USING PARTICIPATORY DESIGN TO CREATE AN IMMERSIVE 360-DEGREE INTERACTIVE VIDEO FOR BREASTFEEDING EDUCATION

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Abstract

Background: There is a lack of evidence-based information around support for mothers during breastfeeding, which makes developing effective knowledge and skills in midwives difficult. Immersive simulations provide an opportunity to increase skills in breastfeeding support to effectively enhance care for mothers. **Methods**: This paper outlines the process of creating a virtual reality simulation programme aimed at enhancing midwifery students' understanding and support for breastfeeding that aligns with the UK Medical Research Council's guidelines. The programme, developed using participatory design and the ADDIE framework, utilises interactive 360-degree videos viewed using a head-mounted display. **Results**: Two scenarios, reviewed by experts in midwifery education and educational technologies, were designed to cover fundamental postnatal care practices that support breastfeeding. The pilot test revealed new criteria for enhancing the design of the 360-degree interactive video and also highlighted several technical challenges. **Conclusion**: This paper provides valuable insights into developing and implementing instructional strategies for midwifery education around breastfeeding support. The 360-degree virtual reality video introduces innovative engagement methods for students, an additional resource for teaching and learning, and a reference point for future research on co-creation of immersive content.

Keywords: 360-degree video, ADDIE, breastfeeding, co-creation, immersive learning, midwifery, nursing, simulation, virtual reality.

1 INTRODUCTION

A lack of practical breastfeeding knowledge is common among pre-registration nursing and midwifery students, and many midwives feel unprepared to provide necessary breastfeeding support to mothers [1]. Breastfeeding support is multifaceted, and involves aspects such as providing information, practical help, and emotional support [2]. Midwives play a significant role in supporting and educating breastfeeding mothers. However, the reported lack of necessary skills to provide effective and evidence-based practice (EBP) and support among midwives is a known factor in the early cessation of breastfeeding by mothers [3]. It is widely acknowledged that undergraduate nursing programmes lack sufficient information about the various methods and techniques that support breastfeeding [4]. Consequently, it has been recommended that educators use innovative teaching methods to teach nursing and midwifery students about the benefits of breastfeeding [2].

Simulations offer participants the chance to safely practice realistic clinical scenarios without the potential risks inherent in actual environments, serving as an alternative to clinical placements. Nonetheless, the setup and planning required for these simulations can be extensive, and may not be accessible to a wide range of students. In contrast, virtual reality (VR) simulation can enable interactive, authentic, and safe learning experiences that promote active engagement [5]. VR is an innovative technology used to enhance medical and healthcare education. Immersion, achieved through the use of a VR head-mounted display (HMD) (also known as a VR headset or goggles), is a particular feature of VR [6]. Through VR immersion, learners can immerse themselves in a particular environment and subsequently reflect on their experiences. Previous research on VR Immersion has indicated that participants generally rate VR applications as either useful, acceptable, or helpful for learning nontechnical skills [7, 8].

Computer-generated imagery (CGI) and animation are commonly used methods for VR video capture, particularly in gaming and other applications, such as in health education using virtual patients. However, for recording live-action events in VR, a 360-degree camera is utilized. The realism achievable with CGI or animation does not match the authenticity of a real clinical environment , but live- action 360-degree video capture can enable learners to observe more nuanced components of interactions,

for example midwife and patients' nonverbal cues, such as facial expressions, enhancing the immersive learning experience.

Nevertheless, unlike traditional VR, 360-degree videos are noted for their lack of interactivity. In most cases, this means that viewers passively observe. Interactive videos allow the viewer to interact with the environment's assets using a controller or by directing their gaze to the hotspot [6]. Specific assets can be added to increase interactivity through embedded hotspots or add-ons, which are customized components added to a video in the editing stage. They can be used to direct the viewer's attention to a particular point of interest, or to provide additional "just-in-time" information [5]. Therefore, research suggests that the use of interactive videos enhances student persistence and accommodate individual learning differences [5].

Using participatory design (PD) to develop this innovative learning resource facilitates user involvement in all stages of co-production, emphasizing collaboration, inclusivity, and an iterative approach [10]. Through collaboration and ongoing engagement, multiple stakeholders contribute to co-creative storyboarding, design and execution that enhances critical thinking, boosts participant engagement, and promotes empowerment [10].

Although VR is a useful tool for education, nursing and midwifery schools typically use online videos instead of immersive VR for practical training [3]. Therefore, this project aimed to create an immersive interactive 360-degree VR video simulation programme designed to educate undergraduate midwifery students about providing breastfeeding support to mothers.

2 METHODOLOGY

This project followed guidance from the National Institute of Health Research (NIHR) and the Medical Research Council (MRC) on the development and assessment of a complex intervention, specifically, the creation of 360-degree VR videos, incorporating multiple perspectives and appropriate methodologies.

2.1 Study Design

The design involves the production of 360-degree media development of the VR programme focused on breastfeeding support. The PD approach, using collaboration and co-creation, was used to produce two breastfeeding scenarios, ensuring relevance for educating undergraduate midwifery students. Stakeholders in PD actively shape the development of the project by drawing upon their expertise, credibility, experience, and knowledge of user needs [10].

2.2 Program Development

To assist with conceptualising and creating this 360-degree VR video educational programme, the ADDIE model's five eponymous stages were used as a guide:: Analysis (identifying learning needs), Design (outlining the instructional approach), Development (creating learning resources), Implementation (delivering the project to the target audience), and Evaluation (assessing effectiveness) [12]. This model uses an iterative process, whereby the designer can return to any stage based on feedback from formative assessments made throughout the process (Fig. 1).

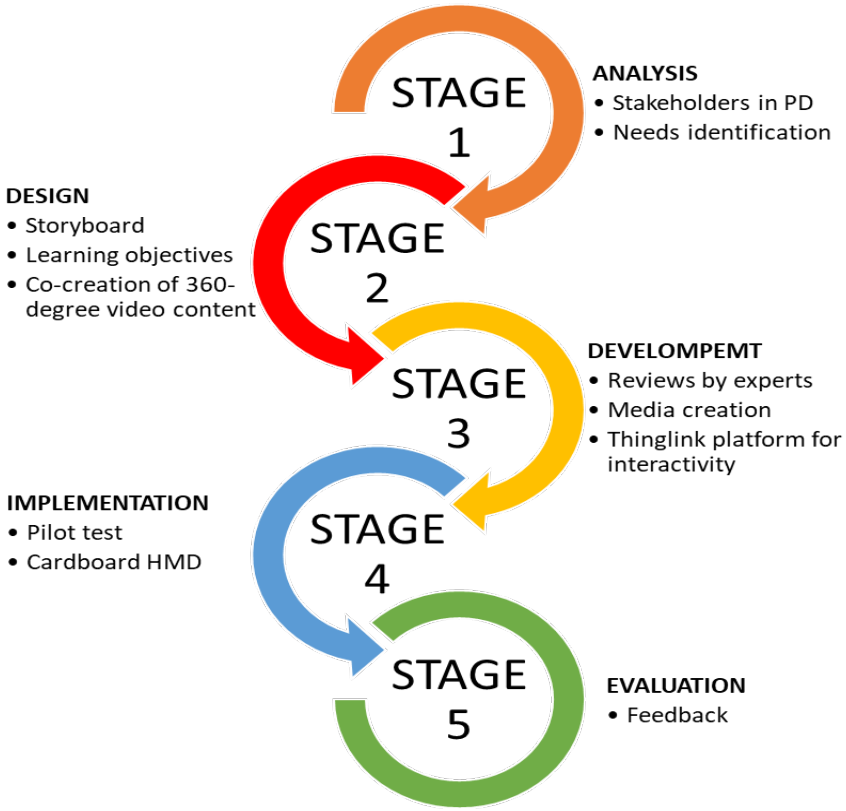

Figure 1. 360-degree video development using ADDIE model.

3 RESULTS

This section details the iterative application of the ADDIE model in developing the resource, with two distinct iterations employed, resulting in progressive improvements.

3.1 Stage 1: Analysis

The first phase aimed to determine the need for breastfeeding encouragement and support training by considering the perspectives of stakeholders through a PD process. Two midwifery expert faculty members and three undergraduate midwifery students at Princess Nourah bint Abdulrahman University (PNU) collaborated to discuss the development of content. These insights followed by a scoping review [7] used to develop a tailored educational programme for midwifery students to raise awareness about the benefits and importance of effective breastfeeding.

3.2 Stage 2: Designing

The 360-degree VR video featured an interactive scenario designed to teach undergraduate midwives how to better support and encourage breastfeeding mothers. Insights from Stage 1 (Analysis) determined the programme's learning outcomes. The main objectives were:

- Provide evidence-based information on the importance of breastfeeding and the benefits of exclusive breastfeeding.
- Utilise the "Baby-Friendly Hospital Initiative's 10 Steps to Successful Breastfeeding" to foster an environment that encourages and supports breastfeeding.
- Identify and effectively manage common breastfeeding problems.

During this stage, a course overview and storyboard were produced. The goal of the storyboard was to create a visual representation of the ideas and concepts used in the educational scenario [13]. To structure the intervention's aim and scenarios, the University of Nottingham Health E-Learning and Media (HELM) team's storyboard sheet was employed.

Students co-created 360-degree video content with educators during the storyboarding sessions. Subsequently, scenarios were systematically developed by employing a template designed for virtual simulations in nursing education [14]. This template included essential components like title, objectives, evaluation, intervention flow, scenario characters, and protocols. The scenario design adhered to established guidelines, drawing from the UNICEF BFI, the International Nursing Association for Clinical Simulation and Learning (INACSL) standards [15], and insights from CoViRR [16] and 360ViSi [17] European projects.

3.3 Stage 3: Development

An introductory learning session in accordance with the UNICEF BFI was created to provide necessary information prior to running the VR simulation. It introduced midwifery students to breastfeeding mothers and the available strategies to provide support and management. The initial content was reviewed and revised based on evaluations provided by a midwifery faculty member.

3.3.1 Scenarios

Scenarios were developed aiming to teach midwifery students how to educate and support a breastfeeding mother who was: (1) a primipara (a woman giving birth for the first time) with limited knowledge about breastfeeding and its advantages, and (2) a multipara (a woman who has previously given birth to one or more children) with a history of sore nipples and breast engorgement. The preliminary scenarios and contents were reviewed by four midwifery experts specialising in breastfeeding from PNU and the University of Nottingham, ensuring the scenarios were accurate and thoroughly detailed. Experts documented any queries or remarks regarding the scenario, process steps, or dialogue that required modification. This led to the dialogue being revised to better align with the scenario's aims and context.

After undergoing adjustments and improvements, two scenarios were created that incorporated basic postnatal care practices to support breastfeeding. The main objectives of the scenarios were structured around the following themes:

1. Enhancing breastfeeding support and practices. This theme encompassed several aspects of breastfeeding support, including the benefits of breastfeeding, postnatal practices aimed at supporting successful breastfeeding, and clinical techniques for effectively positioning a baby at the breast.
2. Breastfeeding navigation: understanding challenges, mechanisms, and care. This theme focused on the exploration of breastfeeding, including the challenges associated with milk supply, the mechanics of breastfeeding, and the management of breast and nipple conditions (Table 1).

Table 1. 360-degree VR video scenarios.

Scenario	Context	Midwife intervention
1: Breastfeeding benefits	A 28-year-old primipara mother gave birth vaginally two hours ago to a healthy baby boy at 39 weeks' gestation. No epidurals were given. The mother admitted that she does not know how to breastfeed and is considering bottle-feeding.	• Explaining breastfeeding's benefits. • Demonstrating colostrum's advantages. • Addressing psychological benefits. • Describing the value of skin-to-skin contact and "rooming-in" for the mother and baby. • Demonstrating early feeding cues and ensuring the baby is getting adequate milk. • Illustrating main breastfeeding positions.
2: Breastfeeding management	A 34-year-old mother gave birth vaginally six days ago to her second baby, a healthy baby girl, at 40 weeks' gestation. She had unpleasant previous experiences with breastfeeding, experiencing breast engorgement and sore nipples. She expressed concern about encountering the same issues again and has not yet initiated breastfeeding	• Explaining poor attachment results. • Explaining the causes of insufficient milk supply. • Explaining breast engorgement causes, prevention, and treatment. • Explaining proper management for sore nipples. • Discouraging the use of pacifiers. • Addressing public feeding culture concerns.

3.3.2 360-degree VR Video

To complete the two scenario modules, the simulation laboratory was set up to mimic a maternity ward and an outpatient clinic for maternity care. Medical supplies and equipment including a hospital crib, a baby doll, a monitor for vital signs, an intravenous pump, hand sanitizer, and gloves were all part of the simulation lab. Two actors, including the researcher, rehearsed and portrayed different roles, with each scene being captured using a 360-degree camera. The actors were dressed in uniforms resembling those found in the intervention's cultural setting to create a sense of authenticity and realism.

The VR simulation programme was developed utilising a Samsung Gear 360 4K camera, equipped with two CMOS 8.4-megapixel fish-eye cameras. The video format was MP4-encoded with H.265, featuring a dual-lens resolution of 4096×2048 (24 fps). Additionally, a stand and Gear 360 Action Director software were employed for video quality control and editing purposes.

The 360-degree VR video simulation began with the initial screen showing the first scenario. Students could explore the surroundings while wearing the HMD. As they explored the virtual environment, a white dot moved with their gaze, indicating their point of focus. This functionality enabled students to interact with and control the VR content effortlessly, as they gazed at specific points or hotspots for 1.5 seconds to open and close them. Additionally, students could pause or replay the scenario by gazing at the respective options. Progress to the next scenario was only possible after completing the current one. Each scenario ranged from 6 to 7 minutes in length.

The 360-degree video was viewed on a computer screen with the mouse for controls, or (for a fully immersive experience) on a mobile device with a VR headset (like Oculus Go or Google Cardboard). The immersive experience, using the HMD, is purported to mimic the experience of being 'really there' for the learner [5, 6].

To add interactive points, the online Thinglink platform was used, which is designed for creating interactive 360-degree environments. The scenarios included hotspots that incorporated audio descriptions, videos, and photographs to motivate the students to interact with the programme. Feedback was obtained from a learning technologist, leading to the addition of more hotspots for clarification purposes (Fig. 2).

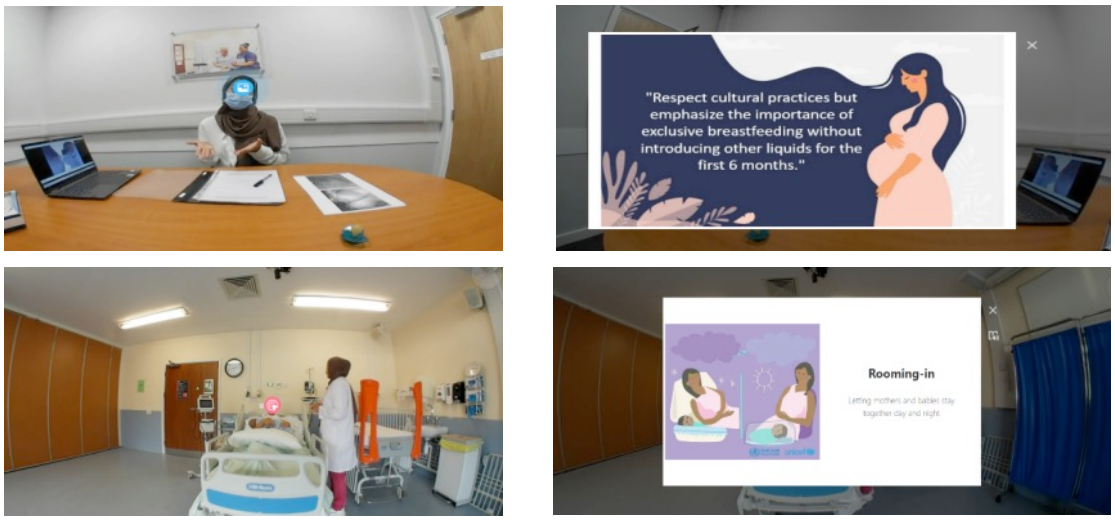

Figure 2. 360-degree video content.

3.4 Stage 4: Implementation

A pilot test was conducted with one nursing education professional and one health informatics professional. These fully immersive VR scenarios were created in a 360-degree video format and were presented to the participants via Cardboard HMD. Cardboard is a low-cost portable device that allows practically any smartphone to power a VR experience (Fig. 3). During the introductory session, participants were familiarised with how to use the device. The 360-degree videos were then played on participants' mobile phones, after receiving an online password-protected link. Participants were instructed to remain seated and insert their phones into a Cardboard HMD. Once inserted, they experienced the full immersive environment of the VR, providing a rich and engaging learning experience about breastfeeding support and guidance.

The subsequent iteration was evaluated at the nursing college at PNU in Saudi Arabia, involving 62 undergraduate midwifery students in their second, third, and fourth years of the programme. The findings of the intervention will follow.

Figure 3. A 360-degree video played on the VR Cardboard.

3.5 Stage 5: Evaluation

Expert evaluations were received, with three different forms utilised for each material: one for the prebriefing lecture, another for the scenarios, and the last for technical feedback for the 360-degree video. Additionally, qualitative feedback was gathered from the pilot test, to gain insight into any required modifications. Qualitative feedback from the pilot test indicated that a fast and reliable mobile network was essential for the platform's performance. The final educational resource will be evaluated following a comprehensive feasibility study.

4 DISCUSSION AND CONCLUSIONS

Researchers have developed a pioneering immersive VR simulation teaching programme to aid midwifery students in providing lactation support to mothers. Currently, breastfeeding education is delivered through lectures, online modules, and clinical training. VR was selected for breastfeeding support training due to the limited emphasis on the role and impact that midwives have in educating and supporting mothers in breastfeeding practices. Emerging technologies like VR and 360-degree video can be incorporated into existing 'traditional' teaching approaches, offering students high-quality simulation experiences.

The virtual and real-world environments of 360-degree video enable midwifery students to familiarise themselves with the clinical setting prior to placement. The goal of capturing hospital environments in 360 degrees is not to completely replace hands-on training in a real environment, but to augment it. Realism is a crucial aspect of simulation training, and 360-degree VR and HMD offer students a highly realistic experience, making them promising tools for midwifery simulation.

The involvement of stakeholders in PD to create initial content was integral to the programme 's success. Future participation between educators and students is necessary to enhance instructional tools and materials. In this regard, the simulation environment would be more secure if it used video shots in a controlled setting with carefully crafted scenarios that are evaluated by a panel of experts. Pears' [8] demonstrated that by incorporating expert input, another significant factor in improving students' learning experience is enhancing their ability to recognise and interpret important cues more effectively in medical environments. Furthermore, Giordano [18] showed that incorporating narrative elements, along with expert feedback, firmly grounds the VR intervention within the core principles of nursing practice.

This project highlights the significance of implementing a collaborative design approach in the development of 360-degree video content. Involving students, educators, and subject matter experts throughout the process ensures that the content aligns closely with educational goals and objectives [8]. Furthermore, the content can be iteratively refined to match the educational needs and preferences of subject-matter experts and tech professionals through ongoing input collection [18].

Additionally, an analysis of technical aspects revealed significant challenges associated with internet connectivity. Wi-Fi networking is utilised by many standalone HMDs. However, a Cardboard headset provides a practical and cost-effective alternative. It is recommended to use the offline mode for VR to avoid glitches and interruptions, as it does not require an internet connection [19, 20]. Nonetheless, the ease of use of the technology remains the decisive factor in achieving widespread acceptance. These insights underscore the critical importance of considering such factors during the design and development phases of 360-degree video projects, as they can significantly enhance the overall effectiveness of the educational experience.

The use of digital instructional resources, along with creative teaching methodologies, is essential for enhancing education. For thorough and efficient scenario development, the ADDIE approach offers an organised framework. Interactivity can also enhance student persistence and support individual learning differences. Midwifery education should prioritise providing clear and effective breastfeeding instruction to enable students to effectively encourage and support breastfeeding mothers and enhance their skills in clinical practice.

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