Development of a Multimedia Educational Programme for First-time Hearing Aid Users: A Participatory Design

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Abbreviations

CP	Communication partner
DVD	Digital video disc
HA	Hearing aid
HD	High definition
IMS	International Machine Standard
NHS	National Health Service
PC	Personal computer
PHL	People with hearing loss
PPI	Public and patient involvement
RCT	Randomised controlled trial
RLO	Reusable learning object
TV	Television

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Abstract

Objective: To develop content for a series of interactive video tutorials (or reusable learning objects, RLOs) for first-time adult hearing aid users, to enhance knowledge of hearing aids and communication.

Design: RLO content was based on an electronically-delivered Delphi review, workshops, and iterative peer-review and feedback using a mixed-methods participatory approach.

Study sample: An expert panel of 33 hearing healthcare professionals, and workshops involving 32 hearing aid users and 11 audiologists. This ensured that social, emotional and practical experiences of the end-user alongside clinical validity were captured.

Results: Content for evidence-based, self-contained RLOs based on pedagogical principles were developed for delivery via DVD for television, PC or internet. Content was developed based on Delphi review statements about essential information that reached consensus (≥90%), visual representations of relevant concepts relating to hearing aids and communication, with iterative peer-review and feedback of content.

Conclusions: This participatory approach recognises and involves key stakeholders in the design process to create content for a user-friendly multimedia educational intervention, to supplement the clinical management of first-time hearing aid users. We propose participatory methodologies are used in the development of content for e-learning interventions in hearing-related research and clinical practice.

Introduction

Hearing aids (HAs) improve listening abilities, hearing-specific and general health-related quality of life (Ferguson et al, 2017). However, despite this, hearing aids are not always worn. Rates of HA non-use range between 3 and 24%, with non-use typically between 10-15% (Ferguson et al, 2017). This non-use of HAs comes at a cost. There is the financial cost to either the individual or publicly-funded healthcare systems, but probably more important is the cost to the individual in terms of continued hearing difficulties. If untreated, hearing loss results in communication difficulties that can lead to social isolation, withdrawal and loneliness (Ciorba et al, 2012; Heffernan et al, 2016), depression (Strawbridge et al, 2000), stigma and reduced self-perception of social identity (Barker et al, 2017), reduced quality of life (Davis et al, 2007), and an increased risk of developing dementia (Lin et al, 2011).

There are a number of reasons why HAs are not used (McCormack & Fortnum, 2013). About half of non-users report background noise as too loud and disturbing (Vuorialho et al, 2006), and it can take many weeks to acclimatise to wearing HAs. Other reasons for non-use include difficulties inserting the earmould, managing the HA controls and inserting batteries, poor fit and comfort (Vuorialho et al., 2006; Bertoli et al, 2009). Furthermore, expectations of new HA users are often set too high (Ferguson et al, 2016b). It has been reported that half (51%) of first-time HA users have significant difficulties using their HAs, with many reporting that they did not know or could not remember what to do with their HAs (AoHL, 2011). Even experienced HA users can have difficulties handling their HAs (Desjardins & Doherty, 2009).

An often-cited holistic approach to adult rehabilitation includes sensory management, instruction, perceptual training and counselling (Boothroyd, 2007). More recently, knowledge

exchange and patient education have been proposed as core aspects of patient-centred care and self-management of hearing loss (Grenness et al, 2014; Barker et al, 2016). In the UK, this is reflected in national quality standards and practice guidance that recommend provision of clear, well-written and accessible information to HA users to supplement that provided by the audiologist (British Society of Audiology, 2016; Welsh Government, 2016). A range of evidence-based educational delivery methods include modified HA users guides (Caposecco et al, 2014), home-delivered videotapes (Kramer et al, 2005), and a written educational programme supplemented by weekly telephone calls (Lundberg et al, 2011) or delivered via the internet with weekly feedback and advice from audiologists (Thorén et al, 2014).

A weakness of many e-health and educational interventions is the lack of stakeholder consultation during the development process (Van Velsen et al, 2013). This can lead to educational materials that are not aligned with the needs of the end-user (O'Keefe et al, 2008). Participatory and co-design approaches aim to overcome this limitation by having end-users at the core of the design and at all stages of the development, in order to improve usability and satisfaction (Bruno & Muzzupappa, 2010; Latif et al, 2017). A further aspect in the development of complex interventions is that they should be underpinned by an appropriate theory and design principles (Medical Research Council, 2006). More generally, there is increasing involvement of patients and the public in the development of research that is relevant to them, and this is often now a requirement of research funding bodies (e.g. UK's National Institute for Health Research).

Educational and psychological research provides convincing evidence that external and visual representations enhance learning, empower learners, reduce anxiety, and improve motivation

(Zhang et al, 2006; Murray et al, 2001). Additionally, studies have indicated that multimedia interventions and visual imagery delivered via computers or online can increase satisfaction, confidence, patient engagement and behaviour change (Lymn et al, 2008; Sawesi et al, 2016). These features, alongside other theoretically-derived pedagogical attributes and a co-design development methodology, are encompassed in an e-learning format, known as the reusable learning object (RLO) (Windle & Wharrad, 2010).

Reusable learning objects (RLOs) are bite-sized chunks of interactive multimedia e-learning focusing on a specific learning goal. The theoretical framework underpinning the pedagogical design of the RLOs is IMS (International Machine Standard) Learning Design (Koper, 2003). This framework emphasises the *environment* in which the learning occurs, the *roles* played by the learner, and the *activities* undertaken. The IMS Learning Design ensures that the most appropriate multimedia environment is created, and that learners take active roles within the RLO. Activities and self-assessments in the RLOs are aligned with the learning goal (Biggs, 2003). These are important because users must be actively engaged in the process of learning and need feedback from self-assessments to determine whether they have successfully achieved the learning goal (Laurillard, 2002). Our pragmatic definition of an RLO is a stand-alone digital resource based on learning goals that includes the following pedagogical components, (i) presentation of the concept or procedure to support the learning goal, (ii) an activity for the learner to engage with the content, (iii) self-assessment to test mastery of the content, and (iv) links to other resources to reinforce the learning. RLOs have consistently been shown to improve exam scores in education. Data suggest that the sense of control and ownership of the learning process that RLOs afforded to the learners, along with ability to reuse the resources, were key to their effectiveness (Windle et al, 2010).

Operationalising stakeholder participation in the form of a design workshop represents a participatory, community of practice approach that involves end-users and provides a forum for inclusive debate around the content creation, leading to relevant and high-quality materials aligned to users' needs (O'Keefe et al., 2008). Though labour intensive, workshops provide important creative input from stakeholders/learners that have enormous power to engage the learner and aid understanding (Edelson & Pittman, 2001). Whilst increased learner satisfaction and knowledge gain are crucial when delivering educational interventions, behaviour change is a desirable outcome although more difficult to achieve and measure from digital educational interventions (Yardley et al, 2016). However, creative workshops allow personal stories, anecdotes and case studies to be captured during the storyboarding process, which when incorporated into RLOs provide triggers for behaviour change, along with the ability to repeatedly reuse the resources (Lymn et al, 2008). A participatory, community of practice approach around the development process initiated via workshops is a key feature of RLO development methodology.

An RLO approach offers a useful means to supplement standard HA management by audiologists in a clinical setting by providing effective additional support to educate HA users. We have developed and evaluated a series of RLOs for first-time HA users that included a broad range of auditory rehabilitation aspects, both practical and psychosocial (Ferguson et al, 2015; Ferguson et al, 2016a). A registered randomised controlled clinical trial (RCT) of the RLOs in 203 first-time HA users (ISRCTN 1186888) showed significant improvements in knowledge and practical skills of HAs, and greater use of HAs in those who did not wear them all the time, with large clinical effect sizes. HA users reported that the

RLOs were highly useful, and about half (49.2%) watched the RLOs two or more times, suggesting self-management of hearing loss. Prior to the development of the RLOs in 2011/12, there was relatively little in the literature on what the content of the RLOs should consist of. To address this we chose to establish a consensus on the informational needs of first-time HA users using a Delphi review.

A Delphi review is an iterative process that is focused upon refining opinion on a designated topic until an accepted degree of consensus is reached amongst an expert panel (Mullen, 2003). It is a technique commonly utilised to establish expert consensus on core information and key priorities, and has been widely used in health research. Delphi studies are typified by four core characteristics: a selected expert panel, numerous iterations and controlled feedback, statistical feedback of whole group responses, and anonymity of responses, although no universal standard for consensus has been established (Diamond et al, 2014). Examples in the hearing literature include a rationale for the development and evaluation of self-management system to support living well with hearing loss (Barker et al, 2015), and to identify a consensus on HA candidature and fitting for mild hearing loss with and without tinnitus (Sereda et al, 2015).

To safeguard against a bias towards the opinions of the most prominent panel members and to prevent peer pressure influencing individual responses, Delphi reviews usually maintain the anonymity of participants. Typically, participants do not meet face-to-face, they answer questions and provide data in isolation, and receive collated, rather than individualised, feedback after each phase of the review. Panel members who are geographically dispersed and

the use of electronic communication, such as e-mail, can further add to the anonymity of the process.

The main objective of this paper is to describe the participatory approach used to develop the content for a series of evidence-based multimedia, interactive RLOs for first-time HA users. HA users and hearing healthcare professionals were core to the development process that integrated methods of a Delphi review, workshops and peer-review process. In particular, to ensure the RLOs were aligned to the end-users needs, we aimed for the content to have a substantial input from HA users. The aims of the participatory approach were to:

(i) obtain a consensus on essential information for first-time HA users using a Delphi review of hearing healthcare professionals

(ii) define the content of the RLOs with HA users and audiologists using participatory workshops

(iii) develop RLO specifications and materials for first-time HA users, using an iterative peer-review process involving HA users and audiologists.

Methods

The RLO development process is a validated, evidence-based methodology conceived by the Universities Collaboration in e-learning and later revised by the Centre for Excellence in Teaching and Learning in Reusable Learning Objects (Windle et al, 2010). An overview of the development process is shown in Figure 1.

(1) Delphi review

An electronic Delphi review was delivered via email to a panel of UK hearing healthcare experts. UK experts were approached as the overall project was focussed primarily on

provision of National Health Service (NHS) audiology services. Experts were identified by the lead author by virtue of their professional role, organisational affiliation, clinical and/or academic expertise, and who held a strategic and/or national perspective on the provision or uptake of HAs. From a total of 38 invited UK experts, 33 were recruited, and were categorised according to their main professional role: publicly-funded NHS audiologists (n=14, of which 5 were heads of service), hearing therapists (n=5), hearing researchers (n=4), representatives from hearing charities (n=3), HA companies (n=5), and independent HA dispensers (n=2). To limit participant drop-out, the review was restricted to three rounds. To ensure anonymity, all e-mail correspondence and data collection was managed by an independent administrator who assigned a unique identifier code to all questionnaires prior to distribution. Anonymised questionnaires were returned via email. The Delphi review ran between January and June 2011.

In Round 1, the panel participants were asked 10 open-response questions about reasons for non-use of HAs, current provision of information relating to HAs and communications, ideal information for first-time HA users as well as their communication partners, pre-fitting advice to appropriately set patient expectations, and outline RLO content (see Supplementary Information for Round 1 questions). These qualitative data were managed using NVivo software, and analysed according to Framework Analysis (Ritchie & Lewis, 2003). Subsequently, a thematic framework was constructed by the research team, which included seven broad themes and 43 sub-themes (see Supplementary Information, Table 1). The populated analytic framework was subsequently used to inform a bank of 67 statements about HA users' needs.

The 67 statements were placed under three sub-headings, (i) non-use of HAs (n=13), (ii) information for first-time HA users (n=39), and (iii) making the most of a DVD for first-time HA users (n=15) (see Supplementary Information for Round 2 questions). In Round 2, panel participants were asked to score each statement on a 5-point Likert scale (strongly agree to strongly disagree). In addition, participants were asked to rank the importance of practical difficulties, audiological, psychosocial and service delivery factors (1=most important to 4=least important). Finally, 15 topics to be considered for inclusion as information for first-time HA users were presented (e.g. benefits and limitations of HAs). Participants were asked to select and rank the top 10 topics they considered to be beneficial for inclusion in the educational resource to be developed (1=most preferable to 10 least preferable). Mean scores were derived for each statement, and mean rankings were derived for the important factors and information topics.

In Round 3, the previous Round 2 statements alongside the summary statistics for Round 2 responses were re-circulated one month later (see Supplementary Information). Participants were invited to score the statements again and to offer reasons for their scoring. Consensus was considered to have been achieved for each statement when ≥90% of the expert panel 'agreed' or 'strongly agreed', and where responses to questions were stable between rounds 2 and 3 (i.e. the number of items where responses changed was less than 9%, n=3 items). A 90% threshold has been used in previous Delphi research (Avery et al, 2005), and considered appropriate here given the heterogeneous nature of the expert panel, and diverse personal and professional perspectives which they represented.

(2) Workshops

The top 10 of the 15 topics of beneficial information identified by the Delphi review were discussed in the workshops as we wanted to ensure that the focus was on the most important and relevant information. Three separate one-day workshops included, (i) seven groups of participants (total n=32) who had been fitted with HAs (18 women; age, mean= 65.6y, range=43-88y; duration of HA ownership, mean = 12.7y, range=1-40y; daily HA use, mean=62% range=0-100%) including eight participants who no longer wore them, and (ii) two groups of audiologists (total n=11). The workshops provided an opportunity for participants to conceptualise the content of short educational RLOs by drawing visual representations of their thoughts and perspectives on A0 size laminated storyboards. The storyboards provided a means for the HA users to incorporate their personal experiences, emotional responses as well as socio-cultural norms and expectations into the RLOs. The workshops were facilitated by researchers (PL, HW or MF) and study specific-PPI (public and patient involvement) representatives who were HA users (n=3) and one charity advocate for people with hearing loss (AD, TW, RR, PB).

Initially, participants were sometimes uncertain as to how they might 'draw' their experience on the storyboard. The key was to ensure the participants had hold of the pens, and that they were fully aware that this was about their own personal perspectives, and there were no right-wrong answers. Typically, once started, the thoughts and drawings followed easily. The topics for the informational content from the Delphi review were considered by the HA users, where each participant ranked each topic in order of their importance. We asked participants what they thought about their involvement in the workshops by asking them to respond on a Likert scale (1=strongly disagree to 5= strongly agree) to questions on expectations and enjoyment of the day, freedom to express their views, being listened to, and value of the

process and their participation. A workshop with audiologists was also held, primarily to ensure specific audiological and clinical information was correctly captured. The storyboards were digitised and stored as an archive to form the basis of the written specifications.

(3) Peer review

A specification was developed for each RLO that contained the key pedagogical components, which included learning goals, a detailed description of the visual imagery and sounds (illustrations, video clips, animations, still images), a transcript of the text to accompany the media (both audio commentary and subtitles), and an interactive multiple-choice quiz with feedback.

The specifications following the e-Learning team's well-developed protocols were initially drafted by MB and MF, and then revised and refined to incorporate e-learning and technical input. Crucially, each specification was peer-reviewed by two panels, (i) a project-specific PPI panel for relevance and clarity, and (ii) a panel of audiologists to ensure clinical validity. Feedback was obtained on proposed imagery, informational content, and relevance and clarity of content, including the quiz, which was then incorporated into a revised specification and redistributed to the peer-review panels for further comment. This iterative feedback process typically produced 2-3 revisions before resulting in the final version. The same iterative peer-review approach was used to finalise the RLO. This was developed using Adobe Premier, and animations and quizzes developed in Adobe Flash. Subtitles were added to each RLO to address the ease of listening needs of the intended audience. Powerful testimonials from seven workshop attendees, including one with the HA user and their spouse, were recorded that supported the users' social and emotional perspectives,

experiences and encouraged perseverance in wearing HAs. The user-interface presented the RLOs as chapter icons representing each topic, enabling the user to have the freedom to choose the RLO play order (See Supplementary Information, Figure 1).

The research was approved by the Nottingham Research Ethics Committee and Nottingham University Hospitals NHS Trust Research and Development department.

Results

(1) Obtaining consensus on essential information

Response rates for the Delphi review were high for round 1 (n=33, 100%), round 2 (n=32, n=97.0%), and round 3 (n=31, 93.9%).

Round 1: open-ended questions

There were seven themes (practical, personal and hearing difficulties, practical and technical information required, advice for communication partners, patient testimonials), and 43 sub-themes (see Supplementary Information, Table 1). The most frequently reported sub-themes were: 'How to use a HA' (n=32 participants, 97.0%); 'HAs do not improve hearing' (n=31, 93.9%); 'Sources of help & information' (n=30, 90.9%); 'Expectations of a HA' (n=30, 90.9%); 'How to care for your HA' (n=30, 90.9%). Some sub-themes, such as 'Developing confidence in your HA' (n=1; 3.0%), were mentioned by only a few participants. The potential benefit of delivering information to first-time HA users in the form of an educational DVD was supported in these data.

Rounds 2 and 3: seeking consensus

At the end of Round 3, 100% agreement was reached in 21 statements (31.3%) (Table 1), and ≥90% agreement reached in a further 21 statements (31.3%) (Supplementary information, Table 2). These 42 statements were then used to inform the nature and content of the information for first-time HA users. Of the original statements, 25 (37.3%) statements were rejected due to a lack of stability in responses, such that there was difference in responses between rounds 2 and 3 for more than 9% of responses (i.e. n=3 items), or due to a lack of consensus (i.e. <90% agreement) on their value for guiding content for HA users (Table 2). In 9 (13.4%) statements less than 50% agreement was achieved.

Factors associated with non-use of HAs in Round 2 identified Psychosocial Factors (e.g. patient expectations, patient motivation, stigma associated with a HA) as the most common reasons for HA non-use (mean ranking = 1.6). This was followed by Practical Difficulties with the HA (mean ranking = 2.2), Audiological Factors (e.g. distortion) (mean ranking of = 2.8), and Service Delivery Factors (e.g. clinical experience, location) (mean ranking = 3.4). The order of ranking remained unchanged for Round 3.

The top 10 ranked topics, out of 15, considered beneficial for inclusion in an educational resource provided to first-time HA users are shown in Table 3. The topics were evenly split between practical and psychosocial advice. Although the topics ranked 11-15 were not the focus of the workshops, all were included at some point within the RLOs.

(2) Generating and defining content

For the workshops, each group generated two or three storyboards with one storyboard per topic (for example, see Figure 1). In total, 23 storyboards were generated, with at least two

storyboards per topic, generated with input from both HA users and audiologists. The majority of HA users (26/32; 81%) reported that taking part in the workshops was a positive experience. The mean scores on their experience based on Likert Scale scores (1=strongly disagree to 5= strongly agree) were: expectations (4.5) and enjoyment (4.7) of the day, freedom to express their views (4.7), being listened to (4.3), and value of the process (4.1) and their participation (4.2).

Table 3 shows the key topics of information for first-time HA users ranked by the HA users. The top four categories identified by the expert panel are broadly similar to those of the HA users. The most striking difference is in the relative ranking of '*Expectations of HAs'*. Whereas the expert panel rated this as the 9th important topic, the users rated this as second highest, after HA controls. The ten topics in Table 3 were distilled into titles for seven RLOs, (*Getting to know your HAs*; *How to insert HAs*; *What to expect when wearing HAs*; *Adapting to wearing HAs*; *Communication tactics*; *Using the phone and other devices*; *HA care and troubleshooting*). An eighth RLO was a short introduction to the research, highlighting issues on hearing non-use and instructions on how to use the RLOs via the DVD or the internet.

(3) Development of specifications and production of the RLOs

Statements from the Delphi review that reached ≥90% agreement, and the content of the storyboards were integrated into written specifications using a matrix that identified key points. These were then mapped onto the relevant RLO title to ensure the input from HA users and hearing healthcare professionals was fully embedded into the RLO specifications.

The specifications and RLOs were then iteratively peer-reviewed by our PPI panel and subsequently revised.

An example of how the data from the participatory approach were combined for the RLO on '*What to expect when wearing HAs*' included:

(i) Delphi review open response: *"There will be an increased awareness of the environment, such as at home, including hearing sounds like paper rustling, clocks ticking, water running, toilet flushing".*

(ii) Delphi review statement with 94% consensus*: "New HA users need to be reassured that the patient's listening environment, including familiar surroundings, will sound different (i.e. the world is a noisy place)".*

(iii) Workshop statement: *"…and then I could hear water rushing loudly out of the tap, flushing the toilet felt like the sound of a waterfall…".*

(iv) Workshop storyboard illustration showing a drawing of a toilet next to Niagara Falls (Figure 2).

Combining these elements resulted in a section of the RLO showing someone who had just received their HAs, and commenting that *"the [car] keys sound harsh" and "I had no idea running water is so loud"*. Photos of birds singing, leaves rustling, children laughing, and doorbells ringing supported the voiceover statement *"lots of sounds will be more noticeable, it can be a wonderful thing to hear these sounds again"*. This was followed by the voiceover "*other sounds may be less welcome*" that was accompanied by photos of traffic, cutlery and flushing toilet.

The interactive quiz was an essential component of the RLO (Biggs, 2003). For example, the question and multiple choice options from the '*What to expect when wearing HAs*' RLO was: *Select the statement that describes the best way to adjust to hearing new sounds*

(1) I live alone so I only need to wear my HAs when my family come to visit

(2) I don't want to hear all the sounds in my house, so I just wear my hearings aids once a week when I go shopping

(3) If I wear my HAs regularly I will learn to ignore background sounds that are not important.

The correct answer (3) is shown and supported by further advice, in this case *"With regular HA use, you can re-learn how to listen to sounds and make the most of your hearing".*

Three versions of the DVD were produced to tailor to the individual's delivery requirements. Two versions were interactive for use with either TV or PC, based on either custom earmoulds or open fits, which the user could select using the remote or mouse. The third was an autoplay version for those unable to use a remote control handset. A fourth option was internet delivery that was accessed via a secure portal that recorded each user interaction (i.e. play, pause, rewind). The introductory RLO at the start of all versions encouraged communication partners to watch the RLOs and provide support, and encouraged users to have their HAs at hand to practice and identify components. For the RLO+ intervention group in the RCT (n=100), DVD for TV was most commonly used (50.6%), followed by internet (32.9%), DVD for PC (15.2%), and DVD autoplay (1.3%) (Ferguson et al, 2016b).

Discussion

Participatory design is used in other fields of product design (e.g. Bruno & Muzzupappa, 2010) to ensure the content, usability, simplicity and intelligibility are aligned to end-users' needs. The purpose of this paper was to provide a description of the participatory design used to develop and co-design the content for a series of educational resources for first-time HA users, based on the concept of reusable learning objects (RLOs). The design included a Delphi review, workshops, and peer review of the subsequent specifications for RLO and the developed RLOs, involving input from HA users and hearing healthcare professionals.

The vast majority of the statements from the Delphi review that reached consensus (≥90%) and many of the images from the workshop storyboards were synthesised and incorporated into the RLOs. These were considered integral to the successful development and positive evaluation of the RLOs. Many of the statements can also be related to the literature. For example, statements included tasks required for hearing aid handling (Desjardins & Doherty, 2009), reasons for HA non-use (McCormack & Fortnum, 2013), and preventing problems that arise with hearing aid use (Bennett et al, 2018).

However, not all statements were used. There were some statements, which suggested that some RLOs should be targetted to communication partners (>90% agreement). It had been our intention to do this but the intensive nature of the participatory design using CPs was not possible within the time or the grant budget. We have since begun some work in this area with a revised RLO on 'C*ommunication tactics'*, developed for an online platform with additional interactive activities for use by the HA user and their CP. The RLO enabled joint-working and benefits for both parties, including increased awareness of the HA user's

communication needs, and identification of behaviours that facilitate better coping with hearing loss (Henshaw et al, 2017).

There were some statements that failed to provide a consensus but were essential to the production of the RLOs. For example, when considering who should appear in the RLOs, neither '*real HA users and audiologists in real clinic settings'* (27% agreement), nor '*professional actors'* (34% agreement), were rated highly. Although we used people with a range of ages in their 50s to 70s (real HA users in most cases), most of the negative comments post-RCT were from people in the older age category who thought that those in the RLOs were 'too old'. There were some inconsistent statements about how the content should be delivered. For example, there was 91% consensus that information might be more effectively deliverered via specially developed DVD than by other traditional means, such as information leaflets. However, there was no consensus as to whether a DVD (87%) or a dedicated website (73%) would be attractive and beneficial. There were also a couple of statements that although pertinent to management of HA users, were not relevant for including in the RLOs (e.g. '*It is essential that the individual lifestyle needs and the abilities of the patient are understood by the audiologist', 100%*). Finally, the Delphi review was only carried out with hearing healthcare professionals, and not hearing aid users. However, the user voice was firmly embedded in the workshops and peer review.

The workshops provided a large repository of visual representations derived from hearing aid users to describe concepts that they thought were important for first-time hearing aid users. This method ensured that the perspectives of the end-user were embedded firmly within the content. Similarly, the interpretation of this content by the researchers and how the

information was presented was informed by an iterative peer-review process. HA users worked closely with the research team and media developers to ensure RLOs were developed that were appropriate and relevant in both content and language.

So was the participatory approach an important factor in producing an educational intervention that was usable, accessible, acceptable, and effective in HA users? We do not have direct data to answer this, however as we have described, all three stages clearly embedded the views, perspectives, and expertise of HA users and audiologists in the development of a series of RLOs. During the workshops, the HA users reported they enjoyed participating, were listened to, could express their viewpoints, and valued the process and taking part. There were a number of indirect markers of success as to the benefits of the participatory approach to RLO development. Feedback on the RLOs from HA users who participated in the RCT was generally very positive (see Table 5, Ferguson et al, 2016b). For example, 97% agreed the illustrations and videos helped their understanding of topics. Ratings for RLO usefulness averaged 8.9/10 on a scale where 0=not useful to 10=highly useful, and 78% said they would recommend the RLOs to other people. Finally, around 50% reported using the RLOs two or more times, and 88% of HA users agreed that they would watch the RLOs again if they had any problems. This suggests the participants used the RLOs to self-manage their hearing loss, HAs and communication needs. This can be viewed as another indirect marker of success in terms of the approach we took to develop the content.

Further developments: from research to clinical practice

Following the completion of the RCT, we reviewed the feedback from participants (closed and open-ended questions, focus groups) and made some changes to the original RLOs. The

474 main changes were that content which participants considered redundant or didn't like was
475 removed, and patient testimonials were shortened and removed from within the RLOs and
476 held separately in a self-contained area. This resulted in reducing the total duration of the
477 RLOs from around 1 hour to 45 minutes. The *'HA care and troubleshooting'* RLO was split
478 into two RLOs, with a separate RLO on *'Troubleshooting'*, and a new RLO developed for
479 *'HA retubing'* (custom). The final revised RLOs were packaged into a revised DVD format,
480 named 'C2Hear', and were made available through a hearing equipment distributor.
481
482 Although the content of the RLOs was developed some years ago, much of this remains
483 relevant today. However, there has been a necessary change in the way the RLOs are
484 delivered. The RLOs were developed in 2011/12, and at that time the smartphone revolution
485 and the use of smartphones to watch videos was in its infancy. Indeed, at that time a survey
486 we conducted in 55-74 year olds (n=1235) showed that PC and internet use in Nottingham for
487 the first-time HA user group (70-74 years) was only 34% and 17% (Henshaw et al, 2012).
488 Therefore, we took the decision to develop the RLOs for a DVD platform to achieve optimal
489 accessibility. The downside was that this inherently limited the use of interactive elements
490 that are integral to online-delivered RLOs. It also became clear over the following years
491 (2014/15) that DVD delivery did in fact limit accessibility. Producing DVDs for clinical use
492 was not cost-neutral, and we found that even a low cost of £1-2/DVD to cover manufacturer
493 costs for the commercial partner was prohibitive for publicly-funded audiology services (only
494 350 DVDs were ordered in a 9 month period).
495 The ultimate aim of this research was always to make the RLOs available to as many people
496 as possible, including HA users, audiologists and the general public. The RLOs were made
497 publicly available on YouTube (known as C2Hear Online) at no charge in November 2015,

and could also be viewed on smartphones and tablet PCs. This was particularly relevant in the current era of social media and open content leading to virtual communities of practice centred around open resources. Although take-up of C2Hear Online was slow initially (16,000 unique views in the first 12 months of release), there was a four-fold increase in the number of views (63,000) in the following 12 months, with a total of >100,000 views in 30 months. Around 62% of views come from outside the UK (38% from North America), with views from more than 20 countries.

Future plans

We are currently developing and evaluating a theoretically-driven, patient-centred, mobile-enhanced RLO (mRLO) intervention designed specifically for smartphones and tablets (m2Hear). This aims to personalise the RLOs to go beyond the current 'one size fits all' approach of C2Hear. The original content decribed in this article will be repurposed into short, bite-sized mRLOs (1-2 minutes). The mRLOs will be tailored to individuals' needs, and incorporate greater user interactivity and self-evaluation. The mRLO development and evaluation will be underpinned by the COM-B system of health behaviour change (Michie et al, 2011; Coulson et al, 2016) and a Think Aloud analysis to gain insights into 'real-world' ecological use. There are a number of projects planned following on from some pilot studies that have focussed on the use of RLOs for CPs (Henshaw et al, 2017), non-audiological healthcare professionals (Wasim, 2017), and early delivery of RLOs at the hearing assessment appointment (Gomez et al, 2017). Improvements in knowledge and practical HA handling skills were seen in carehome assistants and nurses, and early delivery at the assessment appointment showed improved hearing-related knowledge and self-efficacy for HAs at the HA fitting appointment in those who received C2Hear compared to booklets. The

ulitmate goal is to develop an online, interactive self-management system for people with hearing loss, HA users and their CPs. Finally, the RLOs have been 'translated' to US English and are in the process of being translated into other languages (e.g. Chinese).

Conclusions

To address the poor retention of verbally-delivered information in first-time HA users, the content for a series of evidence-based interactive video tutorials (or reusable learning objects, RLOs) was co-designed using a participatory approach. HA users and audiologists were involved across all stages of RLO development to ensure the end-product was fully aligned to the users' needs. An evidence-base on informational needs for first-time HA users has been defined that addresses important and relevant issues about HAs and interpersonal communication. This formed the basis for the content of a series of seven short RLOs plus introductory RLO. Feedback from research participants has been positive, and the RLOs are now freely available for clinical and public use on YouTube (www.youtube.com/c2hearonline). We suggest that this participatory, community of practice approach is embedded in the development of e-learning materials used in hearing healthcare research and clinical practice.

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FIGURE LEGENDS

Figure 1. Schematic diagram showing the stages of the reusable learning object (RLO) development process.

Figure. 2. Example A0 storyboard developed during a workshop with hearing aid users

Figure 1.

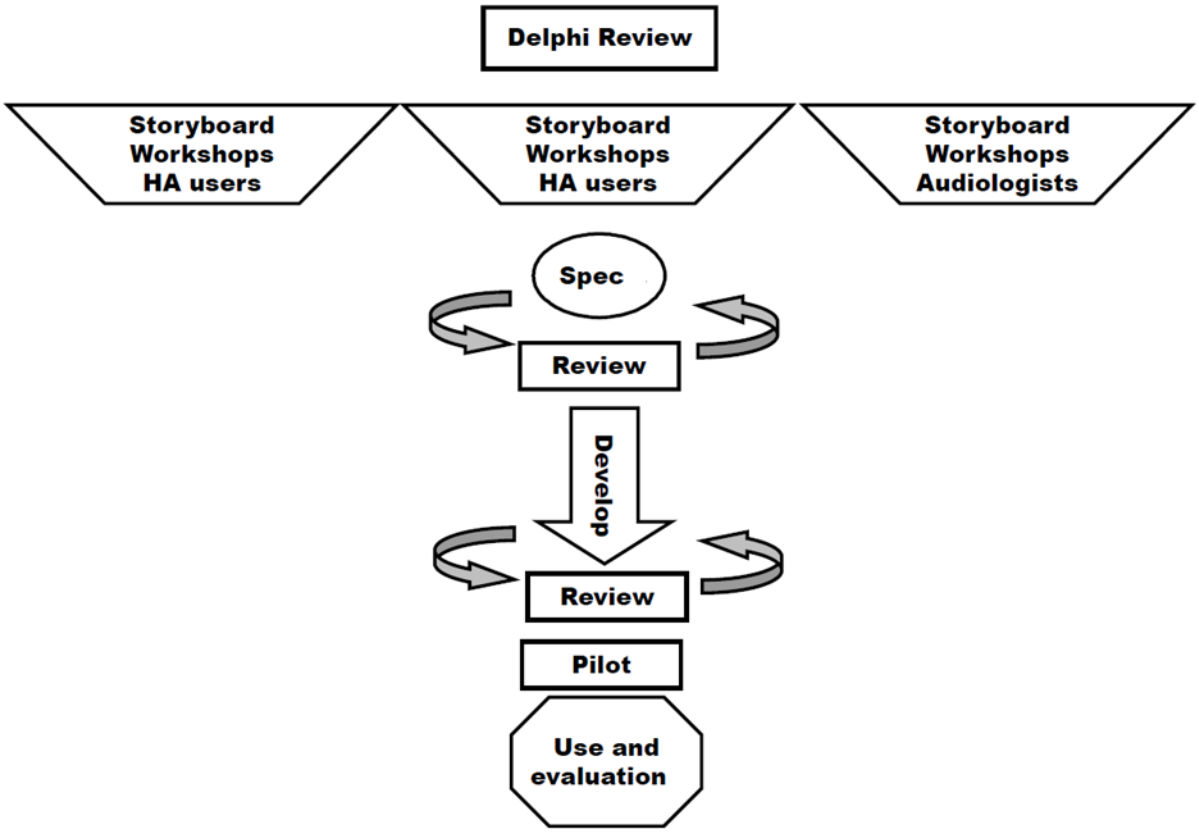
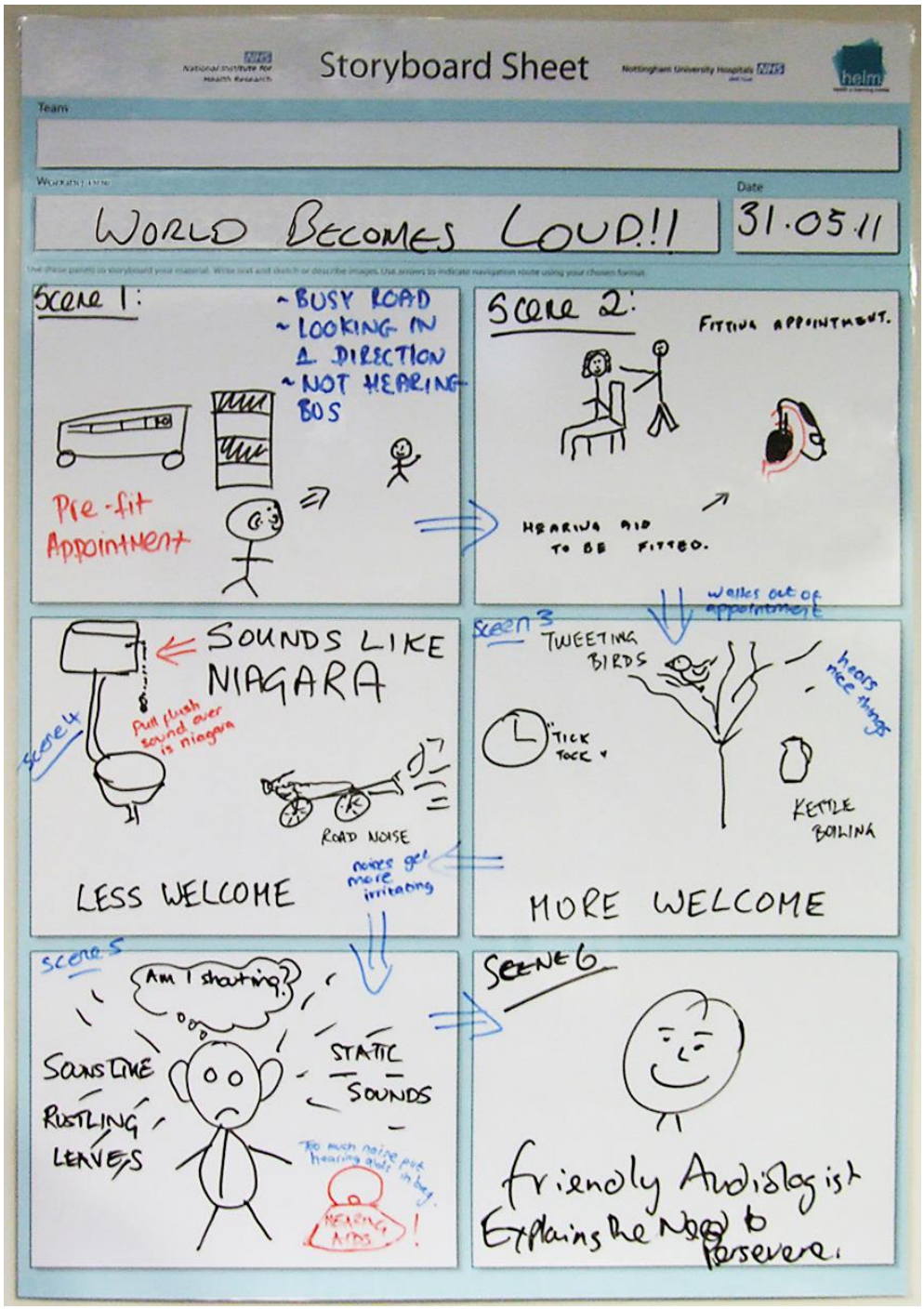

Delphi Review
Storyboard Workshops HA users
Storyboard Workshops HA users
Storyboard Workshops Audiologists
Spec
Review
Develop
Review
Pilot
Use and evaluation

Figure 2.


Storyboard Sheet
Team
Date
WORLD BECOMES LOUD!!
31.05.11
Scene 1:
~BUSY ROAD
~LOOKING IN A DIRECTION
~NOT HEARING BUS
Pre-fit Appointment
Scene 2:
FITTING APPOINTMENT.
HEARING AID TO BE FITTED.
walks out of appointment
Scene 3
TWEETING BIRDS
hears nice things
TICK TOCK
KETTLE BOILING
MORE WELCOME
SOUNDS LIKE NIAGARA
Pull flush sound over is niagara
ROAD NOISE
noises get more irritating
LESS WELCOME
Scene 5
AM I shaving?
SOUNDS LIKE RUSTLING LEAVES
STATIC SOUNDS
Too much noise put hearing aids in bag.
HEARING AIDS
Scene 6
friendly Audiologist Explains he NOW to persevere.

23 Table 1. Delphi review statements where 100% agreement is achieved

On hearing aid non-use:

- Psychosocial factors, such as patient expectations, motivations, perception of old age and the stigma related to wearing a hearing aid are significant causes of non-use.

On information content:

- All new hearing aid users should receive information on how to use their hearing aid(s).
- Essential elements of how to use their hearing aid(s) should include:
    - Correct insertion and removal of the earmould and hearing aid(s)
    - An explanation of how to use hearing aid controls and programmes
    - How to access repairs and further appointments after the patient has been discharged
- All new hearing aid users should receive information on how to maintain their hearing aid(s).
- Essential elements of how to maintain their hearing aid(s) should include:
    - Correct insertion of the batteries and battery life (including warning beeps)
    - Cleaning the earmould
    - When to get tubing replaced and reasons why
    - Where to obtain batteries and what they cost
- New hearing aid users need to be reassured that:
    - Getting a hearing aid is the first step in addressing their hearing difficulties and is not the only solution to their hearing and communication difficulties
    - The patient's listening environment, including familiar surroundings, will sound different (i.e. the world is a noisy place)
    - Using a hearing aid regularly allows the brain to adapt to everyday sounds
    - The benefit they will get in different listening situations will vary (e.g. in quiet and in noise)
- Information to the patient should include communication skills (e.g. lip reading), hearing tactics (e.g. asking the speaker to speak louder/clearer) and strategies (e.g. managing their environment).
- It is essential that the individual lifestyle needs and the abilities of the patient are understood by the audiologist.
- Effective self-management should be encouraged by working together with the patient rather than treating them as a passive recipient of information.
- Communication partners (e.g. spouse, friend) should be made aware that:
    - effective communication depends on communicating and listening strategies being used by both themselves and the hearing aid user.
    - hearing aid has limitations (e.g. it may be less effective in some listening environments compared to others).

On DVD:

- A DVD consisting of several short videos each considering a separate issue or topic (e.g. 10 x 2 minutes) will be more usable and effective than a single video which covers multiple topics.
- Video content should be informal and patient-focused.

24

Table 2. Delphi review statements were there was no consensus (i.e. <90% agreement)

On hearing aid non-use:	**Reason for rejection**
• Audiological factors, such as distortion arising from sensori-neural hearing loss and acoustical characteristics of hearing aids are significant causes of non-use.	66% agreement
• Service delivery factors, such as clinical experience, location, time allowed and the availability of having a follow up appointment, are significant causes of non-use	59% agreement
• The amount of information given at the fitting appointment is too much for patients to remember and is a barrier to effective use.	43% agreement
• Hearing aids are often set up (i.e. programmes and volume control) in a way that is too complex for the patient's needs and so the hearing aid is not used.	16% agreement
• A failure to agree clear and realistic goals within a patient management plan leads to patients giving up.	71% agreement
• Patients who	
○ feel removed from the decision making process relating to their treatment are more likely to give up wearing their hearing aid(s).	Unstable
○ perceive a lack of empathy from the audiologist during their fitting appointments are less inclined to wear their hearing aid(s).	70% agreement
○ experience practical problems early on are more likely to reject their hearing aid(s).	Unstable
On information content:	
• Should include	
○ an explanation of the loop system in relation to the hearing aid(s).	84% agreement
○ instruction on how to use a telephone/mobile phone effectively with the hearing aid(s).	Unstable
○ an explanation of the range of assistive listening devices available.	71% agreement
○ instruction and demonstration on how to use assistive listening devices appropriate to the patient.	45% agreement
Should be reassured that:	
○ wearing a hearing aid, as advised, will be in the patient's best interest.	Unstable
○ wearing a hearing aid all of the time is in the patient's best interest.	36% agreement
• Reassurance should be given that negative feelings (e.g. anxiety and embarrassment) towards wearing a hearing aid are common and normal.	59% agreement
• The audiologist needs to explain the audiogram to the patient to enable them to understand the impact of their hearing loss on their communication abilities.	60% agreement

• The importance of practicing new communication skills should be reinforced.	84% agreement
• The goal of providing effective information and advice should be to create assertive and confident communicators.	48% agreement
On DVD:	
• It is important that the videos include a sign language interpreter.	26% agreement
• Videos will have the biggest impact if real people, real audiologists and real clinic settings are filmed to ensure that the content is authentic, and new hearing aid users can identify with what they are watching.	27% agreement
• Videos will have the biggest impact if professional actors, who are used to being filmed and skilled at portraying emotion and reaction, are used.	34% agreement
• An interactive version of the videos delivered via:	
○ a dedicated website would be attractive and beneficial to some new hearing aid users.	73% agreement
○ DVD would be attractive and beneficial to all new hearing aid users.	87% agreement
• Videos such as the type proposed here should be displayed in public settings (such as GP and audiology waiting rooms) as well as being given to new hearing aid patients.	Unstable
• An introduction to the DVD from a famous person with hearing loss would inspire the patient to watch and interact with the videos.	37% agreement

Table 3. Ranking of RLO topics by hearing healthcare professionals and hearing aid users

	Hearing healthcare professionals	Hearing aid users
Hearing aid insertion	1	3
Hearing aid controls	2	1
Hearing aid maintenance	3	6
Getting used to hearing aids	4	4
Communication tactics	5	9
Hearing aid benefits and limitations	6	7
Information for communication partners	7	10
Listening in different situations	8	5
Expectations of hearing aids	9	2
Telephones and assistive listening devices	10	8