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AI-READY VR/360° E-LEARNING PLATFORM FOR DISTANCE EDUCATION: SYSTEM ARCHITECTURE, DEPLOYMENT, AND ADOPTION EVIDENCE

ANASS TOUIMA [1], MOHAMED MOUGHIT [1,2]

[1] Laboratory Science and Technology for Engineering (LaSTI), National School of Applied Sciences-Khouribga, Sultan Moulay Slimane University, Morocco.

[2] Laboratory Artificial Intelligence, Modeling and Computational Engineering (AIMCE), ENSAM Casablanca, Hassan II University, Casablanca, Morocco.

E-mail: [1]anass.touima@usms.ac.ma, [2]m.moughit@usms.ma

ABSTRACT

The sudden move to distance learning during the COVID-19 pandemic forced universities to rely heavily on videoconferencing tools and basic learning management systems. While these solutions kept courses running, many students reported fatigue, disengagement, and difficulties visualising complex concepts. In response to these challenges, this study describes the design and preliminary evaluation of a Virtual Reality (VR) e-learning platform, extended with an AI-ready facial expression recognition module and a 360° video web alternative, deployed in a Moroccan higher-education context. The platform allows students to access an immersive virtual campus and interactive learning scenarios either through VR headsets or through 360° video on standard devices. A total of 106 students from the Higher Institute of Information and Communication (ISIC) interacted with the system and then completed a structured questionnaire about their experience, perceived usefulness, and intention to adopt the platform. Descriptive analyses were complemented with chi-square and Spearman correlation tests to explore differences between academic levels and the role of prior exposure to immersive media. The results show high awareness of VR and 360° video, strong perceived added value of VR for distance learning, and broad support for regular use of the platform, with no major differences between Licence and Master students and only weak associations with previous VR experience. These findings position the proposed AI-ready VR environment as a promising complement to conventional distance learning tools and motivate future controlled studies focusing on objective learning outcomes and the full integration of AI-driven emotion tracking.

Keywords: *Distance Learning, Virtual Reality, VR, Artificial Intelligence, Higher Education*

1. INTRODUCTION

Over the last few years, distance learning has moved from a complementary option to a central pillar of higher education. This shift was accelerated by the COVID-19 pandemic, when universities had to move most of their activities online in a matter of weeks [1]. At the Higher Institute of Information and Communication (ISIC) and other Moroccan institutions, lecturers rapidly assembled combinations of videoconferencing, email, and basic learning management systems to keep courses running. Although this contingency plan has been rather effective in ensuring continuity, there are also factors which were made apparent which proved to be limiting: the student often reported feeling isolated from others and the ability to sustain their attention when learning online.

These points echo issues evident within the broader distance learning literature, where authors have noted the problem of "transactional distance" and a lack of social and emotional engagement when learning occurs through asynchronous learning materials and one-way communication [2]. In response to this problem, immersive technologies such as Virtual Reality (VR) and 360° video have been suggested as methods to reinstate a richer learning environment through immersion and stimulated curiosity. In parallel, advances in AI create opportunities for future, ethically governed affect-aware analytics (e.g., facial-expression cues), although such capabilities require explicit consent and careful validation.

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In this context, our work focuses on the design and preliminary evaluation of an AI-ready VR e-learning platform that can be used both with head-mounted displays and through 360° video on standard devices. The platform was prototyped and tested with ISIC students during the 2024–2025 academic year. Rather than claiming definitive evidence of learning gains, this first study concentrates on students' awareness of immersive media, their perceptions of the platform, and their intention to adopt it as part of their distance learning practices.

Conventional distance learning environments often struggle to provide social presence, spatial context, and timely feedback on learners' engagement. While prior work shows that VR or 360° video can enhance engagement in specific courses, fewer studies report a deployable, implementation-oriented IT architecture that combines an immersive VR campus, an accessible 360° web alternative, and AI-ready affect sensing in a resource-constrained higher-education context.

We followed a design-and-evaluate approach. First, we implemented a VR campus and interactive learning scenarios in Unity, coupled with a modular, AI-ready facial-expression-recognition service exposed through a RESTful API, and we produced a 360° video web alternative to broaden accessibility. Second, we deployed the prototype to 106 ISIC students and conducted a cross-sectional, questionnaire-based evaluation. Analyses combined descriptive statistics with exploratory chi-square tests (Licence vs Master) and Spearman correlations (prior exposure vs perceptions).

This paper makes four IT-focused research contributions:

- ✓ A dual-access XR delivery stack (VR HMD + browser-based 360° video) to reduce hardware and access barriers.
- ✓ A modular, AI-ready affect-sensing architecture that specifies a CNN-based FER service integrated with Unity via REST APIs (proposed pathway; not activated in this deployment).
- ✓ Deployment evidence from a Moroccan higher-education case study (N = 106), including cross-cycle comparisons and links with prior immersive-media exposure.
- ✓ Actionable implementation guidance (content pipeline, privacy/consent, and scalability considerations) for universities and edtech stakeholders.

This leads to the following overarching research question: How do higher-education students perceive the integration of AI-ready VR environments into distance learning, in terms of usefulness, engagement, and willingness to adopt such tools? More specifically, we ask:

- ✓ To what extent are students familiar with VR, 360° video, and related immersive technologies?
- ✓ How do they evaluate the contribution of the proposed platform to their distance learning experience?
- ✓ Are these perceptions related to academic level or prior exposure to immersive media?

The rest of the paper presents the conceptual background, the design of the platform, the empirical study with 106 students, and a discussion of the implications for the future development and evaluation of AI-integrated VR learning environments.

2. LITERATURE REVIEW

The integration of Virtual Reality (VR) in higher education, in particular in distance learning contexts, has gained growing attention among educators as well as researchers [3]. Virtually Constructed environments of VR with their potential of creating immersive as well as interactive learning spaces have great potential in enhancing student engagement, learning achievement, as well as educational experience in general [4][5]. There have been emerging research studies exploring varied aspects of adoption of VR, from its roles in specialized fields to pedagogic concerns in using it efficiently. There is, however, a new horizon in the maturing domain of Artificial Intelligence (AI) in being utilized in improving such VR environments with hopes of creating more personalized, adaptive, as well as efficient e-learning platforms [6] . In this review, we discuss current literature in utilizing VR in learning as well as extend it in analyzing potentialities as well as implications of integrating AI in such platforms, in paving ways towards designing as well as impact-assessing an AI-integrated VR e-learning solution [7].

There is a large study conducted at Arizona State University (ASU) of their Dreamscape Learn VR biology program with significant positive effects [8]. Based on a study of over 4,000 students, it was determined that being in VR resulted in improved grades, increased persistence as biology majors, and high levels of student satisfaction among diverse groups of students. Students reported the VR experiences very highly (median 5 of 5), and average scores on lab work of 90% or better. In particular, the group of students who underwent learning through the use of VR had better performance and also a reduced dropout rate from STEM majors,

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which implies applications of VR in improving performance and retaining students especially in demanding disciplines [9] . Although the study above demonstrates the capability of VR applications, incorporating AI could also allow the applications to be tailored according to the performance of the users in order to optimize the development stages of the applications.

The incorporation of 360° videos, being a form of VR, in an introductory biology lab class also showed promising results [10]. This study found that the majority of the participants were greatly satisfied with the incorporation of 360° videos in class and that 74% of them wanted more of this type of video in the class. Technical problems were minimal (only 15.9% experienced them), and the vast majority (81.3%) found that the incorporation of VR was of benefit to them. Moreover, their performance improved in various formative and summative assessments. Their grades also improved in semesters that employed VR relative to semesters that did not [11]. This attests to the effectiveness of even simple forms of VR to positively impact student attitude and performance. This sets the groundwork in establishing the impact of AI-enhanced advanced models in the field of education.

Although the advantages of VR applications are being clarified, the best teaching practices, especially regarding the length of VR sessions during online learning, remain the target of research. A longitudinal study of 15 weeks involving 30 participants in a university class using videoconferencing and VR was carried out by McGrath et al. [12]. This study found that the length of the VR sessions resulted in higher social presence levels of instructors and peers compared to videoconferencing sessions, which had a relation to psychological benefits of learning, feeling of competency, and level of enjoyment. The study also observed that the benefits of peer social presence and competency started to diminish when the length of the VR sessions was above 45 minutes of duration. This can be attributed to the factor of fatigue in online meetings [13]. This points towards the efficient integration of VR sessions, encouraging teachers to keep the initial length of the sessions shorter (about 45 minutes), at least until the learning participants are accustomed to the platform. There can also be a provision of alternative ways of accessing the virtual learning environment [14]. Algorithms of adaptive learning applications of AI can be used to remove this constraint and greatly improve the benefits of the system.

The larger impact of VR in the field of higher education has various applications - right from learning to research. The significance of the multidimensional applications of VR has been illustrated in the research work of Markowitz et al. [15], which illustrates the significance of this research work as it is a doctoral thesis itself. The capability of VR to provide a realistic simulation of complex scenarios and develop the same through experiential learning has been the highlighting factor of this research work. The capability to provide realistic training environments through the development of VR has been the basic strength of this method, which has been clarified in the introduction part of this research work [2][16] . The capability of AI to be integrated along with the development of VR environments can be used to provide intelligent tutoring and real-time analytics of performance in order to yield a complete impact assessment of this advanced e-learning platform.

However, there are still many research studies being carried out regarding the impact of VR and Augmented Reality (AR) in increasing student engagement and understanding. The overall judgment that has been reached in the existing literature is that immersive technologies can be a valuable addition to the learning experience [17]. They offer promising avenues of active learning that can be engaging and efficient learning solutions, especially in online learning where it has become challenging to create a feeling of co-presence. The next evolutionary step would be the strategic addition of AI to create smart learning solutions.

This review of the recent literature reveals a clear positive trend concerning the effectiveness of VR within higher education. All studies point to enhancements in engagement levels, learning results, and learner attitudes [18]. The research developing from this initial work encompasses the above points in order to maximize the benefits of the VR platform. This particular study aims to contribute to this body of knowledge regarding this exciting developing technology and provide a framework through which the development of the benefits of this platform can be measured. This study will examine the particular effect of the AI-based VR e-learning platform at ISIC's distance education experience.

3. AI-INTEGRATED VR E-LEARNING PLATFORM

3.1 Introduction

The speed of development of digital technologies and the increasing need for adaptive teaching practices have driven the interest in the use of distance learning solutions. In this context, the

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challenge of mirroring the quality of interaction and engagement of the cognitive and emotional processes involved in face-to-face teaching has constituted a significant challenge. This has been especially the case concerning the ability of the traditional learning environment to create the feeling of presence and provide the non-verbal components of communication essential in teaching. In this regard, the development of our innovative immersive learning platform in the field of virtual reality and AI-based facial expressions presents itself as a remedy to the above challenges. The learning platform has the ability to break the boundaries of teaching through the provision of a rich educational experience rendered in a realistic representation of the National School of Applied Sciences of Khouribga through its AI-driven emotion analysis system based on deep learning. This allows the possibilities of immersion and interaction not only to be widened but also allows the teaching practices to be adapted according to the emotions of the learner.

3.2 Design of the Virtual Academic Environment

The creation of a believable and recognizable virtual world becomes the cornerstone of our platform. The level of spatial rendering's fidelity becomes a crucial factor in its ability to induce the feeling of presence along with the ability to correctly orient the user. In this regard, the project's implementation has been initiated through the completely contextual three-dimensional (3D) modeling of the National School of Applied Sciences (ENSA) of Khouribga's physical environment. The software chosen has been SketchUp, which is also a computer-aided design (CAD). The software gained preference due to its ease of learning along with an intuitive interface and ability to work efficiently even when the geometries involved become complex. The software provides immense benefits due to its large libraries of models of pre-existent 3D items along with the ability to create realistic photo-texture mapping apart from being exportable in industry-standard formats such as FBX/OBJ. The software's ability to be exported in industry-standard formats such as FBX or OBJ helped immensely in the easy integration of the Unity 3D development platform used later.

The modeling phase strictly followed the above approach, which involved an initial phase of data acquisition through topographical mapping and architectural drawings of the campus as a prelude to the acquisition of thorough and detailed photographs of the campus. The data collected was used to create two-dimensional drawings of the buildings and campus which were later "extruded" and "refined" to form three-dimensional images of the buildings and the campus itself. A lot of care was taken to model the architecture of the buildings and their positioning to accurately match the real situation. The next step involved the addition of "realistic textures" and "lighting" of the environment to accurately represent the natural and artificial lighting of the environment. The 3D model of the campus was optimized to run properly in real time and was later saved in "FBX" format. The final product of the above step will be a fully immersive model of the environment of ENSAK and will be used as the principal part of the main scene of the VR application (Figure 1).

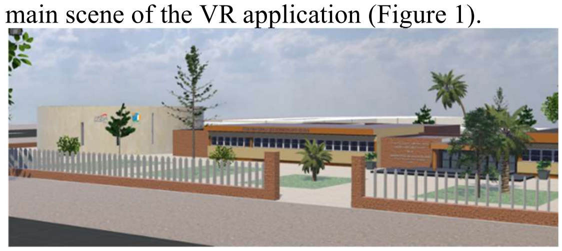

Figure. 1. 3D design of the ENSA Khouribga using SketchUp.

3.3 Development of the Interactive Virtual Reality Platform

The move from static modeling to an immersive experience has been possible through the Unity 3D game development engine (Figure. 2). The reason why Unity has been chosen can be attributed to its robust nature and support from the Asset Store community for various development platforms across the globe. In addition to this, Unity has a lot of support from various VR headphones available in the market today, such as the Meta Oculus Quest. The support from the Asset Store community also allows us to integrate different software modules together effortlessly. This becomes an important factor in the context of incorporating our AI software modules.

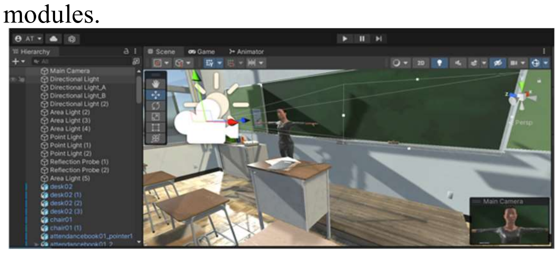

Figure. 2. Scene of a virtual classroom with avatar developed by unity engine.

The development work of the Unity platform involved the importation and setup of the 3D model of ENSA Khouribga. Certain enhancements were implemented to optimize the model's processing when rendered in the VR environment. The addition of the VR navigation

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system marked another crucial development phase of the Unity platform. This provides users of the platform with the ability to move from location to location in the platform without developing motion sickness. The development of interaction systems marked another phase of this work. Users can interact with the different models used in the platform. Additionally, users can access the UI components of the learning platform.

Figure. 3. Typical user interface in the VR environment, showing navigation and interaction options.

3.4 Integration of Artificial Intelligence for Facial Expression Recognition

One planned innovation of the platform is an AI-ready facial expression recognition (FER) pathway intended to support affect-aware learning services. In the present study, FER is handled as a proposed architecture component: we specify the service, data flow, and REST API interface, and illustrate how it could be connected to Unity. However, it was not activated for automatic emotion monitoring during the deployment or used to generate real-time analytics; the evaluation focuses on student perceptions and adoption readiness.

As far as the technical requirements are concerned, the system utilizes a Convolutional Neural Network (CNN). In fact, the CNN architecture has proven to be efficient when it comes to image processing. The CNN model was pre-trained on large-scale public datasets dedicated to facial expression recognition, such as FER2013 (Facial Expression Recognition 2013). This pre-training allows the model to learn relevant facial features for emotion discrimination (Figure. 4). The trained model is then deployed in a separate service, developed in Python using libraries like OpenCV for initial image processing (face detection) [15].

The interaction between the Unity application and the facial recognition service occurs via a RESTful Application Programming Interface (API). The Unity application periodically captures images of the user's face (strictly respecting consent and privacy), sends them to the Python service via a secure HTTP request. The service processes the image, makes an inference based on the CNN model, and sends the classification results of the identified facial expression (for example, probabilities of each basic emotion) to the Unity application (Figure 5). This result can be used in many ways: discreet notification of the emotion indicator to the user's avatar (recognized by the teacher or learner themselves), anonymous processing of the emotions to evaluate the overall engagement of the class, or adaptive notifications (such as the provision of context-sensitive help when confusion has been identified).

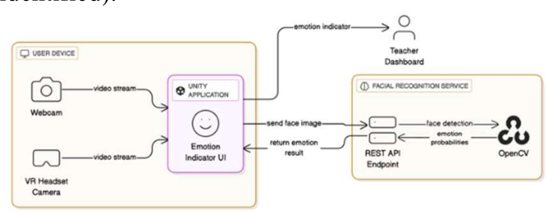

Figure. 4. Architectural diagram illustrating the interaction between the Unity application and the facial recognition service.

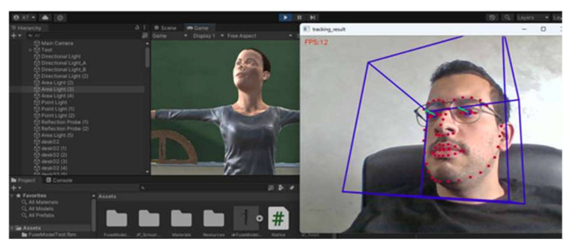

Figure. 5. Prototype interface illustrating the proposed FER integration in Unity (AI-ready component; not used for data collection in this study).

The implementation of this feature raises important ethical and privacy considerations. Collection and analysis of facial data are performed only after obtaining explicit user consent. Data is processed securely and can be anonymized for aggregated analysis. The primary goal remains the improvement of the pedagogical experience, not intrusive surveillance.

3.5 Key Features and Accessibility

In summary, the developed VR platform offers a set of features aimed at creating a rich and engaging distance learning experience:

- ✓ Spatial Immersion: Exploration of a faithful 3D replica of ENSA Khouribga.
- ✓ Social Interaction: Synchronous communication via avatars, chat, and spatialized voice.
- ✓ Pedagogical Access: Virtual classrooms, resource consultation, collaborative tools.
- ✓ Affect sensing (AI-ready): A proposed FER microservice is specified for future, consent-

based analytics and adaptive support (not activated during this evaluation).

- ✓ Hardware Compatibility: Support for standard VR headsets (e.g., Meta Oculus Quest) and potentially a desktop mode for increased accessibility.
- ✓ Multilingual Interface: Availability in Arabic, French, and English to meet the needs of a diverse user community.

3.6 Immersive Alternative via 360° Video

Being aware of the technological and economic constraints that VR might imply for users (need of a VR headset and a PC to support it, etc.), an alternative solution involving immersive video in 360° has also been investigated and has been developed. This allows a good compromise to be achieved between immersion and accessibility.

This involves filming real-school settings and class sessions using 360° cameras. The films are thereafter rendered (stitching and color enhancement) through the aid of software applications (such as Premiere Pro from Adobe and Insta360 Studio). The films can also be equipped with interaction points in the form of hotspots enabling users to transition from one scene to another (such as from the corridor to the classroom) or provide additional educational support materials (text information and images).

These are then used in the delivery of the immersive learning experience through the provision of videos that can be interacted with using a 360° effect, available through an online platform using a browser, either through the computer or the mobile device. Though less advanced than the real-time version when it comes to interactivity support, the option presents a viable method of improving access to immersive learning through less expensive requirements from the learner's side when it comes to the support of the learning platform.

Figure. 6. Interface of the 360° video solution, showing hotspot navigation and access to complementary resources.

3.7 Partial Conclusion

The newly developed immersive learning environment platform incorporating virtual reality along with face-expression identification through artificial intelligence signifies a dramatic breakthrough in the pursuit of creating a more human and engaging distance learning experience. By recreating a relatable learning environment along with the possibility of incorporating emotion-driven response mechanisms, the platform has the ability to minimize the concept of transactional distance and promote higher-level learner engagement. The 360° video platform provides greater accessibility. Future work will be involved in the development of improved emotion identification algorithms along with the development of engaging learning components.

4. MATERIALS AND METHODS

This paper employed a design-and-evaluate research strategy to develop an AI-ready VR/360° e-learning platform and assess students' perceptions after a realistic classroom deployment. The empirical component is a cross-sectional survey administered immediately after students interacted with the prototype; it does not measure exam performance and therefore does not support causal claims about learning achievement.

4.1 Research Paradigm and Reasoning

There was a positivist research paradigm carried out in this study. Positivism utilizes empirical measure and observation in understanding social reality in order to present truth based on verifiable data [16]. This is just like in our research aim of observing in real world how combining AI with VR will affect student learning before testing assumptions of its impact. So, there was a hypothetico-deductive way of reasoning. It is one of proceeding with sharply defined problem as well as research questions, in turn being developed into testable hypotheses. It allows one to have a clear perspective of general research concepts, with specialization of results later based on a small sample.

4.2 Research Method

A quantitative, cross-sectional survey design was employed, with an emphasis on gathering and processing students' self-reported perceptions after interacting with the AI-ready VR/360° platform. Specifically, the questionnaire captured awareness of immersive media, perceived usefulness, engagement-related perceptions, and intention to adopt the platform as a complement to conventional distance learning. Data were collected at the Higher Institute of Information and Communication (ISIC) during the 2024–2025 academic year.

The research approach consisted of two major phases, similar to platform development as well as impact assessment:

- ✓ **Development and Experimentation of the AI-VR Platform (Conceptual/Prototype Phase):** This phase aimed to familiarize students with our prototype of the AI-VR e-learning platform (Figure. 7). It involved allowing students to explore VR equipment relevant to the pedagogical context and various VR-based platforms. Although full AI integration was conceptual at this experimental stage, the presented scenarios aimed to simulate intelligent and adaptive interactions. The goal was to ensure students had a foundational understanding and experience of VR within a framework that foreshadows AI integration before participating in the data collection phase.

Figure. 7. Students explore our prototype during the study.

- ✓ **Data Collection via Online Questionnaire for Impact Assessment**: An online questionnaire was administered to a representative sample of students from different university levels. This survey aimed to gather data on students' knowledge of VR, its use in distance learning, its perceived importance, and their behaviors and interactions following AI-VR platform use. It also collected their perspectives on comprehension, academic performance, and motivation, with a view to assessing the platform's impact.

4.3 Sample and Sampling Technique

The target population observed in this study was made up of 293 students at ISIC during the 2024-2025 academic year, of which 156 took undergraduate (Licence) courses and 137 took postgraduate (Master) courses. However, due to the heterogeneity of this target group, the study used a stratified probabilistic sampling approach. In theory, according to the number of existing students at ISIC, the research intended to select a representative sample of 67 participants of whom 36 would be from the undergraduate level and the remaining 31 from the master's level. The final number of participants who took part in the research and from whom the data was derived consisted of 106 individuals.

4.4 Data Collection Instrument and Procedure

The structured questionnaire was the primary instrument for data collection. This method was selected because it can be distributed efficiently, allows participants to respond at their own pace, and supports standardized measurement of perceptions across a broad range of topics while reducing interviewer bias.

The survey took two main phases in conjunction with the platform experiments:

1) **AI-VR Platform Experimentation:** As it was essential that the students be able to participatefully in the questionnaire survey regarding the effect of VR and AI, the platform experiment phase was also an important requirement. The target group constituted six classes (three from each academic cycle). The class sessions were recorded through the usage of "Insta 360" 360° cameras and wireless microphones ("Rode Wireless Go" microphones). This ensured the best possible video and sound quality. The recorded sessions were then posted privately on YouTube. During the second visit, a comprehensive introduction regarding the VR concept and the applied VR product (which constitutes part of the AI-VR platform of the future) took place. The class had the ability to watch their recorded sessions through the usage of VR headsets ("Meta Oculus Quest" headsets). These had the capability to run the YouTube VR app. To maximize the available time and also allow the group to watch together, the headset projection was reflected upon a screen or a projector. Additionally, the class members experienced the operation of the virtual classroom through our app. They interacted in the above scenarios in a much more realistic and in real-time fashion. Our app acts as a prototype of the smart interaction functionality of the AI-VR platform of the future. Finally, at the end of this "demo" and "experiment" phase of the AI-VR platform of the future, the class members received the opportunity to fill the online survey through a short link and/or QR code while also making available dependable internet access.
2) **Questionnaire Administration:** The online

questionnaire was administered to the university students in both academic cycles immediately after the experiment of the AI-VR platform in their respective classes. The direct method of questionnaire administration was used to ensure that there were fewer non-responses.

The questionnaire was composed of 21 items regarding the study's variables. The questionnaire was organized in the following sections:

- ✓ Section 1 (4 questions): Personal information (gender, age, academic level).
- ✓ Section 2 (8 questions): Knowledge of VR technologies, tools, and operational modes, with particular attention to aspects that could be enhanced by AI.
- ✓ Section 3 (2 questions): Use of VR in education, and potential for AI integration.
- ✓ Section 4 (5 questions): Impact of the AI-VR platform on students' distance learning experiences.
- ✓ Section 5 (2 questions): Alternatives to VR and AI in education.

Questions were a mix of closed-ended, semi-open, and Likert-scale types, chosen to meet specific information needs and align with the research objectives. Clarity was paramount, especially as the questionnaire targeted students who might be experiencing difficulties, and several concepts were detailed within the questionnaire itself.

4.5 Variables

The research investigated the relationship between:

- ✓ **Independent Variable:** Exposure to the AI-Integrated Virtual Reality E-Learning Platform.
- ✓ **Dependent variables:** Rather than measuring learning outcomes through exam scores, this first study focused on students' self-reported perceptions after using the platform. The main dependent variables were perceived usefulness of the AI-ready VR and 360° video environments for distance learning, perceived impact on understanding and retention of course content, perceived effects on motivation, engagement and anxiety, and intention to adopt the platform as a regular component of online learning.

4.6 Data Analysis Tool

Data collected from the questionnaires were processed and analysed using SPSS. Descriptive statistics (frequencies and percentages) were first computed to summarise students' awareness of immersive media, their experience with VR and 360° video, and their perceptions of the proposed platform. To complement these descriptive results, we conducted exploratory inferential analyses: chi-square tests of independence were used to compare key perceptions between Licence and Master students, and Spearman's rank-order correlations were used to examine associations between prior exposure to immersive media and perceived usefulness and intention to adopt the platform. These tests were intended to identify broad trends rather than to support strong causal claims.

5. RESULTS AND DISCUSSION

5.1 Results

This section reports on survey results completed at ISIC with a random sample of 106 students, who accounted for 36% of the population of interest. There were 76 Licence undergraduate students (72%) in the sample, with 30 Master postgraduate students (28%). We recorded six scheduled lessons in 360° video, available on YouTube, and utilized our AI-infused VR e-learning platform to showcase the tech in action. In this way, we invited student participation in the survey, with valuable comments contributing insights in return to further refine the working of our e-learning platform as well as its conceptualizing.

5.1.1 Participant demographics

Gender:

Of the 106 respondents, 57.55% were female, and 42.45% were male, indicating a relatively balanced gender distribution with a slight female predominance.

Age:

The majority of respondents (76.4%) were aged between 20 and 35 years. A smaller group (20.7%) was under 20 years old, and just over 2% were aged between 35 and 50 (see Figure. 8). This age distribution reflects the diverse age range within the student population, likely influenced by the higher number of undergraduate students in the sample.

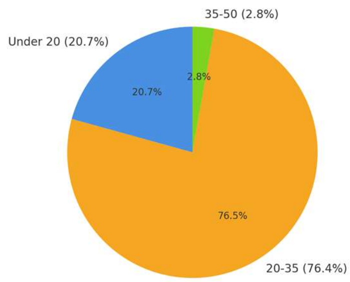

Figure. 8. Participant Age Distribution.

Academic Level:

The sample was composed of 71.7% undergraduate (Licence) students and 28.3% postgraduate (Master) students. This diversity across academic levels was considered beneficial for analyzing the impact of VR according to their university cycle.

5.1.2 Knowledge and experience with VR/360° technologies

Awareness of VR and 360° Video:

A significant majority of students reported awareness of these technologies. Specifically, 78.3% of students knew what virtual reality is, and 88.7% were familiar with 360° video (Figure. 9). This indicates that most students had a foundational understanding of these concepts, which is a positive indicator for the future adoption and development of an AI-integrated VR e-learning platform.

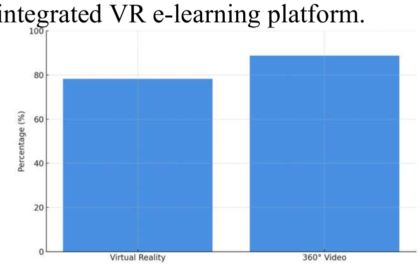

Figure. 9. Awareness of VR and 360° Video.

Use of AR Applications and Viewing 360° Video:

While awareness was high, practical experience varied. 83% of the sample had previously watched a 360° video. However, concerning Augmented Reality (AR) applications, over 77% of students had never installed or used one, suggesting a lower engagement with AR technology despite its accessibility. This highlights an area where AI integration could potentially enhance user experience and utility, making AR more appealing within a comprehensive e-learning platform.

Equipment Used for Viewing 360° Video:

Among those who had watched 360° videos (49 students provided details on equipment), the majority (65.3% of this subgroup, or 30.2% of the total sample) had used an "Oculus" headset (referring to Meta Quest or similar standalone VR headsets). A smaller percentage (10.2% of this subgroup, or 4.7% of total sample) used Google Cardboard or equivalent, and 24.5% (of this subgroup, or 11.3% of total sample) used other means (Figure. 10). This suggests that a considerable portion of students with 360° video experience had used relatively modern VR headsets, indicating a readiness for more advanced VR-based e-learning solutions.

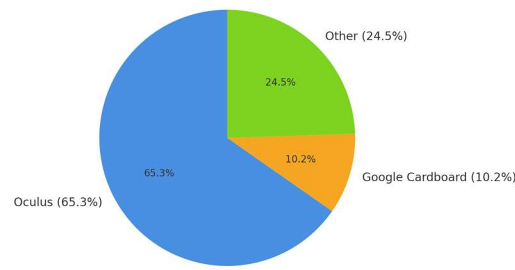

Figure. 10. Equipment Used for 360° Video.

Experience Wearing a VR Headset:

The survey also inquired about the general experience of wearing a VR headset. As summarized in the abstract, 94.3% of students declared they are conscious of the utility of VR on their learning, and 83% confirmed that VR can become a regular distance learning tool. These perceptions are crucial for the successful impact assessment of an AI-integrated VR e-learning platform.

5.1.3 Perceived impact of AI-VR platform on e-learning

This section details student perceptions regarding the integration of artificial intelligence with virtual reality (AI-VR) in distance education, based on survey responses from the 106 participants. The findings highlight not only the acceptance of VR-enhanced learning but also how AI integration amplifies its potential to transform e-learning experiences.

Enrichment of Distance Learning:

A strong majority (82%) of students characterised AI-VR-based distance learning as enriching compared to their usual online courses. Many respondents explained that the immersive environment helped them feel more present in the learning situation and made it easier to follow the flow of activities, even when connecting remotely.

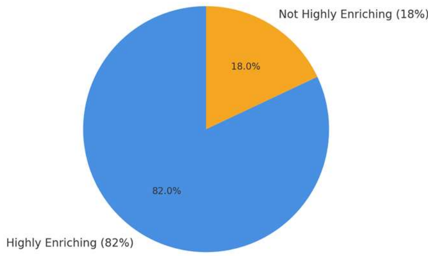

Figure. 11: Perceived Enrichment of Distance Learning

Perceived Learning Benefits and Attitudes:

Around 89% of respondents reported perceived improvements in knowledge retention and understanding after interacting with the VR or 360° environments. Students often referred to the possibility of visualising complex objects or spaces in three dimensions and of revisiting scenes at their own pace as key factors that supported their learning, especially for abstract or highly visual topics.

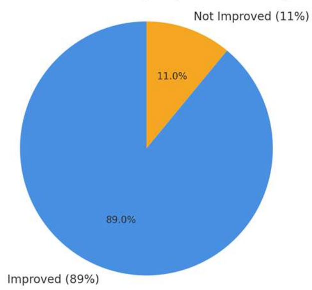

Figure. 12: Perceived Knowledge Retention with AI-VR.

Utility Recognition and Adoption Potential:

Overall, 94.3% of students acknowledged the usefulness of VR in education, and about 71% described the AI-related features presented in the prototype as potentially “transformative” for self-paced learning. These perceptions suggest that students see immersive environments not just as engaging media, but as tools that could genuinely support understanding, revision, and preparation for assessments.

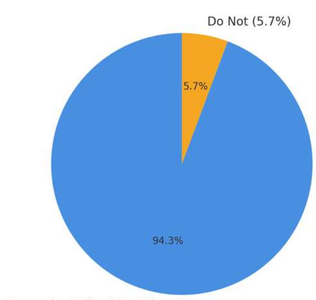

Figure. 13: VR Utility in Education

In addition, 83% of respondents supported the idea of adopting the AI-VR platform as a regular distance learning tool integrated into their courses (Figure. 14). A chi-square test comparing Licence and Master students showed no significant difference in the proportion of students who felt that the AI-VR platform enriched distance learning ($\chi^2(1, N = 106) = 0.05$, $p = 0.83$; see Table 1), indicating that the positive reception is broadly shared across academic levels.

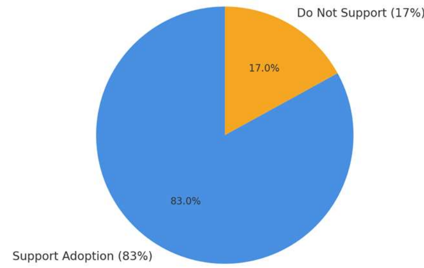

Figure. 14: Support for AI-VR Adoption.

Table 1. Cross-tabulation of perceived enrichment of distance learning by academic level (Licence vs Master).

Academic level	Agree that AI-VR enriches distance learning	Other responses	Total
Licence	62	14	76
Master	25	5	30
Total	87	19	106

To explore the role of prior exposure to immersive media, we computed Spearman’s rank-order correlations between a composite index of VR/360° experience and two key perceptions. The analysis revealed a small, non-significant positive correlation with perceived enrichment of distance learning ($\rho = 0.14$, $p = 0.16$) and a near-zero, non-significant correlation with intention to adopt the platform regularly ($\rho = -0.05$, $p = 0.63$). The above findings indicate that the appreciation of the AI-VR environment was not only experienced by users of VR environment but also novice users of the environment showed positive appreciation.

When asked which learning environment they preferred—the AI-VR learning environment or the traditional VR learning environment—that trusted majority of respondents chose the AI-VR environment: 68% said the AI-VR environment would provide the better learning experience, while 32% were noncommittal. This perceived benefit speaks to the student expectation of value addition from AI.

Students especially cherished the prospect of AI-managed content that might allow the sorting and pacing of information to alleviate cognitive overload, which 59% of the participants favored. Some respondents also mentioned the benefits of AI

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insights that could aid teachers in understanding learning gaps in the class and modifying lessons quicker when needed.

The open comment box also revealed the interests of the participants in the following features the platform can develop in the future: conversational assistants that can answer questions in real time and the display of engagement/emotional response through the dashboard. Although the components mentioned above are not yet implemented in the current version of the platform prototype, the expectations of the participants provide insights regarding the possible direction the next version can take.

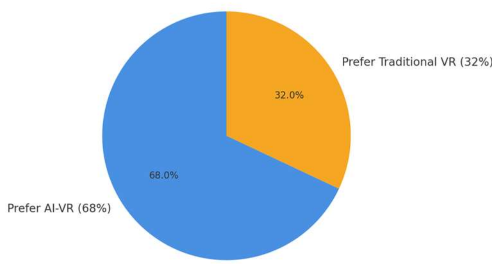

Figure. 15: AI-VR vs. Traditional VR Preference.

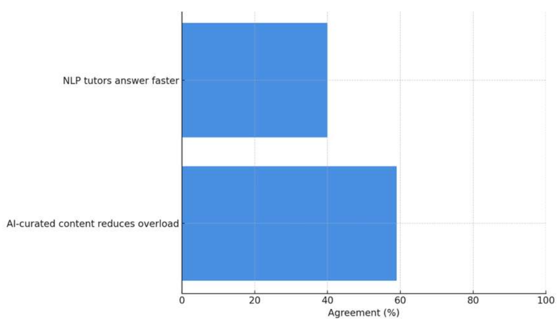

Figure. 16: Specific AI Benefits.

Implications for Platform Development:

The data makes it clear that the role of AI in the transition of VR from a novelty platform to a scalable educational platform cannot be underestimated. Future upgrades of the system should consider the following:

1. **Accessibility:** Optimizing platform compatibility with low-cost VR hardware (e.g., Google Cardboard) to bridge usage disparities observed among undergraduates.
2. **AI Personalization:** Enhancing adaptive algorithms to accommodate diverse learning speeds, particularly for students with limited tech exposure.
3. **AR Integration:** Developing lightweight AR mobile features to attract the 77% of students unfamiliar with AR applications, thereby creating a unified XR ecosystem.

The above findings confirm that the AI-VR fusion not only maintains student engagement but also enhances learning results and makes the platform a promising cornerstone of next-generation distance learning.

5.2 Discussion

This study constitutes the first practice-related exploration of the impact of the AI-ready VR e-learning platform on communication students at a Moroccan institution of higher learning. One of the first things that emerges from this study's findings is the level of awareness regarding immersive tech: over three-quarters of the respondents claimed awareness of VR media, and an even larger group claimed awareness of 360° video. A number of them had already been accessing the latter form of video media through their own personal devices. This goes to show that the two mentioned tech mediums are no longer novel offerings. The two tech trends can be said to be mature enough to be absorbed in the learning field.

However, the survey also confirms the expectation that VR has become more than just a fashion accessory. A vast majority of the students believed that the introduction of VR in distance learning had made the lessons more engaging and easy to understand, and over nine out of ten found it useful in learning. Most of the participants felt that this platform can definitely be used as a learning aid in distance learning. This also has been proven in previous research that immersive environments can be used to support the learner's attention and engagement level.

The exploratory inferential tests provide additional information about the descriptive findings above. The chi-square test comparing Licence and Master students did not reveal any significant difference in the proportion of students who felt that the AI-VR platform enriched distance learning, which means that the positive reception is broadly shared across academic levels. Similarly, correlations between prior exposure to immersive media and perceived usefulness or intention to adopt the platform were weak and non-significant. In other words, the platform was not appreciated only by a small group of highly experienced "VR enthusiasts"; even students with limited previous exposure to VR expressed interest and perceived benefits.

5.2.1 Comparison with related work and research contribution:

Compared with prior VR-in-education studies that focus primarily on course-specific interventions or controlled learning outcomes, this work emphasizes an implementation-oriented IT contribution: a deployable, modular platform architecture that combines immersive VR, an accessible 360° web alternative, and an AI-ready affect-sensing pathway. The high perceived usefulness and adoption intention observed in our sample are consistent with the broadly positive acceptance trends reported in the literature, while our cross-cycle analyses suggest that receptivity is not confined to a single academic level. In addition, the dual-access design directly targets common access barriers (headset availability, device heterogeneity) that often constrain scalability in higher-education deployments.

In comparison with prior studies, this work is distinguished by the following differences, which are significant for both research and deployment:

- ✓ An architecture-level contribution (VR + 360° delivery + AI-ready services) rather than a single VR activity, enabling extensibility and integration.
- ✓ Deployment in Moroccan higher education with heterogeneous resources, adding evidence from an under-represented context.
- ✓ An evaluation focused on adoption readiness and perceived value, providing decision-relevant inputs for institutional rollout before costly controlled trials.

5.2.2 Limitations and unintended outcomes:

Beyond the limitations already noted, the present design does not isolate the respective contributions of VR immersion, 360° access, and the AI-ready components, and the short exposure window may amplify novelty effects. Moreover, potential unintended outcomes—such as cybersickness, increased cognitive load, privacy concerns related to affect sensing, and inequities driven by headset availability—were not measured systematically in this first deployment. Future studies will include validated measures for discomfort and workload, explicit privacy/trust items, and objective learning outcomes (pre/post tests) under controlled or quasi-experimental designs to quantify impact and mitigate risks.

5.2.3 Practical implications:

From an institutional and industry perspective, XR-enabled distance learning is increasingly positioned as a way to improve engagement in hybrid and fully online programs. Based on the observed adoption readiness in this study, we highlight practical implications for decision makers and implementers:

- ✓ **Phased rollout:** start at scale with the browser-based 360° alternative, then target VR headsets for high-value modules (labs, simulations) using a shared device pool.
- ✓ **Integration and analytics:** integrate authentication (SSO) and learning management systems (LMS) with the platform, while keeping AI services modular to enable future dashboards for engagement and support without redesigning the core system.
- ✓ **Governance and trust:** operationalize consent, transparency, and data minimization for any affect-sensing features; favor aggregated or anonymized reporting for pedagogical improvement rather than surveillance.

These findings should nevertheless be interpreted cautiously. The present study relies on self-reported perceptions collected after a limited number of sessions, without control group or pre/post testing of knowledge. It therefore cannot be used to claim definitive improvements in learning outcomes. Instead, it should be seen as a necessary first step: a way to check whether students are receptive to such an environment, whether they can navigate it with available equipment, and whether they see a role for it alongside more traditional distance learning tools. Future work will need to complement this perception-based evaluation with objective measures of performance, such as comparisons between VR-based and conventional activities, longitudinal follow-up, and more detailed analyses of how the AI components, including facial expression tracking, influence feedback, pacing, and support during learning tasks.

6. CONCLUSION

This paper has reported on the development and preliminary evaluation of a Virtual Reality e-learning platform, extended with an AI-ready facial expression recognition module and a 360° video alternative, in the context of distance learning at the Higher Institute of Information and Communication. Rather than attempting to prove definitive learning gains, the study focused on students' perceptions after using the platform in realistic teaching situations. With data from 106 respondents, the results show that immersive environments are both technically accessible and pedagogically well received: most students were already familiar with VR or 360° video, considered the platform enriching for their distance learning, and expressed willingness to adopt such tools on a regular basis.

Institutionally speaking, the results point to the possibility of VR and 360° video being used as valid adjuncts to the more traditional online learning setup, especially in programs of study which emphasize visualisation and spatial awareness. For the educator and learning designer, the platform provides a demonstration of the possibility of going beyond simple video conference solutions and recreating environments where the principles of presence can be applied. The AI aspects of the platform provide promising lines of research regarding deeper levels of learning analytics that take into consideration the behavioral patterns of the users.

Several study limitations require being addressed in future work. The study took place in a single institution, used self-reported assessments administered only after short experience periods, and lacked direct comparison to other modalities of interaction. Future study might benefit from experimental designs comparing VR to 360° video and standard distance education practices, a deeper examination of the impact of student characteristics on the effectiveness of AI-crafted assessments, and longitudinal assessments of learning achievement and retention. In spite of the study limitations, this research makes it clear that it can be built and implemented in a live educational environment at the university level and presents findings demonstrating that this type of environment can be not only technically feasible but also acceptable to the users.

Overall, the proposed platform provides a feasible IT blueprint for XR-enhanced distance learning in resource-constrained contexts; the next phase will operationalize the AI module and validate impacts through controlled studies.

DATA AVAILABILITY

Anonymized student survey/assessment data and the analysis code are available at Figshare via DOI 10.6084/m9.figshare.30494786. Session video recordings, which may reveal participant identity (face/voice), are not publicly available; a confidential, research-only access link can be provided upon reasonable request to the corresponding author (anass.touima@usms.ac.ma), subject to a confidentiality agreement and ethics approval.

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