

Institution: University of Nottingham		
Unit of Assessment: 3 - Allied Health Professions, Dentistry, Nursing and Pharmacy		
Title of case study: Implementing a user centred design process to produce sustainable multimedia learning tools for healthcare benefit		
Period when the underpinning research was undertaken: 2005 – 2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Professor Heather Wharrad	Professor of e-Learning & Health Informatics	1990-present
Professor Richard Windle Dr Stathis Konstantinidis	Professor of Digital Learning Associate Professor in e-Learning & Health Informatics	2000-present 2014-present
Dr Sarah Goldberg	Associate Professor in Older Person's Care	2009-present
Period when the claimed impact occurred: August 2013 to December 2020		
Is this case study continued from a case study submitted in 2014? No		
<p>1. Summary of the impact Research at the University of Nottingham has transformed clinical and care practice, and the ability of individuals to manage their own health, through the development and provision of trusted evidence-based digital learning tools. The conceptual framework ASPIRE, developed between 2005 and 2011, has been implemented in over 50 projects to produce more than 200 open, high quality digital reusable learning objects (RLOs) used by 5,000,000 people in 140 countries. The products reflect the collective expertise of patients, healthcare professionals and researchers. The co-design using a community-based process ensures the content of the RLOs is rigorously aligned to the needs of end-users. ASPIRE has been successful in engaging with traditionally hard to reach groups and across a wide variety of health conditions. These co-design RLOs have empowered hearing aid users to self-manage their hearing aids; increased the capacity of teachers to recognise the needs of children born pre-term; and provided healthcare professionals with evidence-based dementia training relevant to the acute hospital. Over 35,000 evaluations of the RLOs consistently report demonstrable long-lasting improvements in knowledge and health behaviours.</p>		
<p>2. Underpinning research (Number = section 3 reference, Lower case letter = grant) Patients, families, practitioners, students, researchers and support groups all have knowledge to share. In contemporary healthcare one of the key challenges is to develop tools and methodologies that enable us to harness this unique expertise within these groups and make it accessible to the widest possible audiences. At the University of Nottingham, we have met this challenge by developing a unique, conceptual framework and co-design methodology for the production of highly focused, open access, multimedia rich, digital reusable learning objects (RLOs). This six-step methodology was named 'ASPIRE' to reflect the key stages in the process: aims, co-design storyboarding, populate and review specification, technical implementation, release and evaluation).</p> <p>Studies by Professors Wharrad and Windle conducted between 2005 and 2011 demonstrated the benefits of using RLOs, developed using this co-design methodology, in areas commonly identified as difficult by students, and in areas of the curriculum requiring regular reinforcement (e.g. clinical skills) [1,2]. For example, one study showed how Nursing students' perceptions of their own understanding of pharmacology concepts increased substantially following the introduction of our pharmacology RLOs to their course, with some respondents subsequently crediting these RLOs for improvements they made in their prescribing skills [1]. Research published in 2011 showed a significant increase in the number of Nursing students answering biochemistry exam questions correctly following the introduction of RLOs [2]. As the effectiveness of our RLOs for healthcare students became increasingly recognised through these and other studies, the adoption of the ASPIRE methodology was extended to healthcare projects to improve patients' knowledge, confidence and skills, and for training healthcare professionals and carers.</p>		

The team's methodology has been translated to the healthcare sector to provide RLOs for patients, carers, healthcare professionals and public groups in 50 projects across a wide range of healthcare disciplines [3] (for example audiology, child development, dementia care, pharmacy, diabetes, mental health, safe-guarding and infection control). Our research shows that the ASPIRE methodology is essential to the success and sustainability of RLOs, as it encourages participants to 'unlock' their ideas and experiences to shape both educational content and design, to ensure alignment with need and learning preference. A sense of ownership leads to extensive use and reuse by communities [4,5,6]. The following two projects demonstrate this, firstly for a patient group, and then for a professional group:

Patient education and self-management: The C2Hear project is an example of how our co-design methodology [4, b] has ensured that RLO content is aligned with the needs of the patient. 8 RLOs were co-designed with 35 hearing aid users and 42 audiologists to address the problem of non-hearing aid use following fitting at an audiology department. In a Cochrane Review, C2Hear was cited "as the only study of 37, successful in encouraging patients to wear hearing aids". Our RCT (n=203) showed that compared to standard care, patients using the RLOs had:

- 15% greater hearing aid use in those who did not wear hearing aids all the time (p<0.05)
 - significantly better knowledge on hearing aids and communication (p<0.001)
 - better practical handling skills (telephone p=0.001; cleaning ear mold p=0.005)
- all with large clinical effect sizes.

Health economic analysis showed the RLOs were a low-cost, cost-effective intervention [5]. A follow on study (m2Hear), uses the COM-B behavioural model to tailor the C2Hear RLOs to provide individualised learning opportunities according to patients' own specific listening, communication, and hearing aid needs.

Professionals' and carers' training and education: We used the ASPIRE process in a collaboration (2014-2018) (PReterm Infants' Skills in Mathematics (PRISM), c) to improve awareness and understanding among education professionals about premature birth and the risks of children who were pre-term underachieving at school. Teachers, young people who had been premature and their parents, psychologists and teaching assistants (n=26) took part in the co-design workshop to share their experiences and expertise. This multi-stakeholder group designed storyboards covering the topics they identified as important, including 'Cognitive and motor development following preterm birth' and 'How can education professionals support children born preterm?' In the final step of the ASPIRE process, RLOs were evaluated in a pre-post study with 77 teachers to assess knowledge and confidence. The median knowledge score increased by 15 points, from 13 (95% CI 11 to 14; range 0-25) before using the resource to 28 (95% CI 28 to 30; range 18-33) after using it (p<0.0001). After accessing the RLOs, 89% of participants felt adequately equipped to support the learning of children born pre-term, compared to just 13% prior. Fifty (82%) reported that they would consider prematurity when encountering a child who struggles at school compared with 14 (23%) prior to using the RLOs [6].

Capacity building in the use of ASPIRE Methodology

A six week Massive Open Online Course ('Designing e-learning for Health' MOOC) was run in 2016, 2017 and 2018 to promote and train others in the use of the ASPIRE methodology [3]. This led to ASPIRE being the focus of 12 EU funded projects (for example [7] and grants d, e, f). In low and middle income countries including Malaysia (2018-2021) and Turkey (2019-2021) academics, healthcare professionals, students and learning technologists are being trained to produce high quality RLOs for healthcare courses, health professional training and patient care.

3. References to the research (authors in bold affiliated UoN UoA3)

1. **Wharrad HJ**, and **Windle R**. Case studies of creating reusable interprofessional e-learning objects. In Bromage A, Clouder L, Gordon F, and Thistlethwaite J, editors, *Interprofessional E-Learning and Collaborative Work: Practices and Technologies*. IGI-Global; 2010. p 260-274. <https://core.ac.uk/download/pdf/33575423.pdf>

2. **Windle R**, McCormick D, Dandrea J, and **Wharrad HJ** The characteristics of reusable learning objects that enhance learning: a case study in health-science education, *British Journal of Educational Technology*. 2011; 42: 811-823 <https://doi.org/10.1111/j.1467-8535.2010.01108.x>
 3. **Wharrad HJ**, **Windle R** & Taylor M 'Designing elearning for health' In Konstantinidis ST, Bamidis P, Zary N, editors, *Digital Innovations in Healthcare Education and Training*. Academic Press; 2020. p31-45 <http://dx.doi.org/10.1016/B978-0-12-813144-2.00003-9>
 4. Ferguson M, Leighton P, Brandreth M, **Wharrad H** Development of a multimedia educational programme for first-time hearing aid users: A participatory design. *International Journal of Audiology*. 2018; 57(8): 600-609 doi: 10.1080/14992027.2018.1457803
 5. Ferguson MA, Brandreth M, Brassington W, Leighton P, & **Wharrad H**. "A Randomized Controlled Trial to Evaluate the Benefits of a Multimedia Educational Programme for First-time Hearing Aid Users". *Ear and Hearing*. 2016; 2:123-136. doi: [10.1097/AUD.0000000000000237](https://doi.org/10.1097/AUD.0000000000000237)
 6. Johnson S, Bamber D, Bountziouka V, **Wharrad, H** et al. Improving developmental and educational support for children born preterm: evaluation of an e-learning resource for education professionals. *BMJ Open*. 2019;9:e029720. <http://dx.doi.org/10.1136/bmjopen-2019-029720>
 7. McSharry E, Hall C, Glacken M, Brown M, **Konstantinidis S**, Johnson S, Van Landschoot L, Healy D, Healy-McGowan S, Bergmann-Tyacke I, Reis Santos M, Dhaeze M, Taylor M. The development of a European elearning cultural competence education project and the creation of it's underpinning literature based theoretical and organising framework. *Journal of Nursing Education and Practice* 2020; 10(12) doi: <https://doi.org/10.5430/jnep.v10n12p49>
- Grants supporting the research**
- a. **Wharrad HJ**, and Garrud P (University of Nottingham), Boyle T (London Metropolitan University), and Leeder D (University of Cambridge). HEFCE Centre for Excellence in Reusable Learning Objects. 2005-2010 GBP3,300,000 + £40,000 capital
 - b. Ferguson M (National Biomedical Research Unit for Hearing), **Wharrad HJ**, Fortnum H, Leighton P (University of Nottingham). Evaluation of interactive videos for hearing-aid users [C2Hear]. NIHR RFPB. 2010-2014 GBP235,000
 - c. Johnson, S, Gilmore, C, Marlow, N, **Wharrad HJ** et al 'Mathematics learning disabilities from childhood to adolescence: New evidence and intervention for very preterm children [PRISM]. Action Medical Research. 2015-2018 GBP217490
 - d. Hall C, **Wharrad H**, **Windle RJ** et al TransCoCon: Developing Multimedia Learning for Trans-cultural Collaboration and Competence in Nursing. ERASMUS+ Strategic partnership. 2017-2020 EUR234.755
 - e. **Wharrad H**, **Konstantinidis S** et al. Advancing Co-creation of Reusable Learning Objects to Digitise Healthcare Curricula in Malaysia AcoRD. EU Capacity building in HE Fund. 2018-2021 EUR 688,813
 - f. **Windle RJ**, Goktepe N, **Wharrad H**. Newton Research Environment Links THRESHOLD – Training Health Researchers by Experience-Sharing, Harnessing Online Learning Development in Turkey. 2020-2021 GBP39,500

4. Details of the impact (E= evidence source, lower case letter = section 3 grant)

Global feedback [evidence E1]

RLOs produced using ASPIRE methodology have been created by the University of Nottingham team and their collaborators for use by the target group of users. However, they have also been released for non-commercial reuse with a Creative Commons licence so they can be freely accessed by anyone. Our multiple award-winning open repository 'HelmOpen' houses over 200 RLOs [E1.1 and E1.2]. The expertise and insights from stakeholders harnessed within each RLO is accessible to all. Users can choose to return an online evaluation form for each RLO (estimates from comparison with server logs suggest on average 1-2% of users return evaluations) enabling us to gather data about use, reach and significance. Google analytics allow us to identify trends in usage over time and density of use in different countries indicating approximately 5,000,000 users of the RLOs [E1.3].

Based on data from 49,030 feedback forms (35,813 completed since 2014) [E1.4], we know that global usage of HelmOpen RLOs has increased from 50 to 140 countries (a threefold increase since 2014) [E1.5]. An independent report published in 2018 showed that users came from a range of institutions including universities, health care settings and schools as well as the general public. 97% of survey respondents rated the RLO they accessed as 'very helpful or helpful' when learning their subject, with little variation by user type or country of origin. 96% of respondents would recommend the RLO to others [E1.6 pp 3, 5, 11].

A wealth of feedback has evidenced the role of RLOs in enhancing knowledge and behaviours in patients/carers and health/education professionals. Here are three examples:

Patient education and self-management – C2Hear [evidence E2]

The C2Hear RLOs were distributed first on Youtube and in 2019, on a dedicated C2HearOnline website [E2.1]. C2Hear has obtained national and international reach for clinical and research impact, with over 104,000 online views (average >7,000/month) with a spike in use during the Covid pandemic [E2.2] when clinics were closed. C2Hear RLOs have received accolades from patients, family members and audiologists [E2.3]. A hearing aid user said "*If I did not have C2Hear I might have given up wearing my hearing aids*", and a family member remarked "*C2Hear helped us at a time when getting help from an audiologist would have been very difficult*". In a follow up project called m2Hear, a more individualised service is provided to patients with hearing aids through their tablet or mobile phone [E2.4].

In a survey of UK audiologists in 2019 (n=52) 90% believed that C2Hear helps patients to troubleshoot basic repairs independently; 90% said that C2Hear helps family members become involved in learning about hearing aid care; and 64% said they had created educational materials for first-time hearing aid users within their local department, of which 27% had been inspired to do so after watching C2Hear. 42% (22/52) of audiologists surveyed had made C2Hear materials available to patients in their clinic [E2.5].

Healthcare and professionals training [evidence E3 and E4]

Pre-term birth RLOs (PRISM) - since released in May 2019, the PRISM RLOs have been accessed by over 13,800 people from 54 countries. Approximately two thirds are educational professionals, 20% parents and 13% are health professionals [E3.1]. Evidencing the value of our ASPIRE methodology the RLOs have not only benefited the target group, teachers, but also other groups who contributed to the co-design process. The multi-stakeholder input in ASPIRE allows hard to reach voices to influence the RLO content and design as shown in their use of the RLOs and the benefits they gain from them. A parent said, "*I've felt FOREVER that I wanted a resource like this for the teachers of my Former Micro Premie Daughter (born at 26 weeks with a 126 day NICU stay). Thank you so much!!!*". (Parent from the US, May 2019) [E3.3]

6 months after use [E3.2, p232], 84% (95% CI 73 to 96) of teachers still felt adequately equipped and confident to support the learning of children born preterm. 2 primary school teachers comment on how they are making real changes to support children in the classroom: "*I am more aware of the issues a child born prematurely could have. If a child is struggling with certain areas of maths I now always think if the child could have been born premature.*" and "*My enhanced knowledge of preterm birth has encouraged me to give more time to explaining, instructing and supporting these children.*"

Dementia RLOs - healthcare professionals caring for those with dementia are using a suite of our RLOs as outputs of research funded by the NIHR. This research developed and evaluated a specialist medical and mental health unit (MMHU) which provided care to cognitively impaired older patients admitted to the acute hospital as a medical emergency. The RLOs, developed in 2014, use excerpts from the award-winning documentary [Today is Monday](#), which illustrates the evidence-based care provided by the MMHU [E4.1]. Between June 2015 and November 2020, the feedback [E4.2-E4.4] from the RLOs has been:

Impact case study (REF3)

Dementia RLO	Feedback returns (est. total users)	V Helpful or Helpful	Would recommend	Proportion who are HCPs
Cognitive loss	424 (6,000)	99%	98%	89%
Person-centred Care	645 (9,200)	98%	98%	91%
Communication	279 (4,000)	98%	99%	88%

User's commented on what they liked about the RLOs: '*It was clear and precise*' and '*compassionate and easy to understand*'. The value of these RLOs is demonstrated in the user comments which suggest that at least one NHS Hospital Trust has adopted them within their training.

Capacity Building in the use of the ASPIRE methodology [Evidence E5]

The team's capacity building projects are transforming the delivery of digital education and healthcare training and practice in Europe and in low and middle income countries. Our MOOC on RLOs and ASPIRE was delivered in 2016, 2017 and 2018 attracting a total of over 13,000 participants globally [E5.1]. Participants said "*Picked up approaches which will influence my future practice*" and "*in top 5 of all courses I have taken (whether online or in person)*". For some, participating in the MOOC influenced their own health behaviour, "*I myself have hearing loss and I'm supposed to wear a hearing aid, however, as mentioned in the video ... after using the RLOs I might go back to using it.*" [E5.1].

Following the MOOC, other countries have adopted the ASPIRE methodology to develop RLOs across the globe. This demonstrates a shift from global usage of the RLOs themselves, to requesting training on the methodology and skills to create them. For example, there are growing numbers of ASPIRE-trained academics and technologists in Malaysia; the Deputy Dean (Research) and Professor of Primary Care Medicine University of Malaya says "*As a result of this collaboration, the Faculty of Medicine has set up an e-learning unit which comprises academicians, instructional designer and technical team, most of whom have undergone training by Professor Wharrad and her team at the University of Nottingham. RLOs have been developed across six disciplines namely, geriatric medicine, primary care, nursing, paediatrics, nutrition and library science, all of which have champions who have been trained by the ACoRD members. Currently, the RLOs are being used by the medical and nursing students as part of their curricula*" [E5.2](e).

5. Sources to corroborate the impact

E1 Evidence for Global usage and significance of RLOs

E1.1 List of RLOs in the case study accessible [HelmOpen repository](#)

E1.2 Awards for HelmOpen, RLOs and ASPIRE process

E1.3 Global usage of RLOs on HelmOpen from Google Analytics report

E1.4 Number of RLO survey forms returned 2014-2020

E1.5 Global coverage and use map for RLOs on HelmOpen from Google Analytics report

E1.6 Independent report showing the global reach and evaluations of RLOs

E2 Evidence for impact of C2Hear

E2.1 Screenshots of C2Hear on Youtube with access figures [weblink](#)

E2.2 Access figures and analytics from C2Hear Online

E2.3 Video of patient accolades on World Hearing Day 2019 on Youtube [weblink](#)

E2.4. Ferguson et al (2020) [The feasibility of an m-health educational programme \(m2Hear\)](#)

E2.5 Survey of audiologists about C2Hear, p3

E3 Evidence for impact of PRISM

E3.1 Testimonial of the RLO concept and ASPIRE methodology for the PRISM project

E3.2 Follow up study 6 months after release of PRISM RLOs, p232

E3.3 PRISM RLO feedback report (available on request)

E4 Evidence for Dementia RLOs

E4.1 Gladman et al (2014) *Today is Monday*. E4.2-4.4 Feedback reports for the RLOs

E5 Evidence for Capacity Building in Europe and low-middle income countries

E5.1 FutureLearn figures for Designing Elearning for Health MOOC

E5.2 Testimonial from Dean of Research at the School of Medicine, University of Malaya