domains of learner satisfaction, knowledge gain and behavioural change. These three constructs align with levels one (Satisfaction), two (Knowledge) and three (Behaviour change) of Kirkpatrick's (1994) evaluation model of educational outcomes. To date, e-learning programs and their associated evaluation have predominantly focussed on participant satisfaction and knowledge acquisition. This can be largely attributed to the conceptual and practical challenges of e-learning research that corresponds with higher levels of educational evaluation such as behaviour change (Sinclair et al., 2016). The degree of satisfaction and improvement in knowledge are important constructs to measure in asynchronous learning, particularly when also evaluating behavioural or skill change. Data should also be collected about learner participation, performance and number of attempts required to accurately answer questions and items should be embedded to identify level of engagement, problematic questions and/or activities. These data can be used to inform future iterations and isolate issues that may not have been initially identified by the development team. If evaluation conducted in conjunction with the program is unable to demonstrate a statistically significant change in behaviour then these data will assist in determining whether this may have been a result of the program or mode of delivery being ineffective. Learner satisfaction surveys can also be used to elicit feedback from a user's perspective. Satisfaction, although frequently dismissed as being subjective and of little value, is still an important indicator of engaged and meaningful learning experiences (Shea, Fredericksen, Pickett, & Pelz, 2003).

CKD DETECT undertook a rigorous peer review process by content and design experts. Changes were incorporated at both content and instructional levels through this process. The absence of a suitable learner satisfaction instrument necessitated the design and development of the Learner Satisfaction with Asynchronous e-Learning (LSAeL) scale. The development and psychometric testing of this scale will be reported elsewhere.

Box 10: Utilising peer review and evaluating user satisfaction in CKD DETECT

Conclusion

This paper combines instructional design and pedagogical principles to present key elements of e-learning instructional design to inform the development of e-learning resources. Ten key design principles have been presented using descriptions and illustrations from a recently developed e-learning education program that aimed to improve opportunistic CKD screening practices in Australian general practice nurses. We propose that when e-learning resources follow the design principles described in this paper, the learning will be output focused, maximise the potential for learner engagement and the achievement of targeted learning outcomes, and provide learners with the skills and capacity to change their behaviour in the clinical practice setting.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179-211.

Blaschke, L. M. (2012). Heutagogy and lifelong learning: A review of heutagogical practice and self-determined learning. *The International Review of Research in Open and Distributed Learning,* 13(1), 56-71.

Boese, E. (2016). *Just-In-Time Learning for the Just Google It Era.* Paper presented at the Proceedings of the 47th ACM Technical Symposium on Computing Science Education.

Boling, E., Hough, M., Krinsky, H., Saleem, H., & Stevens, M. (2012). Cutting the distance in distance education: Perspectives on what promotes positive, online learning experiences. *The Internet and Higher Education, 15*(2), 118-126.

Bonderud, D. (2011). Adobe Flash Player Turfed for Mobile Devices. Retrieved April 30, 2012, from http://www.theinfoboom.com/articles/adobe-flash-player-turfed-for-mobile-devices/

Prusak, L., Groh, K., Denning, S., & Brown, J. S. (2005). *Storytelling in organizations*. Oxford: Elsevier.

Burgess, M. (2016). Google Chrome will start blocking Flash by default. Retrieved July 12, 2016, from http://www.wired.co.uk/article/google-chrome-adobe-flash-html5

Button, D., Harrington, A., & Belan, I. (2014). E-learning & information communication technology (ICT) in nursing education: A review of the literature. Nurse education today, 34(10), 1311-1323

Brown, A. R., & Voltz, B. D. (2005). Elements of Effective e-Learning Design. *International Review of Research in Open and Distance Learning, 6*(1).

Cantarero-Villanueva, I., Fernandez-Lao, C., Galiano-Castillo, N., Castro-Martin, E., Diaz-Rodriguez, L., & Arroyo-Morales, M. (2012). Evaluation of e-learning as an adjunctive method for the acquisition of skills in bony landmark palpation and muscular ultrasound examination in the lumbopelvic region: A controlled study. *Journal of Manipulative and Physiological Therapeutics, 35*(9), 727-734. doi: http://dx.doi.org/10.1016/j.jmpt.2012.10.007

Chiou, J.-S. (1999). The Effects of Attitude, Subjective Norm, and Perceived Behavioral Control on Consumers' Purchase Intentions: The Moderating Effects of Product Knowledge and Attention to Social Comparison Information. *Proceedings of the National Science Council,* 9(2), 298-308.

Clark, R., & Mayer, R. (2011). *E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning* (3rd ed.). San Francisco: Pfeiffer.

Commonwealth of Australia. (1992). *Disability Discrimination Act*. Canberra: Commonwealth of Australia.

Cook, D. A., Levinson, A. J., & Garside, S. (2010). Time and learning efficiency in Internet-based learning: a systematic review and meta-analysis. *Advances in Health Sciences Education*, 15(5), 755-770.

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(10), 1181-1196.

Cook, D. A., Levinson, A. J., Garside, S., Dupras, D. M., Erwin, P. J., & Montori, V. M. (2010). Instructional design variations in internet-based learning for health professions education: a systematic review and meta-analysis. *Academic Medicine*, 85(5), 909-922.

Darker, C., French, D., Eves, F., & Sniehotta, F. (2010). An intervention to promote walking amongst the general population based on an 'extended'theory of planned behaviour: a waiting list randomised controlled trial. *Psychology and Health, 25*(1), 71-88.

Dihoff, R. E., Brosvic, G. M., Epstein, M. L., & Cook, M. J. (2004). Provision of feedback during preparation for academic testing: Learning is enhanced by immediate but not delayed feedback. *Psychological Record, 54*(2), 207-232.

Dziuban, C., Moskal, P., Kramer, L., & Thompson, J. (2012). Student satisfaction with online learning in the presence of ambivalence: Looking for the will-o'-the-wisp. *The Internet and Higher Education, 17*, 1-8.

Ehlers, U.-D., & Pawlowski, J. M. (Eds.). (2006). *Handbook on Quality and Standardisation in E-learning*. Berlin: Springer.

Gagne, R. M., Wager, W. W., Golas, K. C., & Keller, J. M. (2005). *Principles of Instructional Design* (5 ed.). Belmont, USA: Wadsworth, Cengage Learning.

Gasston, P. (2013). *The Modern Web: Multi-device web development with HTML5, CSS3, and Javascript*. San Francisco: No Starch Press.

Gathercole, S. E., & Alloway, T. P. (2004). Working memory and classroom learning. *Dyslexia Review, 15*, 4-9.

Gee, J. P. (2003). *What video games have to teach us about literacy and learning*. New York: Palgraw Macmillan.

Gerkin, K. L., Taylor, T. H., & Weatherby, F. M. (2009). The perception of learning and satisfaction of nurses in the online environment. *Journal for Nurses in Professional Development, 25*(1), E8-E13.

Giles, M., Connor, S., McClenahan, C., Mallett, J., Stewart-Knox, B., & Wright, M. (2007). Measuring young people's attitudes to breastfeeding using the Theory of Planned Behaviour. *Journal of Public Health, 29*(1), 17-26.

Hatziapostolou, T., & Paraskakis, I. (2010). Enhancing the impact of formative feedback on student learning through an online feedback system. *Electronic Journal of E-learning, 8*(2), 111-122.

Johnson, D. W., Atai, E., Chan, M., Phoon, R. K., Scott, C., Toussaint, N. D., . . . Wiggins, K. J. (2013). KHA‐CARI Guideline: Early chronic kidney disease: Detection, prevention and management. *Nephrology, 18*(5), 340-350.

Kidney Health Australia. (2015). *Charting a comprehensive approach to tackling kidney disease.* Melbourne Kidney Health Australia.

Killen, R. (2005). *Programming and assessment for quality teaching and learning*. Sydney: Thomson.

Kirkpatrick, D. L. (1994). *Evaluating training programs: The four levels*. San Francisco, CA: Berrett-Koehler.

Knowles, M. S. (1980). *The modern practice of adult education: From pedagogy to andragogy (2nd ed.).* New York: Cambridge.

Kothe, E., Mullan, B., & Butow, P. (2012). Promoting fruit and vegetable consumption. Testing an intervention based on the theory of planned behaviour. *Appetite, 58*(3), 997-1004.

Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. *Theory into Practice, 41*(4), 212-218.

Lahti, M., Hätönen, H., & Välimäki, 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*(1), 136-149. doi: 10.1016/j.ijnurstu.2012.12.017

Leacock, T. L., & Nesbit, J. C. (2007). A framework for evaluating the quality of multimedia learning resources. *Journal of Educational Technology & Society, 10*(2), 44-59.

Levett-Jones, T., Kenny, R., Van der Riet, P., Hazelton, M., Kable, A., Bourgeois, S., & Luxford, Y. (2009). Exploring the information and communication technology competence and confidence of nursing students and their perception of its relevance to clinical practice. *Nurse Education Today, 29*(6), 612-616.

Marshall, S. (2012). Determination of New Zealand tertiary institution e-learning capability: An application of an e-learning maturity model. *Journal of Open, Flexible and Distance Learning, 9*(1), 58-63.

Martin, F. (2015). E-learning Design—From Instructional Events to Elements. In B. Khan & M. Ally (Eds.), *International Handbook of E-Learning Volume 1: Theoretical Perspectives and Research* (pp. 153). Oxon: Taylor & Francis.

Mathew, T., & Corso, O. (2009) Review article: Early detection of chronic kidney disease in Australia: Which way to go? *Nephrology,* 14(4), 367-73.

Mbipom, G., & Harper, S. (2011). *The interplay between web aesthetics and accessibility.* Paper presented at the The proceedings of the 13th international ACM SIGACCESS conference on Computers and accessibility.

Mikkonen, T., & Taivalsaari, A. (2011). *Apps vs. Open Web: The Battle of the Decade.* Paper presented at the Proceedings of the 2nd Workshop on Software Engineering for Mobile Application Development.

Murphy, J., Worswick, L., Pulman, A., Ford, G., & Jeffery, J. (2015). Translating research into practice: Evaluation of an e-learning resource for health care professionals to provide

nutrition advice and support for cancer survivors. *Nurse Education Today, 35*(1), 271-276.

Nesbit, J. C., Belfer, K., & Leacock, T. (2003). Learning object review instrument manual (LORI Version 1.5). Retrieved 7th March, 2015, from www.transplantedgoose.net/gradstudies/educ892/LORI1.5.pdf

Obikwelu, C., Read, J., & Sim, G. (2013). Children's Problem-Solving in Serious Games: The "Fine-Tuning System (FTS)" Elaborated. *Electronic Journal of E-learning, 11*(1), 49-60.

Ossiannilsson, E., & Landgren, L. (2012). Quality in e-learning: a conceptual framework based on experiences from three international benchmarking projects. *Journal of Computer Assisted Learning, 28*(1), 42-51.

Palmer, S. R., & Holt, D. M. (2009). Examining student satisfaction with wholly online learning. *Journal of Computer Assisted Learning*, 25(2), 101-113.

Pape-Koehler, C., Immenroth, M., Sauerland, S., Lefering, R., Lindlohr, C., Toaspern, J., & Heiss, M. (2013). Multimedia-based training on Internet platforms improves surgical performance: a randomized controlled trial. *Surgical Endoscopy, 27*(5), 1737-1747.

Perry, A. M. (2011). Lights, camera, action! How to produce a library minute. *College & Research Libraries News, 72*(5), 278-283.

Razavian, M., Heeley, E.L., Perkovic, V., Zoungas, S., Weekes, A., Patel, A.A., et al. (2011). Cardiovascular risk management in chronic kidney disease in general practice (the AusHEART study). *Nephrology Dialysis Transplantation*, 18(10), 2766-72.

Ruiz, J., Candler, C., & Teasdale, T. (2007). Peer Reviewing E-Learning: Opportunities, Challenges, and Solutions. *Academic Medicine*, 82(5), 503–507.

Seale, J., & Cooper, M. (2010). E-learning and accessibility: An exploration of the potential role of generic pedagogical tools. *Computers & Education, 54*(4), 1107-1116.

Shea, P. J., Fredericksen, E. E., Pickett, A. M., & Pelz, W. E. (2003). A preliminary investigation of "teaching presence" in the SUNY learning network. *Elements of Quality Online Education: Practice and Direction, 4*, 279-312.

Shute, V. J. (2008). Focus on formative feedback. *Review of educational research, 78*(1), 153-189.

Sinclair, P. M., Day, J., Levett-Jones, T., & Kable, A. (in press). The barriers and facilitators to opportunistic CKD screening by general practice nurses. *Nephrology*.

Sinclair, P. M., Kable, A., Levett-Jones, T., & Booth, D. (2016). The effectiveness of internet-based e-learning on clinician behavior and patient outcomes: a systematic review. *International Journal of Nursing Studies,* 57, 70-81

Sinclair, P. M., Schoch, M., Black, K., & Woods, M. (2011). Proof of concept: developing a peer reviewed, evidence based, interactive e-earning programme. *Journal of Renal Care, 37*(2), 108-113.

Smith, R. (2006). Peer review: a flawed process at the heart of science and journals. *Journal of the Royal Society of Medicine, 99*(4), 178-182.

Stone, T., & Levett-Jones, T. (2014). A comparison of three types of stimulus material in undergraduate mental health nursing education. *Nurse Education Today, 34*(4), 586-591.

Tavangarian, D., Leypold, M. E., Nölting, K., Röser, M., & Voigt, D. (2004). Is e-learning the Solution for Individual Learning. *Electronic Journal of E-learning, 2*(2), 273-280.

Tracey, K., Cossich, T., Bennett, P.N., Wright, S., & Ockerby, C. (2013). A nurse managed kidney disease program in regional and remote Australia. *Renal Society of Australasia Journal*, 9(1), 28-34.

W3C. (2012). About W3C Standards. Retrieved April 30, 2012, from www.w3.org/standards/about.html

University of Washington. (2010). Accessible University: List of Accessibility Problems. Retrieved 20 August, 2013, from https://www.washington.edu/accesscomputing/AU/problems.html

Watkins, R. (2005). Developing Interactive E-Learning Activities. *Performance Improvement, 44*(5), 5-7.

Webb, T., Joseph, J., Yardley, L., & Michie, S. (2010). Using the internet to promote health behavior change: a systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy. *Journal of Medical Internet Research*, 12(1), e4.