Design to Improve Patients' Sleep Experience in NHS Hospital Wards: Involving students in solving 'real world' problems.

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This paper presents a collaborative educational initiative designed to enhance the learning experience for undergraduate product design students and boost their employability through an introduction to 'real-world' design challenges in healthcare settings. The initiative centred upon enhancing the learning experience for a cohort of 38 product design undergraduate students across a three-year programme through interdisciplinary research-informed teaching. We started with a student project in year one designed to help learners to understand the complexities and opportunities when designing for healthcare environment, as well as the importance of understanding stakeholders' needs (public involvement). This paper addresses the three steps taken to involve them in the project: 1) the research used to guide the selection of the problem; 2) the approaches we used to engage the students with an unfamiliar scenario, and; 3) the involvement of students and stakeholders. The results of the student projects are discussed with some reflection on ways to improve teaching. In this way our ideas contribute to new and innovative approaches to learning and teaching in design through cross-disciplinary collaborations with healthcare researchers, academics, practitioners and patients. These approaches can help to overcome common challenges that might hinder design educators in proposing human-centred healthcare projects to students.

Keywords: healthcare, design education, research-informed teaching, interdisciplinary.

Introduction

Over the last decade, design has been increasingly recognised as a fundamental aspect of problem-solving and more recently a tool for problem-understanding and innovation. Designers can approach problems differently and bring a fresh perspective to

multidisciplinary teams by using empathy, user centred techniques, co-design methods and making skills. Several examples of this approach to collaborative working and learning can be found in accounts of design practice and research; such as the Design Council archive of case studies (2020), the collection of 'What Design Can Do' challenges (2020) and manuscripts from the Design for Health journal and Design4Health conference proceedings.

Although involving students with 'real world' problems is not a new idea (Papanek 2019) it is only recently that initiatives have focused upon involving design students in learning about how design can contribute to improving the health and wellbeing of hospital in-patients or care home residents (Malcolm, Tully, Lim and Mountain, 2019; Potter, Reay and Thornhil 2018; Hannan et al. 2019; Reay et al. 2017; Reay et al. 2015). The aforementioned student projects, set in the context of hospitals and care homes, have demonstrated both the value of this approach to student's learning and a positive impact on participating healthcare organisations. Findings highlighted that students developed a range of skills, knowledge and behaviours. Students developed greater empathy for others when working with end-users (Potter et al. 2018), such as elderly people in care homes (Potter et al. 2018) and hospital in-patients (Reay et al. 2017). They developed a greater understanding of the complexity of healthcare environments (Malcolm et al. 2019; Potter et al. 2018) and learnt about how to work collaboratively in multidisciplinary teams (Malcolm et al. 2019; Reay et al. 2017).

This paper presents an interdisciplinary collaborative learning initiative developed to involve product design students in the complexities of designing for healthcare environment (Bossio et al. 2014). The initiative was developed by a team of academics from two Schools (Design and Human and Health Sciences at the University of Huddersfield) and Registered Nurses from Calderdale and Huddersfield NHS Foundation Trust. It looked at ways to apply research conducted by the School of Human and Health Science - more specifically the Centre for

Applied Research in Health in collaboration with the Calderdale Hospital - to inform undergraduate design student projects (School of Design at University of Huddersfield). The research focused upon the causes of noise at night that disturb in-patient sleep in the hospital ward (Astin et al. 2020). The idea was to gradually involve students in 'real world' problems, reflecting upon any associated challenges and its opportunities, growing the level of complexity as the undergraduate design programme progressed through the three-year programme.. In this way, we thought the partnership between the school of health science and design could be developed in two stages, as described below:

In the first stage, to underline the profound contributions that design can make to the society (Rodgers et al. 2019), we developed a project to situate the students into an unfamiliar environment - a healthcare environment - in which they would build their empathy; appreciate the complex scenario and the different needs of different stakeholders, and; experience the contribution design can make, even with the design of one single product. A product addressing one of the challenges identified in research (Astin et al. 2020) – about in-patients sleep experiences, environmental noise levels at night and an aetiology of factors causing unwanted environmental noise in hospital wards. Therefore, the year one product design students would consider the complexities of a problem - night time noise and its impact on the health and well-being of hospital in-patients in a ward setting. A key factor contributing to unwanted night-time noise was caused by metal waste bins. The design students were to concentrate on the design of a better product to improve the patient's wellbeing and experience.

In the second stage, in year two, building on their familiarisation with the identified healthcare problem, the students would adopt a more pro-active role in tackling a specific hospital challenge. However, at this time, the brief would require greater learner involvement

and the design students would *"take responsibility for the framing of the design problem"*, working on a *"more collaborative relationship where designers reconfigure together with stakeholders the questions being asked and the tasks being set for design"* (Rodgers et al. 2019, 75). Thus, second-year students would look to the environment in a more holistic way to design products and services in a group project with stakeholders. The same concept would be carried out to final-year, so that the students interested in designing for health could look at healthcare scenarios to proactively develop their individual final project.

In this paper we present the strategy we used to translate applied health research into learning and teaching approaches and materials. We aimed to;

- Identify and address any challenges associated with involving students in developing their knowledge in the context of a healthcare environment;

- Support students to help them to understand the different needs of multiple stakeholders;

- Guide students to reflect upon the outcomes of the project instead of validating the projects.

Interdisciplinary research-informed teaching in design

Research-informed teaching (RIT) has increasingly been used in Higher Education to encourage closer links between research and teaching at the same time it improves the quality of teaching and student learning (Pan et al. 2012). Staff can also benefit from RIT as it builds some institutional gaps created between research and teaching (HEA-UA 2017).

RIT can take several forms (Burgum and Stoakes. 2020; Pan et al. 2012), including:

- *research-led*: where students are taught research outcomes in their field of study;

- *research-oriented*: they are taught research methods;

- *research-tutored*: by using critical thinking, students discuss the theme with staff; and

o *research-based*: students learn as researchers.

This method of teaching brings students into the research process and enables them to achieve higher levels of valued competencies such as problem-solving, critical thinking, alternative ways of thinking and creativity skills (Dekker and Wolff 2016). All of these approaches have the potential to enhance the student experience, as they can develop intellectual curiosity, research and communication skills.

In product design and engineering education interdisciplinary design projects often use problem-based learning or project-based learning contexts to enhance learning (MacLeod and van der Veen. 2020; Costa et al. 2019; Koch et.al 2017). The former is based on predefined situations, whilst the latter is based on problems which students must design a solution. Both types of learning context promote engaging, complex and authentic problem solving, as well as professional skills (MacLeod and van der Veen. 2020). However, projects led by applied research in health are rare and interdisciplinary RIT is still an area to explore in design and engineering education.

In a study exploring the advantages and barriers of research-informed teaching, Pan et al. (2012, 103) state that the lack of examples of RIT implementation in design and engineering disciplines limits the "*achievement of a better understanding and therefore the buy-into RIT practice*". This paper provides an initiative of interdisciplinary RIT applied to design higher education, where students benefit from research outcomes, research methods and critical thinking.

The three steps taken to involve the year-one students in the project

The year-one module was revised to accommodate a healthcare project, allowing five weeks of development from the brief to the final presentation. The module focused on RIT to add value to the learning experience (Healey 2005).

The three steps taken to involve the 38 students in the project were the following:

(1) Translating the background research on noise in the hospital ward:

   - summarising the background research and directing it towards the brief;

(2) Engaging the students with an unfamiliar scenario:

   - a visit to a simulation lab to help to assimilate information related to the hospital

   environment;

(3) Involving the students with stakeholders:

   - involvement with stakeholders' routines, experiences and some technical information

   like standards.

Background research on noise in the hospital ward

Using a '*real world'* problem identified through research is an example of research-informed teaching. Implementation of RIT begins with providing students with an overview of the topic and the findings of the research (Dekker and Wolff 2016). In this case, a Research Fellow working with a team of researchers who conducted the applied health research (Astin et al. 2020), gave a lecture to the students. The purpose of this was to introduce students to the context of the problem, research findings and the design brief. The first part of the presentation provided information that answered the question *"Why reduce noise levels in hospital settings?"* This included the factors that influence the quality of healthcare and elements that contribute to creating a healing environment. The negative impact of noise on health was described and the recommended guidelines for hospital environmental noise levels presented. An overview of international research on environmental noise levels in hospitals and the causative factors was provided. Subsequently, students learned about findings from international primary research studies (Garside et al. 2018) and patient feedback collected as part of a quality improvement initiative at an NHS Trust.

The project briefed to the students was related to ongoing research conducted since 2016 by the co-authors of this paper - whose affiliation is to the Human and Health Sciences School - investigating night-time noise levels and patients' sleep experiences in a Medical Assessment Unit and the subsequent quality improvement work at the Calderdale and Huddersfield NHS Foundation Trust (Astin et al. 2020). The Year-one product design students were given the opportunity to create a potential solution to address the unwanted noise in hospital ward. During the introductory lecture, students were informed about the context of the problem and the rationale for the design brief. Figure 1 shows some of the slides presented to the students by the researcher. In summary, they included the following information:

- *The importance of reducing noise levels and its impact on health:* Over the past 50 years, noise levels in hospitals have steadily increased (Busch-Vishniac et al. 2005). Patients in hospitals around the world often experience sleep disturbance at night-time due to unwanted noise (Aaron et al. 1996; Delaney et al. 2018; Dogan, Ertekin and Dogan 2005; Lane and East 2008). Prolonged exposure to noise and sleep deprivation both have negative effects on mental and physical health, such as hypertension, depression, and increased risk of falls and delirium (Alvarez and Ayas 2004; Colten, Altevogt, and Committee on Sleep Medicine and Research 2006; Knutson et al. 2007; Ryan et al. 2013; Helbig et al. 2013). Within a hospital setting, this can compromise patient recovery and lead to increased length of hospital stay and avoidable readmissions (Xyrichis et al. 2018).

- *The World Health Organisation guidelines for noise levels in hospitals and what it means:* The World Health Organisation (WHO) published guidelines for average and maximum night-time noise levels in hospital wards: ≤30 decibels (dBA) LAeq and ≤40 dBA LAmax, respectively (World Health Organisation 1999). This is equivalent to noise levels experienced in a library, however, activities and equipment occurring

within patient wards are usually much higher than 40 dB. For example, noise levels from bin lids can reach between 78 – 93 dBA, which is similar to noise levels of a food processor (Jerlehag et al. 2018; Shield, Shiers, and Glanville 2016). To make noise levels more meaningful, students were shown an infographic that depicted sources of noise with corresponding noise levels between 0 – 120 dBA (slide 5 in figure 1).

- *NOISELESS research results and the Quality Improvement work at the Calderdale and Huddersfield NHS Foundation Trust*: A hospital in the North of England, UK, received feedback from in-patients across different wards about their recent overnight stay in hospital. In common with data reported from other hospitals, over 140 patients indicated that sleep quality and quantity were poor on a medical assessment unit and noise levels exceeded WHO guidelines (Astin et al. 2020). In a quest to solve this problem and improve patient feedback, a team of health professionals and researchers developed a patient and staff questionnaire to collect information specifically on noise and sleep disturbances at night across four different patient wards. Results from the quality improvement project showed that up to 40% of patients rated their sleep at night as poor and noise from the opening and closing of waste bin lids was identified amongst the top five most common causes of noise at night. Previous to this initiative, the hospital had identified waste bin lid noise as an issue and had purchased soft-closing waste bins. However, these models were expensive and still somewhat noisy upon opening.

Figure 1: Selected slides used during the Introductory Lecture.

The presentation given by the researcher brought value to the project. It helped the students to learn about the relevance of the brief, about the problems that products can bring into a context, including the problems of the noise generated by waste bins in wards. By

contextualising the problem and giving a sense of the scope of the problem and its impact, the students were able to apply their problem-solving skills to address a real life 'design problem' derived from the research.

Engaging the students with an unfamiliar scenario

Healthcare environments are hardly a familiar setting to design students. Although the introductory lecture presented into details the research on noise and sleep disturbances, highlighting the importance and the role that design can play, the hospital wards were still a very unfamiliar setting for most students. Thus, 'design to the unknown' was never part of this proposal. While planning the project, we were aware of the challenges involved in getting access to healthcare facilities and insights from nurses, consultants, patients and other stakeholders. Several of these challenges are well explored by Groeneveld et al. (2018) and demand careful planning and time to overcome them. Having only a few months from planning the project and delivering the brief to the students meant that the preferred approach to immersing students in a healthcare setting was to use a clinical laboratory with a simulated ward environment. This approach avoided any disturbance to direct patient care and did not require hospital approvals.

In the session after the brief, the students were taken to a clinical laboratory - Nursing Skills Lab which simulates a ward setting in the School of Human and Health Sciences - shown in Figure 2. In this setting students could see the surrounds of the patient bed area, the equipment that may be needed and the waste bin. The size of the wards, the amount of equipment and the location of them, including the waste bin, helped the students to understand the environment in which their design concept would be part of.

In this environment two guest speakers - a staff nurse from Calderdale and Huddersfield NHS Trust, (who was working with the research team as a Clinical Academic Nurse) and an

'expert' patient who had experienced several admission to hospitals in the region and could give a detailed account of the experience of sleep in hospital.

Figure 2: the nursing skills lab in the School of Human and Health Sciences.

The aim of this seminar was to present and contextualise the problem in order to stimulate ideas about potential solutions to the noisy waste bins on the ward. This would potentially reduce the overall noise levels and improve patients' sleep and rest at night time. Students were given information by the staff nurse about how noise at night time in a hospital setting can have a negative impact on patients through sleep disturbance which if prolonged leads to, reduced wound healing, an increased risk of falls and longer hospital stay (Medrzycka-Dabrowska et al. 2018).

As part of this seminar the staff nurse also did a mapping of the ward (See Figure 3) which highlighted the ward layout, number of beds, waste bins and other sources of noises. Figure 3 shows the hospital ward layout highlighting the hospital waste bins in the ward. A total of 33 waste bins were in use. The patient rooms typically had two waste bins, one in the room and the other in the bathroom. The number of bins gives an indication of the potential for unwanted noise generated by waste bins.

Figure 3: the layout of the ward at Calderdale Royal Hospital: the 'red stars' show where the bins are located.

To contextualise the use of the waste bins the staff nurse described several activities that they would do during a night shift. Tasks such as the administration of medications, setting up intravenous infusions, providing direct patients care, assessing levels of pain, assisting patients with personal care, taking them to the bathroom and recording vital signs. As part of infection control health and social care workers are required to wash their hands regularly. The 'My 5 Moments for Hand Hygiene' approach (WHO 2019) identifies key

moments when health and social care workers must perform hand hygiene: 1-before touching a patient; 2-before clean/aseptic procedures; 3-after body fluid exposure/risk; 4-after touching a patient, and; 5-after touching patient surroundings. The key moments illustrate the number of times that the nurse will be opening and closing the bin to dispose of used paper towels. This is in addition to other times when the waste bins will be used to dispose of other consumables used as part of patient care provision. The staff nurse gave examples of a routine followed by staff from when the shift starts (at 7:30 pm) until its end (at 7:30 am).

The students had the chance to understand the basic principles of infection control and the need for health and social care workers to use single-use personal protective equipment (PPE) to cover their hands, clothes, eyes and mouth, which are all disposed of in the waste bins. He also explained the significance of Hospital Acquired Infections (HAI) to help the students to understand the fundamental importance of various waste streams (National Institute for Health and Care Excellence - NICE 2016).

Students were able to examine, measure and try the waste bins and at the same time became familiar with the different types of waste and the colour-coded waste bin lids that indicated waste type. In this seminar students were guided through the typical ward routine and introduced to the NHS hospital control standards. In this way they were able to recognise that any design would need to comply with the standards and waste bins would need to be operated 'hands-free', anti-bacterial, easy-clean, corrosion-resistant and fire-resistant.

To finish this contextualisation session, the negative impact of noisy waste bins on patients' sleep and rest were revisited. Following this contextualisation session, the students had the opportunity to have an informal discussion and question time with the staff nurse and 'expert' patient.

The involvement of students and stakeholders

The students were involved in discussions with a researcher, 'expert' patient and staff nurses; - one 'expert' patient service user and staff nurse in the first session and a different staff nurse in a second session (described below). The 'expert' patients/service user - a 70 years old man - described the diversity of experiences he had had in different wards at three separate hospitals. He described how fragile he felt during certain treatments and how hard it was to get sleep during the nights in the wards. He used humour and comic descriptions of some scenarios which enabled students to engage easily in the learning. He described the different sources of noise such as alarms on medical equipment, noise from other patients and staff and the peak noise produced by the waste bin when opening and closing. Some students asked questions related to his feelings, while others want to know more about the sources of noise and the products around him in the ward.

The following session took place outside the clinical laboratory, in a lecture room, in which students watched a series of videos (all in the public domain) of past patients accounts of Chapman Barker Unit and RADAR ward as well as brief testimonials from nurses, consultants and other staff. The Chapman Barker, in Great Manchester, is a regional detoxification unit providing treatment and support to individuals with substance misuse problems. The RADAR is a Rapid Access Detoxification Alcohol hospital, also in Great Manchester, which assists people with alcohol dependence problems. These clinical settings were used as exemplar settings by the guest speaker (Staff Nurse), as she wanted to highlight how these settings differed from other with regard to infection control. She reinforced the infection prevention and control procedures (Royal College of Nursing 2005), gave examples of cleaning, disinfection and sterilisation and decontamination of equipment and how all procedures are related to the object of design - the waste bin. Several students engaged in the discussion about unexpected situations and how patients treated for substance misuse may

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react in a ward situation. The lecture was followed by Q&A, which gave the staff nurse plenty opportunity to talk about her experience, involving the students.

Reflections about the outcomes

The students were divided into groups of three to develop their projects. By having a real problem to solve, most of the students engaged in the module and valued the data available to them. The experiences of stakeholders from Calderdale Huddersfield NHS Foundation Trust, Chapman Barker Unit and RADAR ward helped students to recognise the different perspectives of the same problem. The students translated what was reported by the nurses, patients, consultants and other staff to persona profiles (Hanington and Martin 2018).

Each group prepared at least three different personas. The information used to compose the persona combined learning from lectures, videos and informal chats with friends and relatives who had experiences of a ward environment. All of the information was crafted into personas and used as references throughout the phases of their project. In the following weeks they received help with ideation techniques, material, manufacturing, standards review and model making all to help them to materialise their ideas.

Figure 4: Final designs of students' projects (Permission conceded by Caitlyn Barton & Courtney Birchenough).

At the end of the five weeks some students felt their work could in fact be an improvement on available models of hospital ward bins, whilst others were unconvinced that they could have improved patient's experience in the ward. In fact, at the end, none of the solutions could be considered due to the costs involved or in the manufacturing the mechanisms proposed or in the assembly of the retrofit parts. However, considering that the students were at an early stage of learning, some groups excelled and developed working

models for solutions that impressed stakeholders - figure 4 and 5 are examples of four final designs.

Figure 5: Prototyping ideas and final designs of students' projects (Permission conceded by Mubashir Akhtar, Drupath Yadav & Ainlin Xie).

In general, most students agreed that they had experienced a project that could make an impact on real-world problem. Some of them were impressed with all the data available to them - the data from the previous research and hearing about the experiences of the nurses and patients. Student evaluation of the module was collected but focus upon the whole programme rather than individual modules. However, there was specific feedback about the module which was positive. Referring to the project, one student wrote the following: "*this was a very interesting project which helped me a lot. In this project I learnt about the medical industry. It enabled me to learn empathy and taught me how to design inclusive products. The research into standards and regulations gave me insight into strict quality controls and materials used for the medical industry*".

Regarding the involvement of healthcare professionals in the student learning it was a valuable experience for them also showing that it was a two-way learning process. This is demonstrated in the feedback received from one of the staff nurses who wrote: *"As a healthcare professional (clinical academic nurse), being invited to present to year 1 product design students about noisy waste bins was an exhilarating opportunity. Presenting to students an overview of my role as a staff nurse, a map of a hospital ward and nursing activities at night time, all helped set the clinical scene. Students were engaged, making notes and seemed very interested in this problem with the noisy waste bins. Students split into three groups to discuss the noisy waste bins and design a waste bin that opens and closes quietly. Samples of the waste bins were available for the students to open and close, so they*

could hear the noise made by the waste bins and analyse the existing waste bin design. Walking around the laboratory and engaging with students was a great learning opportunity for me. Listening to their passion and enthusiasm to design a new waste bin and find a solution to the existing noisy waste bins was energising."

Discussion & conclusion

Several models have been developed to explain how research can add value to the student learning experience (Healey 2005). Research-informed teaching can take several forms ((Burgum and Stoakes 2020 and the driver for the educational initiative described in this paper was to enhance student knowledge and skills development, student employability and the overall student experience.

The educational sessions used three RIT approaches. First, the research team described the research methods that were used to collect the research data and presented the key findings to the students. These sessions demonstrated both research-led and research-oriented teaching as students learnt about research findings relevant to their field of study and the research processes and methods used to generate the research. Research-tutored learning with a Design lecturer using problem-based learning enabled students to apply their knowledge and problem solving skills to a real life 'design problem' derived from the research. Students worked with their peers and the facilitator to critique and discuss the ideas that were presented. An innovative addition to the student learning experience was the opportunity for participatory learning and public engagement in which a researcher, two Registered Nurses and service user talked about the research and the impact of unwanted environmental noise on the quality and quantity of sleep for in-patients. This included the service user talking about his own personal experiences. This enabled students to understand how their design skills could be applied to address a real-life problem in the NHS which

impacted on the patient experience of care. The aims set when starting this first project are discussed in the sub-sections below.

Knowledge development in the context of a healthcare environment

The project helped the students to understand the several aspects to be considered when designing to address real life problems, especially healthcare-related problems. The research helped them to understand that sleep disturbances at night were related to the design of the surrounds, including the design of the hospital ward bin. In fact, they learnt that design can play an important role in improving patients' experiences in healthcare environments. However, as highlighted in other projects (Malcolm et al., 2019; Porter et al., 2018; Reay et al, 2017) it requires engagement with multiple stakeholders and their contexts in order to understand the *'real needs'* from different perspectives.

Potter et al. (2018, 194) engaged students who had no prior exposure to design for health and wellbeing with healthcare challenges, they mentioned that "*Two main themes emerged: the value of real-world learning and the need for empathy in design. Students perceived that designing for health care was significant, and that health care was a continually changing discipline. Students saw the need for designers to be integrated into the health care system alongside health care professionals to develop solutions for communicating health-related topics"*... they had to *"think broadly about the needs of other people, and to 'not design for myself'"*(200). Similarly, in our initiative, empathy emerged as a key topic in the students' projects. Some students related the patient's experience to what friends, grandparents and other relatives had experienced while stayed in the hospital ward in other hospital across the UK. What was reported by the patient and nurses somehow helped them to build empathy towards patients and healthcare staff. Their personas, empathy maps and project outputs reflected that. In addition, their positive feedback also highlighted empathy and multi

stakeholders' needs and user-centred design as learning uptakes.

Understanding of the different needs of multiple stakeholders

The majority of students engaged with the project and realised that as designers, they could potentially improve the patients experience in a clinical environment. We, as facilitators of the projects, realised that our role as educators involved overcoming the challenges associated with visiting hospitals and making contact with multiple stakeholders. The Nursing Skills Lab visit helped the students to understand the environment in which their product would be inserted. The presentations of key aspects related to hospital wards; the contact with the work of Registered nurses; testimonials of patients and other stakeholders through videos helped them to engage with an unfamiliar context and realise possibilities.

Reflection upon the outcomes of the project

The fact that around a third of the students were not convinced that their project could improve patients experience in the ward can be related to motivational aspects, their perception of design, perception of the project, individual circumstances or other facts. However, it can also be related to 'value of doing' and 'expectancy for success', which must be considered more carefully when setting our next project. As explained by Conley (2012) the attitudes of the students towards a project can reflect their understanding of the value of doing it - "*why am I doing this task?*" Hence, it may reflect that during the first semester there was not enough content to "*build their knowledge"* on the role that design can play to improve life, to the point to "*produce*" designs for real-world problems (Petty 2009). Likewise, maybe the project was too complex for them at that stage - first year design students - or the period in which the project was conducted (five weeks) may have been too short in duration to develop their skills and knowledge to match to the work set.

Also, Conley states that "*students' achievement-related choices can be understood as a function of their expectancy for success, defined as beliefs about how well they will do on an upcoming task - 'Can I do this task?'*"(34). In this way, having design practitioners involved in the briefing session specially, could have improved the way the students perceived the project and the way they took ownership of it. Additionally, having more stakeholders involved in the final design presentation, as well as presenting the final design in the lab setting (figure 2), could have further enhanced their experience and perceptions of the value of the project.

All the above are important aspects to consider in our initiative. In future projects we would ensure that more time is allocated, especially for year-one design students, which might help with the following:

1) to get permission to visit hospital premises;

2) to involve more stakeholders and designers practitioners in different phases of the project;

3) to allow the students to develop their skills to match to the work set;

4) to help students to understanding the difference that design can make in the healthcare environments and the value of it.

The above are improvements that might enhance the students learning experience, avoiding disappointments of students focusing only on the final concept.

Overall reflections

Some students gave feedback stating the value of the sessions with nurses and patient and how insightful user-centred design can be to a project. Reflecting on the module, the project has been taken in the department as an example of research-informed teaching. The outcomes of this study suggest that combining the expertise from health science researchers, academics,

healthcare professionals and patients contribute to engage students with healthcare problems and open their horizons about the opportunities in design for health and wellbeing.

The Registered nurse from Calderdale Royal Hospital mentioned that the students greatly assisted with their expertise. In practical terms the hospital was interested in new ideas to tackle the noise problem. Several suppliers had already developed a 'soft-close' option which was quieter. The tender opportunity shows how the students project (especially the retrofit solutions) brought to light that some possibilities that were already available in the market and that the implementation and costs would depend on the supplier.

Indeed, "*design can play a pivotal role, within an educational and healthcare context"* (Malcolm et al. 2019, 484) and we are keen to repeat the experience, overcoming the challenges when proposing human-centred healthcare projects to students, and thus involving students in real life problems, in which design can be a tool to improve patients' experience.

References

Aaron, J. N., C. C. Carlisle, M. A. Carskadon, T. J. Meyer, N. S. Hill, and R. P. Millman. 1996. "Environmental noise as a cause of sleep disruption in an intermediate respiratory care unit." *Sleep* 19 (9):707-10.

Alvarez, G. G., and N. T. Ayas. 2004. "The impact of daily sleep duration on health: a review of the literature." *Prog Cardiovasc Nurs* 19 (2):56-9.

Astin, F., J. Stephenson, J. Wakefield, B. Evans, P. Rob, J. Garside, and E. Harris. 2020. "Night-time Noise Levels and Patients' Sleep Experiences in a Medical Assessment Unit in Northern England." *Open Nursing Journal* 14:80-91. doi: 10.2174/1874434602014010080.

Bossio, D., B. Loch, M. Schier & A. Mazzolini. 2014. "A roadmap for forming successful interdisciplinary education research collaborations: a reflective approach." *Higher Education Research & Development*, 33:2, 198-211, doi: 10.1080/07294360.2013.832167

Burgum, S. and G. Stoakes. Advance Higher Education Knowledge Hub. "What does research-informed teaching look like?" Retrieve from https://www.advance-he.ac.uk/knowledge-hub - accessed on 11/06/2020

Busch-Vishniac, I. J., J. E. West, C. Barnhill, T. Hunter, D. Orellana, and R. Chivukula. 2005. "Noise levels in Johns Hopkins Hospital." *J Acoust Soc Am* 118 (6):3629-45.

Colten, H.R., B.M. Altevogt, Editors, and Committee on Sleep Medicine and Research. 2006. "Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem " In. Washington, DC.: Institute of Medicine of the National Academies.

Conley, A. M. 2012. "Patterns of motivation beliefs: Combining achievement goal and expectancy-value perspectives." *Journal of Educational Psychology, 104*(1), 32-47. doi:http://dx.doi.org.libaccess.hud.ac.uk/10.1037/a0026042

Costa, A. R., M. Ferreira, A. Barata, C. Viterbo, J. S. Rodrigues, and J. Magalhães. 2019. "Impact of interdisciplinary learning on the development of engineering students' skills". *European Journal of Engineering Education*, 44:4, 589-601, doi: 10.1080/03043797.2018.1523135

Dekker, H, and S.W. Wolff. 2016. "Re-inventing Research-Based Teaching and Learning." In *European Forum for Enhanced Collaboration in Teaching of the European University Association*. Brussels, Belgium: Centre for Education and Learning.

Delaney, L. J., M. J. Currie, H. C. Huang, V. Lopez, and F. Van Haren. 2018. ""They can rest at home": an observational study of patients' quality of sleep in an Australian hospital." *BMC Health Serv Res* 18 (1):524. doi: 10.1186/s12913-018-3201-z.

Design Council. 2020. Retrieved from https://www.designcouncil.org.uk/resources/search/im_field_theme/health-wellbeing-1036/im_field_theme/social-change-1061 - accessed on 07/07/2020

Dogan, O., S. Ertekin, and S. Dogan. 2005. "Sleep quality in hospitalized patients." *J Clin Nurs* 14 (1):107-13. doi: 10.1111/j.1365-2702.2004.01011.x.

Garside, J., J. Stephenson, H. Curtis, M. Morrell, C. Dearnley, and F. Astin. 2018. "Are noise reduction interventions effective in adult ward settings? A systematic review and meta analysis." *Applied Nursing Research* 44:6-17. doi: https://doi.org/10.1016/j.apnr.2018.08.004.

Groeneveld, B., T. Dekkers, B. Boon and P. D'Olivo, 2018. "Challenges for design researchers in healthcare." *Design for Health* 2 (2):305-326. doi: 10.1080/24735132.2018.1541699.

Hannan, J., C. Raber, E. Ellis, N. Beyzaei, D. Levi, A. Phinney and M. Sakamoto 2019. "Zeitgeist publication: a storytelling project with residents and design students." *Design for Health* 3 (1):48-64. doi: 10.1080/24735132.2019.1596210.

Hanington, B. and B. Martin. 2017. *The Pocket Universal Methods of Design: 100 Ways to Research Complex Problems, Develop Innovative Ideas and Design Effective Solutions*: Rockport Publishers.

Healey, M. 2005. "Linking research and teaching: exploring disciplinary spaces and the role of inquiry-based learning." In R. Barnett (Ed.), Reshaping the University: *New Relationships between Research, Scholarship and Teaching* (pp. 67-78). McGraw Hill: Open University Press.

HEA-UA. 2017. "What does research-informed teaching look like?". Case Studies Booklet.

Helbig, A. K., A. Doring, M. Heier, R. T. Emeny, A. K. Zimmermann, C. S. Autenrieth, K. H. Ladwig, E. Grill, and C. Meisinger. 2013. "Association between sleep disturbances and falls among the elderly: results from the German Cooperative Health Research in the Region of Augsburg-Age study." *Sleep Med* 14 (12):1356-63. doi: 10.1016/j.sleep.2013.09.004.

Jerlehag, C., P. J. Lee, S. H. Park, T. Jones, and N. Carroll. 2018. "Acoustic environments of patient room in a typical geriatric ward." *Applied Acoustics* 133:186-93. doi: https://doi.org/10.1016/j.apacoust.2017.12.022.

Koch, F. D., A. Dirsch-Weigand, M. Awolin, R. J. Pinkelman and M. J. Hampe. 2017. "Motivating first-year university students by interdisciplinary study projects." *European Journal of Engineering Education*, 42:1, 17-31, doi: 10.1080/03043797.2016.1193126

Knutson, K. L., K. Spiegel, P. Penev, and E. Van Cauter. 2007. "The metabolic consequences of sleep deprivation." *Sleep Med Rev* 11 (3):163-78. doi: 10.1016/j.smrv.2007.01.002.

Lane, T., and L. A. East. 2008. "Sleep disruption experienced by surgical patients in an acute hospital." *Br J Nurs* 17 (12):766-71. doi: 10.12968/bjon.2008.17.12.30306.

MacLeod, M. and J. T. van der Veen. 2020. "Scaffolding interdisciplinary project-based learning: a case study." *European Journal of Engineering Education*, 45:3, 363-377, doi: 10.1080/03043797.2019.1646210

Malcolm, J., V. Tully, C. Lim and R. Mountain. 2019. "Moving beyond an interdisciplinary paradigm." *The Design Journal* 22 (sup1):475-486. doi: 10.1080/14606925.2019.1595433.

Medrzycka-Dabrowska, W., K. Lewandowska, K. Kwiecień-Jaguś and K. Czyż-Szypenbajl 2018. "Sleep Deprivation in Intensive Care Unit – Systematic Review". *National Library of Medicine* , 13, 384-393. doi: 10.1515/med-2018-0057

NICE. 2016. Healthcare-associated infections. Retrieved from https://www.nice.org.uk/guidance/qs113/resources/healthcareassociated-infections-pdf-75545296430533 - accessed on 11/06/2020

Pan, W., P. Murray, D. Cotton, and H. Garmston. 2012. "Integrating Research-informed Teaching into Sustainable Construction Education". *Journal for Education in the Built Environment*, 7:1, 94-117, doi: 10.11120/jebe.2012.07010094

Papanek, V.. 2019. Design for the Real World. Thames & Hudson, UK.

Petty, G. (2009) *Evidence - based teaching - a practical approach. Oxford University Press*.

Potter, E., S. D. Reay and B. Thornhill, 2018. "Communicating information in health: engaging students in design for health awareness." *Design for Health* 2 (2):194-210. doi: 10.1080/24735132.2018.1483595.

Reay, S., G. Collier, J. Kennedy-Good, A. Old, R. Douglas and A. Bill, 2017. "Designing the future of healthcare together: prototyping a hospital co-design space." *CoDesign* 13 (4):227-244. doi: 10.1080/15710882.2016.1160127.

Reay, S. D., G. Collier, R. Douglas, N. Hayes, I. Nakarada-Kordic, A. Nair and J. Kennedy-Good, 2017. "Prototyping collaborative relationships between design and healthcare experts: mapping the patient journey." *Design for Health* 1 (1):65-79. doi: 10.1080/24735132.2017.1294845.

Reid, D., S. Reay, J. Munn and N. Hayes, 2018. "Prototyping an emotionally responsive hospital environment." *Design for Health* 2 (1):89-106. doi: 10.1080/24735132.2017.1412689.

Rodgers, P., G. Innella, C. Bremner, I. Coxon, C. Broadley, A. Cadamuro, S. Carleklev et al. 2019. "The Lancaster Care Charter." *Design Issues*: 35 (1): 73-77.

Royal College of Nursing, (2005) *Good practice in infection prevention and control - Guidance for nursing staff.* Published by the Royal College of Nursing, London. Retrieved from

http://www.wales.nhs.uk/sites3/documents/739/RCN%20infection%20control.doc.pdf
- accessed on 11/06/2020

Ryan, D. J., N. A. O'Regan, R. O. Caoimh, J. Clare, M. O'Connor, M. Leonard, J. McFarland, et al. 2013. "Delirium in an adult acute hospital population: predictors, prevalence and detection." *BMJ Open* 3 (1). doi: 10.1136/bmjopen-2012-001772.

Shield, B., N. Shiers, and R. Glanville. 2016. "The acoustic environment of inpatient hospital wards in the United Kingdom." *J Acoust Soc Am* 140 (3):2213-24. doi: 10.1121/1.4962276.

What Design Can Do. 2020. https://www.whatdesigncando.com/about-our-challenges/ - accessed on 07/07/2020

World Health Organisation. 1999. "Guidelines for Community Noise." In, edited by B. Berglund, T. Lindvall and D.H. Schwelaand. Geneva, Switzerland: World Health Organisation.

World Health Organization. (2019). *Infection Prevention and Control: My 5 Moments for Hand Hygiene*. Retrieved from https://www.who.int/infection-prevention/campaigns/clean-hands/5moments/en/ - accessed on 11/06/2020

Xyrichis, A., J. Wynne, J. Mackrill, A.M. Rafferty and A. Carlyle, 2018. "Noise pollution in hospitals." 363:k4808. doi: 10.1136/bmj.k4808 %J BMJ