

## Article

# Development and Evaluation of a 360-Degree Video on Home Care in Undergraduate Health Sciences Education

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## Abstract

Access to authentic clinical learning experiences is often limited for undergraduate Health Sciences students. Immersive technologies such as 360-degree video may help bridge this gap, yet evidence regarding their use in home care education and Problem-Based Learning (PBL) remains scarce. To address this gap, we used a Design-Based Research (DBR) approach to develop and implement a 360-degree video-based home care learning experience and evaluated students' perceptions of the video, VR headsets, and associated educational formats across three curricular tracks. The experiences of 251 undergraduate Health Sciences students across three different tracks (Policy, Mental Health and Digital) at Maastricht University were studied. Each track offered a different educational format using the 360-degree video as part of its Problem-Based Learning (PBL) curriculum. Students responded once to a combination of self-developed and standardized questionnaires, which included subscales from the Technology Acceptance Model 3 (TAM3) and the Video Transportation Scale (VTS). A DBR approach facilitated the iterative development and implementation of a 360-degree video-based home care learning experience embedded within a Problem-Based Learning curriculum. The intervention was successfully integrated across three tracks without compromising key PBL principles. Students generally perceived the 360-degree video and associated educational formats positively, particularly appreciating the opportunities for interaction and contextualized learning. The findings suggest that immersive 360-degree video delivered through VR headsets is a feasible and acceptable educational approach for undergraduate Health Sciences students and may provide meaningful exposure to clinical practice when access to placements is limited.



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**Keywords:** virtual reality; immersive learning; health professions education; home care; design-based research; 360-degree video; problem-based learning

## 1. Introduction

Problem-Based Learning (PBL) serves as the foundational educational method at Maastricht University, since its establishment in 1974. Students collaborate and discuss in small tutorial groups, engaging with real-world cases utilizing Maastricht's renowned

structured seven-step approach [1]. The learning process usually unfolds in three cyclical phases—pre-discussion, self-study, and post-discussion—following the structured seven-step methodology.

Bachelor's students often perceive the seven-step process as a routine checklist. Additionally, several critical steps are frequently skipped, hindering the integration and application of newly acquired knowledge [2]. Growing dissatisfaction with PBL in practice has led to calls for greater creativity and flexibility in the implementation of PBL [3,4].

In the Bachelor of Health Sciences at Maastricht University, approximately 300 to 350 undergraduate students enroll each year. During the first year of the program, all students follow a common curriculum. In the second year, students select one of five tracks: (1) Biology and Health; (2) Policy, Management and Evaluation of Health Care; (3) Prevention and Health; (4) Mental Health Sciences; or (5) Digital Technology and Care. Each track spans a total of two years, allowing students to develop in-depth expertise in their chosen area of focus. Students enrolled in these tracks do not participate in formal internships. Students participate in field trips, such as visits to nursing homes. Given the growing number of older adults living independently in the community, the topic of home care has become increasingly significant. Visits to home care services would therefore be highly beneficial, given the Dutch policy encouraging individuals to remain at home for as long as possible. However, logistical challenges, such as high student numbers and concerns regarding privacy, make such visits unfeasible.

Considering the rapid technological advancements and shifts in societal norms, communication patterns, and learning preferences that influence contemporary students, it is crucial for universities and their faculty to account for these unique characteristics. When designing and implementing effective teaching and learning practices, institutions must adapt to the specific preferences and behaviors of today's students to ensure educational approaches remain relevant, engaging, and conducive to optimal learning outcomes [5]. One such innovative solution is the use of immersive 360-degree videos, which can simulate real-world environments such as home care, offering students a richer and more engaging learning experience [6]. Unlike traditional 2D videos, 360-degree videos have the potential to create highly immersive and realistic educational experiences, fostering deeper engagement and enhancing students' understanding of complex concepts [7]. According to Kavanagh et al. (2025), participants reported substantially greater enjoyment, engagement and immersion when interacting with 360-degree video compared with conventional 2D formats [8].

Virtual reality (VR) is increasingly recognized as a promising tool for enhancing health professions education, with medical and nursing students representing the most commonly studied participant groups in existing research [9]. Within nursing education, the use of 360-degree video has been explored, predominantly in relation to mental health contexts [10]. However, there remains a lack of research examining its application in home care settings. Moreover, little is known about the use of such technologies among Health Sciences students who are not practicing healthcare professionals and therefore often have limited or no access to clinical placements. Consequently, there is a clear gap in the literature regarding how 360-degree video can support learning for this specific student population. In addition, existing studies have not sufficiently addressed how 360-degree video can be meaningfully integrated within Problem-Based Learning (PBL), leaving an important gap in understanding its pedagogical value in collaborative and student-centered learning environments.

The current study has two objectives. First, using a Design-Based Research (DBR) approach, we describe the iterative development and implementation of a 360-degree video and accompanying educational materials designed to simulate a home-care placement

within a Problem-Based Learning (PBL) framework. Second, we evaluate undergraduate Health Sciences students' subjective experiences with the use of the 360-degree video and the educational formats in which it was embedded across three curricular tracks. Accordingly, the study addresses the following research questions:

1. How was the 360-degree video and accompanying educational material developed and implemented within three Health Sciences tracks using a Design-Based Research approach?
2. How do undergraduate Health Sciences students perceive the use of the 360-degree video, VR headsets, and the associated educational formats within these tracks?

## 2. Theoretical Background

### 2.1. Problem-Based Learning: Four Key Learning Principles

Problem-Based Learning (PBL) is structured around the core principles of active learning, which include constructive, collaborative, contextual, and self-directed learning [11,12]. The *constructive* learning principle reveals that learning is an active process in which students build or reorganize their knowledge structures. This process entails creating meaning and developing personal interpretations of the world based on individual experiences and interactions. *Collaboration* is a social structure where two or more individuals engage in interactions that can yield positive outcomes under certain conditions. Participants share a common goal, assume joint responsibilities, rely on one another, and reach agreements through open dialogue. *Contextual* learning refers to the idea that the environment in which knowledge is acquired significantly influences how that knowledge is applied. By exposing learners to professionally real (authentic) contexts, a deeper understanding is fostered, which in turn encourages the transfer of knowledge. *Self-directed* learning requires learners to take an active role in planning, monitoring, and evaluating their own learning process [11].

### 2.2. Design-Based Research Approach in Education

The model proposed by McKenny and Reeves (2012) delineates three primary phases: the analysis phase, the design phase, and the evaluation phase [13]. These phases are designed to be both flexible and iterative. Each phase emphasizes the interplay between theory and practice, with the overarching objective of producing both scientific and practice-oriented outcomes. From the beginning, educational practice is incorporated into the development process, ensuring that the educational intervention is progressively implemented and disseminated as the project evolves.

### 2.3. PICRAT Model

In this study, the PICRAT model [14] serves as the theoretical framework for examining the pedagogical value of using 360-degree video in combination with VR headsets in Health Sciences education. The study seeks to accomplish distinct learning objectives, including deepening students' comprehension of complex theories, enhancing their ability to apply theoretical knowledge in practical contexts, and fostering greater engagement through immersive learning experiences. The model outlines two key dimensions: the first pertains to the nature of student engagement with technology, which is classified into three levels—passive, interactive, or creative (PIC). The second dimension concerns the role technology plays within the learning process, specifically whether it serves to replace, amplify, or transform (RAT) established educational practices. Through this dual lens, the model aims to facilitate a more nuanced understanding of how technology can not only increase student engagement but also promote transformative learning experiences that go beyond conventional teaching techniques.

Within the scope of this study, the PICRAT model is employed to evaluate the integration of a 360-degree video into the PBL framework, examining how this technology influences student engagement and transforms conventional learning experiences.

### 3. Development of the Educational Material

#### 3.1. Development of the 360-Degree Video and Supplementary Materials

The development of the 360-degree video and supplementary materials involved several stakeholders, ensuring a comprehensive approach to the project. At Maastricht University, an educational expert, a teacher, a psychologist, and a digital technology specialist contributed their expertise, alongside an occupational therapist from Zuyd University of Applied Sciences and a nurse from the healthcare organization MeanderGroep. All three components of the triangle—research, education, and practice—were thoroughly addressed. In the development of the material, special attention was given to context, one of the key learning principles of PBL. This principle ensured that the content was closely aligned with real-world scenarios, fostering deeper engagement and practical application of knowledge.

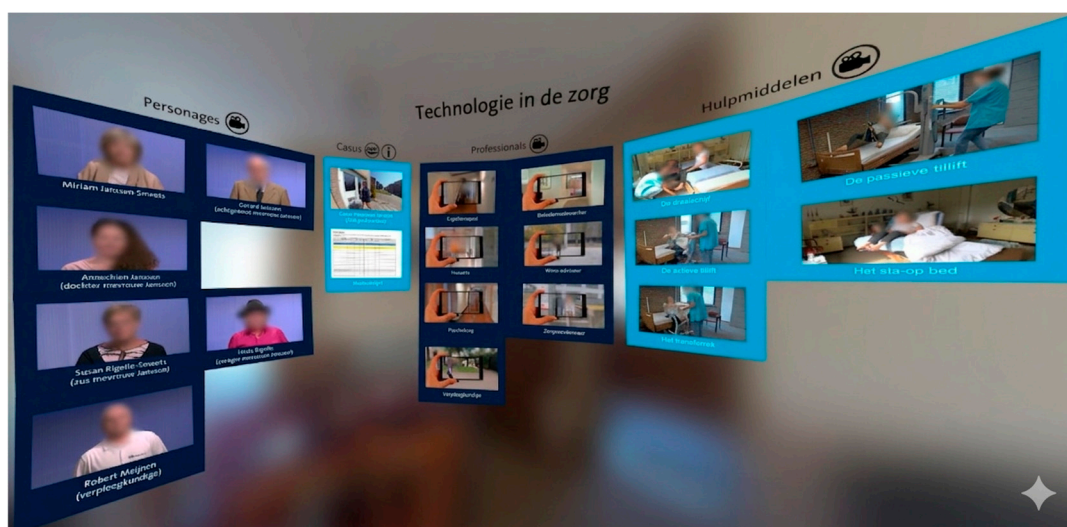
In the development process for this internship placement scenario, we employed four iterative loops (see Table 1). These loops did not follow a sequential order but instead occurred in a non-linear manner. The first loop (Loop 1) focused on scenario development, beginning with an analysis of the context to determine the necessary content. A teacher wrote the scenario, titled *Technology in Healthcare*, and all stakeholders provided iterative feedback throughout the process. A similar procedure was followed for the script (Loop 2), with simulation patients actively involved in the development phase. The 360-degree video was filmed in the home of a client of a healthcare provider, necessitating careful preparation to address privacy-sensitive concerns, as well as to prepare both the client and the environment for recording (Loop 3). Additionally, 2D videos featured interviews with real professionals in their respective contexts, further enhancing the authenticity of the material (Loop 4). Loop 5 focused on the development of educational materials for the various tracks. In each track, a teacher was responsible for the integration and development of educational materials. One to three fellow teachers and the educational expert reviewed the materials.

**Table 1.** Overview of the loops of the developed education material and evaluation sessions within the phases of the Design-Based Research approach.

|               | Analysis Phase                    | Development Phases                         | Evaluation Phase                   | Developed Products/<br>Facilitating Context |
|---------------|-----------------------------------|--------------------------------------------|------------------------------------|---------------------------------------------|
| <b>Loop 1</b> | Orientating content scenario      | Teacher writes scenario                    | Feedback stakeholders <sup>a</sup> | Scenario                                    |
| <b>Loop 2</b> | Orientation script                | Teacher writes script                      | Feedback stakeholders and players  | Script                                      |
| <b>Loop 3</b> | Analyze recording (locations)     | Prepare recording (locations)              | Feedback stakeholders and players  | Preparedness for recording (locations)      |
| <b>Loop 4</b> | Orientation content for 2D videos | Teacher writes content for 2D videos       | Feedback stakeholders              | 2D videos                                   |
| <b>Loop 5</b> | Orientation curriculum            | Teachers develop material (questions e.g.) | Feedback stakeholders              | Material for each track                     |

<sup>a</sup> educational expert, a teacher, a psychologist, a digital technology specialist, an occupational therapist and a nurse.

Ultimately, the iterative loops culminated in the production of one 360-degree video (18:42 min). The 360-degree video scenario depicts a home visit in a rural setting. A woman visits her sister each morning to assist her in getting out of bed; however, this responsibility has become increasingly burdensome. Following consultation with the general practitioner, a community nurse visits the home to discuss potential care solutions. Various healthcare technologies are visible throughout the home environment. Six 2D character videos (between 1:38 and 3:31 min), seven 2D professional videos (between 1:31 and 5:06 min), five 2D aiding tool videos (between 1:06 and 4:20 min) were produced, and a medical chart in PDF format were included. This material was consolidated into a single 3DVista (3DVista Studio S.L.; Málaga, Spain) project. Students accessed the content through VR headsets in offline mode (see Schemes 1 and 2), utilizing the 3DVista app installed on the devices, allowing for an immersive learning experience.



**Scheme 1.** Overview of the *Technology in Healthcare* project environment, viewed in 3DVista using VR headsets.



**Scheme 2.** Part of the *Technology in Healthcare* project, viewed in 3DVista using VR headsets.

### 3.2. Implementation of the Materials in Three Separate Health Sciences Tracks

In the implementation of the materials across the tracks, the four key learning principles of PBL were carefully considered to enhance educational effectiveness. In the Policy and Digital tracks, the 360-degree video technology was used during the initial 8-week module of the second year of the bachelor's program, specifically titled *Care in Context* and *Opportunities in Healthcare: The Role of Digital Technology*, respectively. In the Mental Health track, the video was integrated into a clinical skills training session during the second period, referred to as *Intake*. Both the Policy and Digital track sessions took two hours, whereas the Mental Health track session lasted one hour. In the Policy track, videos in all categories (characters, professionals and assistive technologies) were used, whereas in the Mental Health and Digital tracks, only the 360-degree video was employed as a teaching resource. Prior to viewing the 360-degree video, a test video was played through the VR headset (using Meta Quest 2; Meta Platforms, Inc.; Menlo Park, CA, USA) to ensure proper calibration with the user's eyewear. All students viewed the 360-degree videos individually and simultaneously using VR headsets. A total of 35 VR headsets were available.

The following sections provide a more detailed description of the utilization of the developed materials for each track (see Table 2).

**Table 2.** Overview of the educational activities within each track.

| Tracks <sup>a</sup> | Before the Session                   | During the Session → <sup>b</sup> |                            |                                                                                |                              |
|---------------------|--------------------------------------|-----------------------------------|----------------------------|--------------------------------------------------------------------------------|------------------------------|
|                     |                                      | Read Questions                    | Watch the 360-Degree Video | Small Group Activity                                                           | Plenary Session              |
| Policy track        | -                                    | x                                 | x                          | Discuss questions (4 students)<br>Watch other videos<br>Prepare a presentation | Presentations and discussion |
| Mental Health track | Read literature and follow a lecture | x                                 | x                          | Discuss questions (3–5 students)                                               | Discussion                   |
| Digital track       | -                                    | x                                 | x                          | -                                                                              | Discussion                   |

<sup>a</sup> both the Policy and Digital track sessions take two hours, whereas the Mental Health track session lasts one hour. <sup>b</sup> order of sequence.

#### 3.2.1. Policy, Management and Evaluation of Health Care (Policy Track)

The session was offered twice, with 40 students divided into two groups of 19 and 21 participants. Students were organized into groups of four to first read a set of questions and then watch the 360-degree video. Following the video, they were required to answer the questions, utilizing at least one character from the video and referencing at least one professional during the subsequent presentation within the same session. In formulating their responses, students were encouraged to make use of the videos on the aiding tools to support their answers. The intended learning outcomes were: Students are able to understand and explain how technology policy in home care is structured and organized.

#### 3.2.2. Mental Health Sciences (Mental Health Track)

Prior to the start of the session, students were required to read relevant literature and follow an online lecture focusing on geriatric psychiatry. The session was held on two separate days, with 247 students split into 18 groups consisting of 12 to 15 students. In the Mental Health track, students began by reading a set of questions related to this topic before watching the 360-degree video. Following the video, students participated in small group discussions consisting of 3 to 5 members, where they shared their insights and findings regarding the questions. The session culminated in a plenary discussion, during which the students engaged with an expert in the field of geriatric psychiatry to further

explore the questions and deepen their understanding. The intended learning outcomes here were: Students are able to understand and interpret the mental state of a patient by analyzing their situation and psychological condition.

### 3.2.3. Digital Technology and Care (Digital Track)

The session was held twice, with the 25 students divided into two groups of 13 and 12 participants. In the Digital track, students first attended a lecture delivered by a faculty member, which focused on the role of digital technology in health care and aimed at bridging the gap between the fields of data and technology on the one side, and healthcare on the other. Subsequently, they viewed the 360-degree video, which served to reinforce and contextualize the concepts discussed in the lecture. This strategic integration of lecture content and immersive video, which applies theory to daily care in home care settings, was designed to enhance students' understanding of the complex interactions between technological advancements and healthcare practices. The intended learning outcomes were: Students are able to analyze and apply theoretical knowledge by explaining how technological developments interact with daily care practices in home care settings.

### 3.3. PICRAT Matrix and PBL Evaluation

In evaluating the educational material through the lens of the PICRAT matrix, we classified it within the 'PT category'. The 'P' (passive) indicates that students primarily engaged as passive recipients of knowledge with regard to the technology. The 'T' (transformative) signifies that the learning activities facilitated by the technology were transformative, enabling educational experiences that would not have been possible through traditional methods [14].

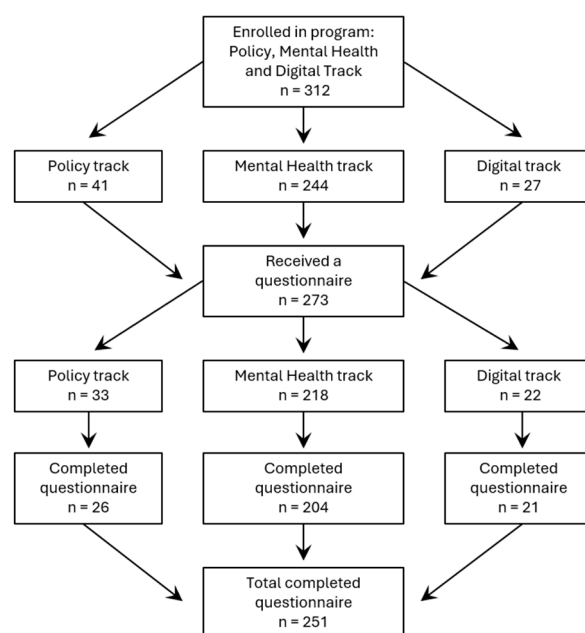
In all tracks, the four key learning principles of PBL are largely evident. However, collaboration is less prominently represented in the Digital track, while the principle of self-directed learning is not fully realized across all tracks, primarily due to the limited duration of only one or two hours.

## 4. Methodology

This study consisted of two complementary components. The first component involved a DBR approach aimed at developing and implementing a 360-degree video and accompanying educational materials. The second component involved an evaluation of students' subjective experiences with these materials across three Health Sciences tracks using a mixed-methods approach. The methodological procedures for both components are described below.

### 4.1. Participants

The study was conducted during the academic year 2023–2024 within the Faculty of Health, Medicine, and Life Sciences at Maastricht University. Participants were second-year undergraduate students enrolled in the Health Sciences program, specializing in Policy, Mental Health, or Digital Health. Of the 312 students enrolled in the program, a total of 273 students (87.5%) participated in the study (see Figure 1). These students were distributed as follows:  $n = 33$  (12%) in the Policy track,  $n = 218$  (80%) in the Mental Health track, and  $n = 22$  (8%) in the Digital track. Those who did not complete the entire questionnaire were excluded from the study to ensure the integrity of the dataset. Consequently, a total of  $n = 22$  (8%) students were removed from the final sample:  $n = 7$  (2.5%) students from the Policy track,  $n = 14$  (5%) students from the Mental Health track and  $n = 1$  (0.5%) from the Digital track. The total number of students was  $n = 251$  (80%).



**Figure 1.** Flow diagram of the number of participants.

Table 3 presents the demographic information, including age and gender distribution, for each track.

**Table 3.** Demographic characteristics of the study population.

| Track         | n   | Age, M (SD)  | Female, n | Male, n | I Do Not Want to Say My Gender (n) |
|---------------|-----|--------------|-----------|---------|------------------------------------|
| Policy        | 26  | 22.50 (2.42) | 16        | 9       | 1                                  |
| Mental Health | 204 | 23.20 (3.09) | 172       | 32      | 0                                  |
| Digital       | 21  | 24.10 (3.48) | 17        | 4       | 0                                  |

Note. M = mean; SD = standard deviation.

#### 4.2. Research Design

This study employed a convergent mixed-methods cross-sectional design [15]. Quantitative and qualitative data were collected simultaneously through a post-session questionnaire administered immediately after participation in the educational activity. Quantitative data were used to describe students' experiences with the VR technology, the 360-degree video, and the educational formats. Qualitative responses to open-ended questions were analyzed to provide additional context and explanation for the quantitative findings. Integration occurred during the interpretation phase, where qualitative themes were used to better understand and contextualize the survey results.

#### 4.3. Data Collection

Data were collected at a single time point, immediately following the session. Students accessed the questionnaire by scanning the provided QR code. The questionnaire, developed by the authors, included a combination of closed and open-ended questions/statements. The questionnaire was reviewed by experts, who provided feedback on the content, clarity, and relevance of the items. The final version was established through discussion and consensus. No formal pilot study was conducted prior to data collection. The questionnaire covered topics such as demographic information, opinions on the session, use of VR headsets (Meta Quest 2), experiences with the 360-degree videos or 2D videos, and the educational format employed. The questionnaire included various Likert scales,

such as a 7-point scale ranging from “strongly disagree” (1) to “strongly agree” (7), adapted from the Technology Acceptance Model 3 (TAM3) to assess the construct ‘Perceived Ease of Use’ (PEOU) using four items. All item loadings were above 0.80, demonstrating adequate convergent validity and confirming that the items appropriately measured their intended constructs [16]. Additionally, the ‘Attentional Focus’ subscale from the Video Transportation Scale (VTS) was incorporated, also using a 7-point scale, with scores ranging from 1 (not at all) to 7 (very much). The attentional focus subscale has demonstrated satisfactory construct validity as a reliable indicator of viewers’ cognitive engagement during narrative exposure [17]. The questions related to the educational format varied across the tracks due to differences in their instructional structures.

Participation in the study was voluntary, and formal informed consent was obtained from all participants. Students were informed that participation would not affect their educational assessment. The educational activity was a small element of the entire module. To safeguard privacy, all responses were anonymized, could not be traced to individual participants, and were treated with strict confidentiality. Students could withdraw from the study at any time and for any reason without consequence.

#### 4.4. Data Analysis

Descriptive statistics were performed to analyze the quantitative data, providing a summary, including frequencies, means, standard deviations, modes, and medians to provide a comprehensive overview of participants’ responses. To compare the answers to the four statements of the perceived ease of use scales for the three tracks, the non-parametric Kruskal–Wallis H test was used with an  $\alpha$  of 0.05.

An exploratory analysis was conducted within the policy track to compare the subjective experiences of 360-degree and 2D videos. The Wilcoxon Signed Rank Test was used to evaluate differences in students’ perceived experiences within the two video formats. The answers to ten statements were compared and median scores were analyzed.

Qualitative data, obtained from open-ended questions, were analyzed using narrative analysis, enabling the capture and interpretation of participants’ perspectives.

All statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS) for Windows, version 26 (SPSS Inc., Chicago, IL, USA).

## 5. Results

### 5.1. Use of VR Headsets

A total of  $n = 132$  (52.5%) students reported having no prior experience with VR headsets, comprising 14 students from the Policy track, 105 from the Mental Health track, and 13 from the Digital track.

On a 7-point scale ranging from strongly disagree (1) to strongly agree (7), students across different tracks rated the clarity of the VR headset explanation. The Policy track had a median score of 6 (range 3 to 7), the Mental Health track had a median of 6.50 (range 1 to 7), and the Digital track recorded a median of 6 (range 4 to 7).

The results of participant feedback regarding the usability of VR headsets, as assessed by the Perceived Ease of Use (PEOU) subscale, are presented in Table 4. These findings suggest that, in general, participants perceive the VR headsets as easy to use and require minimal cognitive effort to operate comparative analyses showed no significant differences between the three tracks.

In the Mental Health track, several students reported experiencing discomfort, some of which was related to the weight of the headset ( $n = 6$ ) and/or pain ( $n = 5$ ). In both the Digital and Policy tracks, one student expressed dissatisfaction with the weight of the VR headset. Five students specifically noted experiencing nausea, including three from

the Mental Health track and two from the Policy track. Additionally, six students in the Mental Health track mentioned that wearing their own VR headsets was uncomfortable or impossible during the session. A student in the Digital track reported difficulties related to the inability to wear a VR headset as well. Another student in the Digital track reported, *‘I wanted to face the front, but my video was playing on the right side, so I had to sit uncomfortable and turn to the right’*.

**Table 4.** Results of statements of the subscale ‘Perceived Ease of Use’ (PEOU) for each track.

|                                                                             | Median <sup>a</sup> |        |         | Min.   |        |         | Max.   |        |         | Kruskal–Wallis H | Sig. <sup>b</sup> |
|-----------------------------------------------------------------------------|---------------------|--------|---------|--------|--------|---------|--------|--------|---------|------------------|-------------------|
|                                                                             | Policy              | Mental | Digital | Policy | Mental | Digital | Policy | Mental | Digital |                  |                   |
| My interaction with the VR glasses is clear and understandable.             | 6                   | 6      | 6       | 4      | 1      | 4       | 7      | 7      | 7       | 0.19             | 0.091             |
| Interaction with the VR glasses does not require a lot of my mental effort. | 6                   | 6      | 6       | 1      | 1      | 3       | 7      | 7      | 7       | 1.14             | 0.57              |
| I find the VR glasses to be easy to use.                                    | 6                   | 6      | 6       | 4      | 1      | 2       | 7      | 7      | 7       | 0.98             | 0.61              |
| I find it easy to get the VR glasses to do what I want them to do.          | 6                   | 6      | 6       | 3      | 1      | 2       | 7      | 7      | 7       | 3.70             | 0.18              |

<sup>a</sup> range is 1 (strongly disagree)–7 (strongly agree). <sup>b</sup>  $\alpha = 0.05$ .

### 5.2. Experiences with the 360-Degree Video and the 2D Videos (Only Policy Track)

The summary of students’ experiences with the 360-degree video and 2D videos is provided in Table 5.

**Table 5.** Results of the statements <sup>a</sup> on the 360-degree video and 2D videos (only Policy track).

|                                                                                                      | 360-Degree Video |                   |                   |                  |                   |                   | 2D Videos |        | Z     | Sig   |
|------------------------------------------------------------------------------------------------------|------------------|-------------------|-------------------|------------------|-------------------|-------------------|-----------|--------|-------|-------|
|                                                                                                      | Min.–Max.        |                   |                   | Median           |                   |                   | Min.–Max. | Median |       |       |
|                                                                                                      | Policy<br>n = 26 | Mental<br>n = 204 | Digital<br>n = 21 | Policy<br>n = 26 | Mental<br>n = 204 | Digital<br>n = 21 | Policy    | Policy |       |       |
| I found my mind wandering while watching the video. <sup>b</sup>                                     | 2–7              | 1–7               | 1–6               | 4                | 3                 | 4                 | 1–7       | 4      | −0.42 | 0.67  |
| While I was watching the video, activity going on in the room around me was on my mind. <sup>b</sup> | 1–7              | 1–7               | 1–7               | 3                | 3                 | 4                 | 1–6       | 4      | −3.20 | <0.01 |
| I was mentally involved in the video while watching it.                                              | 1–7              | 1–7               | 2–7               | 4                | 5                 | 5                 | 1–7       | 4      | −3.19 | <0.01 |
| The video affected my motivation for learning positively                                             | 1–7              | 1–7               | 3–6               | 4                | 4                 | 5                 | 1–7       | 4      | −1.79 | 0.07  |
| Watching the video increased my motivation.                                                          | 1–7              | 1–7               | 1–6               | 4                | 4                 | 4                 | 1–7       | 4      | −1.02 | 0.31  |
| The video is relevant for my learning.                                                               | 2–7              | 1–7               | 2–7               | 4                | 4                 | 5                 | 1–7       | 5      | 0.00  | 1.00  |
| The video raised my interest for the topic ‘technology (in home care)’.                              | 2–7              | -                 | 2–7               | 4                | -                 | 5                 | 1–7       | 4      | −1.34 | 0.18  |
| The video raised my interest for the topic ‘intake in elderly’.                                      | -                | 1–7               | -                 | -                | 4                 | -                 | -         | -      |       |       |
| The video is relevant for my understanding of technology (in home care).                             | 1–7              | -                 | 3–7               | 4.50             | -                 | 5                 | 2–7       | 4      | −1.45 | 0.15  |
| The video is relevant for my understanding of an intake in elderly.                                  | -                | 1–7               | -                 | -                | 5                 | -                 | -         | -      |       |       |
| I learned something from watching the video.                                                         | 3–7              | 1–7               | 2–7               | 5                | 4                 | 4                 | 1–7       | 4      | −1.60 | 0.11  |
| The video helped me to understand the content of the problem.                                        | 1–7              | 1–7               | 2–7               | 5                | 5                 | 5                 | 3–7       | 4      | −1.53 | 0.13  |
| I see myself using 360-degree videos for other topics in the future.                                 | 1–7              | 1–7               | 1–7               | 4                | 4                 | 5                 | -         | -      |       |       |

<sup>a</sup> range is 1 (not at all)–7 (very much). <sup>b</sup> statement was taken from the subscale ‘Attentional Focus’ of the Video Transportation Scale (VTS).

The level of attention for the 360-degree video, as measured by two statements from the VTS—I found my mind wandering while watching the video’, ‘While I was watching the video, activity going on in the room around me was on my mind’—generally indicates a neutral to slightly negative response. Regarding the remaining statements, students across all tracks agreed that the video aided their understanding of the problem’s content. However, for other statements on the 360-degree video, the responses varied, ranging from neutral to slight agreement.

When analyzing the results for the 2D videos, the majority of statements received a median score of 4, with the exception of the statement, *'The video is relevant for my learning'*, which achieved a median score of 5. These findings indicate a lack of clear consensus, neither confirming nor rejecting the statements presented.

In the analysis of participants' experiences comparing 360-degree and 2D videos, ten statements were evaluated using the Wilcoxon Signed-Rank Test. Of these, two statements showed significant differences, indicating a slight preference for 360-degree videos. Specifically, students reported being less distracted by the activity in the room around them while watching the 360-degree video compared to the 2D video. Additionally, they felt more mentally involved in the content when viewing the 360-degree video.

### 5.3. Evaluation of the Educational Formats

#### 5.3.1. Evaluation of the Educational Format Policy Track

One of the 26 students indicated a lack of sufficient prior knowledge, specifically regarding the use of the VR headset. Two students reported difficulty in maintaining focus during the session. One noted that *'some parts were taking a little bit long where you had to listen a lot'*, while the other remarked that the videos were too lengthy. The majority of students (92%) expressed a positive attitude towards the group session format. Seven students highlighted their appreciation for the interactive nature of the session. Some comments were: *'Interactive, multidisciplinary, and makes you think about the problem from different angles'*, *'I really like the session because we could look inside someone's home and see the care. Also to interact with peers and discuss'* and *'I like it when you are active and not just listening'*. Five students expressed their preference for the format, noting that it was distinct from the traditional formats they were accustomed to. Four students appreciated the small group size, which they found favorable. Additional comments included *original, nice application, well organized, not boring, informative, and VR is fun*. One student reported not perceiving any added value from the session.

On a 4-point scale ranging from very dissatisfied (1) to very satisfied (4), all students agreed that the duration (Mdn = 3, range 2 to 4), the content (Mdn = 3, range 2 to 4), extent of interaction (Mdn = 3, range 1 to 4) and the format of group session (Mdn = 3, range 3 to 4) were satisfactory. They demonstrated satisfaction with their capacity to apply knowledge, as indicated by a median score of 3 and a range from 3 to 4.

Students reported, on a 4-point scale ranging from fully disagree (1) to fully agree (4), that their questions were answered and that they learned a lot (Mdn = 3, range 2 to 4 for both statements).

On a 5-point Likert scale ranging from totally disagree (1) to totally agree (5), students found the assignment to be clear and considered the plenary session relevant (Mdn = 4, range 1 to 5 for both statements). Eighty percent expressed a preference for incorporating the 360-degree video as a standard component of the module.

Format was graded on a scale of 1 (very poor) to 10 (excellent), with a mean of 7.00 (SD = 1.55).

#### 5.3.2. Evaluation of the Format Mental Health Track

Seven students (3%) reported having no prior knowledge, indicating a lack of familiarity with aiding tools for older persons and no knowledge of VR. Overall, 178 students prepared for the session, with 174 providing details about their preparation methods. Specifically, three students read the literature, 163 students viewed the knowledge clip, and eight students utilized both resources. Among those who did not prepare (n = 5), the majority cited time constraints, while others reported forgetting to prepare (n = 3) or feeling that preparation was unnecessary (n = 2). Four students reported difficulty focusing on

the group session, with one student indicating ADHD issues and another student noting concentration problems.

A total of 181 students (89%) reported that they liked the format of the session, while 23 (11%) did not. Most students, 45 in total, indicated that they appreciated the format because it was different from traditional education. Some comments from students were: *'It is a new way of learning'*, *'It was different than what we are used to, so that made it fun'*, and *'It is different than what we normally do, and it helps to better observe a surrounding'*. Additionally, in the open-ended question section, 22 students noted that they appreciated working in small groups: *'It was nice to be in small groups to discuss what we saw'* and *'It was a small group, nice setup. Something different than usual'*. The interactive aspect of the session was appreciated by seventeen students. Eleven students mentioned the immersive aspect as an added value: *'It was very immersive, and you really get a grasp of the topic. This helps with understanding the matter and with what plays in these situations ...'*.

Most students ( $n = 10$ ) who expressed dissatisfaction with the format of the session indicated that it was not a valuable supplement. Some comments from students were: *'I think the VR was unnecessary'*, and *'The VR did not really attribute anything to this kind of video. We could have watched it on a screen with the same results'*. Four students suggested that a 2D video would have sufficed: *'I feel like I could watch this on YouTube and do the questions with a group at a different time'*. Furthermore, two students noted that the session was scheduled on a day they were otherwise free, requiring them to travel a long distance for just a one-hour session.

Using a 4-point scale ranging from very dissatisfied (1) to very satisfied (4), students concurred that the duration, content, extent of interaction, and format of the group session were satisfactory, yielding a median score of 3. The range for the content was 2 to 4, while the ranges for the other aspects extended from 1 to 4. Students also expressed satisfaction with their ability to apply knowledge, reflected in a median score of 3 and a range of 1 to 4.

Students indicated, using a 4-point scale from fully disagree (1) to fully agree (4), that their questions were adequately addressed and that they gained substantial knowledge, with both statements yielding a median score of 3 and a range of 1 to 4. On a 5-point Likert scale ranging from totally disagree (1) to totally agree (5), students strongly agreed that the discussions with fellow students after watching the video were relevant, as was the plenary session, resulting in a median score of 4 (range 1 to 5 for both statements). A total of 76% of the students expressed a preference for the integration of the 360-degree video as a standard element within the module.

Students assessed the format on a scale ranging from 1 (very poor) to 10 (excellent), yielding a mean score of 6.66 ( $SD = 1.70$ ).

### 5.3.3. Evaluation of the Format Digital Track

All students ( $n = 21$ ) reported having sufficient prior knowledge, expressed a positive attitude towards the session format, and indicated that they were able to maintain focus during the group session. Students attributed their positive evaluation to several factors. Five students highlighted the distinction from traditional education, four appreciated the focus on real-life home situations, and four emphasized the interactive nature of the session. Some comments from students were:

*'I liked this format because it lets you explore a real-life situation firsthand, as if you were present in the room together with the patient. It also stimulates you to be alert to all the surroundings. Besides that, the video felt like high quality with good acting'*, and *'It was interactive and different than what we normally do/see'*. Three students also noted their appreciation for the connection between theory and practice, as well as the opportunity to apply their knowledge in a

practical context. One student reported: *'It is 'fun', applying our knowledge to real cases. This motivates me'*.

On a 4-point scale ranging from very dissatisfied (1) to very satisfied (4), students agreed that the duration, the content, the format of the group session (Mdn = 3, range 3 to 4, all three statements) and the extent of interaction (Mdn = 3, range 2 to 4) were satisfactory. Additionally, students expressed satisfaction with the opportunity to apply their knowledge (Mdn = 3, range 3 to 4). Students reported, on a 4-point scale ranging from fully disagree (1) to fully agree (4), that their questions were answered and that they learned a lot (Mdn = 3, range 2 to 4 for both statements).

On a 5-point Likert scale ranging from totally disagree (1) to totally agree (5), students strongly agreed that the lecture was clear (Mdn = 4, range = 3–5) and that the discussion following the video was relevant (Mdn = 5, range = 2–5). A total of 91% of the students indicated a preference for integrating the 360-degree video as a regular feature within the module.

The students evaluated the format using a scale from 1 (very poor) to 10 (excellent), resulting in a mean score of 7.33 (SD = 1.20).

## 6. Discussion

In this study, we described the development process using a DBR approach and evaluation of a 360-degree video designed for use in Problem-Based Learning (PBL) at Maastricht University. The results indicate that integrating the 360-degree video into the curriculum enhanced subjective student engagement, particularly in contextual learning. The video and supplementary materials simulated a real-world healthcare setting, providing students with an immersive experience.

### 6.1. Development of a 360-Degree Video

The development process involved a diverse group of stakeholders, including experts in education, psychology, digital technology, occupational therapy, and healthcare from institutions such as Maastricht University and Zuyd University of Applied Sciences, and MeanderGroep. This interdisciplinary collaboration ensured a comprehensive approach, bridging the gap between research, education, and practice. The development process followed a non-linear, iterative, DBR approach. This resulted in a comprehensive suite of materials, including a 360-degree video and multiple 2D videos, featuring both character simulations and professional interviews, all embedded into a 3DVista project. Teachers in the different tracks had their own educational format designed for their specific objectives.

Our results indicate that the integration of the 360-degree video into the module did not alter the underlying philosophy of Maastricht's PBL curriculum. Three key learning principles of PBL are explicitly identified in each track: constructive learning, collaborative learning, and contextual learning. The fourth key learning principle of PBL, 'self-directed learning', remained under-addressed, likely due to the short duration (1–2 h) of the educational activities, limiting the opportunities for students to plan, monitor, and evaluate their own learning process [11]. One key recommendation for using VR in teaching is to promote collaborative learning, as immersion in virtual environments can sometimes feel isolated [18]. This approach thus aligns with one of the learning principles of PBL.

The activities of each track were positioned in the 'PT' box of the PICRAT model, indicating that students were passively interacting with the technology [14]. The educational value may therefore stem not from direct interaction with the technology itself, but from factors such as immersion and contextualization within the video, as well as the surrounding PBL activities, including group discussion. Although the technology was incorporated into highly interactive activities, the 360-degree video itself could be further enhanced to

allow for greater interactivity, resulting in a position in the 'IT' (Interactive-Transforms) box of the PICRAT model. This implies that future versions of the scenario should be expanded in, for example, a decision tree of possibilities, which will result in increased (production) costs for creating an interactive 360-degree video.

### 6.2. Evaluation 360-Degree Video and Its Format

More than half of the students reported a lack of familiarity with the VR headset. Overall, students found the use of the device to be straightforward and user-friendly. Three percent ( $n = 8$ ) of the student population expressed dissatisfaction with the weight of the VR headset. To address this issue, the incorporation of a headband could distribute the weight of the VR headset more evenly, thereby mitigating the problem. A few students encountered difficulties while using their personal VR headsets. In their scoping review, Ranieri et al. (2022) reported physical discomfort associated with the VR headset as well [19]. Additionally, two percent of the students reported experiencing nausea, a common side effect of immersive technology as noted by Schott and Marshall (2021) [20]. Therefore, to enhance accessibility in the future, an option to watch the video on a laptop should be made available, as it may serve as a practical solution in these contexts. The discomfort could potentially be alleviated by reducing the video duration, which currently stands at more than 18 min, a considerable length for a 360-degree video. In their literature review, Evens et al. (2023) reported that most 360-degree videos had a duration of five to 15 min [21]. Videos are most effective when presented in short segments, as this optimizes learners' concentration [22]. The optimal length for a 360-degree video is not yet clearly defined [21].

The attentional focus of students regarding the 360-degree video was moderate to high, suggesting that while the video captured some attention, it did not fully engage students on a deep cognitive level. Most students reported a degree of mental engagement while watching the 360-degree video. They acknowledged the relevance of this video and expressed a clear understanding of the content related to the problem addressed in their educational context.

The educational formats employed in the three tracks differed from traditional formats, enhancing the attractiveness of the educational activities for students. Furthermore, the interactive components within each track were consistently regarded as highly positive. Overall, this indicates a positive acceptance of 360-degree video within interactive education.

### 6.3. Implications

The findings of this study emphasize the potential of VR in education. For visual learners, this alternative instructional method complements traditional text-based approaches. To accommodate diverse learning styles, educators should offer students the chance to interact with content in different formats.

VR scenarios may also be used in situations where placement availability is limited. The integration of 360-degree videos into the curriculum offers a virtual alternative, allowing students to gain practical insights in a simulated environment. Additionally, challenging scenarios can be explored through a VR headset prior to embarking on an internship; an illustrative example is advance care planning.

Immersive experiences within a controlled virtual environment enable students to familiarize themselves with challenging scenarios, thereby fostering a safe and supportive learning atmosphere. This approach not only enhances their understanding of complex situations but also promotes skill development without the risks associated with real-world interactions.

#### 6.4. Limitations and Future Research

Although this study offers valuable insights into the development of a 360-degree video, its supplementary materials, and the students' experiences, the findings should be interpreted in light of some limitations. The diversity in educational formats and the number of participants across the three tracks pose significant challenges for drawing broad generalizations. In addition to these differences in format, the content of the tracks varies substantially. The policy track emphasizes policy arrangements concerning technology in healthcare, while the mental health track concentrates on geriatric psychiatry. Meanwhile, the digital track primarily aims to deepen students' understanding of the complex interplay between technological advancements and healthcare practices. Moreover, the findings primarily reflect students' acceptance and appreciation of the format, rather than demonstrating improved learning outcomes, enhanced knowledge transfer, or superior effectiveness compared to traditional educational methods.

Future research should aim to broaden the scope of 360-degree video integration to encompass a larger segment of the curriculum, facilitating a more comprehensive assessment of its educational benefits. This approach enables a more thorough examination of the effects of integrating virtual reality materials on learning outcomes. By doing so, researchers can gain deeper insights into how 360-degree videos influence educational effectiveness. Also, the inclusion of a control group in future studies would allow for more accurate measurements of the differences between 360-degree video-based and traditional learning environments and their understanding.

While the educational materials in the present study were interactive, subsequent studies should investigate the incorporation of more dynamic and immersive elements into the VR component to further enhance student engagement [23]. This could be achieved through the incorporation of interactive elements within the 360-degree video, such as integrated questions.

## 7. Conclusions

This study demonstrates the development of a 360-degree video and supplementary materials simulating a real-world situation, achieved by integrating research, practice, and education through a DBR approach. The iterative process reflects a thoughtful approach to development, emphasizing continuous improvement and refinement while ensuring that each step is informed by previous insights and feedback.

VR-based education within PBL at Maastricht University can be implemented, with the key learning principles of PBL—constructive, collaborative, contextual, and self-directed learning—remaining prominent.

The majority of students across the various tracks expressed a preference for the innovative educational formats with the 360-degree video, highlighting the interactive elements as particularly appealing. They indicated that they valued the format due to its distinctiveness from traditional educational approaches. This shows acceptance of 360-degree video delivered through VR headsets as a valuable resource within the curriculum.

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